NRCS Watershed Operations Program

Preliminary Investigation Findings Report (PIFR)

Black Brook Watershed/Lake Winnisquam Sanbornton, Belknap County, New Hampshire

February 23, 2025

Contents

Abbreviations

BMP – Best Management Practice
CFR – Code of Federal Regulations (https://www.ecfr.gov/) NECH – National Environmental Compliance Handbook
EPA – Environmental Protection Agency
NCES – National Center for Education Statistics
NH – New Hampshire
NH DES – New Hampshire Department of Environmental Services
NH DOT – New Hampshire Department of Transportation
NRCS – Natural Resources Conservation Service
NWPH – National Watershed Program Handbook
NWPM – National Watershed Program Manual
SHPO - State Historic Preservation Offices
SAWCD – Southern Aroostook Soil and Water Conservation District
USACE – United States Army Corps of Engineers
USC – United States Code (US Code on House.gov)
USDA – United States Department of Agriculture
USFWS – United States Fish and Wildlife Service
USGS – United States Geological Survey

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Summary

The Town of Sanbornton, New Hampshire, the Sponsor for the project, is requesting assistance through Public Law 83-566 (PL-566) to mitigate sediment runoff into Lake Winnisquam to protect the watershed. Specifically, the area of Black Brook is of concern to the Town.

The proposed purpose of the project would be *Watershed Protection*, one of the accepted project types under the PL-566 Watershed Programs. The National Watershed Protection Manual 500.3.B.b.1 defines Watershed Protection as the following:

> *"Watershed protection consists of onsite treatment of watershed natural resource concerns for the primary purposes of reducing offsite floodwater, erosion, sediment, and agriculture-related pollutants. Watershed protection plans may include ecosystem restoration activities. Any practice or combination of practices listed in Title 450 of the National Handbook of Conservation Practices may be considered for inclusion in the systems of practices included in a watershed protection project plan. Watershed protection works of improvement involve land treatment practices installed by land users to conserve and develop resources. They include, but are not limited to, practices for conserving and developing any of the following:*
>
> - *soil*
> - *water quality and quantity*
> - *woodland*
> - *ecosystem restoration*
> - *fish and wildlife habitat*
> - *energy*
> - *air quality*
> - *cultural resources*
> - *aesthetic resources*
> - *recreation and scenic resources"*

The projects aim to reduce the sediment transport along the tributaries leading to Lake Winnisquam, particularly Black Brook.

The resources review for the Black Brook watershed in Sanbornton, New Hampshire outlines critical environmental concerns, particularly regarding sediment in Lake Winnisquam and compromising the ecological integrity of the larger watershed. The Black Brook watershed is predominantly forested, with over 80% of the area designated as farmlands of state importance, indicating the potential for agricultural benefits. Additionally, the resources highlight the presence of various wildlife and plant species, including potential habitat for endangered species such as the Northern Long-eared Bat (*Myotis septentrionalis*) and the Monarch Butterfly (*Danaus plexippus*), and notes the area's cultural resources, including the Bay Meeting House and Vestry, which is listed on the National Register of Historic Places.

During the preparation of this report, environmental and economic reviews were completed for four potential solutions based upon available information. No Action, Alternative 1 (Non-Structural), Alternative 2 (Structural) and Alternative 3 (No Restrictions) in accordance with section 501.12 (A)(4) of Part 500 of the National Watershed Program Manual. However, as the No Action scenario does not address the intended purpose or meet the needs of the project it was not fully advanced and includes limited discussion as presented in the **Alternatives** section below.

No Action does not meet the goals of the project as sediment transport and water quality concerns continue due to unmitigated erosion and soil loss. This is advanced and used as a baseline to evaluate the other proposed alternatives.

Alternative 1 (Non-Structural)

- Address the Huse Road priority sites identified in the previous reports. The top 3 sites identified as major sources of sediment per the Remediation Plan (FBE 2022), the most recent publication, are Sites 1a (Lower Huse – roadside buffers, vegetated swales and proper discharge locations), 1b (Huse Rd Black Brook Crossing - Roadside buffer, stone lined ditches and ditch maintenance), and Site 2 (Upper Huse Rd – stone lined ditches, roadside buffer and ditch maintenance and repair). Address additional Huse Road sites (as necessary) identified in the Black Brook Watershed Management Plan (AECOM 2012) as part of the Best Management Practices (such as BMPs 4 to 15).
- Implement Local Ordinances to reduce sediment loading through Low Impact Design (LID) and Stormwater, Construction and Roadway Drainage practices
- Implement/require BMPs for agricultural and timber harvesting activities.
- Basin Wide Coordination, education and outreach programs, water quality monitoring and continued project identification with grant funding pursuits.

Alternative 2 (Structural)

- Implement Non-Structural work plan
- Implement recommendations along Kaulback Road/Roxbury Road, Woodman Road and Black Brook Road Culvert/Crossing recommendations (vegetative buffers, improved ditches)
- Implement structural non-point source BMPs (e.g. shoulders, swales, and crowns). *It should be noted that real property rights as defined by NWPM Part 501.80.A.14 are not within the scope of the Watershed Protection and Flood Protection Operations Program. The full cost associated with these alternatives shall be undertaken by the sponsor*
- Implement non-structural point source BMPs (e.g. stream restoration, riparian buffers)

Alternative 3 (No Restrictions)

- Implement Non-Structural and Structural work plans
- Implement roadway stormwater improvements
- Comprehensive planning efforts as previously recommended
- Widespread land purchase for long term conservation
- Address other sources

- Redesign/reconstruction problem roadways. *It should be noted that real property rights as defined by NWPM Part 501.80.A.14 are not within the scope of the Watershed Protection and Flood Protection Operations Program. The full cost associated with these alternatives shall be undertaken by the sponsor*
- Implement non-structural point source BMPs.

In terms of the CPA-52 findings, the report concludes that the proposed project meets several statutory requirements, including the potential for agricultural benefits and the presence of viable project alternatives. Many of the proposed alternatives have no impact or a positive impact on resource concerns with the exception of any temporary construction impacts while recommendations are being implemented. The only alternative that could potentially offer negative impacts involves the land buying/conservation initiative mentioned in Alternative 3. Buying land for conservation purposes could be costly to the client and could result in the relocation and displacement of special status species and people. If best management practices are followed for any potential impacts to special status species, long term benefits are expected. Overall, the resource concerns that could see negative impacts include capital, and environmental justice.

All alternatives are feasible and would require the commitment of the Town to support improvements on private property. Some of the recommended alternatives require modification and reconstruction of existing roadways which is considered "real property" under the definition in NWPM Part 501.80.A.14. These recommended solutions would not fall under the scope of the Watershed Protection and Flood Prevention Operations (WFPO) Program. These solutions will require full funding by the sponsor or other programs. However, these solutions are effective and may be necessary to directly address the root cause of the sediment loading within the watershed.

The Consultant Team suggests consideration of a programmatic approach for the implementation of these multi-practice/stepped solutions.

Applicable Agency Authority and Authorized Purposes

The table below provides documentation that the project is eligible for federal assistance and will meet statutory requirements.

Describe the potential project watershed area; how does the area meet the requirements outlined in NRCS's National Watershed Program Manual (See 506.50 NWPM Glossary - TTT. Watershed).		
Response: This project area watershed has a size of 3,049		
Will the project area exceed 250,000 acres in size? [1,2]	☐YES	☒NO
If over 250,000 acres will it be divided into sub-watersheds in one plan?	☐YES	☐NO
Potential Project Area Size: 3,049 acres (Programmatic – Project Area Watershed inputted)		
Will any single structure provide more than 12,500 acre-feet of floodwater detention capacity, or have a 25,000 acre-feet of total capacity?	☐YES	☒NO
How many recreational developments will be included in the project area?		
• One development in a project area less than 75,000 acres	☐YES	☒NO
• Two developments in a project area between 75,000 and 150,000 acres	☐YES	☒NO
• Three developments in a project area greater than 150,000 acres	☐YES	☒NO
Which authorized purposes will the project address? (Indicate only one purpose as primary):		
	Primary	Other
• Flood prevention	☐	☐
• Watershed Protection	☒	☐
• Public Recreation	☐	☐
• Public Fish and Wildlife	☐	☐
• Agricultural Water Management	☐	☐
• Municipal or Industrial Water Supply	☐	☐
• Water Quality Management	☐	☒
Will the project produce substantial benefits to the general public, to communities, and to groups of landowners?	☒YES	☐NO[1]
Can the project be installed by individual or collective landowners under alternative cost-sharing assistance?	☐YES[3]	☒NO
Will the project have strong local citizen and sponsor support through agreements to obtain land rights, permits, contribute the local cost of construction, and carry out operation and maintenance.	☒YES	☐NO
Will the project take place in a Special Designated Area? (if yes, check applicable area below.)	YES	☒NO
Appalachia ☐ Delaware River Basin ☐ Susquehanna River Basin ☐ Tennessee Valley ☐		

Potential for 20% Agricultural (Rural) Benefits

According to USDA Title 390 National Watershed Program Part 506.0.A.73, rural or rural communities are described as “All communities with a population of less than 50,000 according to the latest decennial census of the United States.” The percentage of rural benefits was determined by the percentage of land area occupied by rural communities within the project area. The approximate areas and population shown below were taken from the U.S. Census Bureau (2020). The percentage of agricultural/rural benefits were determined to be as follows:

Town of Sanbornton Population:	3,026
Town of Sanbornton land area:	49.7 sq. mi.
Town of Sanbornton % Agricultural (Rural) Land:	100 (USDA Title 390 - by rural definition)

Project Overview

Proposed Project Name	Winnisquam Lake Watershed Project
State	New Hampshire
County/Parish	Belknap
Congressional District	1st Congressional District
USGS Hydrologic Unit Code (HUC) and Watershed Name	HUC 12 # - 010700020201 (Winnisquam Lake) **Total Watershed Drainage Area: 40,730 acres** A map of the watershed can be found in Exhibit 1. **Total Black Brook Watershed Area: 3,049 acres**
General Coordinates of the Watershed	HUC 12 Winnisquam Lake Watershed: 43.552001, -71.513145 (Centroid) Black Brook Watershed: 43.459538, -71.54889 (Centroid)
Project Setting	The Black Brook watershed and surrounding project area is located primarily within the Town of Sanbornton and partly in the Town of Meredith, NH. The Town of Sanbornton has a population of 3,026 within a land area of 47.4 square miles. The Town of Meredith has a population of 6,662 within a land area of 40.1 square miles. The proposed project area is located approximately 24 miles north of Concord, NH. Sanbornton, NH is located near Lake Winnisquam in the Lakes Region of central New Hampshire. Using the Köppen Classification system, the climate of Sanbornton is considered Dfb: warm summer – humid continental, with the coldest month averaging below 32 °F, all month's average temperatures below 71.6 °F, and at least four months averaging above 50 °F. There is no significant precipitation difference between seasons, and Sanbornton

	receives approximately 43.9 inches of precipitation annually. Per the Existing Land Use classifications included in the 2012 Comprehensive Plan, the Town of Sanbornton contains 30,321 acres of land and 1,453 acres of water for a total area of 31,774 acres. Approximately 1,041 acres (3.28%) is residential, 35 acres (0.11%) is commercial/industrial, 136 acres (0.42%) is outdoor recreation lands, 2,357 acres (7.42%) is agricultural, and 25,573 acres (80.5%) is forest land (Town of Sanbornton NH, 2012). Lake Winnisquam, located just outside the project area has been designated as a 303(d) impaired water under the Clean Water Act due to Aquatic Life Integrity and Fish Consumption. Localized stream reaches may have water quality impairments not captured in this preliminary investigation findings report.
Potential Project Area - Size	3,049 acres

Resource Information

Soils

The soils in the project area are characterized by fine sandy loam textures, with a significant presence of gravelly sandy loam and loamy fine sand textures. Spodosols and Inceptisols are common. The main soils of the project area include Tunbridge-Lyman-Becket, Marlow, Skerry, and Millsite-Woodstock-Henniker (USDA-NRCS Soil Survey, 2025). Steep slopes are found within the project site, including grades of 15-25% and 25-60% Tunbridge-Lyman-Becket. K factor, a measure of the inherent erodibility of soil, for the project area ranges from 0.10 to 0.37 (with the highest possible being 0.64) depending on the soil type and presence of rock fragments.

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

Group A soils have a high infiltration rate (low runoff potential) when thoroughly wet. Group B soils have a moderate infiltration rate when thoroughly wet. Group C soils have a slow infiltration rate when thoroughly wet. Group D soils have a very slow infiltration rate (high runoff potential) when thoroughly wet. If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. The project area contains six hydrologic soil group classifications: A (2.1%), A/D (3.1%), B (1.1%), C (77.3%), C/D (11.6%) and D (4.9%), indicative of a moderate-high runoff potential (USDA-NRCS Soil Survey, 2025).

Within the project area there have been concerns of erosion, especially in regard to gravel road erosion. Erosion concerns have been contributing to sediment runoff into the larger Lake Winnisquam watershed; they have also contributed to a 300-ft radius sediment delta (FBE & Horsley Witten, 2022). A remediation plan for Black Brook was published in 2022 and evaluated erosion and sedimentation sites at 11 sites. One driving factor of erosion at many sites was steep hillslopes. The observed sediment type and erosion severity (with most severe as 10) is displayed in the first table below, and the weighted scoring for site prioritization in the second table below both taken from the remediation report (FBE, 2022).

Table 3. Summary of results from the field visit conducted by FBE staff on April 6, 2022.

Site ID and Name	Eroded Sediment Volume (ft^3)	Transport to Black Brook	Sediment type	Erosion Severity
1a. Lower Huse Road	8,000	Close to channel	Gravel, Sand	7
1b. Huse Road Crossing	1,200	Direct transport	Gravel, Sand	6
2. Upper Huse Road	6,000	Limited transport	Gravel, Sand, Silt	5
3. Kaulback-Roxbury Intersection	5,000	Direct to tributary	Gravel, Sand	7
4. Kaulback Road West	6,000	Direct transport	Sand, Silt	5
5. Kaulback Road East	5,600	Direct to tributary	Sand, Silt	6
6. Kaulback Road Far North	8,000	Upland from channel	Gravel, Sand	7
7. Black Brook Road Crossing	60	Direct transport	Sand, Silt	2
8. Woodman Road Crossing	575	Direct transport	Gravel, Sand	4
9. Union Cemetery	1,000	Direct transport	Gravel, Sand	4
10. Roxbury Road	5,000	Close to channel	Gravel, Sand	7

Table 4: Summary of modeled and weighted field observed parameters, intermediate priority calculations, and final overall site priority using color bars (above), and as a text list (below).

Site ID and Name	Modeled Annual Sediment Discharge (tons/year)	Observed Sediment Volume (weighted)	Transport to Black Brook (weighted)	Observed Sediment Type (weighted)	Observed Erosion Severity (weighted)	Total Field Score	Modeled Priority	Field Priority	Priority Sum	Overall Priority	Tie Breaker
1a. Lower Huse Rd	4.4	4	1.5	1	2	12.0	1	1	2	1	
1b. Huse Rd crossing	4.4	1	2	1	1.8	3.6	1	6	7	2	modeled sediment discharge
2. Upper Huse Rd	3.9	3	1	1.25	1.6	6.0	2	5	7	3	modeled sediment discharge
4. Kaulback Rd west	0.33	3	2	1.25	1.6	12.0	6	1	7	4	
10. Roxbury Road	0.44	3	1.25	1	2	7.5	5	4	9	5	larger site area
3. Kaulback-Roxbury intersection	0.44	3	1.25	1	2	7.5	5	4	9	6	
8. Woodman Rd crossing	3.5	1	2	1	1.4	2.8	3	7	10	7	modeled sediment discharge
5. Kaulback Rd east	0	3	1.25	1.25	1.8	8.4	8	2	10	8	
6. Kaulback Rd far north	0	4	1	1	2	8.0	8	3	11	9	
7. Black Brook Rd crossing	2.9	1	2	1.25	1	2.5	4	8	12	10	
9. Union Cemetery	0.22	1	2	1	1.4	2.8	7	7	14	11	

Water

Black Brook is a 2.6-mile-long perennial stream system which intersects the project area. Black Brook flows into Lake Winnisquam, located just outside the project area (Town of Sanbornton). The watershed containing the project area is the Winnisquam Lake (HUC 12 – 010700020201) and the greater Merrimack watershed (AECOM, 2012).

There are a few unnamed ponds and swamps located within the project area as well. Just outside the boundary of the project is Lake Winnisquam, the fourth largest lake in New Hampshire. Lake Winnisquam is downstream of the larger Lake Winnipesaukee and the Merrimack River.

Air

The project area, located in Belknap County, NH had an average of 301 days of Air Quality Index (AQI) values from 2014 to 2024. Each year had the majority of days (average of 274) listed as Good (<= 50 AQI) with the next largest group (average of 27) being listed as Moderate (51 – 100 AQI) (EPA, 2025).

The project area is rural in nature, so emissions are sourced mainly from mobile sources such as highway vehicles, trucks, and buses (EPA, 2022).

Plants

The project area is located in the Worcester/Monadnock Plateau, which covers parts of south-central New Hampshire. The general vegetation types include transition hardwoods (maple-beech-birch, oak-hickory) and northern hardwoods (maple-beech-birch) (USGS, 2009).

The project area has approximately 70 acres of crop land including: Hay/Non-Alfalfa (97.6%), Christmas Trees (1.3%), Corn (0.6%), Sorghum (0.3%) and Miscellaneous Vegetables and Fruits (0.3%) (USDA, 2023).

Animals

Sightings of the following wildlife species have been spotted in the towns of Sanbornton and Meredith. While not a comprehensive list, this gives an understanding of the types of wildlife and their habitats that are present within the project area (New Hampshire Fish & Game Department, 2025).

Amphibians
Green Frog (*Lithobates clamitans)*
Spotted Salamander (*Ambystoma maculatum)*
American Toad (*Anaxyrus americanus)*
Eastern Newt (*Notophthalmus viridescens)*
Gray Treefrog (*Dryophytes versicolor)*
Redback Salamander (*Plethodon cinereus)*
Wood Frog (*Lithobates sylvaticus)*

Birds

	Bald Eagle (*Haliaeetus leucocephalus)* **Mammals** Bobcat (*Lynx rufus)* **Reptiles** Common Garter Snake (*Thamnophis sirtalis)* Eastern Painted Turtle (*Chrysemys picta)* Milk Snake (*Lampropeltis Triangulum)* Musk Turtle (*Sternotherus odoratus)* Northern Water Snake (*Nerodia sipedon)* Snapping Turtle (*Chelydra serpentina)* Wood turtle (*Glyptemys insculpta)* Rainbow trout (Onorhynchus mykiss), eastern brook trout (*Salvelinus fontinalis*), and landlocked salmon (*Salmo salar*) were stocked in Lake Winnisquam in 2024 for recreational fishing opportunities (NH Fish and Game, 2024).
Energy	No wind or solar farms are found within the project area. No transmission line is within or intersects the project area.
Human	The project area is found within the Town of Sanbornton and the Town of Meredith. Based on the 2020 Census, The Town of Sanbornton has a population of 3,026 and 1,695 housing units within a land area of 47.4 square miles. The Town of Meredith has a population of 6,662 and 4,742 housing units within a land area of 40.1 square miles. The population of Sanbornton is 94% white, 1.8% Hispanic or Latino, 0.6% Asian, and 0.4% Black or African American (U.S. Census Bureau, 2020). The population of Meredith is 94% white, 2% Hispanic of Latino, 0.9% Asian, and 0.4% Black or African American (U.S. Census Bureau, 2020). In Sanbornton, the median household income is $92,279 and the employment rate is 65.6%. In the Town of Meredith, the median household income is $70,069 and the employment rate is 50.6%. These rates are higher than the U.S. averages. Only local roads are found within the project area, including Woodman Road, Steele Hill Road, Roxbury Road, and Kaulback Road. The project area contains Steele Hill Resort and Golf Course, a 3-star hotel with a 9-hole golf course, and hiking trails. Adjacent to the project area is Lake Winnisquam, which is used for watersports and water activities such as boating, swimming and fishing. Union Cemetery is also located within the project area (Steele Hill Resorts).

Resources of Special Concern

Clean Water Act	Black Brook, located within the project area has been assessed as impaired though is not a 303(d) water under the Clean Water Act (USEPA, 2024). Lake Winnisquam which Black Brook outflows into is listed as a 303(d) impaired water under the Clean Water Act (USEPA, 2024). The impaired parameter for Black Brook was fish

	consumption, and for Lake Winnisquam was aquatic life integrity, and fish consumption. The northeast regional mercury TMDL applies to Black Brook and Lake Winnisquam. Lake Winnisquam also has a TMDL for pH and a watershed-based plan to address turbidity. The New Hampshire watershed report card lists Black Brook Aquatic Life Integrity as "likely bad" and Fish Consumption as "poor." Potential drinking water supply for Black Brook has received a "good" rating, meaning it meets potassium and sulfate standards/thresholds by a relatively large margin (NHDES, 2024). Phosphorus loading is a prevalent concern in the watershed as excess phosphorous levels have been assessed as contributing an estimated 151 kg/yr of phosphorus loads to Lake Winnisquam, which can contribute to algal blooms in the lake (FBE & Horsley Witten, 2022).
Clean Air Act	The Clean Air Act has required the EPA to set National Ambient Air Quality Standards (NAAQS) for "criteria" pollutants (e.g. carbon monoxide). For those areas that don't meet NAAQs, they are considered to be in "nonattainment" for a specific pollutant. The project and surrounding area are currently in attainment status for criteria pollutants. The NHDES also has state plans for haze and visibility, as well as acid rain.
Coastal Zone Management	The project area is located inland, and as such, coastal zone management is not applicable.
Coral Reefs	The project area is located inland, and no coral reefs are present.
Cultural Resources	The Bay Meeting House and Vestry, a building in the National Register of Historic Places, is located within the project area. Built in 1836, the church is an example of transitional Federal and Gothic Revival architecture (NPS, 1984). It was listed on the National Register of Historic Places in 1984. A concurrence from the State Historic Preservation Offices would be required prior to commencement of the project. There are no locations within the project area listed in the New Hampshire State Register of Historic Places.
Endangered & Threatened Species	There is one endangered (Northern Long-eared Bat or *Myotis septentrionalis*), one proposed threatened (Monarch Butterfly or *Danaus plexippus)*, and one threatened (Small Whorled Pogonia or *Isotria medeoloides*) species listed in the project area (United States Fish and Wildlife Service, 2024). No critical habitat overlaps with the Project Area. This list was obtained using the U.S. Fish and Wildlife Service's (USFWS) Information for Planning and Consultation (IPaC) system using the project site location and is a draft IPaC (Appendix E). This information should be confirmed with the local USFWS Field Office to make sure that ESA species surveys are not required before any project is undertaken. Included in the References is the State list of Endangered and Threatened species in New Hampshire (NHFG, 2017). No lists of state listed species by county were available.
Environmental Justice and Equity	The project area has some overlap with areas with environmental burden factors including lead paint (50-80th percentile) and drinking water non-compliance (95-

	100 percentile). Adjacent to the project area on Lake Winnisquam, there is hazardous waste proximity in the 80-90th percentile (EPA, 2025). For socioeconomic indicators, the project area has overlap with several factors including: high unemployment rate (80-95th percentile), limited English speaking (50-80th percentile), less than high school education (50-80th percentile), and over the age of 64 (50-90 percentile) (EPA, 2025). The project area has overlap with climate risk factors including flood risk (50-90th percentile), extreme heat, and 100-year floodplain (EPA, 2025). There are factors regarding health disparities that overlap the project area including: low life expectancy (50-80th percentile), heart disease (50-80th percentile), asthma (50-80th percentile), cancer (95-100th percentile) and persons with disabilities (95-100th percentile) (EPA, 2025).
Essential Fish Habitat	NA
Floodplain Management	The Black Brook watershed has not been mapped by FEMA. The brook and surrounding area, is mapped as a Zone C. Areas of minimal flood hazard, which are outside the Special Flood Hazard Area (SFHA) and higher than the elevation of the 0.2% annual chance of flooding is labeled as Zone C. The mapping is shown in Flood Insurance Rate Map 3300080010B, dated June 15, 1979 (FEMA, 2024). In the 2012 Black Brook Management Plan, increased flooding events were listed as a primary concern as many roads within the project area, such as Black Brook Road, flood during large storm events due to undersized culverts (AECOM, 2012).
Invasive Species	There are 16 invasive insect species that have been detected in Belknap County (USDA, 2024): Larch Casebearer (*Coleophora laricella*) Red Pine Scale (*Matsucoccus matsumarae*) Pear Thrips (*Taeniothrips inconsequens*) Satin Moth (*Leucoma salicis*) Beech Bark Scale (*Cryptococcus fagisuga*) Balsam Woolly Adelgid (*Adelges piceae*) Introduced Pine Sawfly (*Diprion similis*) Emerald Ash Borer (*Agrilus planipennis*) Japanese Beetle (*Popillia japonica*) Winter Moth (*Operophtera brumata*) Hemlock Woolly Adelgid (*Adelges tsugae*) Strawberry Root Weevil (*Otiorhynchus ovatus*) Elongate Hemlock Scale (*Fiorinia externa Ferris*) Spongy Moth (*Lymantria dispar*) Pine Shoot Beetle (*Tomicus piniperda*) European pine shoot moth (*Rhyacionia buoliana*) According to iNaturalist, there have been several sighted introduced species within the project area, including: Blue Globe-Thistle *(Echinops bannaticus)* Creeping Bellflower (*Campanula rapunculoides)*

	Immigrant Pavement Ant *(Tetramorium immigrans)* (iNaturalist, 2025). According to iMapInvasives, there has only been one occurrence of an invasive plant within Belknap County (Common Reed Grass, *Phragmites australis*). There have been no records of nonindigenous aquatic species within the project area (iMapInvasives, 2025). In the references is a comprehensive list of invasive plant species as determined by the New Hampshire Department of Agriculture, Markets & Food and the New Hampshire Department of Environmental Services.
Migratory Birds/Bald & Golden Eagle Protection Act	Bald Eagles (*Haliaeetus leucocephalus*) are not known to visit the project site, but they are listed as a Non-BCC Vulnerable because of the Bald & Golden Eagle Protection Act. However, they are presumably found throughout the state (USFWS, 2024). Fourteen species of birds are found within the project area that are both migratory birds, protected by the Migratory Bird Treaty Act (MBTA), and birds of concern by the USFWS. These species and their status are: Bald Eagle (*Haliaeetus leucocephalus*) (Non-BCC Vulnerable), Bay-breasted Warbler (*Setophaga castanea*) (BCC-BCR), Black-billed Cuckoo (*Coccyzus erythropthalmus*) (BCC Rangewide (CON)), Bobolink (*Dolichonyx oryzivorus*) (BCC Rangewide (CON)), Canada Warbler (*Cardellina canadensis*) (BCC Rangewide (CON)), Cape May Warbler (*Setophaga tigrine*) (BCC-BCR), Chimney Swift (*Chaetura pelagica*) (BCC Rangewide (CON)), Evening Grosbeak (*Coccothraustes vespertinus*) (BCC Rangewide (CON)), Olive-sided Flycatcher (*Contopus cooperi*) (BCC Rangewide (CON)), Prairie Warbler (*Setophaga discolor*) (BCC Rangewide (CON)), Rose-breasted Grosbeak (*Pheucticus ludovicianus*) (BCC-BCR), Semipalmated Sandpiper (*Calidris pusilla*) (BCC-BCR), Veery (*Catharus fuscescens fuscescens*) (BCC-BCR), Wood Thrush (*Hylocichla mustelina*) (BCC Rangewide (CON)). This is not an exhaustive list of MBTA-listed birds that could occur in the project area (USFWS, 2024). During any project planning, the local state biologist should be consulted for more recent information on potential eagle or MBTA presence, nesting, and survey and agency coordination requirements.
Natural Areas	There are two conservation easements that overlap the project area, Black Brook WMA and Dr True Road. Black Brook WMA is managed by New Hampshire Fish and Game Department whereas Dr True Road is privately owned.
Prime and Unique Farmlands	The project area contains four farmland classifications: All Areas are Prime Farmland (2.4%), Farmland of Local Importance (80.7%), Farmland of Statewide Importance (4.6%) and Not Prime Farmland (12.4%) (USDA-NRCS, 2025).
Riparian Area	Riparian areas likely exist all along the wetlands, ponds, and brooks within the project area and any impacts should be considered given their importance for wildlife, aesthetic value, and recreational use.

	The NHDES Wetland Bureau sets standards for prime wetland buffers, being the 100-foot upland buffer for wetlands that have been designated as prime wetlands.
Scenic Beauty	No noted areas.
Wetlands	Geospatial data from the National Wetlands Inventory (NWI) was reviewed to assess potential Waters of the US (WOUS) and other jurisdictional features within the anticipated project boundary. Based on the NWI spatial data, the following wetlands are found within the project area (National Wetlands Inventory, 2025): • Freshwater Forested/Shrub Wetland (PFO4E, PSS1E, PFO1E, PSS1/EM1E, PFO4/SS1E, PFO4/SS4E, PSS1/EM1Eb) – 8.797 acres • Freshwater Emergent Wetland (PEM1Eb, PEM1E, PEM1A) – 1.342 acres • Freshwater Pond (PUBHb, PABHb, PUBHx) – 5.686 acres • Lake (L2UBHh) – 3.528 acres • Riverine (R2UBH, R4SBC) – 3.281 acres The wetlands provide significant wildlife value, flood reduction, and aesthetic value to the project area. Any project work could affect runoff quantity, quality, and timing of flows within wetlands. An evaluation of wetlands and other WOTUS within the Project Area should be evaluated during project planning.
Wild and Scenic Rivers	There are no National Wild and Scenic Rivers within or near the project site.

Proposed Project Purpose and Need Statement

The purpose of the proposed project is Watershed Protection through the mitigation of sediment transport via the tributaries leading to Lake Winnisquam, inclusive of Black Brook. It is anticipated that the primary PL-566 project purpose will be Watershed Protection.

The need for the proposed project is based upon the degraded water quality in Lake Winnisquam and its impact from the watershed as a whole as summarized in the 2012 Black Brook Management Plan prepared by AECOM.

Lake Winnisquam is the fourth-largest lake entirely in New Hampshire and is a major natural resource for the state. In addition to being a major natural resource, home to many cold water fish such as rainbow trout, lake trout, landlocked salmon, and whitefish, it is also a major recreational and economic resource for rural communities surrounding the area. The lake offers numerous recreational activities such as boating, beaches, islands, hiking, rail biking, and golfing.

Resource Concerns

This section summarizes the resource concerns that may potentially be impacted by implementation of the proposed project as expected in the long term. A full description of the resource concerns can be found in Appendix D.

Potential Effects of Proposed Alternatives on SWAPA + E + H Resources and Resources of Special Concern

Use: ***+ - Positive Impact*** ***- - Negative Impact*** ***0 - No Impact***

	Alternative 1: Non-Structural Address the Huse Road priority sites, implement local ordinances to reduce sediment loads, implement/require BMPs for agricultural and timber harvesting activities, and basin wide coordination focusing on education and outreach programs, water quality monitoring, and continued project identification.	**Alternative 2: Structural** Implement non-structural plan; Implement recommendations for roads within project area, implement structural non-point and point source BMPs (shoulders, swales, stream restoration, riparian buffers).	**Alternative 3: No Restrictions** Implement non-structural and structural work plans, implement roadway stormwater improvements, redesign and reconstruct problem roadways, and purchase widespread land for long term conservation.	**No Action** Without federal investment, mitigate sediment runoff and nutrient levels in the watershed with current state requirements.
Soil	**+**	**+**	**+**	**-**
Water	**+**	**+**	**+**	**-**
Air	**0**	**0**	**0**	**0**
Plants	**+**	**+**	**+**	**-**
Animals	**+**	**+**	**+**	**-**
Energy	**0**	**0**	**0**	**0**
Human	**+**	**+**	**+/-**	**-**
Clean Air Act	**0**	**0**	**0**	**0**
Clean Water Act/Waters of the U.S.	**+**	**+**	**+**	**-**
Coastal Zone Management	**0**	**0**	**0**	**0**
Coral Reefs	**0**	**0**	**0**	**0**
Cultural Resources/ Historic Properties	**0**	**0**	**0**	**0**
Endangered &	**+**	**+**	**+**	**-**

Threatened Species				
Environmental Justice	**+**	**+**	**+/-**	**-**
Essential Fish Habitat	**0**	**0**	**0**	**0**
Floodplain Management	**+**	**+**	**+**	**-**
Invasive Species	**+/-**	**+/-**	**+**	**+/-**
Migratory Birds/Bald and Golden Eagle Protection Act	**0**	**+**	**+**	**0**
Natural Areas	**+/-**	**+**	**+**	**0**

Opportunities

Lake Winnisquam is currently a high-quality lake and current analyses suggest that the current phosphorous load to Lake Winnisquam should be maintained at the current lake level. However, recently the lake has experienced threats to water quality in recent years

Potential opportunities include:

- A larger Lake Winnisquam Watershed-Based Plan has already been published in July 2022 with potential projects identified and shared with the local agencies within the Black Brook Watershed
- Cooperating agencies and stakeholders are already involved and are supportive of the effort. Cooperating agencies include the following:
    - NH Association of Conservation Commissions
    - EPA Region 1
    - New Hampshire Department of Environmental Services
    - Winnisquam Watershed Network
    - Belknap County Conservation District
    - Lakes Region Planning Commission
- A mix of structural and non-structural measures can be combined and forwarded to incrementally advance the project purpose and positively impact resource concerns

State, Tribal, Federal Stakeholder Engagement

The potential stakeholders for this project are as follows:

At the local and State government level potential stakeholders include:

- Town of Sanbornton, New Hampshire
- Sanbornton Conservation Commission
- NH Department of Environmental Services
- State Historic Preservation Office

The Indian Tribes of New Hampshire include:

- Federally Recognized Tribes:
    - None

- State Recognized Tribes:
    - None

- Tribes with interests in New Hampshire:
    - Abenaki Nation of New Hampshire
    - Golden Hill Indian Reservation
    - Schaghticaoke Tribal Nation
    - Nulhegan Band of the Coosuk Abenaki Nation
    - Eastern Pequot Reservation
    - Paucatuck Eastern Pequot Tribe

- Koasek of the Koas of the Abenaki Nation
- Sovereign Abenaki Nation of Missisquoi, St. Francis/Sokoi Band
- Cowasuck Band Pennacook/Abenaki People
- Koasek (Cowasuck) Traditional Band of the Sovereign Abenaki Nation
- Koasek (Cowasuck) Traditional Band of the Abenaki Nation
- Laconia Indian Historical Association LIHA, Inc
- NH Intertribal Native American Council
- THPO, Penobscot Indian Nation
- Tribal Chief, Penobscott Indian Nation
- THPO, Wampanoag Tribe of Gay Head-Aquinnah
- Mashantucket Pequot Tribal Nation, Eastern Area Office
- Mohegan Tribal Council, Eastern Area Office
- THPO, Narragansett Indian Tribe
- THPO, Passamaquoddy Tribe

Federal stakeholders may include:

- U.S. Army Corp of Engineers
- USFWS
- EPA
- NOAA

Other non-government stakeholders that should be engaged during planning may include:

- Winnisquam Watershed Network Board
- Belknap County Conservation District

Alternatives

Three alternatives, in addition to the discounted No Action Alternative, were identified to meet the purpose and need for the project. These alternatives meet the following PL-566 project purposes and resource concerns: Watershed Protection (primary Purpose), and Water Quality Management.

Alternative 1: Non-Structural includes a combination of regulatory and best management practices to actively reduce the transport of sediment, and associated nutrients into the target tributaries and water bodies.

Huse Road

Address the Huse Road priority sites identified in the Black Brook Watershed Management Plan (AECOM 2012), Black Brook Watershed Assessment Update Report (BCCD and Lang 2021), and the Black Brook Remediation Plan (FBE 2022). The top 3 sites Identified as major sources of sediment per the Remediation Plan (FBE 2022), the most recent publication, are Sites 1a, 1b, and Site 2. Address additional Huse Road sites (as necessary) identified in the Black Brook Watershed Management Plan (AECOM 2012) as part of the Best Management Practices (such as BMPs 4 to 15) in Table 6-1 of that report (Appendix J).

Implement Local Ordinances to Reduce Sediment Loading

Such as ordinances that:

- Promote LID Development, and limit development of new impervious surface(s)
- Promote Stormwater Recharge/Infiltration Practices
- Road Drainage (future development/redevelopment)
- Construction Ordinances that minimize disturbed areas limit runoff, erosion, etc.

BMP Development

- Agricultural Practices
- Timber Harvesting

Project Identification

Continue to Identify and prioritize projects to reduce sediment loading to Black Brook. Including those outlined in the Black Brook Watershed Management Plan (AECOM 2012), the Remediation Plan (FBE 2022), the Lake Winnisquam Watershed-Based Plan (FBE and HWG 2022), and other available information sources.

Basin-Wide Coordination

Coordinate with larger Lake Winnipesaukee Watershed Restoration efforts, as outlined in the Lake Winnisquam Watershed-Based Plan (FBE and HWG 20222022) that limit sediment loads to the lake.

Project Grant Funding Support

Identify current grant funding sources, and secure funding for priority projects. Pursue sources of funding as presented in the Black Brook Watershed Management Plan (AECOM 2012), the Lake Winnisquam Watershed-Based Plan (FBE and HWG 2022), and identify new funding sources.

Education and Outreach Efforts

Continue and support education and outreach efforts as outlined in the Black Brook Watershed Management Plan (AECOM 2012); and applicable measures in the Lake Winnisquam Watershed-Based Plan (FBE and HWG 2022), and other identified actions.

Water Quality Monitoring

Support on-going water quality monitoring efforts as part of the greater basin/lake plans such as the Lake Winnisquam Watershed-Based Plan (FBE and HWG 2022).

Alternative 2: Structural
Implement Measures Included as Non-structural (above) in addition to the following:

Kaulback Road

Identified in multiple plans as a significant or major source of sediment to Black Brook. Diversion of stormwater into vegetated swales needed with level spreaders and lengthen culverts to create more vegetated shoulder is called out in the Black Brook Watershed Assessment Update Report (BCCD and Lang 2021). Corrective action for Kaulback Road is also identified in the following reports/plans:

- Remediation Plan (FBE 2022); Sites 4, Site 5 and Site 6.
- Lake Winnisquam Watershed-Based Plan (FBE and HWG 2022); Table 13, Site Id 3-23.
- Black Brook Watershed Management Plan (AECOM 2012); Best Management Practices, Table 6-1, BMPs 17 to 29. Implement as necessary if not addressed in the more recent reports/plans.
- It should be noted that real property rights (i.e. work associated with roadways or culverts) as defined by NWPM Part 501.80.A.14 are not within the scope of the Watershed Protection and Flood Protection Operations Program. The full cost associated with these alternatives shall be undertaken by the sponsor

Also address Roxbury Road at its intersection with Kaulback Road as identified in the Remediation Plan (FBE 2022); Site 3. This site is also identified in the Black Brook Watershed Assessment Update Report (BCCD and Lang 2021) as a minor source of sediment.

Woodman Road

Address sedimentation issues from the roadway and Remediation Plan (FBE 2022) Site 8; and sites identified in Table 13 of the Lake Winnisquam Watershed-Based Plan (FBE and HWG 2022), Sites 3-25, 3-26, and 3-28. Also, a site along Woodman Road at a partially blocked culvert is identified in the Black Brook Watershed Update Report (BCCD and Lang 2021). Sites are also identified in the in the Black Brook Management Plan AECOM (2012); Table 6-1: BMP 31, BMP 33, BMP 34 and BMP 35 that still could be addressed if not identified in the fixes called out in the more recent plans/reports.

Black Brook Road Culvert/Crossing

If problematic, address/fix the box culvert at Black Brook Road where a replacement culvert was installed in 2012. Per the Black Brook Watershed Assessment Update Report (BCCD and Lang 2021), deposition is occurring at and upstream of the replaced culvert. This report identified the following actions to address the issues at this culvert: conduct a detailed channel survey, remove debris at the stop log dam, and maintain vegetated shoulders at Black Brook Road, 500 feet in both directions of the culvert (BCCD and Lang 2021). This culvert is also identified in the Remediation Plan (FBE 2022), as Site 7. Address any sedimentation issues at this culvert as necessary.

Implement Structural Non-Point Source BMPs

- Identify and stabilize problematic road shoulders, reshape/revegetate shoulders.
- Stabilize/restore associated ditches.
- These alternatives were also identified as potential solutions; however, it should be noted that real property rights (i.e. work associated with roadways or culverts) as defined by NWPM Part 501.80.A.14 are not within the scope of the Watershed Protection and Flood Protection Operations Program. The full cost associated with these alternatives shall be undertaken by the sponsor
    - Identify where to reshape or crown roadways in problematic areas.

- Replace problematic culverts. Trout Unlimited conducted a culvert survey in 2020 identified in the Lake Winnisquam Watershed-Based Plan (FBE and HWG 2022).

Implement Non-Structural Source BMPs

- Stream Restoration in Black Brook. Build upon previous work completed by Belknap County Conservation District (BCCD) and Trout Unlimited 2021 restoration actions in Black Brook. Identify other areas where stream restoration would be suitable to help minimize sediment delivery to Lake Winnisquam.

Restore Buffer Areas along Black Brook

- Where lacking plant/create a riparian buffer. Site example identified in Appendix C of the Lake Winnisquam Watershed-Based Plan (FBE and HWG 2022 – Appendix G): Woodman Road, buffer enhancement identified through an open field, Site Id 3-27. Also, the same site on Woodman Road was identified in the Black Brook Watershed Management Plan, Section 5.6.3 (AECOM 2012).

Alternative 3: No Restrictions

Implement Measures identified above in addition to the following:

Road Stormwater Drainage Improvements

Install facilities that control flow conveyance and reduce peak flow velocities and improve the drainage channels/ditch network and control runoff entering Black Brook.

Comprehensive Planning

Participate in planning efforts, as outlined in Lake Winnisquam Watershed Plan (FBE and HWG 2022) for Non-Structural Non-Point Source (NPS) Restoration (listed in Section 4.2), and the Black Brook Watershed Management Plan (AECOM 2012). Implement additional measures not addressed in either the Low or Medium alternatives including, but not limited to:

- Implementation of basin-wide Green Infrastructure.
- Implementation of LID infrastructure.
- Septic System Upgrades/Replacement in critical areas affecting lake water quality.
- Sanitary Sewer Inspections.
- Fertilizer use restrictions in areas affecting lake water quality. Sanbornton participates in the NRCS Comprehensive Nutrient Management Plan (CNMP).
- Pet Waste Management.
- Nuisance Wildlife Controls.
- Land Conservation.
- Others

Widespread Land Purchase for Long-Term Conservation

Purchase or participate in easements of parcels of land for protection of water resources, Black Brook stream buffer areas (riparian areas and wetlands) providing water quality benefit. Purchase land that is proposed for future development to eliminate the potential for future pollutant loads associated with development (i.e. impervious surface runoff, landscaping) entering Black Brook and Lake Winnisquam. Prioritize basin areas with high runoff/erosion rates per soil types with slow infiltration rates (Soil Group C and D) that have the potential for drainage to enter Black Brook or Lake Winnisquam.

Address other Sediment Input Sites

Review areas not addressed as part of the Low or Medium Alternative Actions above. As outlined in the Remediation Plan (FBE 2022); Black Brook Watershed Management Plan AECOM (2012), Table 6-1; the Lake

Winnisquam Watershed-Based Plan (FBE and HWG 2022), and other available sources:

- Union Cemetery. Identified as minor erosion by BCCD and Lang (2021), per Remediation Plan (FBE 2022), Site 9.
- Roxbury Road. Site where roadway slopes into low point, per Remediation Report (FBE 2022), Site 10.
- Other sites listed in the Lake Winnisquam Watershed-Based Plan (FBE and HWG 2022 – Appendix G) in Table 13 and Appendix C: BMP Matrix of that report.

Redesign/rebuild all problem roadways in Black Brook watershed

Huse/Kaulback/Woodman/Roxbury Roads. This includes a comprehensive approach to addressing roadway drainage issues where roadway runoff is causing erosion; sediment mobilization, transport and delivery to Black Brook and Lake Winnisquam. As this alternative includes the alteration or installation of real property, construction costs shall be provided by the sponsor and not the owner.

Alternatives	Possible Positive Impacts and Effects	Possible Adverse Impacts and Effects
Alternative 1: Non-structural Solution • Improvement of drainage swales at Huse Road • Implement local ordinances to reduce sediment loading • BMP development • Project Identification • Basin-wide coordination • Project Grant Funding Support • Education and Outreach Efforts	• Will improve protection of the Black Brook Watershed and Lake Winnisquam • Mostly retains the current aesthetics of the area • Make use of existing infrastructure. Mitigates significant impacts to the community	• Does not permanently solve continuous observed erosion at dirt roads specifically Huse Road • Enforcement of new ordinances may be challenging
Alternative 2: Structural • Implement Structural Non-Point Source BMPs • Stream Restoration at Black Brook • Restore Buffer Areas around Black Brook • Lengthen culverts and divert water into vegetated swales with level spreaders at Kaulback Road[1] • Rehabilitate or replace the culvert crossing at the Black Brook Road Culvert[1]	• Will improve protection of the Black Brook Watershed and Lake Winnisquam • Can take account for new sediment loading into the watershed with design of new infrastructure	• Vegetation for riparian buffer might encroach on to roadways and paths requiring more maintenance • Aesthetics of proposed structural solution are potentially undesirable to current stakeholders • Restoration and recrowning of roadways slows down but does not eliminate erosion at roadways. • Frequent maintenance may be needed to be effective.

[1] Real property rights as defined by NWPM Part 501.80.A.14 are not within the scope of the Watershed Protection and Flood Protection Operations Program. The full cost associated with these alternatives shall be undertaken by the sponsor

		• Real property rights shall be at full cost to the sponsor
Alternative 3: No Restrictions • Inclusion of projects noted in both Alternative 1 and 2 • Road Stormwater Drainage Improvements • Comprehensive Planning • Widespread Land Purchase for Long-Term Conservation[2] • Further investigation of other problem sites within the watershed	• Will improve protection of the Black Brook Watershed and Lake Winnisquam • Can take account new sediment loading into the watershed with design of new infrastructure • Paving of roadways can significantly reduce sediment erosion and reduce maintenance costs associated with rebuilding dirt roads[2]	• Reshaping topography might introduce new unintended problem areas • Implementation of alternatives will take longer • Aesthetics of proposed structural solutions are potentially undesirable to current stakeholders • Significant temporary construction impacts to the local community • Enforcement of new ordinances may be challenging • Asphalt paving of roads might increase runoff and ponding in other areas[2] • Frequent maintenance may be needed to be effective. • Real property rights shall be at full cost to the sponsor

[2] Real property rights as defined by NWPM Part 501.80.A.14 are not within the scope of the Watershed Protection and Flood Protection Operations Program. The full cost associated with these alternatives shall be undertaken by the sponsor

Facilitating Factors

The following facilitating factors were identified:

Alternative 1: Non-Structural

- The community is committed to addressing the concerns.
- Huse Road is a recognized source of sediment and is subject to regular damage/repair due to poor drainage.
- Water quality monitoring and current mitigation practice are already available.
- Local agencies have already been engaged through the Lake Winnisquam Watershed Plan dated July 2022.
- Water quality at Lake Winnisquam will be improved or maintained. Natural, recreational, and economic resources from Lake Winnisquam will be further protected.

Alternative 2: Structural

- The community is committed to addressing the concerns.
- Water quality monitoring and current mitigation practice are already available.
- Local agencies have already been engaged through the Lake Winnisquam Watershed Plan dated July 2022.
- Water quality at Lake Winnisquam will be improved or maintained. Natural, recreational, and economic resources from Lake Winnisquam will be further protected.

Alternative 3: No Restrictions

- The community is committed to addressing the concerns.
- Water quality monitoring and current mitigation practice are already available.
- Local agencies have already been engaged through the Lake Winnisquam Watershed Plan dated July 2022.
- Water quality at Lake Winnisquam will be improved or maintained. Natural, recreational, and economic resources from Lake Winnisquam will be further protected.

Obstructing Factors

The following obstructing factors were identified for the alternatives considered:

Alternative 1: Non Structural

- Local residents may not be receptive of new ordinances

Alternative 2: Structural

- Based upon the performance of previously installed BMPs, investment in raingardens, vortechnics and other BMPs, approval of funding for such infrastructure may be questioned
- Residents are suspicious of new infrastructure fearing it may cause unintentional but additional flooding within their property
- NRCS policy does not allow the acquisition, replacement or installation of 'real property' which is inclusive of roadways, bridges and culverts. Re-grading and relocating roadways s more suited for a public works project.
- Town funding and manpower to perform maintenance on any new or existing BMPs
- These alternatives may not have net economic benefits.

Alternative 3: No Restrictions

- Some residents are opposed to paving roadways that are currently aggregate based surfaces for fear of losing the rural feel of the community.
- NRCS policy does not allow the acquisition, replacement or installation of 'real property' which is inclusive of roadways, bridges and culverts. Regrading and relocating roadways s more suited for a public works project.
- Residents are suspicious of new infrastructure fearing it may cause unintentional but additional flooding within their property
- Town funding and manpower to perform maintenance on any new or existing BMPs
- These alternatives may not have net economic benefits.

Environmental Document

The potential projects within the alternatives identified during the preparation of this report are anticipated to be presented and grouped such that the groups of projects approved shall cost not exceeding $25,000,000. Therefore, at this point in the planning process, it was determined that the appropriate Plan – Environmental Document for the project may be a Plan – Environmental Assessment.

Should the alternatives be changed during future phases of project planning, the appropriate Plan – Environmental Document for the project may become a Plan – Environmental Impact Statement.

As the project includes a variety of alternative actions that can be implemented separately or in conjunction with one another, it is recommended that the environmental document be prepared following a programmatic approach for a tiered implementation with one alternative for each of the proposed watershed improvement actions. This will allow the impacts and feasibility of each proposed action to be evaluated separately, facilitating efficient allocation of project funding and efforts to the actions having the greatest positive impacts and economic feasibility.

Sponsor

The project sponsors for this project have been identified as listed below:

Sponsor Will:	Assist in Planning	Land Rights / Eminent Doman	Local Cost Share	O/M Funds	Permits	Land Treatment	In-Kind MOU
Town of Sanbornton	Yes	Yes	Yes	Yes	Yes	No	No

Sponsor(s) will:

- Assist in the locally led planning effort.
- Obtain needed land rights including the use of power of eminent domain, if necessary.
- Provide local cost-share funds and/or in-kind services to provide the required portion of total project costs.
- Provide funds for continuing operation and maintenance actions.
- Obtain required permits and approvals at sponsor cost
- Provide leadership to help ensure adequate conservation land treatment measures are maintained on at least 50% of the watershed area above retention reservoirs.
- Before being credited with the value of any in-kind contribution for any in-kind services and/or acquisition of land rights, sponsor will sign a Memorandum of Understanding (MOU) with NRCS.

Potential Cooperating Agencies

Agency	Contact Information	Type of Involvement
US Army Corps of Engineers	Us Army Corps of Engineers New England District 696 Virginia Rd Concord, MA 01742-2751 cenae-pa@usace.army.mil 978-318-8238	Regulatory [X] Informed [X] Prepare permits or letters of permission document [] Provide input [X]
New Hampshire Department of Environmental Services	29 Hazen Drive Concord, NH 03302-0095 603-271-3503	Regulatory [X] Informed [X] Prepare permits or letters of permission document [] Provide input [X]
New Hampshire Division of Historical Resources	172 Pembroke Road Concord, NH 03301 603-271-3483	Regulatory [X] Informed [X] Prepare permits or letters of permission document [] Provide input []
New Hampshire Department of Transportation (NH DOT)	7 Hazen Drive Concord, NH 03302 info@dot.nh.gov 603-271-3734	Regulatory [X] Informed [X] Prepare permits or letters of permission document [] Provide input []

Potential Stakeholders

Stakeholder	Role	Resources	Planning Contribution
Town of Sanbornton, NH	Sponsor	Funding, permits, current and historic data regarding water condition, knowledge of current and historic mitigation actions. Staffing to plan and coordinate proposed improvements.	Local cost share, host public meetings, coordinate and assist in implementation of improvements, provide land / access where necessary.
USDA-Natural Resources Conservation Service	Lead Federal Agency	Funds and engineering, environmental, and cultural resources staff.	Federal portion of costs, responsible for overall development of Plan-Environmental Document.
U.S. Army Corps of Engineers	404 Permit, planning assistance	Wetlands, Waters of the US Jurisdiction, 2022 Watershed Management plan	Nationwide permit, input on wetlands and other environmental concerns, input on proposed work plan.
New Hampshire Division of Historical Resources	Section 106 Project Review	Review of project area	Permit for project area, Programmatic Agreement for phased approach
New Hampshire Department of Environmental Services	Permit	Review of project area. Current data regarding soil condition, knowledge of current and historic mitigation actions and BMP's.	Permit for project area, Programmatic Agreement for phased approach.
EPA	Project Review	Review of project area	Review of project area
Winnisquam Watershed Network Board	Supporter	Local Support. Current data regarding soil condition, knowledge of current and historic mitigation actions and BMP's. Information on water quality monitoring and invasive species management	Local outreach, provide information on current water quality monitoring and invasive species management practices
Belknap County Conservation District	Supporter, Local Agency	Local Support. Current data regarding soil condition, knowledge of current and historic mitigation actions and BMP's. Information on water quality monitoring and invasive species management	Local outreach, provide information on current management practices

Principal Sponsors – Primary Stakeholders who will make financial and in-kind commitments to the project.	Regulatory – Entities involved in regulatory aspects of the project's implementation, whose input during planning is sought.	Keep Informed – Stakeholders who should be kept informed of the projects progress and whose input during planning is sought.

Notifications

If a preliminary investigation findings report is undertaken, the State Conservationist must notify in writing the Governors concerned, the U.S. Fish and Wildlife Service, the U.S. Army Corps of Engineers, and all other Federal agencies concerned with a decision to initiate any survey or field investigation involving water resources development work and furnish them with appropriate information regarding the scope, nature, status, and results of such survey or investigation (Executive Order 10584 Section 3).

Agency	Method and Date Notified
New Hampshire Governor	Letter by Mail on 3/14/2025
U.S. Fish and Wildlife Service	Letter by Mail on 3/14/2025
U.S. Army Corps of Engineers	Letter by Mail on 3/14/2025
U.S. Environmental Protection Agency	Letter by Mail on 3/14/2025

Initial consultation with Indian Tribes (to include Alaska Natives) and Native Hawaiian Organizations that may be impacted by the potential watershed project will occur during the development of the preliminary investigation findings report. (NHPA- 36 CFR 800 and Executive Order 13175).

Tribe / Nation	Method and Date Notified
Abenaki Nation of New Hampshire	Letter by Mail on 3/14/2025
Golden Hill Indian Reservation	Letter by Mail on 3/14/2025
Schaghticaoke Tribal Nation	Letter by Mail on 3/14/2025
Nulhegan Band of the Coosuk Abenaki Nation	Letter by Mail on 3/14/2025
Eastern Pequot Reservation	Letter by Mail on 3/14/2025
Paucatuck Eastern Pequot Tribe	Letter by Mail on 3/14/2025
Koasek of the Koas of the Abenaki Nation	Letter by Mail on 3/14/2025
Sovereign Abenaki Nation of Missisquoi, St. Francis/Sokoi Band	Letter by Mail on 3/14/2025
Cowasuck Band Pennacook/Abenaki People	Letter by Mail on 3/14/2025
Koasek (Cowasuck) Traditional Band of the Sovereign Abenaki Nation	Letter by Mail on 3/14/2025
Koasek (Cowasuck) Traditional Band of the Abenaki Nation	Letter by Mail on 3/14/2025
Laconia Indian Historical Association LIHA, Inc	Letter by Mail on 3/14/2025
NH Intertribal Native American Council	Letter by Mail on 3/14/2025
THPO, Penobscot Indian Nation	Letter by Mail on 3/14/2025
Tribal Chief, Penobscott Indian Nation	Letter by Mail on 3/14/2025
THPO, Wampanoag Tribe of Gay Head-Aquinnah	Letter by Mail on 3/14/2025
Mashantucket Pequot Tribal Nation, Eastern Area Office	Letter by Mail on 3/14/2025
Mohegan Tribal Council, Eastern Area Office	Letter by Mail on 3/14/2025
THPO, Narragansett Indian Tribe	Letter by Mail on 3/14/2025
THPO, Passamaquoddy Tribe	Letter by Mail on 3/14/2025

Estimated Project Implementation Timeline

Below is a summary of overall anticipated schedule. The schedule is based on the assumptions that: 1) Funding for planning would be received in time to sign a cooperative agreement by 9/30/25, 2) NHNRCS uses an engineering consultant to help with the design of improvements to the watershed.

Planning Start	10/2025
Planning End	10/2027
Design Start	4/2028
Design End	4/2030
Implementation Start	7/2030
Implementation End	7/2035

Recommendation

This preliminary investigation findings report has been completed and submitted for approval to Becky Ross, NH State Conservationist.

This report was prepared by the Pare Corporation and reviewed by Brian Eisenmann, Civil Engineer, NRCS – New Hampshire on 3/21/2025.

It has been determined that:

- Based on USGS watershed naming conventions, the potential project should be called the **Winnisquam Lake Watershed Project**.
- This potential PL-566 watershed operations project:

Does	Does Not	
■	☐	… meet the statutory acreage, volume/capacity of structure and recreational limit requirements;
■	☐	… meet the requirements of one or more Watershed Operations authorized purposes;
■	☐	… have the potential for a minimum of 20% agricultural, or rural, benefits;
■	☐	… have one or more viable alternatives;
■	☐	… have potential project sponsor(s) that meet and agree to all terms of responsibilities;
■	☐	… have apparent insurmountable obstacles.

Reviewer Signature (PARE Corp prepared with review from NRCS) Signature: Digitally signed by BRIAN EISENMANN Date: 2025.04.29 08:09:15 -04'00' Date: 4/29/25

State Watershed Operations Program Manager Signature: Date: 2025.04.29 13:31:26 -04'00' Date: 4/29/25

State Technical Lead (SRC, SCE, Other) (Someone other than the Program Manager) Signature: DONALD KEIRSTEAD Digitally signed by DONALD KEIRSTEAD Date: 2025.04.29 14:49:22 -04'00' Date: 4/29/25

✓	Not recommended for planning funding
	Accepted and recommended for Planning Funding

This project is not recommended as there is concern with the ability for continued maintenance of the proposed improvements based on previously installed BMPs. In addition, there are potential project constraints that could result in insurmountable obstacles associated with public opposition from residents that are concerned implementing new BMPs would have the potential for flooding their property. Lastly, several of the alternatives would not be covered by the project as the program does not cover transportation infrastructure such as road paving and road realignment.

State Conservationist Signature: Digitally signed by BECKY ROSS Date: 2025.04.30 08:46:12 -04'00' Date: 4/30/25

Glossary

Cooperating Agency – Federal, State, Tribal, or local agency with jurisdiction by law or special expertise with respect to any environmental impact involved in a proposal that has been designated by the lead agency. (40 CFR Part 1508 – Definitions)

Real Property Rights - The cost of real property rights includes all costs for the following items, including elements of work that involves planning, design, acquisition, construction, mitigation for fish and wildlife habitat losses, and administrative services directly associated with real property. All expenditures made in acquiring needed real property rights and other interests must follow the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (42 U.S.C. §§ 4601 et seq., as implemented by 49 CFR Part 24).

a. Removal of buildings, improvements, or timber for salvage or relocation, or the construction of dikes or other protective works. This does not include moving of buildings or other improvements from flood-prone to flood-free land as a nonstructural flood damage reduction measure.
b. Salvaging, moving, or reconstructing fences not needed for the proper operation, maintenance, public safety, or inspection of the works of improvement. This does not include constructing fences for conservation easements and fish and wildlife habitat loss mitigation requirements.
c. Changes of existing telephone, power, gas, water, and sewer lines or other utilities made necessary by the works of improvement, conservation easements, or fish and wildlife habitat loss mitigation requirements. For works of improvement, this does not include changes to existing irrigation or drainage facilities.
d. All new roads and changes of existing public roads or private roads, or railroad bridges, culverts, approaches, and other crossings, including approaches. This does not include costs of reinforcing, underpinning, or reconstructing existing bridge piers and abutments of public roads and railroads made necessary by channel modification. This also does not include the cost for the excavation and installation of a closed conduit crossing of a public road or railroad when it is an integral part of an overall closed conduit structural measure.
e. All modifications and changes of roads and railroads that must remain serviceable after project installation.
f. Premiums for construction liability insurance when someone other than the construction contractor is made the principal.
g. Relocation Costs. Pub. L. No. 83-566 costs and other costs associated with the requirements of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (49 CFR Part 24). Relocation payments include moving and related expenses for a displaced person, business, or farm operation as well as financial assistance for replacement housing for the displaced person who qualifies and whose dwelling is acquired because of the project. Costs above replacement in kind are treated as non-project costs.

[390 NWPM Part 500.80.14]
Real property rights as defined by NWPM Part 501.80.A.14 are not within the scope of the Watershed Protection and Flood Protection Operations Program. The full cost associated with these alternatives shall be undertaken by the sponsor

Rural or rural communities – All communities with a population of less than
50,000 according to the latest decennial census of the United States. [390 NWPM Part 506.0.A.73]

Stakeholder – any federal, state, tribal, or local government who might have an interest in the potential project (390 NWPM Part 501.C, 5th Ed, Jun 2024, 501.20.D.4.l)

Watershed – A watershed area comprises all land and water within the confines of a drainage divide and must follow hydrologic boundaries. In the case of irrigation or salinity projects, the watershed boundary may be based on the irrigation problem area or subsurface hydrologic area, respectively. A watershed area may comprise the land and water of two or more minor drainageways that are separate tributaries to a stream, artificial waterway, lake, or tidal area. Areas from which water is brought in by diversion may be excluded from the watershed if these sources of water have no significant effect on the flood prevention and water management problems of the watershed area. The watershed area must include all direct tributary drainageways and lands from which, after project installation, water and sediment could adversely affect any proposed structural measure, such as an irrigation or drainage canal, floodway, or floodwater retarding structure, included in the plan (390-506-M, 4th Ed, Apr 2014, NWPM Part 506.50 Glossary, TTT)

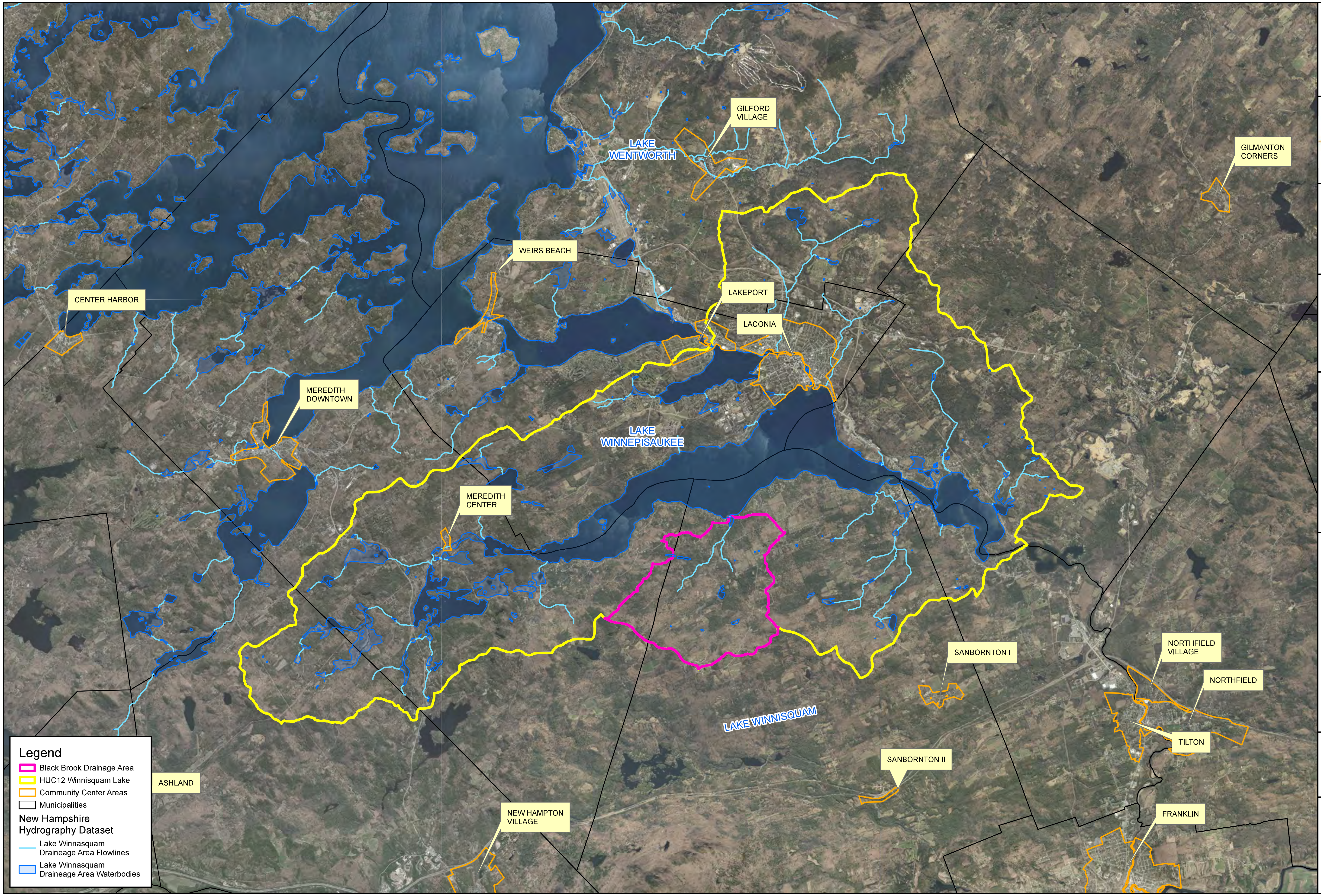
Watershed Program – The Watershed Program consists of activities carried out under the authority of Watershed Protection and Flood Prevention Act (Public Law 82-566, as amended), and the Flood Control Act of 1944 (Public Law 78-534 as amended). (390-506-M, 4th Ed., Apr 2014, NWPM Part 506.50 Glossary, UUU)

Appendices

- Appendix A: Exhibits
  - Exhibit 1: Lake Winnisquam – Annotated Aerial Photograph
  - Exhibit 2: Lake Winnisquam – Land Use
  - Exhibit 3: Site Location Map
  - Exhibit 4: Black Brook – Annotated Aerial Photograph
  - Exhibit 5: Black Brook – Land Use
- Appendix B: Sponsor Letter of Request
- Appendix C: WS-4 PIFR Sponsor Declaration Form
- Appendix D: CPA 52 Environmental Evaluation Worksheet
- Appendix E: Draft IPaC
- Appendix F: Forecasted NRCS Staffing Needs (POW)
- Appendix G: Lake Winnisquam Watershed-Based Plan dated July 2022
- Appendix H: Black Brook Remediation Plan Memorandum dated April 2022
- Appendix I: Black Brook Watershed Assessment Update Report dated December 2021
- Appendix J: Black Brook Watershed Management Plan dated September 2012

Appendix A:

Exhibits



PARE CORPORATION
ENGINEERS • SCIENTISTS • PLANNERS
8 BLACKSTONE VALLEY PLACE
LINCOLN, RI 02865
401-334-4100

NH GRANIT

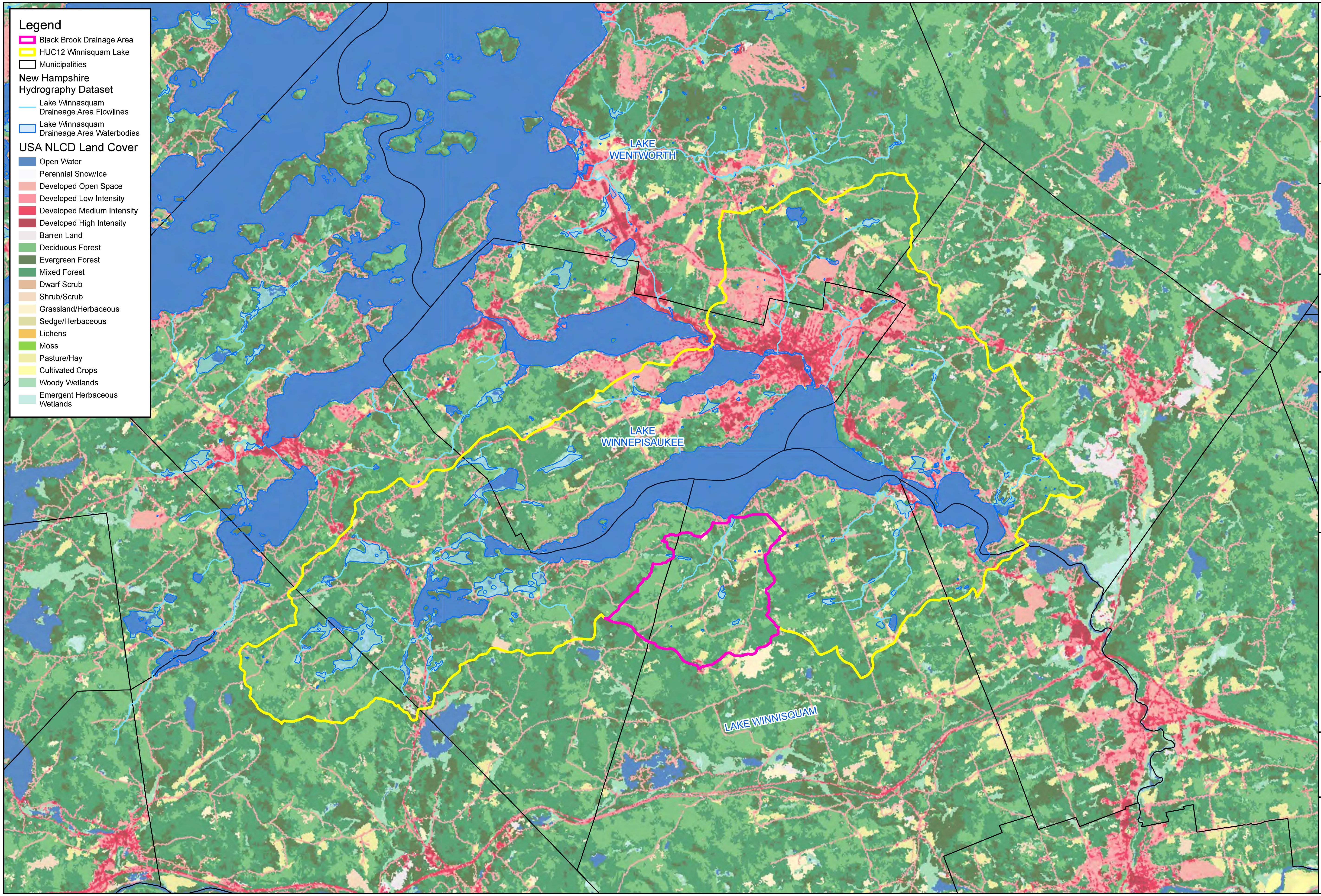
1 INCH = 8,000 FEET
0" 1"
BAR IS ONE INCH ON ORIGINAL DRAWING

N E S W

LAKE WINNISQUAM
SANBORNTON, NH

PROJECT NO.: 24226.00
DATE: FEBRUARY 2025
SCALE: AS NOTED

EXHIBIT 1: ANNOTATED AERIAL PHOTOGRAPH



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ENGINEERS - SCIENTISTS - PLANNERS
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LINCOLN, RI 02865
401-334-4100

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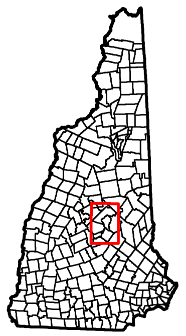
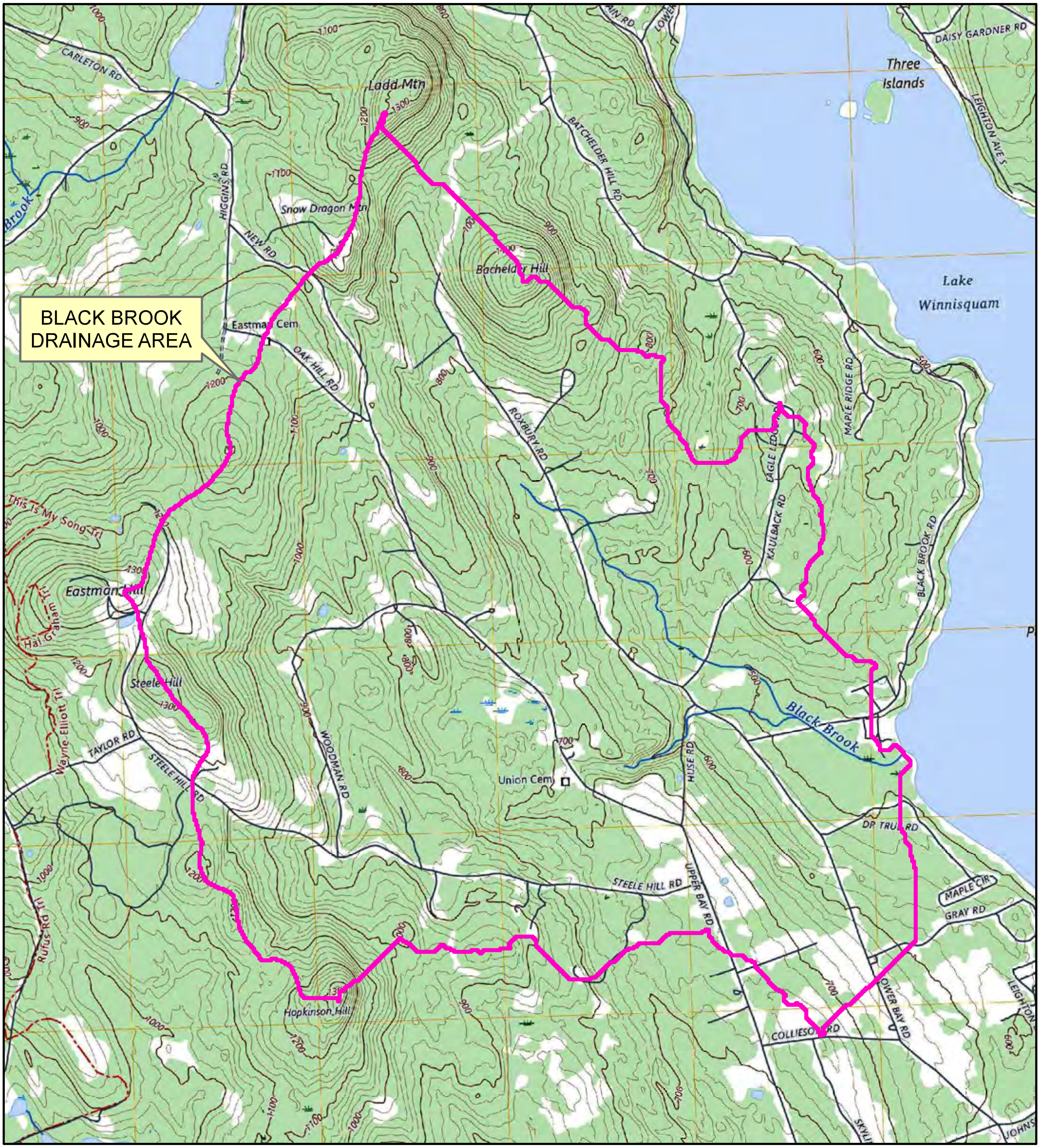


LAKE WINNISQUAM
SANBORNTON, NH

PROJECT NO.: 24226.00
DATE: FEBRUARY 2025
SCALE: AS NOTED

EXHIBIT 2: ANNOTATED AERIAL PHOTOGRAPH



SITE LOCATION MAP

SCALE: 1" = 2,500'

NH GRANIT

N
W E
S

8 BLACKSTONE VALLEY PLACE
LINCOLN, RI 02865
(401) 334-4100

10 LINCOLN ROAD, SUITE 210
FOXBORO, MA 02035
(508) 543-1755

PARE PROJECT No. 24226.00 FEBRUARY 2025

EXHIBIT 3

BLACK BROOK
SANBORTON, NH

PARE CORPORATION

ENGINEERS • SCIENTISTS • PLANNERS
8 BLACKSTONE VALLEY PLACE
LINCOLN, RI 02865
401-334-4100

NH GRANIT

1 INCH = 2,000 FEET
0" 1"
BAR IS ONE INCH ON ORIGINAL DRAWING

N
W E
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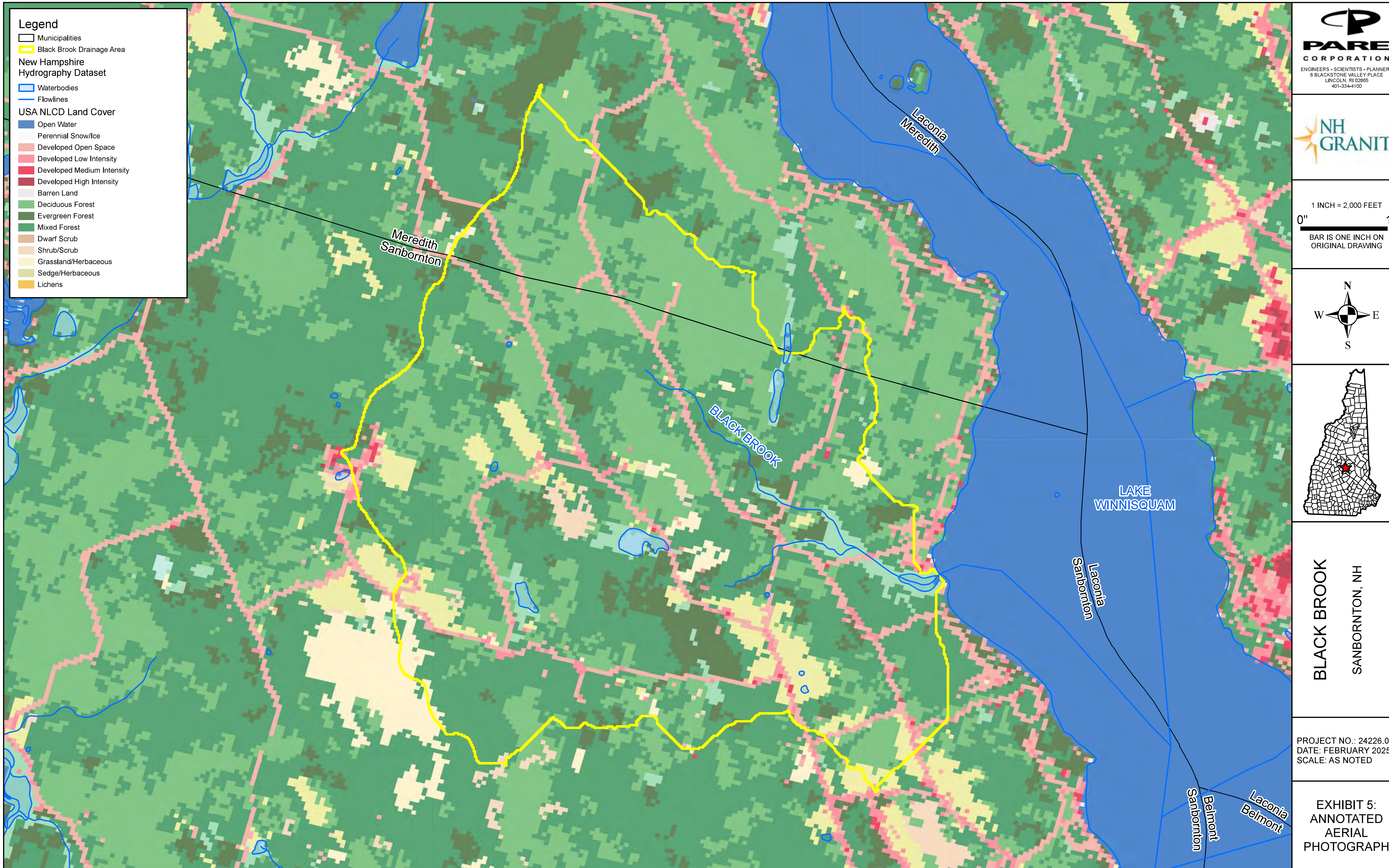
BLACK BROOK
SANBORNTON, NH

PROJECT NO.: 24226.00
DATE: FEBRUARY 2025
SCALE: AS NOTED

EXHIBIT 4: ANNOTATED AERIAL PHOTOGRAPH


Legend
Municipalities
Black Brook Drainage Area
New Hampshire Hydrography Dataset
Waterbodies
Flowlines
USA NLCD Land Cover
Open Water
Perennial Snow/Ice
Developed Open Space
Developed Low Intensity
Developed Medium Intensity
Developed High Intensity
Barren Land
Deciduous Forest
Evergreen Forest
Mixed Forest
Dwarf Scrub
Shrub/Scrub
Grassland/Herbaceous
Sedge/Herbaceous
Lichens
Meredith
Sanbornton
Laconia
Meredith
BLACK BROOK
LAKE WINNISQUAM
Laconia
Sanbornton
Sanbornton
Belmont
Laconia
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PARE
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W E
S
BLACK BROOK
SANBORNTON, NH
PROJECT NO.: 24226.00
DATE: FEBRUARY 2025
SCALE: AS NOTED
EXHIBIT 5: ANNOTATED AERIAL PHOTOGRAPH

Appendix B:

Sponsor Letter of Request

TOWN OF SANBORNTON
OFFICE OF THE TOWN ADMINISTRATOR
P.O. Box 124 • 17 Meetinghouse Hill Road
Sanbornton, New Hampshire 03269
603.729.8090

February 7, 2023

Becky Ross
State Conservationist
Natural Resources Conservation Service
273 Locust St, Suite 2D
Dover, NH 03820

Dear Conservationist Ross:

We request NRCS Watershed Program planning assistance for a potential Public Law (PL) 566 project in Belknap County, HUC 01070002 Black Brook. The project would allow for a feasibility study to see what types of design or engineer services could help mitigate sediment runoff into Lake Winnisquam. Protecting the watershed and the wildlife habitat is paramount for continued vitality of the resource.

We are a municipality with a legal interest in or responsibility for the watershed project proposed. We understand, as sponsors of a PL 566 planning effort, that our responsibilities will include:

- Assisting in the locally led planning effort,
- Contributing a share of the project costs, as determined by NRCS, by providing funds or eligible services necessary to undertake the activity,
- Before being credited with the value of any in-kind contributions for in-kind services and/or acquisition of land rights, Sponsor will sign a Memorandum of Understanding (MOU) with NRCS,
- Obtaining any necessary real property rights, by eminent domain, if necessary,
- Obtaining any needed water rights, and regulatory permits at the Sponsor's cost,
- Agreeing to provide for any required operation and maintenance of the completed measures.

We look forward to working with NRCS staff to complete a Preliminary Investigation Findings Report (PIFR) to provide reasonable assurance that a potential watershed project can be developed that addresses a PL 566 purpose and that there are no apparent insurmountable obstacles to the completion of that project.

The names, addresses, and telephone numbers of the administrative and technical contact persons in our organization are as follows:

Trish Stafford
Town Administrator
PO Box 124, Sanbornton, 03269
townadministrator@sanborntonnh.org
603.729.8090

Brad Crosby
Conservation Commission Chair
PO Box 124, Sanbornton, NH 03269
Bkcrosby2@myfairpoint.net
603.286.8605

Brandon Deacon
Selectboard Representative
PO Box 124, Sanbornton, NH 03269
Brandondeacon.nh@gmail.com
603.530.1702

Please contact them for any additional information that you might need in assessing our request.

Sincerely,

Trish Stafford
Town Administrator
Town of Sanbornton

Appendix C:

WS-4 PIFR Sponsor Declaration Form

State: NH County: Belknap Watershed: HUC 12 #: 010700020201

Project Name: Lake Winnisquam/Black Brook Watershed Protection

Sponsor's Name:	Town of Sanbornton, NH		
Sponsor's Mailing Address:	17 Meetinghouse Hill Rd, Sanbornton, NH 03269		
Contact Name:	Trish Stafford	**Phone:**	603-729-8090
Title:	Town Administrator	**Email:**	townadministrator@Sanborntonnh.org
Sponsor Website:	https://www.sanborntonnh.org/		

Description of the existing condition in the watershed that would be addressed through a Watershed Flood Prevention Operations program project.

- Lake Winnisquam is the fourth-largest lake entirely in New Hampshire and is a major natural resource for the state. In addition to being a major natural resource, home to many cold water fish such as rainbow trout, lake trout, landlocked salmon, and whitefish, it is also a major recreational and economic resource for rural communities surrounding the area. The lake offers numerous recreational activities such as boating, beaches, islands, hiking, rail biking, and golfing.
- Lake Winnisquam is a high-quality lake but has experienced threats to water quality in recent years. This threat is in the form of uncontrolled sediment transport into the waterbody through erosion, land management practices and other activities that have increased within the watershed.
- Previous studies suggest that the current loads of phosphorus to Lake Winnisquam should be maintained at the current in-lake phosphorus concentration. However, based on recent evaluations, the target value of 6.4 g/L should be coupled with a short-term goal of 6.1 g/L to allow for some inevitable future increases in phosphorus without compromising water quality. The potential projects will put primary emphasis on reducing watershed phosphorus through reduction in sediment sources over other sources due to the relative sediment load contribution from the watershed and practical implementation considerations.
- While the Black Brook watershed is only a small part of the greater Lake Winnisquam watershed, the potential projects for this watershed are expected to serve as a model for additional watersheds around the lake.

Potential benefits of a Watershed Flood Prevention Operations program project.

- Reduce sediment load and improve/protect water quality of Lake Winnisquam
- Improve aquatic habitats in Lake Winnisquam
- Improve the recreational value of the lake for public use

State: NH County: Belknap Watershed: HUC 12 #: 010700020201

Project Name: Lake Winnisquam/Black Brook Watershed Protection

-Potentially reduce road maintenance costs by reducing erosion at roadways within problem areas

SPONSOR WILL:

- Assist in the locally led planning effort: YES X NO ___
- Obtain needed land rights including the use of power of eminent domain, if necessary: YES X NO ___
- Provide local cost-share funds for the required portion of total project costs: YES X NO ___
- Provide Funds for continuing Operation and Maintenance actions: YES X NO ___
- Obtain required permits and approvals at Sponsor cost: YES X NO ___
- Provide leadership to help ensure adequate conservation land treatment measures are maintained on at least 50% of the watershed area above retention reservoirs: N/A ___ YES X NO ___

Authorized Representative of Sponsor

Name (printed): Trish Stafford **Title:** Town Administrator

Signature: [signature] **Date:** 2/28/25

Appendix D:

CPA-52 Environmental Evaluation Worksheet

U.S. Department of Agriculture — NRCS-CPA-52
Natural Resources Conservation Service — 04/2023

ENVIRONMENTAL EVALUATION WORKSHEET

A. Client Name: Town of Sanbornton

B. Conservation Plan ID # (as applicable):
Program Authority (optional): PL-566

C. Identification # (farm, tract, field #, etc. as required):
Winnisquam Lake (HUC 12 # 010700020201)

D. Client's Objective(s) (purpose):
The Town of Sanbornton seeks watershed improvements, specifically to improve water quality by eliminating the sediment transport and phosphorus loading along the tributaries leading to Lake Winnisquam, particularly Black Brook which has had erosion and sedimentation issues.

E. Need for Action:
Lake Winnisquam and the watershed as a whole has seen degraded water quality in the form of algal blooms caused by excess sediment transport and phosphorus loading.

H. Alternatives

No Action √ if RMS ☐	√ if RMS ☐	√ if RMS ☐
No Action does not meet the goals of the project as sediment transport and water quality concerns would continue to occur due to unmitigated erosion and soil loss.		

Resource Concerns

In Section "F" below, analyze, record, and address concerns identified through the Resources Inventory process (see FOTG Section 3 - Resource Concerns List and Planning Criteria for guidance).

F. Resource Concerns and Existing/ Benchmark Conditions (Analyze and record the existing/benchmark conditions for each identified concern)	**I. Effects of Alternatives** — ***No Action*** — **Amount, Status, Description** *(Document both short and long term impacts)*	√ if does NOT meet PC	**Amount, Status, Description** *(Document both short and long term impacts)*	√ if does NOT meet PC	**Amount, Status, Description** *(Document both short and long term impacts)*	√ if does NOT meet PC
SOIL						
Sheet and rill erosion Soils potential for erosion within the project area is moderate-high. Areas alongside roadways and areas with steep slopes are especially susceptible to erosion after heavy rains. K factors within the project area range from 0.10 to 0.37.	Sheet and rill erosion would continue to occur and cause issues in the short and long-term.	☐ NOT meet PC		☐ NOT meet PC		☐ NOT meet PC
Ephemeral gully erosion Soils have moderate-high runoff potential. Areas alongside roadways and areas with steep slopes are more problematic after heavy rains, causing gully erosion.	Ephemeral gully erosion would continue to occur and cause issues in the short and long-term.	☐ NOT meet PC		☐ NOT meet PC		☐ NOT meet PC
WATER						
Nutrients transported to surface water Nutrient enrichment (phosphorus) has been found in Lake Winnisquam and tributaries from point and non-point sources causing excess phosphorus levels and increased algal presence.	Nutrients would continue being carried to the Black Brook Watershed and Lake Winnisquam in the short and long-term.	☐ NOT meet PC		☐ NOT meet PC		☐ NOT meet PC
Sediment transported to surface water Erosion from gravel and paved roadways contributes sediment loads to Lake Winnisquam, Black Brook and other tributaries.	Sediments would continue being carried to the Black Brook Watershed and Lake Winnisquam in the short and long-term.	☐ NOT meet PC		☐ NOT meet PC		☐ NOT meet PC

F. Resource Concerns and Existing/ Benchmark Conditions (Analyze and record the existing/benchmark conditions for each identified concern)	I. Effects of Alternatives (continued)					
	No Action					
	Amount, Status, Description *(Document both short and long term impacts)*	**√ if does NOT meet PC**	**Amount, Status, Description** *(Document both short and long term impacts)*	**√ if does NOT meet PC**	**Amount, Status, Description** *(Document both short and long term impacts)*	**√ if does NOT meet PC**
AIR						
No resource concern identified		☐ NOT meet PC		☐ NOT meet PC		☐ NOT meet PC
PLANTS						
Plant structure and composition Roadways with high levels of erosion and runoff lack vegetation needed to mitigate nutrient and sediment loads.	Aquatic and riparian plants would continue being impacted by poor water quality in the short and long-term.	☐ NOT meet PC		☐ NOT meet PC		☐ NOT meet PC
ANIMALS						
Aquatic habitat for fish and other organisms Water quality and sediment loads degrade aquatic habitat.	Aquatic animals would continue being impacted by poor water quality and sediment loads in the short and long-term.	☐ NOT meet PC		☐ NOT meet PC		☐ NOT meet PC
Terrestrial habitat for wildlife and invertebrates Water quality and sediment loads degrade terrestrial habitat in riparian areas.	Terrestrial animals would continue being impacted by poor water quality and sediment loads in the short and long-term.	☐ NOT meet PC		☐ NOT meet PC		☐ NOT meet PC
ENERGY						
No resource concern identified		☐ NOT meet PC		☐ NOT meet PC		☐ NOT meet PC
Human Economic and Social Considerations						
Public Health and Safety Fish consumption was identified as an impaired parameter for Black Brook and Lake Winnisquam. Algal blooms occur in Lake Winnisquam.	Water quality issues could continue to get worse and ultimately worsen recreational opportunities, drinking water, and public health in the short and long term. Harmful algal blooms could occur in Lake Winnisquam that can cause a series of different ailments if humans are exposed.					

Special Environmental Concerns: Environmental Laws, Executive Orders, Policies, etc.

In Section "G" complete and attach Environmental Procedures Guide Sheets for documentation as applicable. Items with a "•" may require a federal permit or consultation/coordination between the lead agency and another government agency. In these cases, effects may need to be determined in consultation with another agency. Planning and practice implementation may proceed for practices not involved in consultation.

G. Special Environmental Concerns (Document existing/ benchmark conditions)	**J. Impacts to Special Environmental Concerns** — ***No Action*** Document all impacts (Attach Guide Sheets as applicable)	√ if does NOT meet	Document all impacts (Attach Guide Sheets as applicable)	√ if needs further action	Document all impacts (Attach Guide Sheets as applicable)	√ if needs further action
•Clean Air Act *Guide Sheet* Belknap County is in Attainment Status for National Ambient Air Quality Standards.	No Effect	[ ]	No Effect	[ ]	No Effect	[ ]
•Clean Water Act / Waters of the U.S. *Guide Sheet* The brook and wetlands will be considered as waters of the US.	May Affect Water quality would likely continue to worsen both in Black Brook and Lake Winnisquam.	[ ]	No Effect	[ ]	No Effect	[ ]
•Coastal Zone Management *Guide Sheet* Not present.	No Effect Not applicable.	[ ]	No Effect	[ ]	No Effect	[ ]
Coral Reefs *Guide Sheet* Not present.	No Effect Not applicable.	[ ]	No Effect	[ ]	No Effect	[ ]
•Cultural Resources / Historic Properties *Guide Sheet* Federally listed historic properties are present in the Black Brook Watershed.	No Effect	[ ]	No Effect	[ ]	No Effect	[ ]
•Endangered and Threatened Species *Guide Sheet* Three ESA listed species may be present in the Project Area: Tricolored Bat, Northern Long-Eared Bat, (critical habitat is adjacent), and Monarch Butterfly. A federally threatened species, small whorled pogonia *(Isotria medeoloides*), exists in Belknap County.	May Affect Impaired water quality and sediment transport could impact special status species habitat in the long-term.	[ ]	No Effect	[ ]	No Effect	[ ]
Environmental Justice *Guide Sheet* Project area has overlap with several environmental burden factors including drinking water non-compliance and flood risk.	May Affect Continued worsening of water quality and roadways would negatively impact burdened communities in the long term.	[ ]	No Effect	[ ]	No Effect	[x]
•Essential Fish Habitat *Guide Sheet* Not present.	No Effect Not applicable.	[ ]	No Effect	[ ]	No Effect	[ ]
Floodplain Management *Guide Sheet* Many parcels are not mapped or digitally available. Known Zones C with 0.2% chance of annual flooding exist in the Black Brook.	May Affect Floods would continue to occur and negatively impact roads and developed areas.	[ ]	May Affect	[ ]	May Affect	[ ]

Invasive Species *Guide Sheet* Sixteen invasive insect species have been detected within the county and several invasive plants have also been found.	May Affect It is unclear what the impact in the short and long-term would be for invasive species with no action. Generalists, including invasive species, are more likely to succeed in degraded habitat and within impaired waters, while native species may suffer more.	☐	No Effect	☐	No Effect	☐
•Migratory Birds/Bald and Golden Eagle Protection Act *Guide Sheet* Migratory birds and eagles may utilize the watershed habitats. There are 14 birds of special concern, including bald eagles, potentially present in the site.	May Affect Impaired water quality and sediment transport could impact bird habitat and foraging in the long-term.	☐	No Effect	☐	No Effect	☐
Natural Areas *Guide Sheet* There are two conservation easements that overlap the project area.	No Effect	☐	No Effect	☐	No Effect	☑
Prime and Unique Farmlands *Guide Sheet* Prime farmland, farmland of local importance and farmland of statewide importance is present in the watershed.	No Effect	☐	No Effect	☐	No Effect	☑
Riparian Area *Guide Sheet* Riparian Area exists along all wetlands, ponds, and brooks within the project area.	May Affect Riparian areas may worsen with continued floods and erosion.	☐	No Effect	☐	No Effect	☐
Scenic Beauty *Guide Sheet* The area is forested and has many wetlands and ponds providing scenic beauty.	May Affect Continued sediment erosion and debris build-up would worsen the scenic beauty in the long-term.	☐	No Effect	☐	No Effect	☐
•Wetlands *Guide Sheet* There are over 22 acres of wetlands within the project area.	May Affect Wetlands would continue to be degraded with poor water quality.	☐	No Effect	☐	No Effect	☐
•Wild and Scenic Rivers *Guide Sheet* Not present.	No Effect Not applicable.	☐	No Effect	☐	No Effect	☐

K. Other Agencies and Broad Public Concerns	*No Action*		
Easements, Permissions, Public Review, or Permits Required and Agencies Consulted.			
Cumulative Effects Narrative (Describe the cumulative impacts considered, including past, present and known future actions regardless of who performed the actions)			
L. Mitigation (Record actions to avoid, minimize, and compensate)			
M. Preferred Alternative – √ preferred alternative	☐	☐	☐
M. Preferred Alternative – Supporting reason			

N. Context (Record context of alternatives analysis) The significance of an action must be analyzed in several contexts such as society as a whole (human, national), the affected region, the affected interests, and the locality.	
	-Town or city
	-County
	-Sub-watershed (ex. 12-digit HUC, or smaller)

O. To the best of my knowledge, the data shown on this form is accurate and complete:

In the case where a non-NRCS person (e.g. a TSP) assists with planning they are to sign the first signature block and then NRCS is to sign the second block to verify the information's accuracy.

Signature (TSP if applicable)	Title	Date
Jelena Grbic [signature]	Environmental Scientist	4/28/2025

Signature (NRCS)	Title	Date
KELLY BOLAND Digitally signed by KELLY BOLAND Date: 2025.04.29 12:53:33 -04'00'	State Biologist	4/29/25

If preferred alternative is not a federal action where NRCS has control or responsibility and this NRCS-CPA-52 is shared with someone other than the client, then indicate to whom this is being provided.

-Other (please describe:______________________________)	Town of Sanbornton

The following sections are to be completed by the Responsible Federal Official (RFO)

NRCS is the RFO if the action is subject to NRCS control and responsibility (e.g., actions financed, funded, assisted, conducted, regulated, or approved by NRCS). These actions do not include situations in which NRCS is only providing technical assistance because NRCS cannot control what the client ultimately does with that assistance and situations where NRCS is making a technical determination (such as Farm Bill HEL or wetland determinations) not associated with the planning process.

P. Determination of Significance or Extraordinary Circumstances

To answer the questions below, consider the severity (intensity) of impacts in the contexts identified above. Impacts may be both beneficial and adverse. A significant effect may exist even if the Federal agency believes that on balance the effect will be beneficial. Significance cannot be avoided by terming an action temporary or by breaking it down into small component parts.

If you answer ANY of the below questions "yes" then contact the State Environmental Liaison as there may be extraordinary circumstances and significance issues to consider and a site specific NEPA analysis may be required.

Yes	No	
☐	☑	• Is the preferred alternative expected to cause significant effects on public health or safety?
☐	☑	• Is the preferred alternative expected to significantly affect unique characteristics of the geographic area such as proximity to historic or cultural resources, park lands, prime farmlands, wetlands, wild and scenic rivers, or ecologically critical areas?
☑	☐	• Are the effects of the preferred alternative on the quality of the human environment likely to be highly controversial?
☐	☑	• Does the preferred alternative have highly uncertain effects or involve unique or unknown risks on the human environment?
☐	☑	• Does the preferred alternative establish a precedent for future actions with significant impacts or represent a decision in principle about a future consideration?
☐	☑	• Is the preferred alternative known or reasonably expected to have potentially significant environment impacts to the quality of the human environment either individually or cumulatively over time?
☑	☐	• Will the preferred alternative likely have a significant adverse effect on ANY of the special environmental concerns? Use the Evaluation Procedure Guide Sheets to assist in this determination. This includes, but is not limited to, concerns such as cultural or historical resources, endangered and threatened species, environmental justice, wetlands, floodplains, coastal zones, coral reefs, essential fish habitat, wild and scenic rivers, clean air, riparian areas, natural areas, and invasive species.
☐	☑	• Will the preferred alternative threaten a violation of Federal, State, or local law or requirements for the protection of the environment?

Q. NEPA Compliance Finding (check one)

The preferred alternative:		Action required
☐	1) is **not a federal action** where the agency has control or responsibility.	Document in "R.1" below. No additional analysis is required
☐	2) is a federal action **ALL** of which is **categorically excluded** from further environmental analysis **AND** there are **no extraordinary circumstances as identified in Section "P".**	Document in "R.2" below. No additional analysis is required
☐	3) is a federal action that has been **sufficiently analyzed** in an existing Agency state, regional, or national NEPA document **and** there are no predicted significant adverse environmental effects or extraordinary circumstances.	Document in "R.1" below. No additional analysis is required.
☐	4) is a federal action that has been sufficiently analyzed in another Federal agency's NEPA document (EA or EIS) that addresses the proposed NRCS action and its' effects **and has been formally adopted by NRCS**. NRCS is required to prepare and publish its own Finding of No Significant Impact for an EA or Record of Decision for an EIS when adopting another agency's EA or EIS document. (**Note: This box is not applicable to FSA**)	Contact the State Environmental Compliance Liaison for list of NEPA documents formally adopted and available for tiering. Document in "R.1" below. No additional analysis is required
✓	5) is a federal action that has **NOT** been sufficiently analyzed or may involve predicted significant adverse environmental effects or extraordinary circumstances and may require an EA or EIS.	Contact the State Environmental Compliance Liaison. Further NEPA analysis required. Explain in Notes Section.

R. Rationale Supporting the Finding

R.1 Findings Documentation	EIS necessary
R.2 Applicable Categorical Exclusion(s) **(more than one may apply)** 7 CFR Part 650 *Compliance With NEPA*, subpart 650.6 *Categorical Exclusions* states prior to determining that a proposed action is categorically excluded under paragraph (d) of this section, the proposed action must meet six sideboard criteria. See NECH 610.116.	

I have considered the effects of the alternatives on the Resource Concerns, Economic and Social Considerations, Special Environmental Concerns, and Extraordinary Circumstances as defined by Agency regulation and policy and based on that made the finding indicated above.

S. Signature of Responsible Federal Official:

Becky L Ross — Digitally signed by BECKY ROSS Date: 2025.04.30 10:38:24 -04'00'	State Conservationist	4/30/25
Signature	**Title**	**Date**

Additional Notes

U.S. Department of Agriculture — Natural Resources Conservation Service — NRCS-CPA-52 04/2023

ENVIRONMENTAL EVALUATION WORKSHEET

A. Client Name: Town of Sanbornton

B. Conservation Plan ID # (as applicable):
Program Authority (optional): PL-566

C. Identification # (farm, tract, field #, etc. as required):
Winnisquam Lake (HUC 12 # 010700020201)

D. Client's Objective(s) (purpose):
The Town of Sanbornton seeks watershed improvements, specifically to improve water quality by eliminating the sediment transport and phosphorus loading along the tributaries leading to Lake Winnisquam, particularly Black Brook which has had erosion and sedimentation issues.

E. Need for Action:
Lake Winnisquam and the watershed as a whole has seen degraded water quality in the form of algal blooms caused by excess sediment transport and phosphorus loading.

H. Alternatives

Alternative 1 √ if RMS ☐	Alternative 2 √ if RMS ☐	Alternative 3 √ if RMS ☐
Alternative 1 (Non-Structural) includes addressing the Huse Road priority sites, implement local ordinances to reduce sediment loads, implement/require BMPs for agricultural and timber harvesting activities, and basin wide coordination focusing on education and outreach programs, water quality monitoring, and continued project identification.	Implement all alternatives within Alternative 1, as well as implement structural work plans including: implementing recommendations along key roadways, and implementing structural and non-structural BMPs for point and non-point sources.	Implement all alternatives within 1 and 2, plus additional measures, including redesigning and reconstructing problem roadways, implementing roadway stormwater improvements, widespread land purchace for long-term conservation, and comprehensive planning efforts as previously recommended.

Resource Concerns

In Section "F" below, analyze, record, and address concerns identified through the Resources Inventory process (see FOTG Section 3 - Resource Concerns List and Planning Criteria for guidance).

F. Resource Concerns and Existing/ Benchmark Conditions (Analyze and record the existing/benchmark conditions for each identified concern)	I. Effects of Alternatives — Alternative 1: Amount, Status, Description (Document both short and long term impacts)	√ if does NOT meet PC	Alternative 2: Amount, Status, Description (Document both short and long term impacts)	√ if does NOT meet PC	Alternative 3: Amount, Status, Description (Document both short and long term impacts)	√ if does NOT meet PC
SOIL						
Sheet and rill erosion Soils potential for erosion within the project area is moderate-high. Areas alongside roadways and areas with steep slopes are especially susecptiable to erosion after heavy rains. K factors within the project area range from 0.10 to 0.37.	If implemented, non-structural work could reduce sheet and rill erosion in the short and long term. Short term construction work impacts are expected.	☐ NOT meet PC	Addressing roadway sedimentation issues and other solutions will reduce sheet and rill erosion in the short and long term. Short term construction work impacts are expected.	☐ NOT meet PC	Addressing roadway sedimentation issues and other solutions will significantly reduce sheet and rill erosion in the short and long term. Short term construction work impacts are expected.	☐ NOT meet PC
Ephemeral gully erosion Soils have moderate-high runoff potential. Areas alongside roadways and areas with steep slopes are more problematic after heavy rains, causing gully erosion.	If implemented, non-structural work could reduce ephemeral gully erosion in the short and long term. Short term construction work impacts are expected.	☐ NOT meet PC	Addressing roadway sedimentation issues and other solutions will reduce ephemeral gully erosion in the short and long term. Short term construction work impacts are expected.	☐ NOT meet PC	Addressing roadway sedimentation issues and other solutions will significantly reduce ephemeral gully erosion in the short and long term. Short term construction work impacts are expected.	☐ NOT meet PC
WATER						
Nutrients transported to surface water Nutrient enrichment (phosphorus) has been found in Lake Winnisquam and tributaries from point and non-point sources causing excess phosphorus levels and increased algal presence.	If implemented, non-structural work could reduce nutrient enrichment. Short term construction work impacts are expected.	☐ NOT meet PC	Nutrient enrichment in WOTUS would decrease with roadway improvements, riparian restoration work, and erosion controls. Short term construction work impacts are expected.	☐ NOT meet PC	Nutrient levels may return to normal conditions in WOTUS with comprehensive roadway improvements, riparian restoration work, erosion controls and extensive land conservation measures. Short term construction work impacts are expected.	☐ NOT meet PC
Sediment transported to surface water Erosion from gravel and paved roadways contributes sediment loads to Lake Winnisquam, Black Brook and other tributaries.	If implemented, non-structural work could reduce sedimentation. Short term construction work impacts are expected.	☐ NOT meet PC	Sediment inputs in WOTUS would decrease with roadway improvements, riparian restoration work, and erosion controls. Short term construction work impacts are expected.	☐ NOT meet PC	Sediment inputs may return to normal conditions in WOTUS with comprehensive roadway improvements, riparian restoration work, erosion controls and extensive land conservation measures. Short term construction work impacts are expected.	☐ NOT meet PC

F. Resource Concerns and Existing/ Benchmark Conditions (Analyze and record the existing/benchmark conditions for each identified concern)	I. Effects of Alternatives (continued)					
	Alternative 1		*Alternative 2*		*Alternative 3*	
	Amount, Status, Description *(Document both short and long term impacts)*	√ if does NOT meet PC	**Amount, Status, Description** *(Document both short and long term impacts)*	√ if does NOT meet PC	**Amount, Status, Description** *(Document both short and long term impacts)*	√ if does NOT meet PC
AIR						
No resource concern identified		☐ NOT meet PC		☐ NOT meet PC		☐ NOT meet PC
PLANTS						
Plant productivity and health	Short term negative impacts to plants may occur with construction, so impacts should be mitigated.	☐ NOT meet PC	Short term negative impacts to plants may occur with construction, so impacts should be mitigated. Long term benefits are expected for plant health.	☐ NOT meet PC	Short term negative impacts to plants may occur with construction, so impacts should be mitigated. Long term benefits are expected for plant health.	☐ NOT meet PC
Plant structure and composition Roadways with high levels of erosion and runoff lack vegetation needed to mitigate nutrient and sediment loads.	Short term negative impacts to roadway vegetation may occur with construction, so impacts should be mitigated.	☐ NOT meet PC	Short term negative impacts to roadway vegetation may occur with construction, so impacts should be mitigated. BMPs and shoulder improvements would long-term restore vegetation.	☐ NOT meet PC	Short term negative impacts to roadway vegetation may occur with construction, so impacts should be mitigated. BMPs and shoulder improvements would long-term restore vegetation.	☐ NOT meet PC
ANIMALS						
Aquatic habitat for fish and other organisms Water quality and sediment loads degrade aquatic habitat.	If implemented, non-structural work could improve aquatic habitat. Short term construction work impacts are expected.	☐ NOT meet PC	Reducing nutrient and sediment loads with strucutral work would improve aquatic habitat. Short term construction work impacts are expected.	☐ NOT meet PC	Reducing nutrient and sediment loads with extensive restoration work would improve aquatic habitat. Short term construction work impacts are expected.	☐ NOT meet PC
ENERGY						
No resource concern identified		☐ NOT meet PC		☐ NOT meet PC		☐ NOT meet PC
Human Economic and Social Considerations						
Land Use Cropland, rural urban areas, and forest and open water or wetlands are present.	Short term construction work impacts are expected.		Short term construction work impacts are expected.		Short term construction impacts may occur. riparian conservation and restoration (i.e. purchasing of land) would change land use.	
Capital	The total cost is yet unknown, and will vary by each action undertaken.		The total cost is yet unknown, and will vary by each action undertaken.		The cost of buying lands for conservation purposes would be costly for the clients.	

Special Environmental Concerns: Environmental Laws, Executive Orders, Policies, etc.

In Section "G" complete and attach Environmental Procedures Guide Sheets for documentation as applicable. Items with a "•" may require a federal permit or consultation/coordination between the lead agency and another government agency. In these cases, effects may need to be determined in consultation with another agency. Planning and practice implementation may proceed for practices not involved in consultation.

G. Special Environmental Concerns (Document existing/ benchmark conditions)	**J. Impacts to Special Environmental Concerns** — ***Alternative 1*** — Document all impacts (Attach Guide Sheets as applicable)	√ if does NOT meet	***Alternative 2*** — Document all impacts (Attach Guide Sheets as applicable)	√ if needs further action	***Alternative 3*** — Document all impacts (Attach Guide Sheets as applicable)	√ if needs further action
•Clean Air Act *Guide Sheet* Belknap County is in Attainment Status for National Ambient Air Quality Standards.	May Affect Fugitive dust and emissions from idling construction vehicles would occur during construction only and all CAA restrictions would be followed.	☐	May Affect Fugitive dust and emissions from idling construction vehicles would occur during construction only and all CAA restrictions would be followed.	☐	May Affect Fugitive dust and emissions from idling construction vehicles would occur during construction only and all CAA restrictions would be followed.	☐
•Clean Water Act / Waters of the U.S. *Guide Sheet* The brook and wetlands will be considered as waters of the US.	May Affect If implemented, restoration work could improve water quality issues. Short term construction work impacts are expected.	☐	May Affect Roadway improvements and BMPs would improve water quality by reducing nutrient inputs and sedimentation. Short term construction work impacts are expected.	☐	May Affect Riparian restoration and BMPs would improve water quality by reducing nutrient inputs and sedimentation. Short term construction work impacts are expected.	☐
•Coastal Zone Management *Guide Sheet* Not present.	No Effect Not applicable.	☐	No Effect Not applicable.	☐	No Effect Not applicable.	☐
Coral Reefs *Guide Sheet* Not present.	No Effect Not applicable.	☐	No Effect Not applicable.	☐	No Effect Not applicable.	☐
•Cultural Resources / Historic Properties *Guide Sheet* Federally listed historic properties are present in the Black Brook Watershed.	No Effect Nonstructural work is not expected to have an impact to the historic properties.	☐	No Effect Possible roadway improvements and BMPs are not expected to take place near the historic properties.	☐	May Affect Possible roadway improvements and BMPs are not expected to take place near the historic properties. However, if identifed as an additonal sediment input site, there could be construction impacts to the property.	☑
•Endangered and Threatened Species *Guide Sheet* Three ESA listed species may be present in the Project Area: Tricolored Bat, Northern Long-Eared Bat, (critical habitat is adjacent), and Monarch Butterfly. A federally threatened species, small whorled pogonia *(Isotria medeoloides*), exists in Belknap County.	May Affect If implemented, habitat may be improved by non-structural work. Short term construction work impacts are expected and may impact state-listed species if present.	☐	May Affect If implemented, habitat may be improved by structural work such as roadway and riparian buffer improvements and BMP implementation. Short term construction work impacts are expected and may impact state-listed species if present.	☐	May Affect If implemented, habitat may be greatly imporved by structural work such as roadway and riparian buffer improvements, BMP implementation, and land conservation. Short term construction work impacts are expected and may impact state-listed species if present.	☐
Environmental Justice *Guide Sheet* Project area has overlap with several environmental burden factors including drinking water non-compliance and flood risk.	May Affect Improving water quality and roadways would positively impact burdened communities in the long term.	☐	May Affect Improving water quality and roadways would positively impact burdened communities in the long term.	☐	May Affect Improving water quality and roadways would positively impact burdened communities in the long term. Displacement of disadvantaged communities is possible with purchasing land for conservation, and should be carefully planned to not occur/burden communities.	☑
•Essential Fish Habitat *Guide Sheet* Not present.	No Effect Not applicable.	☐	No Effect Not applicable.	☐	No Effect Not applicable.	☐
Floodplain Management *Guide Sheet* Many parcels are not mapped or digitally available. Known Zones C with 0.2% chance of annual flooding exist in the Black Brook.	May Affect Non-structural improvements would decrease risk of flooding. Short term construction work impacts are expected to negatively impact the floodplain.	☐	May Affect Riparian buffer and roadway improvements and BMPs would decrease risk of flooding. Short term construction work impacts are expected to negatively impact the floodplain.	☐	May Affect Comprehensive structural work including Riparian buffer and floodplain restoration would decrease or fully ameliorate risk of flooding. Short term construction work impacts are expected to negatively impact the floodplain.	☐

Invasive Species *Guide Sheet* Sixteen invasive insect species have been detected within the county and several invasive plants have also been found.	May Affect If any non-structural restoration is implemented, water and habitat quality may improve and provide better habitat for native species to compete with invasive species. BMPs will be developed to mitigate spread of invasive species.	☑	May Affect If any structural restoration is implemented such as roadway and riparian buffer improvements, water and habitat quality may improve and provide better habitat for native species to compete with invasive species. BMPs will be developed to mitigate spread of invasive species.	☑	May Affect If any comprehensive restoration is implemented such as roadway and riparian buffer improvements, BMP implementation, and land conservation, water and habitat quality may improve and provide better habitat for native species to compete with invasive species. BMPs will be developed to mitigate spread of invasive species.	☑
●Migratory Birds/Bald and Golden Eagle Protection Act *Guide Sheet* Migratory birds and eagles may utilize the watershed habitats. There are 14 birds of special concern, including bald eagles, potentially present in the site.	May Affect BMPs would be implemented to mitigate disruptions to bald eagle and migratory bird areas of use in the short and long term.	☑	May Affect BMPs would be implemented to mitigate disruptions to bald eagle and migratory bird areas of use in the short and long term.	☑	May Affect BMPs would be implemented to mitigate disruptions to bald eagle and migratory bird areas of use in the short and long term.	☑
Natural Areas *Guide Sheet* There are two conservation easements that overlap the project area.	May Affect Current Natural Areas may be impacted with potential non-structural work.	☐	May Affect Additional Natural Areas may establish with structrual work. Negative impacts are possible if project planning to avoid impacts are not implemented.	☐	May Affect Additional Natural Areas are more likely to establish with the conservation of land and floodplain restoration. There may be negative impacts to existing natural areas.	☑
Prime and Unique Farmlands *Guide Sheet* Prime farmland, farmland of local importance and farmland of statewide importance is present in the watershed.	May Affect Short term construction work impacts are expected, if implemented on prime and unique farmland.	☐	May Affect Short term construction work impacts are expected, if implemented on prime and unique farmland.	☐	May Affect If farmlands are purchased for conservation measures, prime and unique farmlands may be negatively impacted.	☑
Riparian Area *Guide Sheet* Riparian Area exists along all wetlands, ponds, and brooks within the project area.	May Affect Riparian areas might be improved, if restoration work is implemented. Short term construction work impacts are expected.	☐	May Affect Riparian areas would be improved. Short term construction work impacts are expected.	☐	May Affect Riparian areas would be improved. Short term construction work impacts are expected.	☐
Scenic Beauty *Guide Sheet* The area is forested and has many wetlands and ponds providing scenic beauty.	May Affect If implemented, non-structural work in riparian areas could increase scenic beauty. Short term construction work impacts are expected.	☐	May Affect The restoration riparian buffers would increase scenic beauty. Short term construction work impacts are expected.	☐	May Affect The conservation and restoration of riparian and floodplain areas would increase scenic beauty. Short term construction work impacts are expected.	☐
●Wetlands *Guide Sheet* There are over 22 acres of wetlands within the project area.	May Affect If implemented, non-structural improvements would enhance wetlands. Short term construction work impacts are expected.	☐	May Affect Roadway and riparian area improvements would enhance wetlands. Short term construction work impacts are expected.	☐	May Affect The conservation and restoration of riparian and floodplain areas would further restore wetlands to natural functioning. Short term construction work impacts are expected.	☐
●Wild and Scenic Rivers *Guide Sheet* Not present.	No Effect Not applicable.	☐	No Effect Not applicable.	☐	No Effect Not applicable.	☐

K. Other Agencies and Broad Public Concerns		Alternative 1	Alternative 2	Alternative 3
Easements, Permissions, Public Review, or Permits Required and Agencies Consulted.				
Cumulative Effects Narrative (Describe the cumulative impacts considered, including past, present and known future actions regardless of who performed the actions)				
L. Mitigation (Record actions to avoid, minimize, and compensate)		Potential effects to wetlands and WOTUS, prime and unique farmlands, migratory birds, and riparian habitat.	Potential effects to wetlands and WOTUS, prime and unique farmlands, migratory birds, and riparian habitat.	Potential effects to wetlands and WOTUS, prime and unique farmlands, migratory birds, riparian habitat, environmental justice and cultural resources.
M. Preferred Alternative	√ preferred alternative	☐	☑	☐
	Supporting reason			

N. Context (Record context of alternatives analysis) The significance of an action must be analyzed in several contexts such as society as a whole (human, national), the affected region, the affected interests, and the locality.	
	-Town or city
	-County
	-Sub-watershed (ex. 12-digit HUC, or smaller)

O. To the best of my knowledge, the data shown on this form is accurate and complete:

In the case where a non-NRCS person (e.g. a TSP) assists with planning they are to sign the first signature block and then NRCS is to sign the second block to verify the information's accuracy.

Signature (TSP if applicable)	Title	Date
Jelena Grbic [signature]	Environmental Scientist	4/28/2025

Signature (NRCS)	Title	Date
KELLY BOLAND Digitally signed by KELLY BOLAND Date: 2025.04.29 12:55:09 -04'00'	State Biologist	4/29/25

If preferred alternative is not a federal action where NRCS has control or responsibility and this NRCS-CPA-52 is shared with someone other than the client, then indicate to whom this is being provided.

-Other (please describe:________________________)	Town of Sanbornton

The following sections are to be completed by the Responsible Federal Official (RFO)

NRCS is the RFO if the action is subject to NRCS control and responsibility (e.g., actions financed, funded, assisted, conducted, regulated, or approved by NRCS). These actions do not include situations in which NRCS is only providing technical assistance because NRCS cannot control what the client ultimately does with that assistance and situations where NRCS is making a technical determination (such as Farm Bill HEL or wetland determinations) not associated with the planning process.

P. Determination of Significance or Extraordinary Circumstances

To answer the questions below, consider the severity (intensity) of impacts in the contexts identified above. Impacts may be both beneficial and adverse. A significant effect may exist even if the Federal agency believes that on balance the effect will be beneficial. Significance cannot be avoided by terming an action temporary or by breaking it down into small component parts.

If you answer ANY of the below questions "yes" then contact the State Environmental Liaison as there may be extraordinary circumstances and significance issues to consider and a site specific NEPA analysis may be required.

Yes	No	
☐	☑	Is the preferred alternative expected to cause significant effects on public health or safety?
☐	☑	Is the preferred alternative expected to significantly affect unique characteristics of the geographic area such as proximity to historic or cultural resources, park lands, prime farmlands, wetlands, wild and scenic rivers, or ecologically critical areas?
☑	☐	Are the effects of the preferred alternative on the quality of the human environment likely to be highly controversial?
☐	☑	Does the preferred alternative have highly uncertain effects or involve unique or unknown risks on the human environment?
☐	☑	Does the preferred alternative establish a precedent for future actions with significant impacts or represent a decision in principle about a future consideration?
☐	☑	Is the preferred alternative known or reasonably expected to have potentially significant environment impacts to the quality of the human environment either individually or cumulatively over time?
☑	☐	Will the preferred alternative likely have a significant adverse effect on ANY of the special environmental concerns? Use the Evaluation Procedure Guide Sheets to assist in this determination. This includes, but is not limited to, concerns such as cultural or historical resources, endangered and threatened species, environmental justice, wetlands, floodplains, coastal zones, coral reefs, essential fish habitat, wild and scenic rivers, clean air, riparian areas, natural areas, and invasive species.
☐	☑	Will the preferred alternative threaten a violation of Federal, State, or local law or requirements for the protection of the environment?

Q. NEPA Compliance Finding (check one)

The preferred alternative:		Action required
☐	1) is **not a federal action** where the agency has control or responsibility.	Document in "R.1" below. No additional analysis is required
☐	2) is a federal action **ALL** of which is **categorically excluded** from further environmental analysis **AND** there are **no extraordinary circumstances as identified in Section "P".**	Document in "R.2" below. No additional analysis is required
☐	3) is a federal action that has been **sufficiently analyzed** in an existing Agency state, regional, or national NEPA document **and** there are no predicted significant adverse environmental effects or extraordinary circumstances.	Document in "R.1" below. No additional analysis is required.
☐	4) is a federal action that has been sufficiently analyzed in another Federal agency's NEPA document (EA or EIS) that addresses the proposed NRCS action and its' effects **and has been formally adopted by NRCS**. NRCS is required to prepare and publish its own Finding of No Significant Impact for an EA or Record of Decision for an EIS when adopting another agency's EA or EIS document. (**Note: This box is not applicable to FSA**)	Contact the State Environmental Compliance Liaison for list of NEPA documents formally adopted and available for tiering. Document in "R.1" below. No additional analysis is required
☑	5) is a federal action that has **NOT** been sufficiently analyzed or may involve predicted significant adverse environmental effects or extraordinary circumstances and may require an EA or EIS.	Contact the State Environmental Compliance Liaison. Further NEPA analysis required. Explain in Notes Section.

R. Rationale Supporting the Finding

R.1 Findings Documentation	EIS necessary
R.2 Applicable Categorical Exclusion(s) **(more than one may apply)** 7 CFR Part 650 *Compliance With NEPA*, subpart 650.6 *Categorical Exclusions* states prior to determining that a proposed action is categorically excluded under paragraph (d) of this section, the proposed action must meet six sideboard criteria. See NECH 610.116.	

I have considered the effects of the alternatives on the Resource Concerns, Economic and Social Considerations, Special Environmental Concerns, and Extraordinary Circumstances as defined by Agency regulation and policy and based on that made the finding indicated above.

S. Signature of Responsible Federal Official:

Signature	Title	Date
Becky L Ross — Digitally signed by BECKY ROSS Date: 2025.04.30 10:43:08 -04'00'	State Conservationist	4/30/25

Additional Notes

Appendix E:

Draft IPaC

IPaC **U.S. Fish & Wildlife Service**

IPaC resource list

This report is an automatically generated list of species and other resources such as critical habitat (collectively referred to as *trust resources*) under the U.S. Fish and Wildlife Service's (USFWS) jurisdiction that are known or expected to be on or near the project area referenced below. The list may also include trust resources that occur outside of the project area, but that could potentially be directly or indirectly affected by activities in the project area. However, determining the likelihood and extent of effects a project may have on trust resources typically requires gathering additional site-specific (e.g., vegetation/species surveys) and project-specific (e.g., magnitude and timing of proposed activities) information.

Below is a summary of the project information you provided and contact information for the USFWS office(s) with jurisdiction in the defined project area. Please read the introduction to each section that follows (Endangered Species, Migratory Birds, USFWS Facilities, and NWI Wetlands) for additional information applicable to the trust resources addressed in that section.

Location

Belknap County, New Hampshire

Local office

New England Ecological Services Field Office

(603) 223-2541
(603) 223-0104

70 Commercial Street, Suite 300
Concord, NH 03301-5094

Endangered species

This resource list is for informational purposes only and does not constitute an analysis of project level impacts.

The primary information used to generate this list is the known or expected range of each species. Additional areas of influence (AOI) for species are also considered. An AOI includes areas outside of the species range if the species could be indirectly affected by activities in that area (e.g., placing a dam upstream of a fish population even if that fish does not occur at the dam site, may indirectly impact the species by reducing or eliminating water flow downstream). Because species can move, and site conditions can change, the species on this list are not guaranteed to be found on or near the project area. To fully determine any potential effects to species, additional site-specific and project-specific information is often required.

Section 7 of the Endangered Species Act **requires** Federal agencies to "request of the Secretary information whether any species which is listed or proposed to be listed may be present in the area of such proposed action" for any project that is conducted, permitted, funded, or licensed by any Federal agency. A letter from the local office and a species list which fulfills this requirement can **only** be obtained by requesting an official species list from either the Regulatory Review section in IPaC (see directions below) or from the local field office directly.

For project evaluations that require USFWS concurrence/review, please return to the IPaC website and request an official species list by doing the following:

1. Draw the project location and click CONTINUE.
2. Click DEFINE PROJECT.
3. Log in (if directed to do so).
4. Provide a name and description for your project.
5. Click REQUEST SPECIES LIST.

Listed species[1] and their critical habitats are managed by the Ecological Services Program of the U.S. Fish and Wildlife Service (USFWS) and the fisheries division of the National Oceanic and Atmospheric Administration (NOAA Fisheries[2]).

Species and critical habitats under the sole responsibility of NOAA Fisheries are **not** shown on this list. Please contact NOAA Fisheries for species under their jurisdiction.

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1. Species listed under the Endangered Species Act are threatened or endangered; IPaC also shows species that are candidates, or proposed, for listing. See the listing status page for more information. IPaC only shows species that are regulated by USFWS (see FAQ).

2. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

The following species are potentially affected by activities in this location:

Mammals

NAME	STATUS
Northern Long-eared Bat *Myotis septentrionalis* Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/9045	Endangered

Insects

NAME	STATUS
Monarch Butterfly *Danaus plexippus* Wherever found There is **proposed** critical habitat for this species. Your location does not overlap the critical habitat. https://ecos.fws.gov/ecp/species/9743	Proposed Threatened

Flowering Plants

NAME	STATUS
Small Whorled Pogonia *Isotria medeoloides* No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/1890	Threatened

Critical habitats

Potential effects to critical habitat(s) in this location must be analyzed along with the endangered species themselves.

There are no critical habitats at this location.

You are still required to determine if your project(s) may have effects on all above listed species.

Bald & Golden Eagles

Bald and Golden Eagles are protected under the Bald and Golden Eagle Protection Act [2] and the Migratory Bird Treaty Act (MBTA) [1]. Any person or organization who plans or conducts activities that may result in impacts to Bald or Golden Eagles, or their habitats, should follow appropriate regulations and consider implementing appropriate avoidance and minimization measures, as described in the various links on this page.

Additional information can be found using the following links:

- Eagle Management https://www.fws.gov/program/eagle-management
- Measures for avoiding and minimizing impacts to birds https://www.fws.gov/library/collections/avoiding-and-minimizing-incidental-take-migratory-birds
- Nationwide avoidance and minimization measures for birds https://www.fws.gov/sites/default/files/documents/nationwide-standard-conservation-measures.pdf
- Supplemental Information for Migratory Birds and Eagles in IPaC https://www.fws.gov/media/supplemental-information-migratory-birds-and-bald-and-golden-eagles-may-occur-project-action

There are Bald Eagles and/or Golden Eagles in your project area.

Measures for Proactively Minimizing Eagle Impacts

For information on how to best avoid and minimize disturbance to nesting bald eagles, please review the National Bald Eagle Management Guidelines. You may employ the timing and activity-specific distance recommendations in this document when designing your project/activity to avoid and minimize eagle impacts. For bald eagle information specific to Alaska, please refer to Bald Eagle Nesting and Sensitivity to Human Activity.

The FWS does not currently have guidelines for avoiding and minimizing disturbance to nesting Golden Eagles. For site-specific recommendations regarding nesting Golden Eagles, please consult with the appropriate Regional Migratory Bird Office or Ecological Services Field Office.

If disturbance or take of eagles cannot be avoided, an incidental take permit may be available to authorize any take that results from, but is not the purpose of, an otherwise lawful activity. For assistance making this determination for Bald Eagles, visit the Do I Need A Permit Tool. For assistance making this determination for golden eagles, please consult with the appropriate Regional Migratory Bird Office or Ecological Services Field Office.

Ensure Your Eagle List is Accurate and Complete

If your project area is in a poorly surveyed area in IPaC, your list may not be complete and you may need to rely on other resources to determine what species may be present (e.g. your local FWS field office, state surveys, your own surveys). Please review the Supplemental Information on Migratory Birds and Eagles, to help you properly interpret the report for your specified location, including determining if there is sufficient data to ensure your list is accurate.

For guidance on when to schedule activities or implement avoidance and minimization measures to reduce impacts to bald or golden eagles on your list, see the "Probability of Presence Summary" below to see when these bald or golden eagles are most likely to be present and breeding in your project area.

Review the FAQs
The FAQs below provide important additional information and resources.

NAME	BREEDING SEASON
Bald Eagle Haliaeetus leucocephalus This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities. https://ecos.fws.gov/ecp/species/1626	Breeds Dec 1 to Aug 31

Probability of Presence Summary

The graphs below provide our best understanding of when birds of concern are most likely to be present in your project area. This information can be used to tailor and schedule your project activities to avoid or minimize impacts to birds. Please make sure you read "Supplemental Information on Migratory Birds and Eagles", specifically the FAQ section titled "Proper Interpretation and Use of Your Migratory Bird Report" before using or attempting to interpret this report.

Probability of Presence (■)

Each green bar represents the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during a particular week of the year. (A year is represented as 12 4-week months.) A taller bar indicates a higher probability of species presence. The survey effort (see below) can be used to establish a level of confidence in the presence score. One can have higher confidence in the presence score if the corresponding survey effort is also high.

How is the probability of presence score calculated? The calculation is done in three steps:

1. The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted

Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.

2. To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12 (0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is 0.25/0.25 = 1; at week 20 it is 0.05/0.25 = 0.2.
3. The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

To see a bar's probability of presence score, simply hover your mouse cursor over the bar.

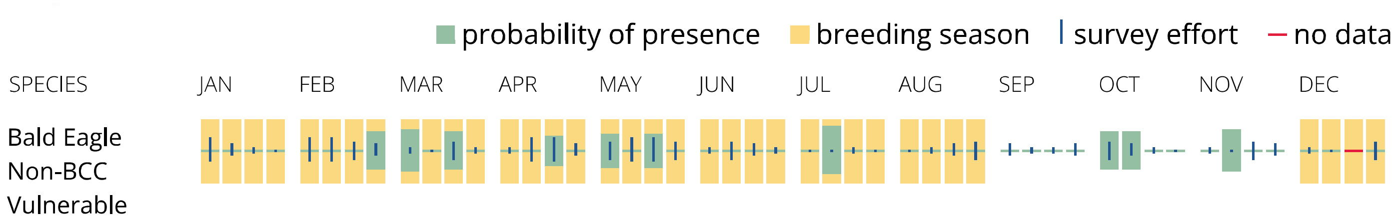
Breeding Season (■)
Yellow bars denote a very liberal estimate of the time-frame inside which the bird breeds across its entire range. If there are no yellow bars shown for a bird, it does not breed in your project area.

Survey Effort (|)
Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps. The number of surveys is expressed as a range, for example, 33 to 64 surveys.

To see a bar's survey effort range, simply hover your mouse cursor over the bar.

No Data (–)
A week is marked as having no data if there were no survey events for that week.

Survey Timeframe
Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information. The exception to this is areas off the Atlantic coast, where bird returns are based on all years of available data, since data in these areas is currently much more sparse.



Bald & Golden Eagles FAQs

What does IPaC use to generate the potential presence of bald and golden eagles in my specified location?

The potential for eagle presence is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) which your project intersects, and that have been identified as warranting special attention because they are an eagle (Bald and Golden Eagle Protection Act requirements may apply).

Proper interpretation and use of your eagle report

On the graphs provided, please look carefully at the survey effort (indicated by the black vertical line) and for the existence of the "no data" indicator (a red horizontal line). A high survey effort is the key component. If the survey effort is high, then the probability of presence score can be viewed as more dependable. In contrast, a low survey effort line or no data line (red horizontal) means a lack of data and, therefore, a lack of certainty about presence of the species. This list is not perfect; it is simply a starting point for identifying what birds have the potential to be in your project area, when they might be there, and if they might be breeding (which means nests might be present). The list and associated information help you know what to look for to confirm presence and helps guide you in knowing when to implement avoidance and minimization measures to eliminate or reduce potential impacts from your project activities or get the appropriate permits should presence be confirmed.

How do I know if eagles are breeding, wintering, or migrating in my area?

To see what part of a particular bird's range your project area falls within (i.e. breeding, wintering, migrating, or resident), you may query your location using the RAIL Tool and view the range maps provided for birds in your area at the bottom of the profiles provided for each bird in your results. If an eagle on your IPaC migratory bird species list has a breeding season associated with it (indicated by yellow vertical bars on the phenology graph in your “IPaC PROBABILITY OF PRESENCE SUMMARY” at the top of your results list), there may be nests present at some point within the timeframe specified. If "Breeds elsewhere" is indicated, then the bird likely does not breed in your project area.

Interpreting the Probability of Presence Graphs

Each green bar represents the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during a particular week of the year. A taller bar indicates a higher probability of species presence. The survey effort can be used to establish a level of confidence in the presence score.

How is the probability of presence score calculated? The calculation is done in three steps:

The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.

To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12 (0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is 0.25/0.25 = 1; at week 20 it is 0.05/0.25 = 0.2.

The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

Breeding Season ()

Yellow bars denote a very liberal estimate of the time-frame inside which the bird breeds across its entire range. If there are no yellow bars shown for a bird, it does not breed in your project area.

Survey Effort ()
Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps.

No Data ()
A week is marked as having no data if there were no survey events for that week.

Survey Timeframe
Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information. The exception to this is areas off the Atlantic coast, where bird returns are based on all years of available data, since data in these areas is currently much more sparse.

Migratory birds

The Migratory Bird Treaty Act (MBTA) [1] prohibits the take (including killing, capturing, selling, trading, and transport) of protected migratory bird species without prior authorization by the Department of Interior U.S. Fish and Wildlife Service (Service). The incidental take of migratory birds is the injury or death of birds that results from, but is not the purpose, of an activity. The Service interprets the MBTA to prohibit incidental take.

1. The Migratory Birds Treaty Act of 1918.
2. The Bald and Golden Eagle Protection Act of 1940.

Additional information can be found using the following links:

- Eagle Management https://www.fws.gov/program/eagle-management
- Measures for avoiding and minimizing impacts to birds https://www.fws.gov/library/collections/avoiding-and-minimizing-incidental-take-migratory-birds
- Nationwide avoidance and minimization measures for birds
- Supplemental Information for Migratory Birds and Eagles in IPaC https://www.fws.gov/media/supplemental-information-migratory-birds-and-bald-and-golden-eagles-may-occur-project-action

Measures for Proactively Minimizing Migratory Bird Impacts

Your IPaC Migratory Bird list showcases birds of concern, including Birds of Conservation Concern (BCC), in your project location. This is not a comprehensive list of all birds found in your project area. However, you can help proactively minimize significant impacts to all birds at your project location by implementing the measures in the Nationwide avoidance and minimization measures for birds document, and any other project-specific avoidance and minimization measures suggested at the link Measures for avoiding and minimizing impacts to birds for the birds of concern on your list below.

Ensure Your Migratory Bird List is Accurate and Complete

If your project area is in a poorly surveyed area, your list may not be complete and you may need to rely on other resources to determine what species may be present (e.g. your local FWS field office, state surveys, your own surveys). Please review the Supplemental Information on Migratory Birds and Eagles document, to help you properly interpret the report for your specified location, including determining if there is sufficient data to ensure your list is accurate.

For guidance on when to schedule activities or implement avoidance and minimization measures to reduce impacts to migratory birds on your list, see the "Probability of Presence Summary" below to see when these birds are most likely to be present and breeding in your project area.

Review the FAQs

The FAQs below provide important additional information and resources.

NAME	BREEDING SEASON
Bald Eagle Haliaeetus leucocephalus This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities. https://ecos.fws.gov/ecp/species/1626	Breeds Dec 1 to Aug 31
Bay-breasted Warbler Setophaga castanea This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA	Breeds May 25 to Aug 1
Black-billed Cuckoo Coccyzus erythropthalmus This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9399	Breeds May 15 to Oct 10
Bobolink Dolichonyx oryzivorus This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.	Breeds May 20 to Jul 31
Canada Warbler Cardellina canadensis This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.	Breeds May 20 to Aug 10
Cape May Warbler Setophaga tigrina This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA	Breeds Jun 1 to Jul 31

Chimney Swift *Chaetura pelagica* — Breeds Mar 15 to Aug 25

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Evening Grosbeak *Coccothraustes vespertinus* — Breeds May 15 to Aug 10

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Olive-sided Flycatcher *Contopus cooperi* — Breeds May 20 to Aug 31

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/3914

Prairie Warbler *Setophaga discolor* — Breeds May 1 to Jul 31

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Rose-breasted Grosbeak *Pheucticus ludovicianus* — Breeds May 15 to Jul 31

This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA

Semipalmated Sandpiper *Calidris pusilla* — Breeds elsewhere

This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA

Veery *Catharus fuscescens fuscescens* — Breeds May 15 to Jul 15

This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA

Wood Thrush *Hylocichla mustelina* — Breeds May 10 to Aug 31

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Probability of Presence Summary

The graphs below provide our best understanding of when birds of concern are most likely to be present in your project area. This information can be used to tailor and schedule your project activities to avoid or minimize impacts to birds. Please make sure you read "Supplemental Information on Migratory Birds and Eagles", specifically the FAQ section titled "Proper Interpretation and Use of Your Migratory Bird Report" before using or attempting to interpret this report.

Probability of Presence (■)

Each green bar represents the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during a particular week of the year. (A year is represented as 12 4-week months.) A taller bar indicates a higher probability of species presence. The survey effort (see below) can be used to establish a level of confidence in the presence score. One can have higher confidence in the presence score if the corresponding survey effort is also high.

How is the probability of presence score calculated? The calculation is done in three steps:

1. The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.
2. To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12 (0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is 0.25/0.25 = 1; at week 20 it is 0.05/0.25 = 0.2.
3. The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

To see a bar's probability of presence score, simply hover your mouse cursor over the bar.

Breeding Season (■)
Yellow bars denote a very liberal estimate of the time-frame inside which the bird breeds across its entire range. If there are no yellow bars shown for a bird, it does not breed in your project area.

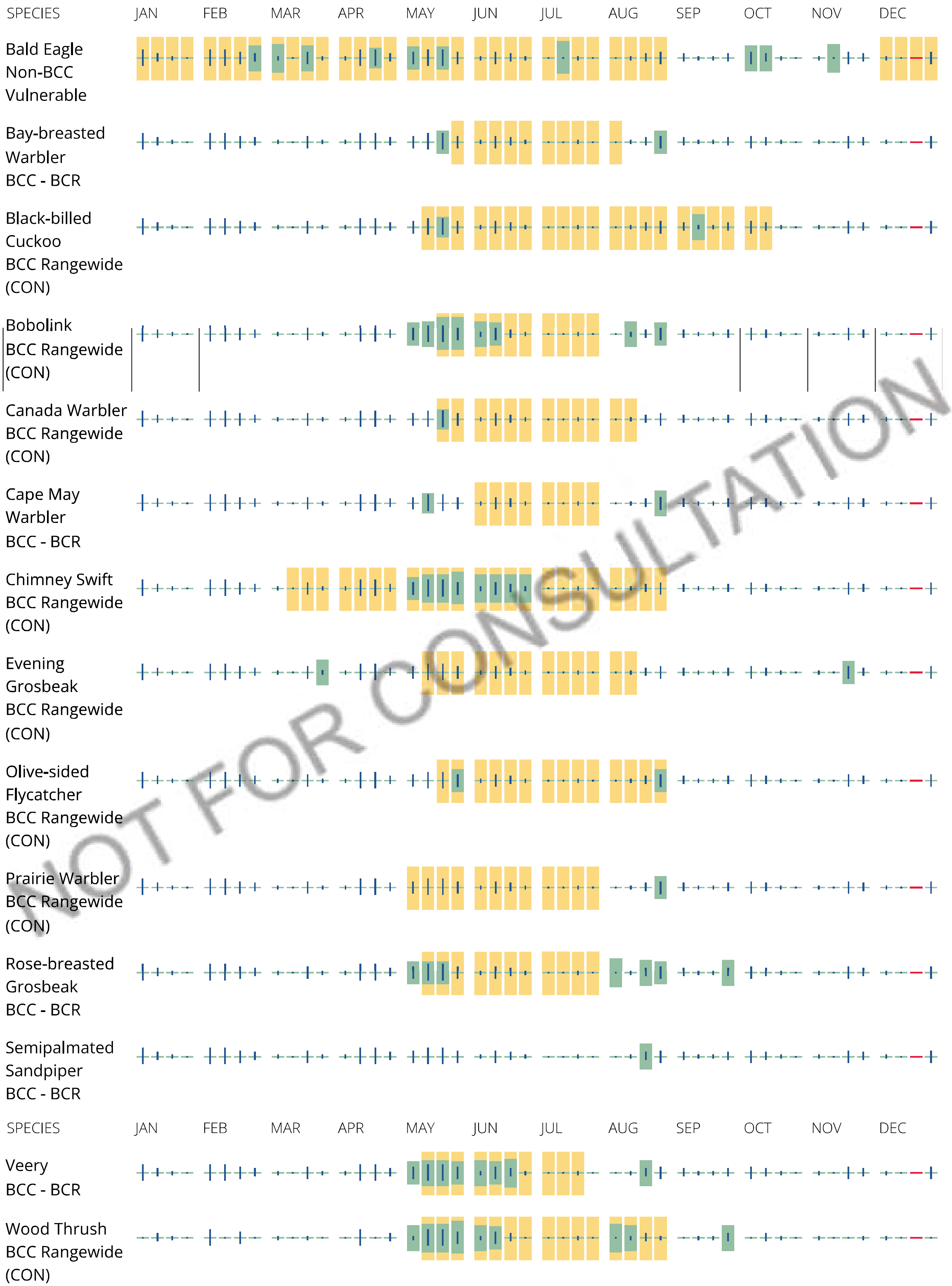
Survey Effort (|)
Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps. The number of surveys is expressed as a range, for example, 33 to 64 surveys.

To see a bar's survey effort range, simply hover your mouse cursor over the bar.

No Data (–)
A week is marked as having no data if there were no survey events for that week.

Survey Timeframe
Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information. The exception to this is areas off the Atlantic coast, where bird returns are based on all years of available data, since data in these areas is currently much more sparse.

■ probability of presence ■ breeding season | survey effort – no data


SPECIES
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
Bald Eagle
Non-BCC
Vulnerable
Bay-breasted
Warbler
BCC - BCR
Black-billed
Cuckoo
BCC Rangewide
(CON)
Bobolink
BCC Rangewide
(CON)
Canada Warbler
BCC Rangewide
(CON)
Cape May
Warbler
BCC - BCR
Chimney Swift
BCC Rangewide
(CON)
Evening
Grosbeak
BCC Rangewide
(CON)
Olive-sided
Flycatcher
BCC Rangewide
(CON)
Prairie Warbler
BCC Rangewide
(CON)
Rose-breasted
Grosbeak
BCC - BCR
Semipalmated
Sandpiper
BCC - BCR
SPECIES
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
Veery
BCC - BCR
Wood Thrush
BCC Rangewide
(CON)

Migratory Bird FAQs

Tell me more about avoidance and minimization measures I can implement to avoid or minimize impacts to migratory birds.

Nationwide Avoidance & Minimization Measures for Birds describes measures that can help avoid and minimize impacts to all birds at any location year-round. When birds may be breeding in the area, identifying the locations of any active nests and avoiding their destruction is one of the most effective ways to minimize impacts. To see when birds are most likely to occur and breed in your project area, view the Probability of Presence Summary. Additional measures or permits may be advisable depending on the type of activity you are conducting and the type of infrastructure or bird species present on your project site.

What does IPaC use to generate the list of migratory birds that potentially occur in my specified location?

The Migratory Bird Resource List is comprised of Birds of Conservation Concern (BCC) and other species that may warrant special attention in your project location, such as those listed under the Endangered Species Act or the Bald and Golden Eagle Protection Act and those species marked as "Vulnerable". See the FAQ "What are the levels of concern for migratory birds?" for more information on the levels of concern covered in the IPaC migratory bird species list.

The migratory bird list generated for your project is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) with which your project intersects. These species have been identified as warranting special attention because they are BCC species in that area, an eagle (Bald and Golden Eagle Protection Act requirements may apply), or a species that has a particular vulnerability to offshore activities or development.

Again, the Migratory Bird Resource list includes only a subset of birds that may occur in your project area. It is not representative of all birds that may occur in your project area. To get a list of all birds potentially present in your project area, and to verify survey effort when no results present, please visit the Rapid Avian Information Locator (RAIL) Tool.

Why are subspecies showing up on my list?

Subspecies profiles are included on the list of species present in your project area because observations in the AKN for **the species** are being detected. If the species are present, that means that the subspecies may also be present. If a subspecies shows up on your list, you may need to rely on other resources to determine if that subspecies may be present (e.g. your local FWS field office, state surveys, your own surveys).

What does IPaC use to generate the probability of presence graphs for the migratory birds potentially occurring in my specified location?

The probability of presence graphs associated with your migratory bird list are based on data provided by the Avian Knowledge Network (AKN). This data is derived from a growing collection of survey, banding, and citizen science datasets.

Probability of presence data is continuously being updated as new and better information becomes available. To learn more about how the probability of presence graphs are produced and how to interpret them, go to the Probability of Presence Summary and then click on the "Tell me about these graphs" link.

How do I know if a bird is breeding, wintering, or migrating in my area?

To see what part of a particular bird's range your project area falls within (i.e. breeding, wintering, migrating, or resident), you may query your location using the RAIL Tool and view the range maps provided for birds in your area at the bottom of the profiles provided for each bird in your results. If a bird on your IPaC migratory bird species list has a breeding season associated with it (indicated by yellow vertical bars on the phenology graph in your "IPaC PROBABILITY OF PRESENCE SUMMARY" at the top of your results list), there may be nests present at some point within the timeframe specified. If "Breeds elsewhere" is indicated, then the bird likely does not breed in your project area.

What are the levels of concern for migratory birds?

Migratory birds delivered through IPaC fall into the following distinct categories of concern:

1. "BCC Rangewide" birds are Birds of Conservation Concern (BCC) that are of concern throughout their range anywhere within the USA (including Hawaii, the Pacific Islands, Puerto Rico, and the Virgin Islands);
2. "BCC - BCR" birds are BCCs that are of concern only in particular Bird Conservation Regions (BCRs) in the continental USA; and
3. "Non-BCC - Vulnerable" birds are not BCC species in your project area, but appear on your list either because of the Bald and Golden Eagle Protection Act requirements (for eagles) or (for non-eagles) potential susceptibilities in offshore areas from certain types of development or activities (e.g. offshore energy development or longline fishing).

Although it is important to avoid and minimize impacts to all birds, efforts should be made, in particular, to avoid and minimize impacts to the birds on this list, especially BCC species. For more information on avoidance and minimization measures you can implement to help avoid and minimize migratory bird impacts, please see the FAQ "Tell me more about avoidance and minimization measures I can implement to avoid or minimize impacts to migratory birds".

Details about birds that are potentially affected by offshore projects

For additional details about the relative occurrence and abundance of both individual bird species and groups of bird species within your project area off the Atlantic Coast, please visit the Northeast Ocean Data Portal. The Portal also offers data and information about other taxa besides birds that may be helpful to you in your project review. Alternately, you may download the bird model results files underlying the portal maps through the NOAA NCCOS Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf project webpage.

Proper interpretation and use of your migratory bird report

The migratory bird list generated is not a list of all birds in your project area, only a subset of birds of priority concern. To learn more about how your list is generated and see options for identifying what other birds may be in your project area, please see the FAQ "What does IPaC use to generate the migratory birds potentially occurring in my specified location". Please be aware this report provides the "probability of presence" of birds within the 10 km grid cell(s) that overlap your project; not your exact project footprint. On the graphs provided, please look carefully at the survey effort (indicated by the black vertical line) and for the existence of the "no data" indicator (a red horizontal line). A high survey effort is the key component. If the survey effort is high, then the probability of presence score can be viewed as more dependable. In contrast, a low survey effort bar or no data bar means a lack of data and, therefore, a lack of certainty about presence of the species. This list does not represent all birds present in your project area. It is simply a starting point for identifying what birds of concern have the potential to be in your project area, when they might be there, and if they might be breeding (which means nests might be present). The list and associated information help you know what to look for to confirm presence and helps guide implementation of avoidance and minimization measures to eliminate or reduce potential impacts from your project activities, should presence be confirmed. To learn more about avoidance and minimization measures, visit the FAQ "Tell me about avoidance and minimization measures I can implement to avoid or minimize impacts to migratory birds".

Interpreting the Probability of Presence Graphs

Each green bar represents the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during a particular week of the year. A taller bar indicates a higher probability of species presence. The survey effort can be used to establish a level of confidence in the presence score.

How is the probability of presence score calculated? The calculation is done in three steps:

The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.

To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12 (0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is 0.25/0.25 = 1; at week 20 it is 0.05/0.25 = 0.2.

The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

Breeding Season ()

Yellow bars denote a very liberal estimate of the time-frame inside which the bird breeds across its entire range. If there are no yellow bars shown for a bird, it does not breed in your project area.

Survey Effort ()

Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps.

No Data ()

A week is marked as having no data if there were no survey events for that week.

Survey Timeframe

Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information. The exception to this is areas off the Atlantic coast, where bird returns are based on all years of available data, since data in these areas is currently much more sparse.

Facilities

National Wildlife Refuge lands

Any activity proposed on lands managed by the National Wildlife Refuge system must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

There are no refuge lands at this location.

Fish hatcheries

There are no fish hatcheries at this location.

Wetlands in the National Wetlands Inventory (NWI)

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

Please note that the NWI data being shown may be out of date. We are currently working to update our NWI data set. We recommend you verify these results with a site visit to determine the actual extent of wetlands on site.

This location overlaps the following wetlands:

FRESHWATER EMERGENT WETLAND
- PEM1Eb
- PEM1E
- PEM1A

FRESHWATER FORESTED/SHRUB WETLAND
- PFO4E
- PSS1E

- PFO1E
- PSS1/EM1E
- PFO4/SS1E
- PFO4/SS4E
- PSS1/EM1Eb

FRESHWATER POND

- PUBHb
- PABHb
- PUBHx

LAKE

- L2UBHh

RIVERINE

- R2UBH
- R4SBC

A full description for each wetland code can be found at the National Wetlands Inventory website

NOTE: This initial screening does **not** replace an on-site delineation to determine whether wetlands occur. Additional information on the NWI data is provided below.

Data limitations

The Service's objective of mapping wetlands and deepwater habitats is to produce reconnaissance level information on the location, type and size of these resources. The maps are prepared from the analysis of high altitude imagery. Wetlands are identified based on vegetation, visible hydrology and geography. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or classification established through image analysis.

The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of ground truth verification work conducted. Metadata should be consulted to determine the date of the source imagery used and any mapping problems.

Wetlands or other mapped features may have changed since the date of the imagery or field work. There may be occasional differences in polygon boundaries or classifications between the information depicted on the map and the actual conditions on site.

Data exclusions

Certain wetland habitats are excluded from the National mapping program because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and nearshore coastal waters. Some deepwater reef communities (coral or tuberficid worm reefs) have also been excluded from the inventory. These habitats, because of their depth, go undetected by aerial imagery.

Data precautions

Federal, state, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, state, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate Federal, state, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.

Appendix F:

Forecasted NRCS Staffing Needs (POW)

State: New Hampshire | Watershed Name: Black Brook | Project Purpose: Watershed Protection

Forcasted NRCS workload for PIFR

Back to

NRCS - this is the estimated hours and expensed to be incurred by NRCS to either perform and/or provide oversight of activities preformed by the Contractor.

	Tasks / Activities	STC	SCE	Supervisory Engineer	Hydraulic Engineer	Geologist/ Soil Scientist	Ecologist or Biologist	Hydrologist	Geotech Engineer	Structural Engineer	Engineer	CADD / CET	Clerical Support	GIS	Economist	SRC	Archeologist	Agronomist	DC		Total Labor by task/ activity	Related Plan Section	Outcome Products
		$ 125.68	$ 103.56	$ 84.73	$ 91.79	$ 84.73	$ 87.08	$ 87.08	$ 84.73	$ 87.08	$ 84.73	$ 76.58	$ 55.18	$ 84.73	$ 84.73	$ 106.35	$ 87.08	$ 84.73	$ 82.37	$ -			
1. INITIATE PLANNING & FUNDING																							
A.	Develop Plan of Work (POW), SOW, IGE	2	26	20	14	4	4	4	14	4	4			4	4	4	4	4			116		POW
B.	Written Request for Assistance (SF-424) & enter into a cooperative agreement	2	16	20									10			8					56		
C.	Complete literature review of past planning efforts, cursory analysis		4	30	16		4		16							4					74	Purpose and Need	Analysis data
D.	Discuss Purpose and Need for project with Sponsors		16	20	8				8							8					60	Purpose and Need	List of project needs
E.	Initial Site Visit & Initial Project Map		16	20	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8		156	Appendix B - Project Map	List of individuals that will assist
F.	Establish Reviewable Record		8	8									8								24	Appendix A - Comments &	Distribution List
	Subtotal (hrs)	**4**	**86**	**118**	**46**	**12**	**16**	**12**	**46**	**12**	**12**	**8**	**26**	**12**	**12**	**32**	**12**	**12**	**8**	**0**	**486**		
2. PROBLEMS AND OPPORTUNITIES																							
A.	Develop Interagency Team and Cooperating (federal) Agencies.			4																	4	Consult., Coord. & Public	Public Participation Plan
B.	Initiate consultation with THPOs			10												2	10				22	Consult., Coord. & Public	
C.	Conduct interdisciplinary planning team meeting, include field review	4	4	8	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4		76	List of Preparers	Team member assignments
D.	Develop Public Participation Plan			2																	2	Consult., Coord. & Public	Public Participation Plan
E.	Conduct public meeting to obtain local input, including scoping		4	4							4										12	Appendix A - Comments &	People impacted
F.	Conduct interagency team meeting, consider field tour		4	8	4		4									4					24		
G.	Develop and formally adopt Purpose & Need (P&N)		4	4			4				4										16	Purpose and Need	List of project needs
	Subtotal (hrs)	**4**	**16**	**40**	**8**	**4**	**12**	**4**	**4**	**4**	**12**	**4**	**4**	**4**	**4**	**10**	**14**	**4**	**4**	**0**	**156**		
3. SCOPING																							
A.	Develop Scoping Materials (NWPM 501.24/NWPH 601.24)		2	4																	6	Scope of EA/EIS	List of resource attributes and
B.	Develop Scope of EA/EIS (NWPM 501.35/NWPH 601.35)		2	4																	6	Scope of EA/EIS	Selected approach
C.	Prioritize objectives/resource issues		2	4												4					10	Scope of EA/EIS	List of resource issues or concerns
	Subtotal (hrs)	**0**	**6**	**12**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**4**	**0**	**0**	**0**	**0**	**22**		
4. INVENTORY & ANALYZE RESOURCES																							
A.	Compile inventory data; i.e. physical, ecological, economic, and social.		4	8			8									4					24	Affected Environment	Description of resource context
B.	Develop support maps formatted for suitable use in final plan appendix.			4										8							12	Appendix C - Support Maps	Support maps
C.	Develop existing watershed hydrologic conditions summary		4	4	4			16													28	Affected Environment	Characterization of surface water
D.	Develop existing conditions watershed hydraulic conditions summary		4	4	16																24	Affected Environment	Characterization of surface water
E.	Develop benefits analysis framework with existing conditions parameters		4	4											16						24	Affected Environment	People impacted
F.	Water (i.e. RUSLE2) and air quality models or applications to match P&N		4	4			8											8			24	Affected Environment	Historic sedimentation rate
G.	Write draft applicable portions of Affected Environment Section (NWPM 501.36/NWPH 601.36)		4	8	4	4	8	4								4		4	4		44	Affected Environment	Identify resource concerns
H.	Write draft existing conditions for H&H and economics		4	12	12		12	12								4					56	Appendix D - I&E Analyses	Analysis Tools/Methods
I.	Continue consultation process		4												12	4	16				36	Consult., Coord. & Public	Cultural Resources Report
J.	Initiate Cultural Resources investigations; Lit review, undertakings, APE.		4													4	16				24	Consult., Coord. & Public	APE
K.	NRCS review of all EC models/analysis (RUSLE2, H&H, benefits, etc.) and draft reports listed above.		4	4	16		8	16							16	2					66	Affected Environment	Characterization of surface water
	Subtotal (hrs)	**0**	**40**	**52**	**52**	**4**	**44**	**48**	**0**	**0**	**0**	**0**	**0**	**8**	**44**	**22**	**32**	**12**	**4**	**0**	**362**		
5. FORMULATE ALTERNATIVES																							
A.	Identify quality criteria		2	4			2									2					10	Alternatives	Criteria associated with needs
B.	Develop reasonable strategies considering P&N, feasibility, effectiveness, and efficiency		2	4	2		2									2					12	Alternatives	Selected approach
C.	Determine preferred strategies based on loss assessment; document those removed in screening report		2	2	2											2					8	Appendix D - I&E Analyses	Selected planning methodologies
D.	Develop initially selected alternatives from preferred strategies	2	2	2												2					8	Alternatives	Selected planning methodologies
E.	Develop impacted lands & resource summary, including geology offsite investigation		2			8	2		4							2					18	Alternatives	Measured extents and locations
F.	Public outreach - impacted landowner meetings (assume 2)			2																	2	Consult., Coord. & Public	People impacted
G.	Revise alternatives		2	2	2																6	Alternatives	Analysis data
H.	Identify utility locates at alternative site locations			2																	2	Alternatives	Health & Safety issues impacted
I.	Additional site surveys as needed to aid in design										2										2	Alternatives	Measured extents and locations
J.	Develop existing conditions CAD files, including Civil3D surface model										8	8									16	Alternatives	Analysis data
K.	Basic project design, following NRCS requirements		4	4	8	8		8	8	4	4	8									56	Alternatives	Criteria associated with needs
L.	Additional project purposes design features	4	8	16	8		8	8	8	8	16	8				8			4		104	Alternatives	Criteria associated with needs
M.	Update economics analysis with project details to determine benefits			4	16										16						36	Alternatives	Criteria associated with needs
N.	Engineering design, design report, and cost estimate (30% plans)		8	8							8	8									32	Appendix D - I&E Analyses	Analysis Tools/Methods
O.	Wetland delineation, functional scoring, and report (assume some locations, but not expansive)				4	4	4	4								4					20	Appendix D - I&E Analyses	Analysis Tools/Methods
P.	Biological surveys and develop report (assume 2 river reaches)						4									4					8	Appendix D - I&E Analyses	APE
Q.	Cultural resources review															4	40				44	Appendix D - I&E Analyses	APE
R.	Conduct land ownership survey		4	8																	12		Boundary map
S.	Conduct public meeting to obtain local input			4																	4	Consult., Coord. & Public	People impacted
T.	Write draft applicable portions of Alternatives Section (NWPM 501.37/NWPH 601.37)		4	4	4	4	4	4	4	4	4	4				4	4	4	4		56	Alternatives	Measured extents and locations
	Subtotal (hrs)	**6**	**40**	**66**	**46**	**24**	**26**	**24**	**24**	**16**	**42**	**36**	**0**	**0**	**16**	**34**	**44**	**4**	**8**	**0**	**456**		
6. EVALUTATE ALTERNATIVES																							
A.	Determine unavoidable adverse impacts and mitigation strategy for adverse impacts		2	2	2											2					8	Environmental Consequences	Selected planning methodologies
B.	Incorporate mitigation features in design & cost estimate, plus consider additional for EQ benefits (if app		2	2	2		2									2					10	Environmental Consequences	Description of resource context
C.	Calculate Physical (water quantity and quality) benefits/consequences		2	2	2		2														8	Environmental Consequences	Description of resource context
D.	Determine Physical and Ecological (Soils, Habitat, Plant & Animals) benefits/consequences			2			2									2					6	Environmental Consequences	Description of resource context
E.	Determine Social (including cultural resource) benefits/consequences			2												2	20				24	Environmental Consequences	Description of resource context
F.	Calculate Economic benefits/consequences and write report		2	2	2										12						18	Appendix D - I&E Analyses	Alternative cost estimate
G.	Determine cumulative effects and compliance/permits (as applicable)			4																	4	Environmental Consequences	Analysis Tools/Methods
H.	Conduct public meeting to obtain local input			2																	2	Appendix A - Comments &	People impacted
I.	Complete Alternatives section with summary table of detailed description of 1 or more alternatives		2	4	2	2		2	2	2	2								2		20	Alternatives	Analysis data
J.	Write draft applicable portions of Environmental Consequences (NWPM 501.38/NWPH 601.38)			4												2					6	Environmental Consequences	Analysis Tools/Methods
K.	Write draft Consultation, Coordination, and Pubic Participation section (NWPH 601.39)			4																	4	Consult., Coord. & Public	People impacted
	Subtotal (hrs)	**0**	**10**	**30**	**10**	**2**	**6**	**2**	**2**	**2**	**2**	**0**	**0**	**0**	**12**	**10**	**20**	**0**	**2**	**0**	**110**		
7. PREPARE WATERSHED PLAN																							
A.	Interdisciplinary team meeting, plus meet with sponsor to identify preferred alternative	4	4	8	4											4					24	Preferred Alternative	Measured extents and locations
B.	Verify NEPA required is EA/EIS (NWPH 601.1)		2	4												2					8	Environmental Consequences	NOI
C.	Write draft applicable portions of Preferred Alternative Section (NWPM 501.40/NWPH 601.40)		2	4												2					8	Preferred Alternative	Measured extents and locations
D.	Write draft References section (NWPH 601.41)																					References	
E.	Write draft List of Preparers section (NWPH 601.42)																					List of Preparers	
F.	Write draft Distribution List (NWPH 601.43)																					Distribution List	
G.	Write draft Index section (NWPH 601.44)																						
H.	Prepare draft Appendices (NWPH 601.45)																					Appendix A - Comments &	Analysis data
I.	Prepare draft plan for review (Culminate prior written sections to one document)																						
J.	NRCS Interdisciplinary team reviews (State Staff and then NWMC) (NWPH 602.11)		8	8	8	8	8	8	8	8	8	8		8	8	8	8	8	8		128		
K.	Address NWMC comments and update Watershed Plan - EA		4	8												4					16		
L.	Solicit and address public/agency comments (NWPH 602.20)	2	4	8	8		8									8					38		
M.	Finalize Watershed Plan - EA		4	16									8			4					32		
	Subtotal (hrs)	**6**	**28**	**56**	**20**	**8**	**16**	**8**	**8**	**8**	**8**	**8**	**8**	**8**	**8**	**32**	**8**	**8**	**8**	**0**	**254**		
	Totals	**20**	**226**	**374**	**182**	**54**	**120**	**98**	**84**	**42**	**76**	**56**	**38**	**32**	**96**	**144**	**130**	**40**	**34**	**0**	**1,846**		
	Subtotal Name (can be edited)																						
	1. INITIATE PLANNING & FUNDING	4	86	118	46	12	16	12	46	12	12	8	26	12	12	32	12	12	8	0	486		
	2. PROBLEMS AND OPPORTUNITIES	4	16	40	8	4	12	4	4	4	12	4	4	4	4	10	14	4	4	0	156		
	3. SCOPING	0	6	12	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	22		
	4. INVENTORY & ANALYZE RESOURCES	0	40	52	52	4	44	48	0	0	0	0	0	8	44	22	32	12	4	0	362		
	5. FORMULATE ALTERNATIVES	6	40	66	46	24	26	24	24	16	42	36	0	0	16	34	44	4	8	0	456		
	6. EVALUTATE ALTERNATIVES	0	10	30	10	2	6	2	2	2	2	0	0	0	12	10	20	0	2	0	110		
	7. PREPARE WATERSHED PLAN	6	28	56	20	8	16	8	8	8	8	8	8	8	8	32	8	8	8	0	254		
	8. Misc. Contracts																						
	Total Initiate Planning and Steps 1 through 7	20	226	374	182	54	120	98	84	42	76	56	38	32	96	144	130	40	34	-	1,846		

Appendix G:

Lake Winnisquam Watershed-Based Plan dated July 2022

LAKE WINNISQUAM

WATERSHED-BASED PLAN

PREPARED BY FB ENVIRONMENTAL ASSOCIATES & HORSLEY WITTEN GROUP

in cooperation with the Winnisquam Watershed Network, the New Hampshire Department of Environmental Services, and the US Environmental Protection Agency

JULY 2022 | **FINAL**

LAKE WINNISQUAM

WATERSHED-BASED PLAN

Prepared by **FB ENVIRONMENTAL ASSOCIATES & HORSLEY WITTEN GROUP**
in cooperation with the Winnisquam Watershed Network, the New Hampshire Department of Environmental Services, and the US Environmental Protection Agency Region 1

JULY 2022 | **FINAL**

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Cover Photo: Winnisquam Watershed Network

ACKNOWLEDGEMENTS

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***In Memory of Toby Stover**, TMDL and 303(d) Listing Coordinator for NH; Regional TMDL Alternative Restoration Plan Coordinator, US EPA Region 1*

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LIST OF ABBREVIATIONS

ACRONYM	DEFINITION
AC	Assimilative Capacity
AIPC	Aquatic Invasive Plant Control, Prevention and Research Grants
ACEP	Agricultural Conservation Easement Program
ALI	Aquatic Life Integrity
ARM	Aquatic Resource Mitigation Fund
ARP	Alternative Restoration Plan
BCCD	Belknap County Conservation District
BMP	Best Management Practice
CAGR	Compound Annual Growth Rate
CHL-A	Chlorophyll-a
CNMP	Comprehensive Nutrient Management Plan
CSP	Conservation Stewardship Program
CUM	Cubic Meters
CWA	Clean Water Act
CWP	Center for Watershed Protection
CWSRF	Clean Water State Revolving Fund
DO	Dissolved Oxygen
DOS	Division of Security and Emergency Management
DPW	Department of Public Works
EPA	United States Environmental Protection Agency
EQIP	Environmental Quality Incentives Program
ESRI	Environmental Systems Research Institute
FBE	FB Environmental Associates
FT	Feet
HA	Hectare
HAB	Harmful Algal Bloom
HW	Horsley Witten Group
ILF	In-Lieu Fee
KG	Kilogram
LCHIP	Land and Community Heritage Investment Program
LID	Low Impact Development
LLMP	Lay Lakes Monitoring Program
LLRM	Lake Loading Response Model
LOPA	Lake Opechee Preservation Association
LRPC	Lakes Region Planning Commission
LWA	Lake Winnipesaukee Association
LWCF	Land and Water Conservation Fund
M	Meter
NAWCA	North American Wetlands Conservation Act
NERFG	New England Forest and River Grant
NCEI	National Centers for Environmental Information
NFWF	National Fish and Wildlife Foundation
NH GRANIT	New Hampshire Geographically Referenced Analysis and Information Transfer System
NHACC	New Hampshire Association of Conservation Commissions
NHD	National Hydrography Dataset
NHDES	New Hampshire Department of Environmental Services
NHDOT	New Hampshire Department of Transportation
NHFGD	New Hampshire Fish and Game Department

ACRONYM	DEFINITION
NHGS	New Hampshire Geological Survey
NHLCD	New Hampshire Land Cover Database
NOAA	National Oceanic and Atmospheric Administration
NPS	Nonpoint Source Pollution
NRCS	Natural Resources Conservation Service
NRI	Natural Resources Inventory
NWI	National Wetlands Inventory
PCR	Primary Contact Recreation
PCS	Potential Contamination Source
ppb, ppm	parts per billion, parts per million
PSU	Plymouth State University
QAPP	Quality Assurance Project Plan
RCCP	Regional Conservation Partnership Program
RCRA	Resource Conservation and Recovery Act
ROW	Right-of-Way
SADES	Statewide Asset Data Exchange System
SCC	State Conservation Committee
SCM	Stormwater Control Measure
SDT	Secchi Disk Transparency
TMDL	Total Maximum Daily Load
TP	Total Phosphorus
UNH	University of New Hampshire
USLE	Universal Soil Loss Equation
VLAP	Volunteer Lake Assessment Program
VRAP	Volunteer River Assessment Program
WBP	Watershed-Based Plan
WRBP	Winnipesaukee River Basin Program
WWN	Winnisquam Watershed Network
YR	Year

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.

Alternative Restoration Plan (ARP or 5-alt) is a voluntary plan for restoration developed in advance of a TMDL. These plans are created to speed up the planning and restoration process to meet water quality standards. A full TMDL planning process is not needed for Lake Winnisquam, so an ARP that demonstrates the practicality of meeting water quality standards in a reasonable timeframe can be developed instead. When the plan is accepted by EPA, the waterbody will remain at Category 5 (needing a TMDL) but can be assigned a lower priority for TMDL development. If water quality degrades or remains unchanged after 10 years (as set by this plan) or if implementation of the plan is not progressing during that time, then EPA may require a full TMDL process. Many of the required planning elements for the ARP overlap with the nine planning elements for WBPs.

Anoxia is a condition of low dissolved oxygen (Generally accepted as less than 2 ppm of dissolved oxygen).

Areal Water Load is the total annual flow volume reaching the waterbody divided by the surface area of the waterbody.

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

Best Management Practices (BMPs) are conservation practices designed to minimize discharge of NPS pollution from developed land to lakes and streams. Management plans should include both non-structural (non-engineered) and structural (engineered) BMPs for existing and new development to ensure long-term restoration success.

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 (Chl-a) is a measurement of the green photosynthetic 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; the higher the Chl-a value, the higher the concentration of algae in the lake.

Clean Water Act (CWA) is a federal law administered by the United States Environmental Protection Agency (EPA) that 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 as blooms when enough nutrients are available. Some cyanobacteria can fix nitrogen and/or produce toxins, in particular microcystin, a hepatoxin that is highly toxic to humans and other life forms.

Dimictic lakes mix twice per year, typically in spring and fall (see turnover).

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

Epilimnion is the top layer of lake water, the depth (or thickness) of which is 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.

Flushing rate is the amount of time water spends in a waterbody. It is calculated by dividing the inputs of water to the lake (streams, groundwater, precipitation, etc.) by the volume of the waterbody. The flushing rate of a lake is the inverse of the time that water spends in the lake, known as the retention time.

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 to the minimum size allowed.

Hypolimnion is the bottom-most layer of the lake that experiences periods of low oxygen during stratification and is commonly characterized by a lack of sunlight for photosynthesis.

Impervious surfaces 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 positive feedback to eutrophication with negative consequences.

Low Impact Development (LID) 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.

Nonpoint Source (NPS) 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 NPS pollution is sediment, which contains a mixture of nutrients (like phosphorus) and inorganic and organic material that stimulate plant and algae growth.

Non-structural BMPs, which do not require extensive engineering or construction efforts, can help reduce stormwater runoff and associated pollutants through operational actions, such as land use planning strategies, municipal maintenance practices, and targeted education and training.

Oligotrophic lakes are less productive or have fewer nutrients (i.e., low levels of phosphorus and chlorophyll-a), deep Secchi Disk Transparency readings (8.0 m or greater), and high dissolved oxygen levels throughout the water column. In contrast, **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).

Secchi Disk Transparency (SDT) 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 (m). A reading of less than 2 meters is generally considered a nuisance algal bloom.

Structural BMPs, or engineered Best Management Practices, are often at the forefront of most watershed restoration projects and help reduce stormwater runoff and associated pollutants.

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

Total Phosphorus (TP) is one of the major nutrients needed for plant growth including algae. It is generally present in small amounts (measured in parts per billion (ppb)) and usually limits plant growth in lakes.

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

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.

EXECUTIVE SUMMARY

As the fourth largest lake in New Hampshire at 4,249 acres, Lake Winnisquam is situated within the economically vital Lakes Region of central New Hampshire and drains Lake Winnipesaukee through Paugus Bay and Lake Opechee via the Winnipesaukee River. The direct watershed area of Lake Winnisquam spans portions of the municipalities of Meredith, Laconia, Sanbornton, Belmont, Gilford, New Hampton, and Tilton and includes other important waterbodies such as Lake Wicwas and Lake Opechee, along with major tributaries such as Black Brook, Chapman Brook, Dolloff Brook, Durgin Brook, Durkee Brook, and Jewett Brook. From the outlet of Lake Winnisquam, water flows south to Silver Lake then west via the Winnipesaukee River until it joins with the Pemigewasset River to form the Merrimack River in Franklin.

The Problem

Lake Winnisquam is classified as an oligotrophic, Class B waterbody in New Hampshire but was placed on the New Hampshire Department of Environmental Services (NHDES) 303(d) List of Impaired Waters for the designated use of Aquatic Life Integrity (ALI) due to excessive turbidity coming from Hueber Brook, a small tributary to the southeast side of Lake Winnisquam off Route 3 and near Sun Lake Drive. Elevated turbidity indicates that Lake Winnisquam is experiencing enhanced sedimentation or infill of sediment and other materials from the landscape. Black Brook, a tributary to Lake Winnisquam, has been long impacted by excessive sediment loading from the gravel roads throughout the sub-watershed, most especially Huse Rd, Kaulback Rd, and Woodman Rd. This sediment load is transported out into Lake Winnisquam where a visible 300-ft radius sediment delta has formed over the years. Sediment often transports nutrients such as phosphorus to surface waters. Enhanced loading of phosphorus, a key limiting nutrient for growth in freshwater, to surface waters such as Lake Winnisquam can stimulate excessive plant and algae growth and degrade water quality. Lake Winnisquam has already experienced cyanobacteria bloom warnings, which were issued by NHDES in 2008 (28 days) and 2010 (43 days). NHDES issued a cyanobacteria bloom alert on 6/27/22 for the north end of Lake Winnisquam. Cyanobacteria concentrations were below the advisory level and dissipated within a couple days.

Potential sources of phosphorus in the watershed impacting the lake's water quality include stormwater runoff from urban areas, shoreline erosion, erosion from construction activities or other disturbed ground particularly along roads, excessive fertilizer application, illicit connections, failed or improperly functioning septic systems, leaky sewer lines, unmitigated agricultural activities, and pet, livestock, and wildlife waste. Over 100 problem sites were identified in the watershed during a field survey, and the main issues found were unpaved road and ditch erosion; waterfront park and beach erosion; buffer clearing; and untreated urban stormwater runoff. 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 Lake Winnisquam 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 ongoing climate change.

The Goal

The purpose and overarching goal of the Lake Winnisquam Watershed-Based Plan (WBP) is to guide implementation efforts over the next 10 years (2022-2031) to improve the water quality of Lake Winnisquam such that it meets state water quality standards for the protection of ALI. *Note: this plan covers only the direct Lake Winnisquam watershed area located in Laconia, Gilford, Belmont, Tilton, Sanbornton, Meredith, and New Hampton. Restoration efforts for the larger Lake Winnipesaukee watershed are being led by other local groups. In addition, two other lakes are located within the immediate drainage area to Lake Winnisquam: Lake Wicwas and Lake Opechee. While not the focus of the plan, their water quality status has a direct impact on the water quality of Lake Winnisquam, and thus secondary water quality objectives were set to improve their water quality both for their own benefit and for the benefit of Lake Winnisquam. Monitoring of these two waterbodies should continue and/or be expanded, and if water quality decline is evident, then development of individual plans may be warranted in the future.*

This goal will be achieved by accomplishing the following summarized objectives:

- OBJECTIVE 1: Reduce pollutant loading from Hueber Brook to remove Lake Winnisquam's impaired listing for ALI due to excessive turbidity.
- OBJECTIVE 2: Mitigate (prevent or offset) anticipated additional pollutant loading from future development in the watershed.

- OBJECTIVE 3: Reduce pollutant loading from existing development in the watershed, especially in the Black Brook sub-watershed.

The Solution

Through the efforts of many key watershed protection groups, including, but not limited to, the Winnisquam Watershed Network (WWN), Belknap County Conservation District (BCCD), Lake Wicwas Association, Lake Opechee Preservation Association (LOPA), Lake Winnipesaukee Association (LWA), Lakes Region Planning Commission (LRPC), NHDES, and municipalities and their conservation commissions, much planning and restoration work to protect and restore Lake Winnisquam's water quality has been accomplished in the watershed to date.

A watershed management plan for the Black Brook sub-watershed was completed in 2012. In 2017, WWN was formed in part to unify monitoring and assessment efforts around Lake Winnisquam. The monitoring program was significantly revamped and expanded to include more frequent sampling of the deep spot and key tributaries. In 2020, a shoreline survey of Lake Winnisquam was completed by WWN volunteers, 11 stream crossing culvert assessments were completed by Trout Unlimited in the Black Brook sub-watershed, septic system data in the shoreland zone were collected by WWN volunteers (and separated out from sewered parcels), and funding from the US Environmental Protection Agency (EPA) was secured to develop a WBP for Lake Winnisquam. As part of the development of the WBP, a build-out analysis, land-use model, water quality and assimilative capacity analysis, and watershed survey were conducted to better understand the sources of phosphorus and other pollutants to the lake. In addition, remaining stream crossing culverts in the watershed were assessed in 2021 by Trout Unlimited and the NHDES Wetlands Mitigation Program; BCCD hired an engineer in 2021 to review and assess sedimentation issues impacting Black Brook; BCCD teamed with Trout Unlimited to complete a large wood installation stream restoration project in 2021 for a one mile segment of Black Brook; and BCCD hired a consultant in 2022 to perform a quantitative evaluation and prioritization of 11 erosion sites in the Black Brook sub-watershed to serve as supporting documentation for future grant funding applications.

Results from these analyses were used to determine recommended management strategies for the identified pollutant sources in the watershed. An Action Plan was developed in collaboration with a plan development committee comprised of the key watershed protection groups noted above. The following actions were recommended to meet the established water quality goal and objectives for the Lake Winnisquam watershed:

WATERSHED STRUCTURAL BMPS: Sources of phosphorus from watershed development should be addressed through installation of stormwater controls, stabilization techniques, buffer plantings, etc. for stormwater infrastructure in the Hueber Brook sub-watershed, the top 24 high priority sites (and the remaining 84 medium and low priority sites as opportunities arise) identified during the watershed survey, including road erosion in the Black Brook sub-watershed, the 20 high impact shoreline properties (as well as the 282 medium impact shoreline properties) identified during the shoreline survey, 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. WWN, in concert with University of New Hampshire (UNH) Lay Lakes Monitoring Program (LLMP) and NHDES Volunteer Lake Assessment Program (VLAP), has implemented the Lake Winnisquam Tiered Monitoring Plan since 2017 and should continue the annual monitoring protocol and consider incorporating additional monitoring recommendations laid out in this plan.

EDUCATION AND OUTREACH: WWN and other key watershed protection groups 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 (LID) requirements on new construction; 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;

completing stream restoration projects; and improving agricultural practices. Future development should also be considered as a pollutant source and potential threat to water quality. Lake Winnisquam is at risk for greater water quality degradation because of new development in the watershed unless climate change resiliency and LID strategies are incorporated to existing zoning standards.

The recommendations of this plan will be carried out largely by WWN with assistance from a diverse stakeholder group, including representatives from the seven municipalities (e.g., select boards, planning boards), conservation commissions, state and federal agencies or organizations, nonprofits, land trusts, schools and community groups, local business leaders, and landowners. The cost of successfully implementing the plan is estimated at $2.1-$3.2 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 residents. Of significant note, this plan meets the nine planning elements required by the EPA, and eligible entities within the Lake Winnisquam watershed are now eligible for federal watershed assistance grants.

Important Notes

The success of this plan is dependent on the continued effort of volunteers and a strong and diverse stakeholder group 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 no easy task, and because there are many diffuse sources of phosphorus reaching surface waters in the watershed, it will require an integrated and adaptive approach across many different parts of the watershed community to be successful.

Each municipality will likely have a unique response or implementation approach to the recommendations in the Action Plan, and thus, the execution of the actions may take a decentralized path. WWN and other local groups can work with each municipality to provide support in reviewing and tailoring the recommendations to fit the specific needs of each municipality. It should also be understood that the recommendations in this plan are idealized and, in some cases, may be difficult to achieve given the physical and political realities of each municipality dealing with old infrastructure, lack of access to key lakefront areas, and limited funding and staff capacity.

Finally, we all have a common responsibility to protect our lakes for future generations to enjoy. Private landowners arguably hold the most power in making significant impact to restoring and maintaining excellent water quality in our lakes; however, engaging private landowners as a single stakeholder group can be difficult and outreach efforts often have limited reach, especially to those individuals who may require the most education and awareness of important water quality protection actions. WWN and other key watershed protection groups will continue to engage the public as much as possible so that private individuals can help review and implement the recommendations of this plan and protect the water quality of Lake Winnisquam long into the future.

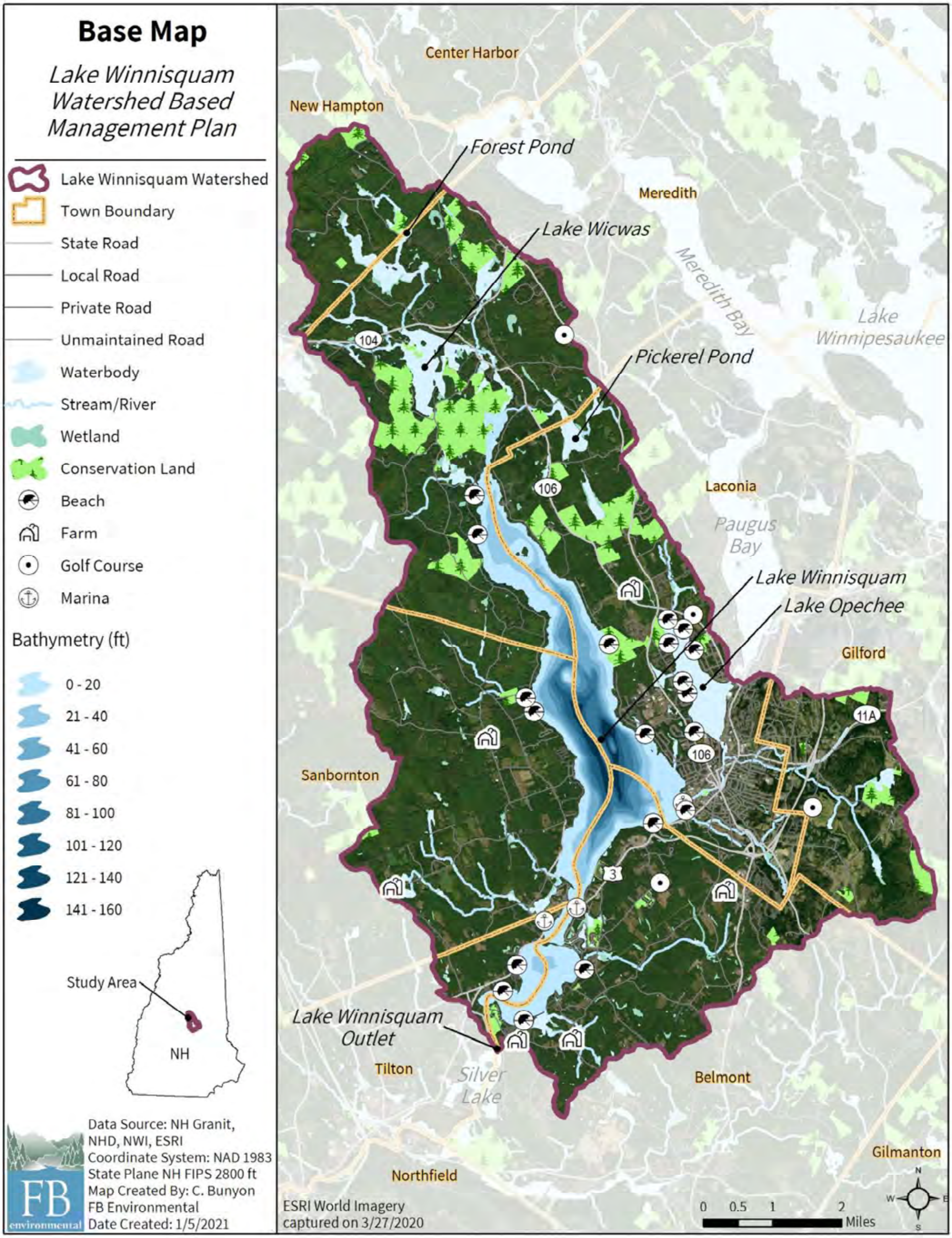
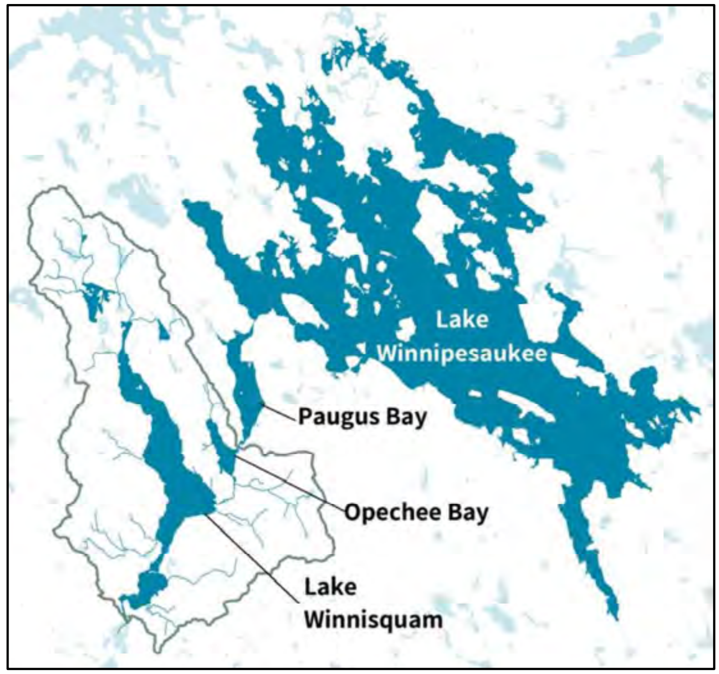


Figure 1. Lake Winnisquam watershed basemap.

1 INTRODUCTION

1.1 WATERBODY DESCRIPTION AND LOCATION

As the fourth largest lake in the State of New Hampshire, Lake Winnisquam is a 6.6-square-mile (4,249-acre) lake with a 64-square-mile (40,694-acre) direct watershed area (Figure 1) in the municipalities of Meredith (24%), Laconia (23%), Sanbornton (21%), Belmont (16%), Gilford (9%), New Hampton (5%), and Tilton (3%). The total watershed area to Lake Winnisquam includes Lake Winnipesaukee via Paugus Bay and the Winnipesaukee River (pictured right). Other major waterbodies in the direct Lake Winnisquam watershed include Lake Opechee (449 acres) and Lake Wicwas (350 acres), along with major tributaries such as Black Brook, Chapman Brook, Dolloff Brook, Durgin Brook, Durkee Brook, and Jewett Brook. From the outlet of Lake Winnisquam, water flows south to Silver Lake then west via the Winnipesaukee River until it joins with the Pemigewasset River to form the Merrimack River in Franklin, New Hampshire.



The Lake Winnisquam watershed is situated within a temperate zone of converging weather patterns from the hot, wet southern regions and the cold, dry northern regions, which causes various natural phenomena such as heavy snowfalls, severe thunder and lightning storms, and hurricanes. The area experiences moderate to high rainfall and snowfall, averaging 43 inches of precipitation annually (data collected for the period 1950-2020 from the Lakeport 2, NH US weather station (USC00274480), with gaps covered by the following weather stations: Lakeport, NH US (USC00274475), Franklin Falls Dam, NH US (USC00273182), and Plymouth, NH US (USC00276945) (Figure 2). Annual air temperature (from average monthly data) generally ranges from 20 °F to 70 °F with an average of 46 °F (NOAA NCEI, 2022).

The highest elevation in the watershed (about 1,480 feet above sea level) is located between the Bald Ledge Scenic Vista and the Sky Pond State Forest conservation areas in New Hampton. Lake Winnisquam and the direct shoreline area are situated at approximately 580 feet above sea level. These elevation measurements were derived from digital elevation models provided by NH GRANIT.

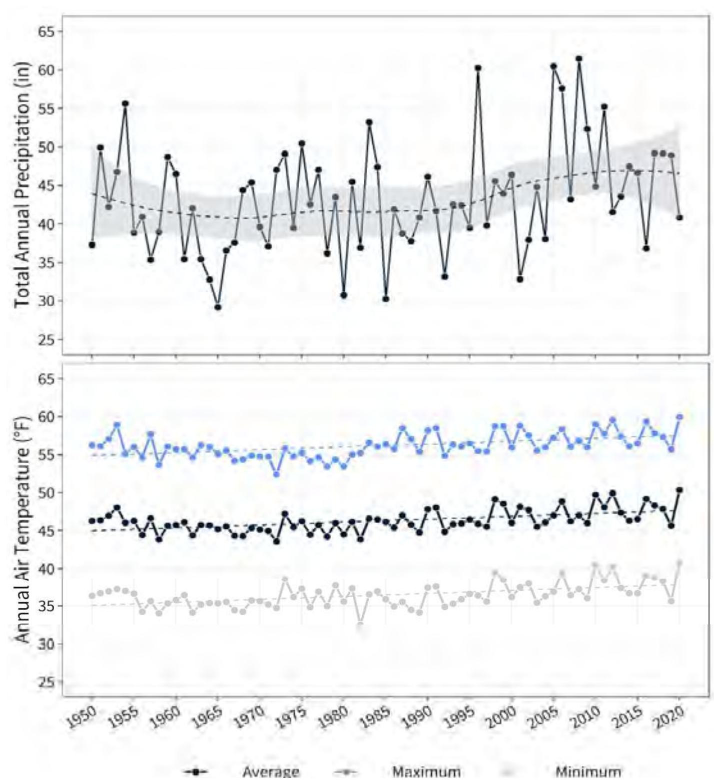


Figure 2. Total annual precipitation (TOP) and annual max, average, and min of monthly air temperature (BOTTOM) from 1950 - 2020 for the Lake Winnisquam watershed area. Data collected from NOAA NCEI.

The watershed is characterized primarily by mixed forest that includes both conifers (e.g., white pine and eastern hemlock) and deciduous (e.g., beech, red oak, and maple) tree species. Fauna that enjoy 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, gulls, geese, multiple species of ducks[1], wild turkeys, ruffed grouse, cormorants, bald eagles, and song birds), and fish. The only recorded invasive aquatic plant species present in Lake Winnisquam is variable milfoil (*Myriophyllum heterophyllum*) which became established in the lake in 1995. Invasive Chinese mystery snails have also been recorded in Lake Winnisquam. Vigilant Weed Watchers and Lake Hosts are helping to keep the lake free from additional invasive aquatic species.

1.2 WATERSHED PROTECTION GROUPS

The Winnisquam Watershed Network (WWN) serves as a non-profit lake association for Lake Winnisquam and its surrounding watershed with the mission to "*preserve and protect Lake Winnisquam and its watershed now and for future generations*." With focuses on water quality monitoring and invasive species prevention and control, the WWN helps educate members of the community and promote management initiatives.

Belknap County Conservation District (BCCD) is one of 10 county conservation districts in New Hampshire that operate as resource management agencies and a subdivision of local governments. BCCD's mission is to "*coordinate and implement programs for education and on the ground work regarding conservation, use, and development of soil, water, and related resources*." BCCD works with farmers, forest owners, landowners, schools, and municipalities to help protect and conserve the area's natural resources through projects such as stream bed restoration, invasive species management, and pollinator plantings. The BCCD is led by two paid staff and a volunteer Board of Supervisors with representation from each municipality.

The Lake Wicwas Association serves as a non-profit lake association for Lake Wicwas with the mission to "*maintain and promote what's best for the health and preservation of Lake Wicwas*." They perform water quality monitoring, watches for invasive species through the Lake Host and Weed Watcher programs and maintains effective communication with lake residents to promote education and awareness of lake protection initiatives. Their Conservation Committee actively pursues watershed parcels for conservation.

The Lake Opechee Preservation Association (LOPA) was created to combat the issue of invasive aquatic species in the lake, as well as to protect the overall health of the watershed and water quality of the lake. The group plans to expand their activities to include water quality monitoring in the future.

The Lake Winnipesaukee Association (LWA) is a non-profit organization with the mission of "*protecting the water quality and natural resources of Lake Winnipesaukee and its watershed. Through monitoring, education, stewardship, and utilizing science-guided approaches for lake management, LWA works to ensure that Winnipesaukee's scenic beauty, wildlife habitat, water quality, and recreational potential continues to provide enjoyment today and for the future*." LWA serves the 14 communities located in Belknap and Carroll counties. LWA is led by several paid staff and a volunteer Board of Directors.

The New Hampshire Association of Conservation Commissions (NHACC) works to provide educational assistance to conservation commissions throughout New Hampshire (216 in total). As a non-profit organization, the NHACC'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 Lake Winnisquam

[1] American black duck, black scoter, canvasback, common goldeneye, hooded merganser, long tailed duck, wood duck, red breasted merganser, northern pintail, and mallard.

watershed include those from the municipalities of Tilton, Meredith, Laconia, Belmont, Gilford, Sanbornton, and New Hampton.

Covering 31 communities, the Lakes Region Planning Commission (LRPC) is a valuable resource to the WWN and the Lake Winnisquam watershed. The LRPC aids communities with their local planning services in a targeted approach to protect the environment, while supporting local economies and cultural values.

The New Hampshire Department of Environmental Services (NHDES) works with local organizations to improve water quality in New Hampshire at the watershed level. NHDES works with communities to identify water resource goals and to develop and implement watershed-based plans. This work is achieved by providing financial and technical assistance to local watershed management organizations and by investigating actual and potential water contamination problems, among other activities.

1.3 PURPOSE AND SCOPE

The purpose and overarching goal of the Lake Winnisquam Watershed-Based Plan (WBP) is to guide implementation efforts over the next 10 years (2022-2031) to improve the water quality of Lake Winnisquam such that it meets state water quality standards for the protection of Aquatic Life Integrity (ALI). *Note: this plan covers only the direct Lake Winnisquam watershed located in Laconia, Gilford, Belmont, Tilton, Sanbornton, Meredith, and New Hampton. Restoration efforts for the larger Lake Winnipesaukee watershed are being led by other local groups. In addition, two other lakes are located within the immediate drainage area to Lake Winnisquam: Lake Wicwas and Lake Opechee. While not the focus of the plan, their water quality status has a direct impact on the water quality of Lake Winnisquam, and thus secondary water quality objectives were set to improve their water quality both for their own benefit and for the benefit of Lake Winnisquam. Monitoring of these two waterbodies should continue and/or be expanded, and if water quality decline is evident, then development of individual plans may be warranted in the future.*

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 (Sections 2 and 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 (Sections 5 and 6). Recommended management strategies involve using a combination of **structural and non-structural Best Management Practices** (BMPs), 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 a plan development committee (Section 1.4).

This plan meets the nine elements required by the United States Environmental Protection Agency (EPA) so that communities become eligible for federal watershed assistance grants (Section 1.5). This plan is also considered a Total Maximum Daily Load (TMDL) **Alternative Restoration Plan** (ARP or 5-alt), which is a voluntary plan for restoration developed in advance of a TMDL. These plans are created to speed up the planning and restoration process to meet water quality standards. A full TMDL planning process is not needed for Lake Winnisquam, so an ARP that demonstrates the practicality of meeting water quality standards in a reasonable timeframe can be developed instead. When the plan is accepted by EPA, the waterbody will remain at Category 5 (needing a TMDL) but can be assigned a lower priority for TMDL development. If water quality degrades or remains unchanged after 10 years (as set by this plan) or if implementation of the plan is not progressing during that time, then EPA may require a full TMDL process. Many of the required planning elements for the ARP overlap with the nine planning elements for WBPs.

1.4 COMMUNITY INVOLVEMENT AND PLANNING

This plan was developed over a period of nearly two years through active collaboration among FB Environmental Associates (FBE), Horsley Witten Group (HW), WWN, NHDES, EPA, BCCD, LWA, Lake Wicwas Association, LRPC, representatives from the municipalities of Meredith, Laconia, Gilford, Belmont, Tilton, Sanbornton, and New Hampton, and private landowners (see Acknowledgments).

1.4.1 Plan Development Meetings

Ten meetings were held over the duration of the plan's development. The following list does not include other smaller check-in meetings conducted among project partners.

1. **December 14, 2020:** EPA, NHDES, and the technical project staff (FBE, HW) held a logistics kickoff meeting to discuss project roles, communications, and timeline for tasks and deliverables.
2. **January 5, 2021:** Key project team members, including WWN, EPA, NHDES, FBE, and HW held a content kickoff meeting which walked through project tasks and the expected project timeline. Additional supporting organizations attending included LWA and BCCD.
3. **February 2, 2021:** WWN held a project kick-off meeting for local conservation commissions to attend and learn about the plan and the project's objectives, technical partners, timeline, and strategy.
4. **March 9, 2021:** The committee discussed the Quality Assurance Project Plan (QAPP) development and prepared for the virtual public workshop.
5. **April 6, 2021:** The committee discussed the outreach efforts for the upcoming public workshop and preparations for watershed assessments by FBE and HW.
6. **May 4, 2021:** The committee discussed the upcoming virtual public workshop, including WWN's advertisement, expected attendees, and break-out group facilitation. The committee also discussed the to-date work for the watershed assessment (FBE), culvert assessments (Trout Unlimited), and septic system database (WWN).
7. **June 1, 2021:** The committee discussed survey responses associated with the public workshop. FBE presented preliminary build-out results. HW and FBE provided an update on watershed assessments completed.
8. **August 3, 2021:** The committee walked through numerous task updates, including a summary of the public workshop, FBE's review of environmental monitoring data to-date, the updated draft of the build-out report with feedback from the watershed municipalities, and completed estimates of pollutant load reductions for the watershed assessment sites.
9. **December 7, 2021:** The committee discussed the completed land-use model by FBE and the recommended water quality goal and specific objectives identified for Lake Winnisquam. WWN submitted a full proposal for a Section 319 Watershed Assistance Grant that focuses on remediating several identified watershed assessment sites.
10. **March 1, 2022:** The committee discussed final rounds of edits made for reports that inform the plan, including the build-out analysis report, modeling report, water quality goal memorandum, public workshop summary, and watershed assessments and NPS management measures technical memorandum.

1.4.2 Public Workshop

A virtual public workshop was held on May 18, 2021 to introduce the project to the watershed community and solicit feedback on local interests, values, and concerns related to water quality and practical solutions. The workshop was attended by 44 people, including 12 team members and stakeholders who served as presenters and facilitators. Key topics discussed included land conservation and municipal planning, road erosion and maintenance, septic systems, stormwater management, and other water quality concerns. Refer to Appendix A for a full summary of solicited feedback.

1.4.3 Public Surveys

WWN posted a survey online to gather local feedback on water quality perceptions, values, and interests in the watershed. There were 133 respondents. Survey responses indicate that 50% of respondents live in the watershed year-round, most on Lake Winnisquam. Most respondents felt that water quality was about the same or getting somewhat worse and that maintaining excellent water quality was very important to them, valuing roughly equally recreational use, fishery health, wildlife health, drinking water, and property value. Respondents identified stormwater runoff, fertilizers, septic systems, and road salt as the largest perceived contributors to water quality degradation. About 57% of respondents were served by sewer; most septic systems were around 20 years old; 60% pumped their septic system in last 3-5 years. About 42% of respondents use fertilizer at least once per year on their lawn. About 92% of respondents supported land conservation to protect water quality. Other specific environmental concerns that respondents listed included: density of waterfront homes, lack of shoreline buffers, large tree removal, trash/litter, boat wakes generating shoreline erosion, boat and swimmer pollution at the sandbar, winter road maintenance, loss of wetland habitat, light pollution, and dirt road erosion, among others.

With a rise in the number of boaters entering Lake Winnisquam each year, WWN is concerned about boaters launching from private launches around the lake and bypassing the Lake Host Program inspection for invasives at the public launch. WWN created a survey targeting Winnisquam boaters to determine where boaters were coming from and where they were launching into the lake. There were 136 survey respondents, of which 48% were year-round and 52% were seasonal. Most of the boaters used motor boats (90%) compared to jet skis (31%), sail boats (11%), and wake boats (10%). About 41% of the boaters used the public launch, while 25% used private property, 19% used a marina, and 14% used a neighborhood/association launch. Of the public boat launches and neighborhood/association launches listed in the survey, most used the Laconia/Water Street launch with only a handful of respondents using Sunray Shore, Wildwood Shores, Mallards Landing, Winnisquam Marine, Black Brook Rd, and Waldron Bay Owner's Association. Most boaters keep their boats in the lake for the season (81%), while others launch their boats for day trips (12%) or short vacations (4%). While 84% of boaters do not bring their boat to other lakes, about 6% of boaters do, including such waterbodies as Lake Winnipesaukee, Rye Harbor, Lake George, Sarantac Lake, Beaver Lake, Merrimack River, Squam Lake, Arlington Pond, Lake Wicwas, Lake Champlain, and Sunapee Lake. Most boaters reported draining and drying their boats prior to launching them, though 5% were not familiar with the protocol.

1.4.4 Final Public Presentation

A final public presentation was held on June 7, 2022 to summarize the analyses and recommendations detailed in the plan. An opportunity for public feedback on the plan was offered. The presentation was attended by 26 people, including nine team members and stakeholders on the committee.

1.5 INCORPORATING EPA'S NINE ELEMENTS

EPA guidance lists nine components that are required within a WBP to restore waters impaired or likely to be impaired by **nonpoint source (NPS) pollution**. These guidelines highlight important steps in restoring and protecting water quality for any waterbody affected by human activities. The nine required elements found within this plan are as follows:

- **A. IDENTIFY CAUSES AND SOURCES: Sections 2 and 3** highlight known sources of NPS pollution to Lake Winnisquam and describe the results of the watershed survey and other assessments conducted in the watershed. These sources of pollutants must be controlled to achieve load reductions estimated in this plan, as discussed in item (B) below.
- **B. ESTIMATE PHOSPHORUS LOAD REDUCTIONS EXPECTED FROM MANAGEMENT MEASURES: Sections 2 and 5** describe the calculation of pollutant load to Lake Winnisquam and the amount of reduction needed to meet the goal.
- **C. DESCRIPTION OF MANAGEMENT MEASURES: Sections 4 and 5** identify ways to achieve the phosphorus load reduction and water quality targets through general management strategies and specific action items in the Action Plan. The Action Plan focuses on non-structural BMPs integral to the implementation of structural BMPs.
- **D. ESTIMATE OF TECHNICAL AND FINANCIAL ASSISTANCE: Sections 5 and 6** include a description of the associated costs, sources of funding, and primary authorities responsible for implementation. Sources of funding need to be diverse and should include local, state, and federal granting agencies, local groups, private donations, and landowner contributions for implementation of the Action Plan.
- **E. EDUCATION & OUTREACH: 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 ADDRESSING PHOSPHORUS REDUCTIONS: Section 5** provides a list of action items and recommendations to reduce the phosphorus load to Lake Winnisquam. Each item has a set schedule that defines when the action should begin and/or end or run through (if an ongoing activity). The schedule should be adjusted by the WWN on an annual basis (see Section 4 on Adaptive Management).
- **G. DESCRIPTION OF INTERIM MEASURABLE MILESTONES: Section 6** outlines indicators along with milestones of implementation success that should be tracked annually.
- **H. SET OF CRITERIA: Sections 2 and 6** can be used to determine whether loading reductions are being achieved over time, substantial progress is being made towards water quality objectives, and if not, criteria for determining whether this plan needs to be revised.
- **I. MONITORING COMPONENT: Section 6** describes the long-term water quality monitoring strategy for Lake Winnisquam, the results of which can be used to evaluate the effectiveness of implementation efforts over time as measured 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 BMP implementation projects.

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, which identified pollutants of concern and informed the established water quality goal and objectives for Lake Winnisquam.

2.1 WATER QUALITY SUMMARY

2.1.1 Water Quality Standards & Impairment Status

2.1.1.1 Designated Uses & Water Quality Criteria

The **Clean Water Act** (CWA) requires states to determine designated uses for all surface waters within the state's jurisdiction. Designated uses are the desirable activities and services that surface waters should be able to support and include uses for aquatic life, fish consumption, shellfish consumption, drinking water supply, primary contact recreation (swimming), secondary contact recreation (boating and fishing), and wildlife. Surface waters can have multiple designated uses. **Primary Contact Recreation (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). **Lake Winnisquam is classified as a Class B waterbody**. Additionally, from 1974 to 2010, NHDES conducted surveys of lakes to determine **trophic state** (**oligotrophic**, **mesotrophic**, or **eutrophic**). The trophic surveys evaluated physical lake features, as well as chemical and biological indicators. **For Lake Winnisquam, the trophic state was determined to be oligotrophic** during all four completed surveys (1980, 1984, 1994, 2007) (NHDES, 2007). This means that in-lake water quality was consistent with the standards for oligotrophic lakes.

Water quality criteria are then developed to protect designated uses, serving as a "yardstick" for identifying water quality exceedances and for determining the effectiveness of state regulatory pollution control and prevention programs. Depending on the designated use and type of waterbody, water quality criteria can become more or less strict if the waterbody is classified as either Class A or B or as oligotrophic, mesotrophic, or eutrophic. 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 toxics) 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 can be found in RSA 485 A:8, IV and in the state's surface water quality regulations.

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 (e.g., projects that require Alteration of Terrain Permit or 401 Water Quality Certification) may be subject to an Antidegradation Review to ensure compliance with the state's water quality regulations. The Antidegradation Provision is often invoked during the permit review process for projects adjacent to waters that are designated 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% 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.

2.1.1.3 Waterbody Impairment Status

According to New Hampshire's 2020-2022 303(d) List of Impaired Waters, **Lake Winnisquam is impaired for ALI due to excessive turbidity**, which was documented at one location: the outlet area of Hueber Brook, a small tributary to the southeast side of Lake Winnisquam off Route 3 and near Sun Lake Drive in Belmont. Excessive turbidity represents a threat to water quality and lake health. The original impairment was determined in 2007 during reconstruction of Route 3 and Route 11 when a plume of sediment with turbidity exceeding 10 NTU after rain events was documented in the lake and coming from Hueber Brook. Even with reconstruction of Route 3 and Route 11 complete, resampling of the area in 2015 revealed turbidity still exceeding 10 NTU after rain events. The water quality criteria for turbidity must be met everywhere in the lake to be considered attaining for ALI. Elevated turbidity indicates that Lake Winnisquam is experiencing enhanced sedimentation or infill of sediment and other materials from the landscape, in this case washed in from Hueber Brook. Sediment often transports nutrients such as phosphorus to surface waters. Enhanced loading of phosphorus to surface waters such as Lake Winnisquam can stimulate excessive plant and algae growth and degrade water quality. Lake Winnisquam has already experienced **cyanobacteria** bloom warnings, which were issued by NHDES in 2008 (28 days) and 2010 (43 days). NHDES issued a cyanobacteria bloom alert on 6/27/22 for the north end of Lake Winnisquam. Cyanobacteria concentrations were below the advisory level and dissipated within a couple days.

Lake Wicwas is currently listed on the NHDES 303(d) List of Impaired Waters for ALI due to low dissolved oxygen, which is often indicative of enhanced nutrient loading from external watershed sources and/or internal sediment sources. Low dissolved oxygen can release legacy phosphorus from bottom sediments and contribute to cyanobacteria blooms that capitalize on available light and nutrients in the water column. NHDES issued cyanobacteria (*Dolichospermum*) bloom warnings in August 2018 (14 days) and 2019 (6 days) for Lake Wicwas. **Lake Opechee is currently not listed as impaired for ALI** (but is listed as impaired for PCR due to elevated *E. coli*). There was evidence of low oxygen (at 13 m and deeper) and elevated hypolimnetic total phosphorus concentrations (at 15 m) in the 1979, 1986, and 1999 NHDES Trophic Survey Reports for Lake Opechee; thus, there is likely some internal loading occurring. Cyanobacteria bloom warnings were issued for Lake Opechee in 2008 (37 days) for *Anabaena* at Bond Beach, which represents localized blooms that should be tracked closely in the future; a lake-wide cyanobacteria advisory was issued by NHDES in June 2022 (5 days) for *Dolichospermum*. The high **flushing rate** of Lake Opechee due to the large incoming water volume from Lake Winnipesaukee through Paugus Bay helps to mix the lake with lower concentration water than that coming from the direct watershed area to Lake Opechee in Laconia. Much of the area in Laconia directly draining to Lake Opechee is already built-out but increasing the density of new or re-development will have consequences for the water quality of Lake Opechee in the future, especially when compounded by the effects of climate change.

2.1.2 Water Quality Data Collection

Prior to 2017, volunteers conducted monitoring on Lake Winnisquam as part of both the UNH Lay Lakes Monitoring Program (LLMP) and NHDES Volunteer Lake Assessment Program (VLAP). LLMP monitoring was conducted almost every year from 1997-2016 during the summer months at four nearshore stations along the western shoreline of the lake in Sanbornton and Meredith. VLAP monitoring (going back to 1987) was conducted at three deep spot stations near Three Island, Pot Island, and Mohawk Island (Figure 3). NHDES also conducted monitoring of the three deep spot stations several times as part of their lake trophic surveys (1980, 1984, 1994, 2007). In 2017, the WWN met with the directors of both the LLMP and VLAP programs and put together a tiered monitoring plan for the lake that allowed for better coordination of volunteers, resources, and data.

Since 2017, the WWN, in collaboration with VLAP and LLMP, has been implementing the first tier of the monitoring plan, conducting sampling at two of the nearshore stations and the three deep spot stations. VLAP monitors three deep spot stations in Lake Winnisquam (Three Island, Pot Island, and Mohawk Island), and LLMP monitors two nearshore stations in Lake Winnisquam (10 Waldron and 30 Bartlett), three to five times each summer for total phosphorus (**epilimnion**, metalimnion, and **hypolimnion**), chlorophyll-a (composite or epilimnion), **Secchi disk transparency**, and dissolved oxygen-temperature profiles. Samples are analyzed by the NHDES laboratory in Concord. Volunteers also collect additional Secchi disk transparency readings at the three deep spot stations throughout the summer season. Dissolved oxygen-temperature profiles for 2017-2019 were not collected except for two profiles, one in 2017 and one in 2018, at the Three Island deep spot station.

In 2018, the WWN also added a tributary monitoring program using NHDES Volunteer River Assessment Program (VRAP) protocols to monitor nine stations for total phosphorus two to three times each summer (Figure 3). The City of Laconia has also monitored Jewett Brook under VRAP. Three stations (Jewett Brook, Black Brook, and Winnipesaukee River inlet to the lake) have been monitored consistently in the last 10 years. The other seven stations include Lake Wicwas outlet, Durkee Brook, Collins Brook, Chapman Brook (two branches), Durgin Brook, and the outlet of Lake Winnisquam.

Once each year, VLAP also monitors the deep spot, west cove, east cove, and the Route 104 inlet to Lake Wicwas in the headwaters of the Lake Winnisquam watershed for total phosphorus, chlorophyll-a, Secchi disk transparency, and/or dissolved oxygen-temperature profiles. VLAP collects up to six chlorophyll-a samples from Hunkins Pond. Dissolved oxygen and temperature are also monitored at several other sites throughout the watershed and at beaches.

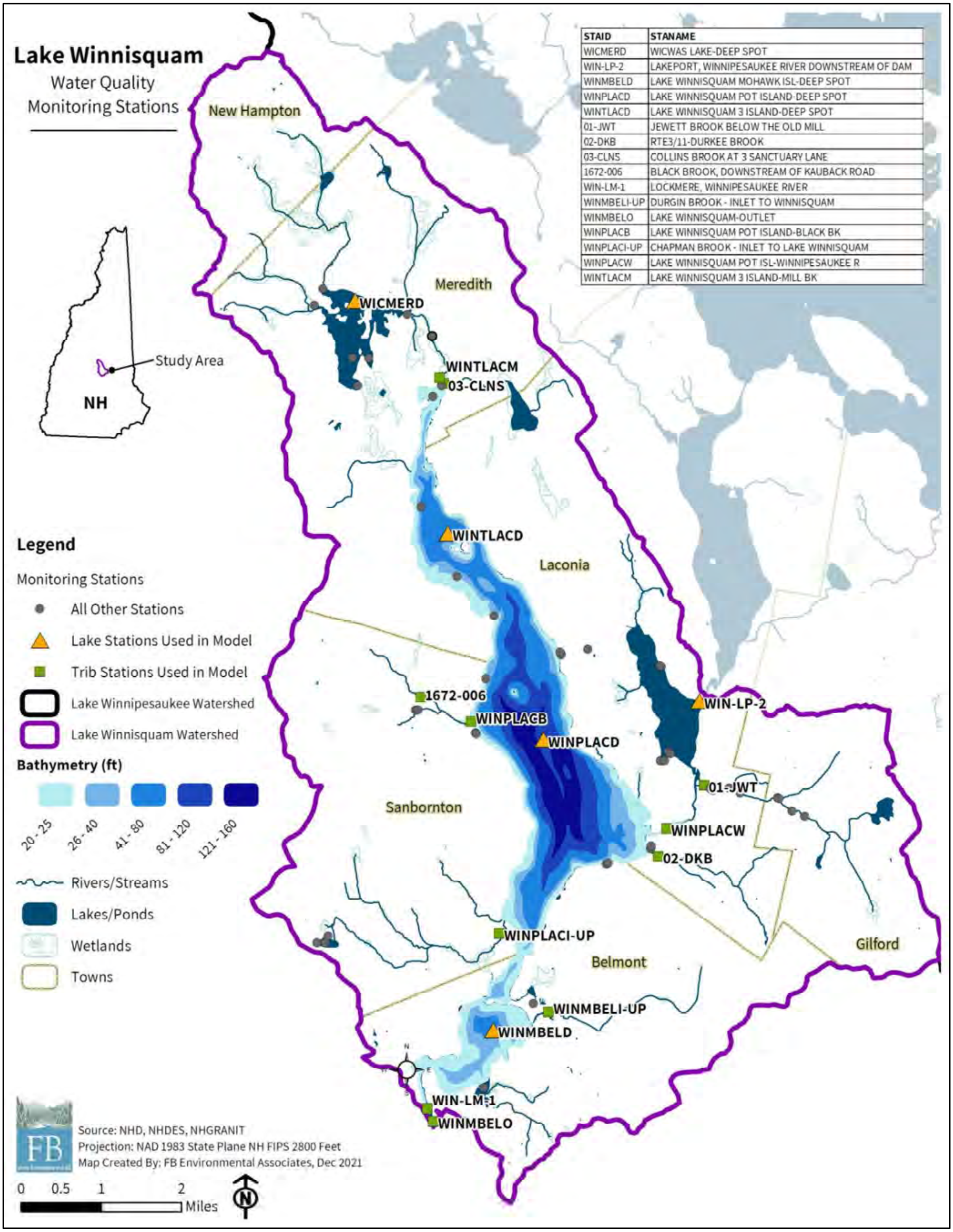


Figure 3. Bathymetric map with water quality monitoring stations in the Lake Winnisquam watershed.

2.1.3 Trophic State Indicator Parameters

Total phosphorus, chlorophyll-a, and Secchi disk transparency are trophic state indicators, or indicators of biological productivity in lake ecosystems. The combination of these parameters helps determine the extent and effect of **eutrophication** in lakes and helps signal changes in lake water quality over time. For example, changes in Secchi disk transparency may be due to a change in the amount and composition of algae communities (typically because of greater total phosphorus availability) or the amount of dissolved or particulate materials in a lake. Such changes are likely the result of human disturbance or other impacts to the lake's watershed.

Annual average water clarity at the three deep spot stations on Lake Winnisquam range from the shallowest of 5.6 m at Mohawk Island deep spot to the deepest of 8.6 m at Pot Island deep spot (Figure 4), with overall average water clarity from 2011-2021 ranging from 6.2 m to 7.7 m at the three stations. Annual average total phosphorus was highest at 13.0 ppb at Three Island deep spot in 2021 (possibly due to the extreme wet summer generating runoff that concentrated nutrient-laden sediment from the upper watershed); otherwise, the three stations range comparably similar from 6.7 ppb to 7.5 ppb for overall average total phosphorus concentration from 2011-2021. Mohawk Island deep spot generally had lower total phosphorus concentrations, likely due to the diluting effects of the large volume of incoming water from upstream waterbodies including Lake Winnipesaukee (though Pot Island is also influenced by Lake Winnipesaukee inflows). Annual average chlorophyll-a was consistently and comparably low, ranging from the lowest of 0.7 pb at Pot Island deep spot to the highest of 3.8 ppb at Three Island deep spot, with overall average chlorophyll-a from 2011-2021 ranging from 1.5 ppb to 1.9 ppb at the three deep spot stations.

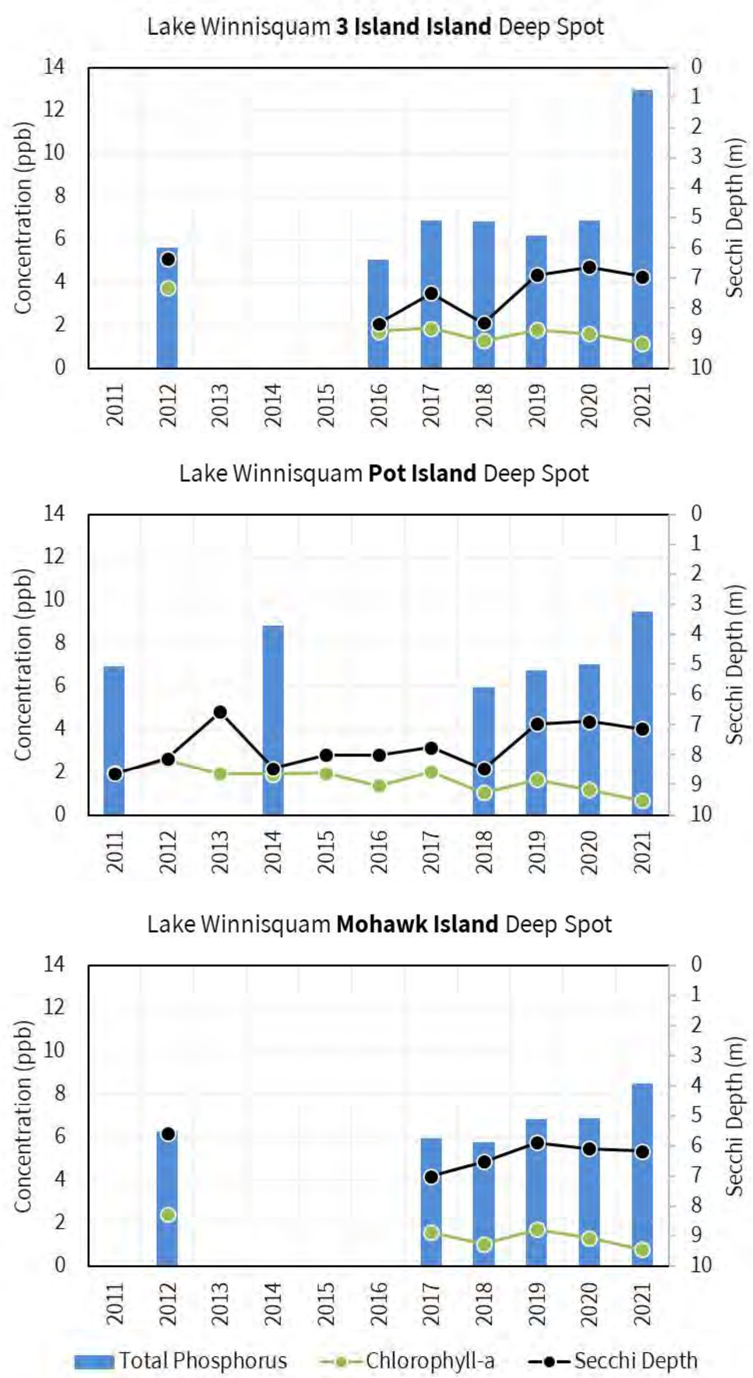


Figure 4. Annual average epilimnetic total phosphorus (blue), chlorophyll-a (green), and water clarity (Secchi depth, black) measured intermittently from 2011-2021 at three deep spot stations on Lake Winnisquam (from upstream to downstream): Three Island (TOP), Pot Island (MIDDLE), and Mohawk Island (BOTTOM).

2.1.4 Dissolved Oxygen & Water Temperature

A common occurrence in many New England lakes is the depletion of dissolved oxygen in the deepest part of lakes throughout the summer months, a natural phenomenon in some **dimictic** lakes that is made more severe by human disturbance. 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 ppm (and water temperature above 24 °C) can stress and reduce habitat for coldwater fish and other sensitive aquatic organisms. In addition, **anoxia** (dissolved oxygen < 2 ppm) at 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. It is important to keep tracking 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.

Figure 5 shows temperature and dissolved oxygen profiles averaged across sampling dates (2012-2020) during **thermal stratification** in summer (between spring and fall **turnover**) for the three deep spot stations on Lake Winnisquam. The change in temperature, seen most dramatically between 6 and 12 m depth, indicates thermal stratification in the water column at all three sites. Dissolved oxygen levels did not fall below the 5 ppm threshold at the most upstream station, Three Island, indicating good oxygenation throughout the water column. Anoxia was measured at both Pot Island and Mohawk Island deep spots, though only near the very bottom at Pot Island. Mohawk Island deep spot showed dissolved oxygen depleting rapidly below the 5 ppm threshold at 9 m and below the 2 ppm threshold at 16 m.

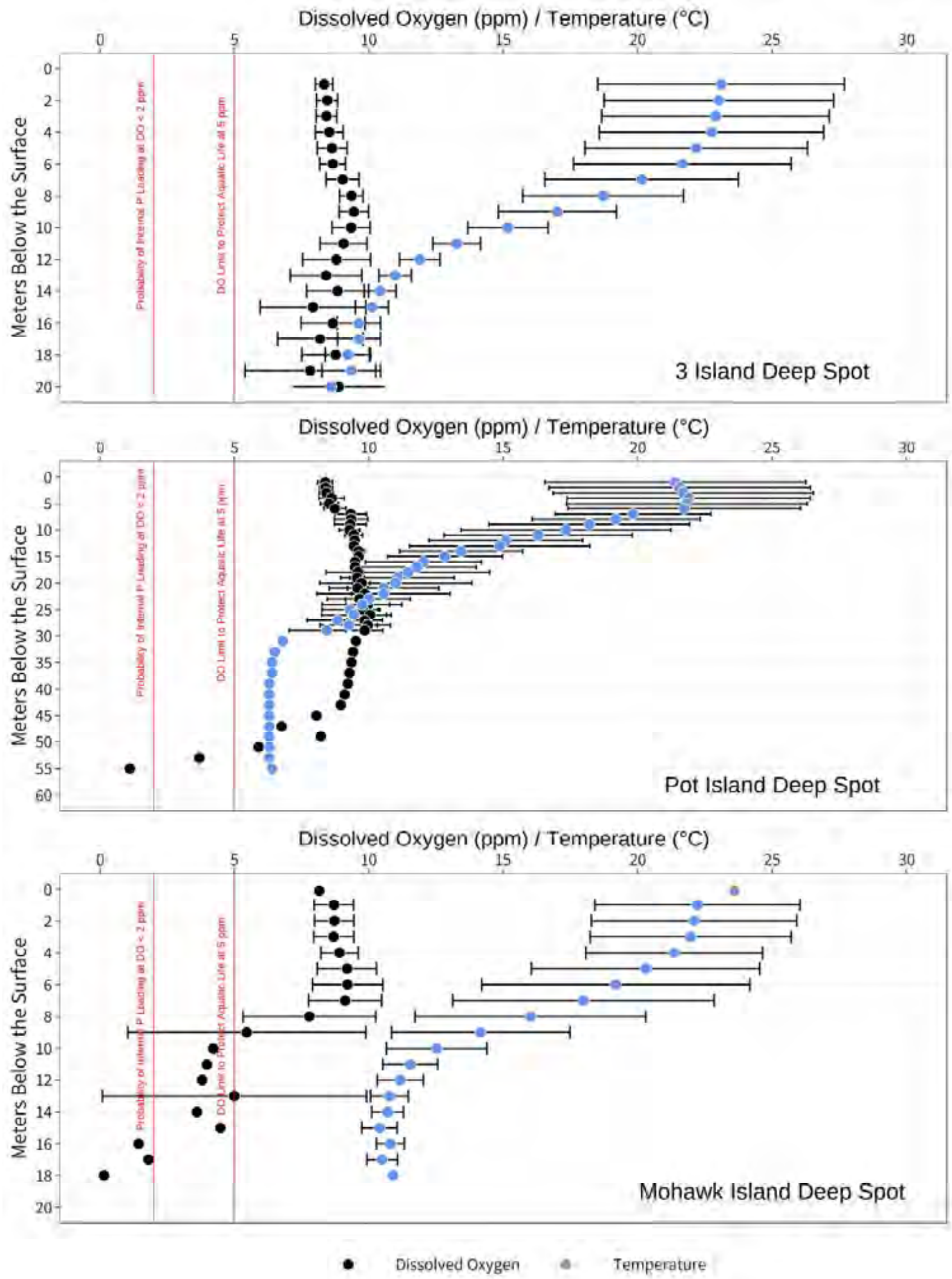


Figure 5. Dissolved oxygen (black) and temperature (blue) depth profiles for three deep spot stations on Lake Winnisquam (ordered from upstream to downstream): Three Island (TOP), Pot Island (MIDDLE), and Mohawk Island (BOTTOM). Profiles were measured once in 2012, 2013, 2016, 2017, and 2018, and twice in 2020 during thermal stratification in summer. Dots represent average values across sampling dates for each respective depth. Error bars represent standard deviation.

2.1.5 Cyanobacteria

Nutrients such as phosphorus and nitrogen, as well as algae and cyanobacteria, naturally occur in the environment, including lakes and tributaries and their contributing watersheds, and are essential to lake health. Under natural conditions, algae and cyanobacteria concentrations are regulated by limited nutrient inputs and lake mixing processes that keep them from growing too rapidly. However, human related disturbances, such as erosion, overapplied fertilizers, polluted stormwater runoff, excessive domesticated animal waste, and inadequately treated wastewater, can dramatically increase the amount of nutrients entering lakes and their tributaries. Excess nutrient loading to human-disturbed lake systems, in combination with a warming climate, has fueled the increasing prevalence of Harmful Algal Blooms (HABs) or the rapid growth of algae and cyanobacteria in lakes across the United States.

Cyanobacteria are small photosynthesizing, sometimes nitrogen-fixing, single-celled bacteria that grow in colonies in freshwater systems. Cyanobacteria blooms can (but not always) produce microcystins and other toxins that pose a serious health risk to humans, pets, livestock, and wildlife, such as neurological, liver, kidney, and reproductive organ damage, gastrointestinal pain or illness, vomiting, eye, ear, and skin irritation, mouth blistering, tumor growth, seizure, or death. Blooms can form dense mats or surface scum that can occur within the water column or along the shoreline. Dried scum along the shoreline can harbor high concentrations of microcystins that can re-enter a waterbody months later.

Cyanobacteria blooms and their associated toxins have been recorded in the Lake Winnisquam watershed, including Lake Winnisquam, Hunkins Pond, Lake Opechee, and Lake Wicwas (Table 1). Lake Winnisquam has experienced cyanobacteria bloom warnings, which were issued by NHDES in 2008 (28 days) and 2010 (43 days). NHDES issued a cyanobacteria bloom alert on 6/27/22 for the north end of Lake Winnisquam. The bloom appeared as diffuse green clouds or ribbons of material suspended in the water along the shoreline. Cyanobacteria concentrations contained *Dolichospermum* but were below the advisory level and dissipated within a couple days.

Cyanobacteria are becoming more prevalent in low-nutrient lake systems likely due to climate change warming effects (e.g., warmer water temperatures, prolonged thermal stratification, increased stability, reduced mixing, and lower flushing rates at critical low-flow periods that allow for longer residence times) that allow cyanobacteria to thrive and outcompete other phytoplankton species (Przytulska, Bartosiewicz, & Vincent, 2017; Paerl, 2018; Favot, et al., 2019). Many cyanobacteria can regulate their buoyancy and travel vertically in the water column to maximize their capture of both sunlight and sediment phosphorus (even during stratification and/or under anoxic conditions) for growth. In addition, some cyanobacteria can also fix atmospheric nitrogen, if enough light, phosphorus, iron, and molybdenum are available for the energy-taxing process. 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 as climate warming increases the prevalence and dominance of cyanobacteria, cyanobacteria are one of the major factors driving positive feedbacks with lake eutrophication and may be both accelerating eutrophication in low-nutrient lakes and preventing complete recovery of lakes from eutrophic states (Dolman, et al., 2012; Cottingham, Ewing, Greer, Carey, & Weathers, 2015). A better understanding of cyanobacteria's role in nutrient feedbacks will be needed for better and more effective lake restoration strategies. However, we can substantially minimize conditions favorable for blooms, such as reducing nutrient-rich runoff from the landscape during warm, sunny spells. Regulating water level and flow also helps to either flush out blooms or limit upstream nutrient sources to stymie growth.

Table 1. Cyanobacteria blooms occurring in the Lake Winnisquam watershed since 2006.

Location	Date of Advisory	Number of Advisory Days	Species	Illness Reported	Total Cell Concentration (cells/mL)
HUNKINS POND	7/20/2006	95	*Anabaena*	Unknown	>70,000 or >50%
LAKE WINNISQUAM	6/25/2008	28	Unidentified	Unknown	>70,000 or >50%
LAKE OPECHEE (BOND BEACH)	7/7/2008	37	*Anabaena*	Unknown	>70,000 or >50%
HUNKINS POND	8/21/2008	102	*Anabaena*	Unknown	>70,000 or >50%
LAKE WINNISQUAM (EPHRAIMS COVE)	9/19/2010	43	*Anabaena*	Unknown	58,459
HUNKINS POND	9/5/2014	25	*Anabaena*	Unknown	102,000
LAKE WICWAS	8/9/2018	14	*Anabaena/Dolichospermum*	Unknown	119,000
HUNKINS POND	6/26/2019	34	*Anabaena/Dolichospermum*	Unknown	611,000
HUNKINS POND	8/9/2019	19	*Anabaena/Dolichospermum*	Unknown	165,000
LAKE WICWAS	8/21/2019	6	*Anabaena/Dolichospermum*	Unknown	446,675
LAKE WINNISQUAM	6/27/2022	Alert Only	*Dolichospermum*	Unknown	<70,000
LAKE OPECHEE	6/27/2022	5	*Dolichospermum*	Unknown	73,133

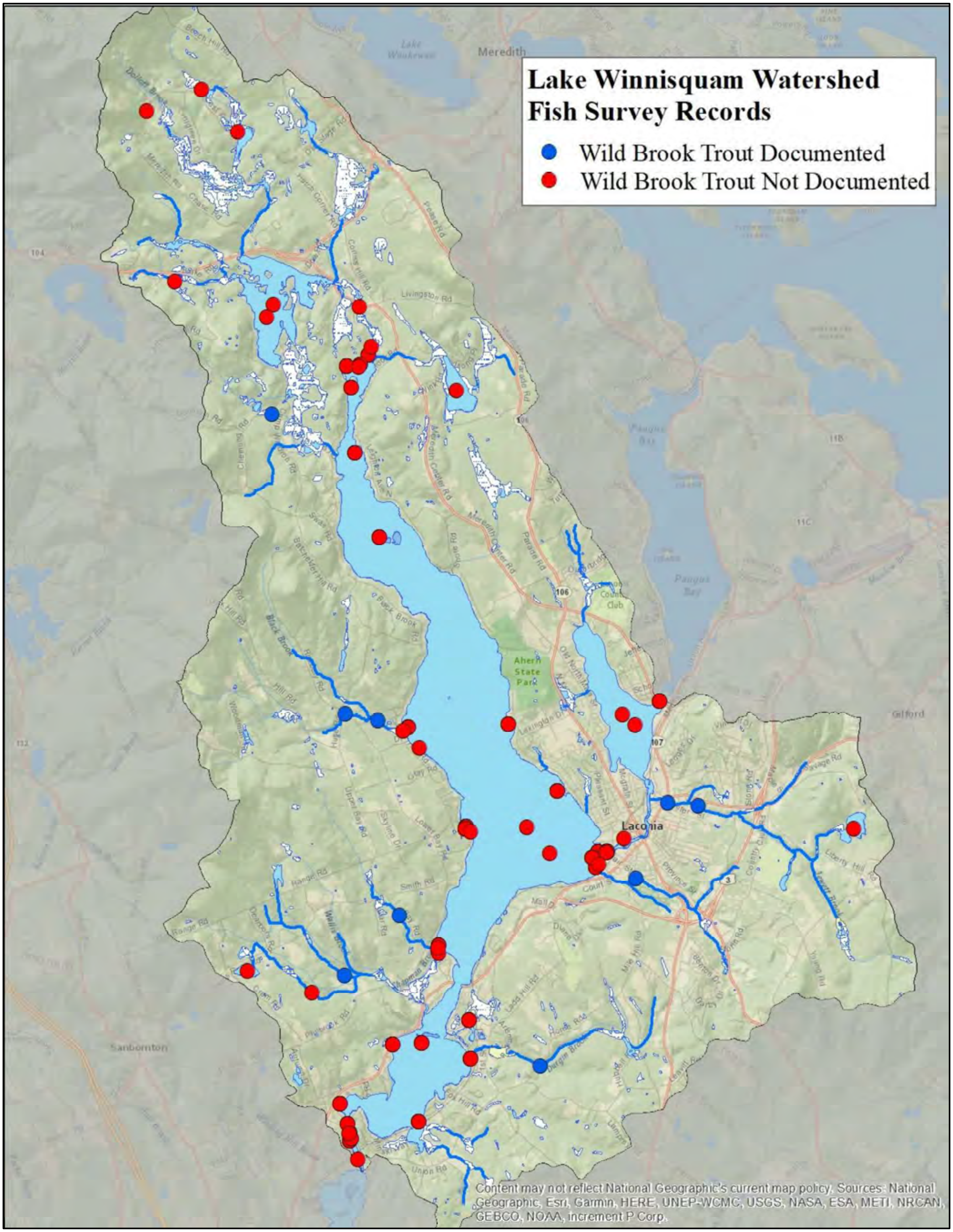


Figure 6. Map of documented wild brook trout occurrences. Courtesy of Trout Unlimited.

2.1.6 Fish

Fish are an important natural resource for sustainable ecosystem food webs and provide recreational opportunities. Lake Winnisquam supports a thriving population of both cold and warm water species including but not limited to rainbow trout, land locked salmon, lake trout, small and large mouth bass, eastern chain pickerel, brown bullhead, white perch, black crappie, bluegill, rock bass, burbot, and American eel. A map of documented wild brook trout occurrences is shown in Figure 6. Fish species of concern include river herring (whose population is stocked by the New Hampshire Fish and Game Department, NHFGD) in the Winnipesaukee River, as well as brown trout in Black Brook, Chapman Brook, Jewett Brook, and Durgin Brook. Historically, the Lake Winnisquam watershed hosted an abundant rainbow smelt population that spawned in the tributaries. Land use changes and sedimentation have since buried the cobble/gravel substrate needed to support egg incubation in fish spawning areas. Each year, about 20,000 migrating adult herring and alewives are trapped at dams in Massachusetts and transported to Lake Winnisquam where the adults spawn. At one time, Black Brook also supported a commercial alewife fishery.

2.1.7 Invasive Aquatic Species

The introduction of non-indigenous invasive aquatic plant species to New Hampshire's waterbodies has been on the rise. These invasive aquatic plants are responsible for habitat disruption, loss of native plant and animal communities, reduced property values, impaired fishing and degraded recreational experiences, and high removal costs. Once established, invasive species are difficult and costly to remove.

Variable milfoil (*Myriophyllum heterophyllum*) was first established in Lake Winnisquam around 1995 and was only managed sporadically in a few areas until 2018 when WWN began actively managing milfoil and other invasive aquatic species through several programs, including the NH Lakes' Lake Host Program, the NHDES Weed Watcher Program, and WWN's Milfoil Management Program. Through the Lake Host Program, which WWN operates in cooperation with NH Lakes, trained Lake Hosts inspect boats and trailers both entering and exiting Lake Winnisquam for invasive aquatic plants to prevent their spread. The Weed Watcher Program uses trained volunteers to survey the near-shore areas of the lake for any invasive aquatic plants. These survey efforts have identified previously unknown infestation areas that have since been eradicated. WWN established the Milfoil Control Program for Lake Winnisquam in 2018 with funding from NHDES, local matches from the municipalities of Meredith, Belmont, Tilton, Sanbornton, and Laconia, and donations from neighborhood associations and WWN members. Under the leadership of WWN, milfoil management, including diver-assisted harvesting and herbicide treatments, is done comprehensively lake-wide and according to a *Long-Term Variable Milfoil Management Plan* first created by NHDES in 2017 (with annual updates since) for Lake Winnisquam (NHDES, 2020). These survey efforts have identified previously unknown infestation areas that have since been eradicated, treated with herbicide, or removed by divers and monitored to detect any regrowth. At the end of the 2021 season, no milfoil was detected in Lake Winnisquam, which was declared milfoil-free. Although milfoil will likely return in future years, the eradication monitoring efforts (Weed Watcher, Lake Host) by WWN and volunteers followed by treatment of any infestation has proven to be effective and will continue each year.

Invasive Chinese mystery snails have also been recorded in Lake Winnisquam, but populations are low and are not actively managed by any group.

2.2 ASSIMILATIVE CAPACITY

The assimilative capacity of a waterbody describes the amount of pollutant that can be added to a waterbody without causing a violation of the water quality criteria. For oligotrophic waterbodies such as Lake Winnisquam and Lake Opechee, the water quality criteria are set at 8 ppb for total phosphorus and 3.3 ppb for chlorophyll-a (Table 2). Each trophic state has a certain phytoplankton biomass (chlorophyll-a) that represents a balanced, integrated, and adaptive community. Exceedances of the chlorophyll-a criterion suggests that the algal community is out of balance. Since phosphorus is the primary limiting nutrient for growth of freshwater algae (chlorophyll-a), phosphorus is included in this assessment process. NHDES requires 10% 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. For mesotrophic waterbodies such as Lake Wicwas, the water quality criteria are set at 12 ppb for total phosphorus and 5 ppb for chlorophyll-a (Table 2). The 10% reserve assimilative capacity for mesotrophic lakes is set at 11.6 ppb for total phosphorus and 4.8 ppb for chlorophyll-a. Chlorophyll-a will dictate the final assessment if both chlorophyll-a and total phosphorus data are available and the assessments differ (Table 3).

Results of the assimilative capacity analysis showed that Lake Winnisquam, Lake Wicwas, and Lake Opechee are classified as Tier 2 high quality waters for their respective trophic class designations (Table 4). Tier 2 waters have one or more water quality parameters that are better than the water quality standard and that also exhibit a reserve capacity of at least 10% of the waterbody's total assimilative capacity.

Table 2. Aquatic life integrity (ALI) nutrient criteria ranges by trophic class in New Hampshire. TP = total phosphorus. Chl-a = chlorophyll-a, a surrogate measure for algae.

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

Table 3. Decision matrix for aquatic life integrity (ALI) assessment in New Hampshire. TP = total phosphorus. Chl-a = chlorophyll-a, a surrogate measure for algae concentration.

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

Table 4. Assimilative capacity (AC) analysis results for Lake Winnisquam, Lake Wicwas, and Lake Opechee. Chlorophyll-a dictates the assessment results. Water quality data summarized from NHDES Environmental Monitoring Database (EMD) and applied to state water quality standards described in NHDES (2022).

Parameter	AC Threshold (ppb)	Existing Mean WQ (ppb)*	Remaining AC (ppb)	Assessment Results
Lake Winnisquam - Three Island Deep Spot [WINTLACD]				
Total Phosphorus	7.2	7.2	+0.0	Tier 2 (High Quality)
Chlorophyll-a	3.0	1.9	+1.1	
Lake Winnisquam – Pot Island Deep Spot [WINPLACD]				
Total Phosphorus	7.2	7.5	-0.3	Tier 2 (High Quality)
Chlorophyll-a	3.0	1.7	+1.3	
Lake Winnisquam – Mohawk Island Deep Spot [WINMBELD]				
Total Phosphorus	7.2	6.7	+0.5	Tier 2 (High Quality)
Chlorophyll-a	3.0	1.5	+1.5	
Lake Winnisquam - Aggregate Deep Spot Sites				
Total Phosphorus	7.2	7.1	+0.1	Tier 2 (High Quality)
Chlorophyll-a	3.0	1.7	+1.3	
Lake Wicwas – Deep Spot [WICMERD]				
Total Phosphorus	11.6	7.5	+4.1	Tier 2 (High Quality)
Chlorophyll-a	4.8	4.0	+0.8	
Lake Opechee – Lakeport, Winnipesaukee River Downstream of Dam [WIN-LP-2]				
Total Phosphorus	7.2	6.3	+0.9	Tier 2 (High Quality)
Chlorophyll-a	3.0	1.3	+1.7	

** Existing water quality data truncated to May 24-Sept 15 (though a few mid to late September samples were kept if thermal stratification was still evident) in the previous 10 years (2011-2020) for composite, epilimnion, or upper samples (in order of priority on a given day). Data were summarized by day, then month, then year using mean statistic.*

2.3 WATERSHED MODELING

2.3.1 Lake Loading Response Model (LLRM)

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 very simple equations that can be solved with pen and paper, to highly 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 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, attenuation factors, and equations from scientific literature on lakes, rivers, and nutrient cycles to generate annual average predictions[2] 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 water quality goals, and guide watershed improvement projects. A complete detailing of the methodology employed for the Lake Winnisquam LLRM is provided in the *Lake Winnisquam Lake Loading Response Model Report* (FBE, 2021a).

2.3.1.1 Lake Morphometry & 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 Lake Winnisquam is 4,249 acres (28 miles of shoreline) with a maximum depth of 174 feet (53 m) and volume of 278,744,376 m^3. The **areal water load** is 111 ft/yr (33.7 m/yr), and the flushing rate is 2.1 times per year. The relatively high flushing rate of 2.1 means that the entire volume of Lake Winnisquam is replaced twice per year, allowing less time for pollutants to settle in lake bottom sediments or be taken up by biota.

There are multiple dams in the watershed controlling water flow, including: (1) Lake Wicwas Dam at the lake outlet on Mill Brook; (2) Winnipesaukee Lakeport Dam on the Winnipesaukee River between Paugus Bay and Lake Opechee; (3) Lake Opechee Avery Dam on the Winnipesaukee River between Lake Opechee and Lake Winnisquam; (4) Holding Pond Dam on Hunt Brook between Hunkins Pond and Lake Winnisquam (in the Chapman Brook drainage); and (5) Lochmere Dam at outlet from Lake Winnisquam.

2.3.1.2 Land Cover

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

Current land cover in the Lake Winnisquam watershed was determined by FBE and the LRPC, using a combination of the 2001 New Hampshire Landcover Database (NHLCD), ESRI World Imagery from March 27, 2020, and Google Earth satellite imagery from July 7, 2019. For more details on methodology, see the *Lake Winnisquam Lake Loading Response Model Report* (FBE, 2021a). Final land cover is shown in Appendix B, Map B-1.

The direct Lake Winnisquam watershed (not including the Lake Winnipesaukee and Paugus Bay watersheds) is 35,648 acres, not including the lake areas of Lake Wicwas, Lake Opechee, and Lake Winnisquam. Development accounts for 29% (10,392

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[2] The model cannot simulate short-term weather or loading events.

acres) of the watershed, while forested and natural areas account for 67% (23,703 acres). Wetlands and open water represent 1% (361 acres) of the watershed (Figure 7). Agriculture represents 3% (1,191 acres). Figure 7 shows a breakdown of land cover by major category for the entire watershed (not including lake area), as well as total phosphorus load by major land cover category (refer to Section 2.3.1.4 or FBE, 2021a for details on methodology). Developed areas cover 29% of the watershed and contribute 84% of the total phosphorus watershed load to Lake Winnisquam.

Developed areas within the Lake Winnisquam watershed are characterized by **impervious surfaces**, including areas with asphalt, concrete, compacted 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.

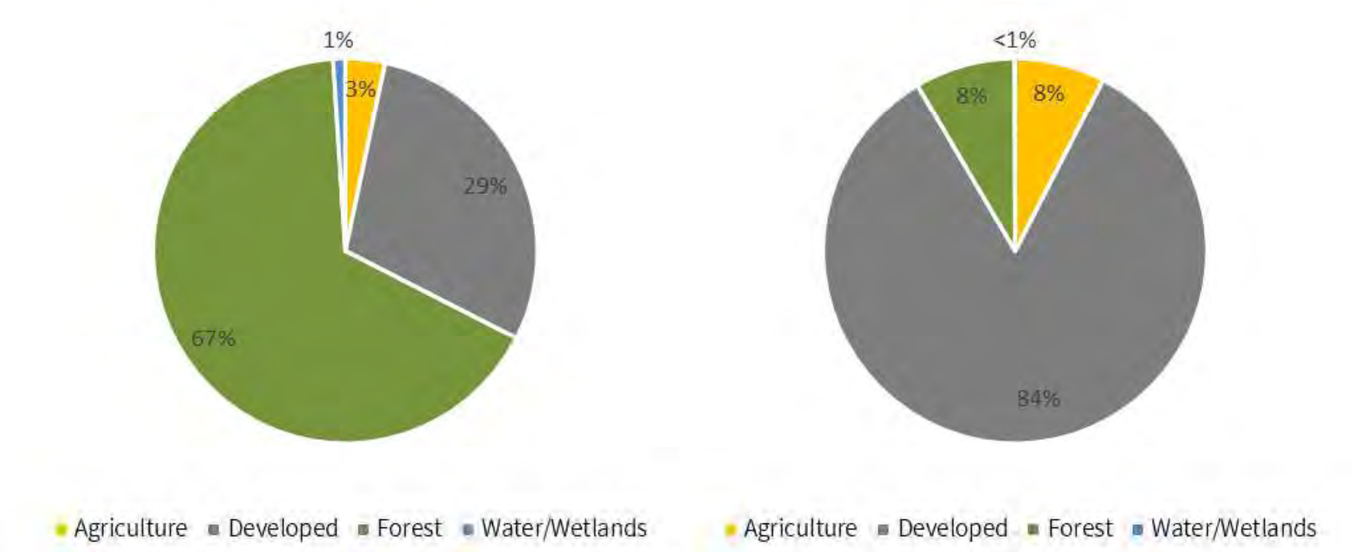


Figure 7. Lake Winnisquam watershed (including Lake Wicwas and Lake Opechee but not including Lake Winnipesaukee) land cover area by general category (agriculture, developed, forest, and water/wetlands) and total phosphorus (TP) watershed load by general land cover type. This shows that developed areas cover 29% of the watershed and contribute 84% of the TP watershed load to Lake Winnisquam. Water/wetlands category does not include the lake areas.

2.3.1.3 Internal Phosphorus Loading

Phosphorus that enters the lake and settles to the bottom can be re-released from sediment under anoxic conditions, 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 props, aquatic macrophyte management activities). Internal loading estimates were derived from dissolved oxygen and temperature profiles taken at the deep spots of Lake Winnisquam and Lake Wicwas from 2011-2020 (to determine average annual duration and depth of anoxia defined as <2 ppm dissolved oxygen) and epilimnion/hypolimnion total phosphorus data taken at the deep spots of Lake Winnisquam and Lake Wicwas from 2011-2020 (to determine average difference between surface and bottom phosphorus concentrations). These estimates, along with anoxic volume and surface area, helped determine rate of release and mass of annual internal phosphorus load. There were insufficient data to determine whether there is a significant internal phosphorus load to Lake Opechee.

2.3.1.4 LLRM Results

Overall, model predictions were in good agreement with observed data for total phosphorus, chlorophyll-a, and Secchi disk transparency (Table 5). 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 were insufficient data available to evaluate the influence of these other factors on observed chlorophyll-a concentrations and Secchi disk transparency readings.

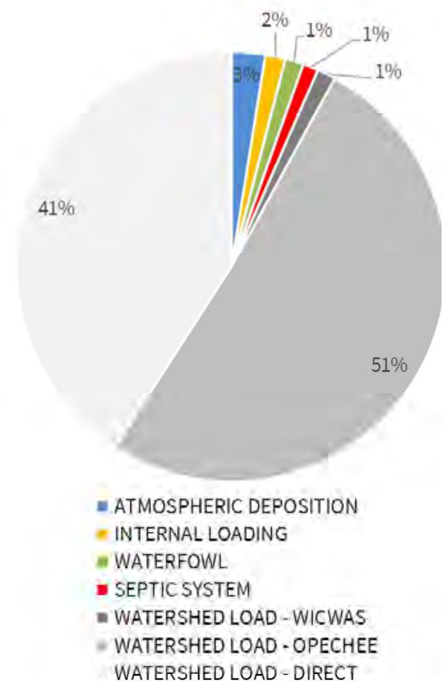


Figure 8. Summary of total phosphorus loading by major source for Lake Winnisquam. Refer to Table 6 for a breakdown.

Watershed runoff combined with baseflow (93%) was the largest phosphorus loading contribution across all sources to Lake Winnisquam. The watershed load (93%) includes the watershed loads from Lake Wicwas (1%), Lake Opechee and thus Lake Winnipesaukee via Paugus Bay (51%), and the direct land area to Lake Winnisquam (41%) (Figure 8, Table 6). Atmospheric deposition (3%), internal loading (2%), waterfowl (1%), and septic systems (1%) were relatively minor sources. Development in the watershed is most concentrated around the shoreline where septic systems or holding tanks are located within a short distance to the water, leaving little horizontal (and sometimes vertical) space for proper filtration of wastewater effluent. Improper maintenance or siting of these systems can cause failures, which leach untreated, nutrient-rich wastewater effluent to the lake. Nearly half of the shoreline area of Lake Winnisquam is serviced by sewer systems, which also represent a potential vulnerability if the sewer systems are old or damaged and leaking wastewater into groundwater near the lake. Note that septic systems are a relatively minor load to Lake Winnisquam because 1) the estimate is only for those systems directly along the shoreline and potentially short-circuiting minimally treated effluent to the lake and 2) much of the shoreline area is serviced by sewer which is not accounted for in the model since the assumption is that the sewer lines are not leaking. The load from septic systems throughout the rest of the watershed is inherent to the coefficients used to generate the watershed load.

Internal loading is currently a relatively minor source of phosphorus to Lake Winnisquam; however, locally significant internal phosphorus loading is occurring in the Mohawk Island basin area and should be monitored closely, especially given that cyanobacteria bloom warnings were issued for Lake Winnisquam in 2008 (28 days) and 2010 (43 days) with a brief alert issued in June 2022. Internal loading is currently a significant source of phosphorus (23%) to Lake Wicwas and may be driving recent cyanobacteria (*Dolichospermum*) bloom warnings issued by NHDES in August 2018 (14 days) and 2019 (6 days). (Note: The Lake Wicwas model estimated an average annual bloom probability of nine days at chlorophyll-a > 8 ppb and two days at chlorophyll-a > 10 ppb.) The 2009 NHDES Lake Trophic Survey Report for Lake Wicwas noted that zooplankton abundance was low which might otherwise help to keep phytoplankton at bay, depending on the palatability of dominant cyanobacteria species. Lake Wicwas is also highly colored (>30 CPU), which may help to block light at depth and limit phytoplankton growth. However, anecdotal information from the Lake Wicwas Association indicates that the lake may be becoming clearer in recent years and thus the 2009 color data may be outdated. The Lake Wicwas Association also noted that the lake is relatively shallow with legacy loading from an old sawmill that was decommissioned around 1950 and from log sinking to protect the logs from insects following the 1938 hurricane (5-10 logs continue to float to the surface each year). There were insufficient data to assess whether internal loading is occurring in Lake Opechee. There was evidence of low oxygen (at 13 m and deeper) and elevated hypolimnetic total phosphorus concentrations (at 15 m) in the 1979, 1986, and 1999 NHDES Trophic Survey Reports; thus, there is likely some internal loading occurring, but there were insufficient data to support an estimation for internal loading. Cyanobacteria bloom warnings were issued for Lake Opechee in 2008 (37 days) for *Anabaena* at Bond Beach and lake-wide in June 2022 (5 days) for *Dolichospermum*.

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 mass exported by area (> 0.20 kg/ha/yr) generally had more development (i.e., the southern portion of the watershed around Laconia; Figure 9). Drainage areas directly adjacent to waterbodies have direct connection to the lakes and are usually targeted for development, thus increasing the possibility for phosphorus export.

As part of the 2012 *Black Brook Watershed Management Plan* (AECOM, 2012), a portion of Lake Winnisquam was modeled (excluded most downstream Mohawk Island basin). The 2012 model outputs generally agreed well with 2020 model outputs when accounting for the differences in lake area modeled, annual precipitation, atmospheric deposition coefficient used, waterfowl estimates or lack thereof, and attenuation assumptions. The 2020 model assumed default water and phosphorus attenuation for longer stream networks such as Black Brook. The 2012 model assumed higher attenuation factors (more water and phosphorus passed through) due to relatively steep, shallow, moderate- to poorly-drained soils in the watershed, which accounted for the difference in total water and phosphorus load output from Black Brook between the two models.

Once the model is calibrated for current in-lake phosphorus concentration, we can then manipulate land cover and other factor loadings to estimate pre-development loading scenarios (e.g., what in-lake phosphorus concentration was prior to human development or the best possible water quality for the lake). Refer to FBE (2021a) for details on methodology. Pre-development loading estimation showed that total phosphorus loading to Lake Winnisquam increased by 438%, from 1,385 kg/yr prior to European settlement to 7,458 kg/yr under current conditions (Table 6). These additional phosphorus sources are coming from development in the watershed (especially from Lake Winnipesaukee, the direct shoreline of Lake Winnisquam, the direct shoreline of Lake Opechee, Durkee Brook, and Jewett Brook), septic systems, atmospheric dust, and internal loading (Table 6). Water quality prior to settlement was predicted to be excellent with extremely low phosphorus and chlorophyll-a concentrations and high water clarity (Table 5).

We can also manipulate 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 constraints or the worst possible water quality for the lake). Refer to FBE (2021a) and the 2021 *Lake Winnisquam Direct Watershed Build-out Analysis Report* (FBE, 2021b) for details on methodology. Note: the future scenario did not assume a 10% increase in precipitation over the next century (NOAA Technical Report NESDIS 142-1, 2013), which would have resulted in a lower predicted in-lake phosphorus concentration; this is because the model does not consider the rate and distribution of the projected increase in precipitation. Climate change models predict more intense and less frequent rain events that may exacerbate erosion of phosphorus-laden sediment to surface waters and therefore could increase in-lake phosphorus concentration (despite dilution and flushing impacts that the model assumes).

Future loading estimation showed that total phosphorus loading to Lake Winnisquam may increase by 54%, from 7,455 kg/yr under current conditions to 11,492 kg/yr at full build-out (2076) under current zoning for Lake Winnisquam (Table 6). Additional phosphorus will be generated from more development in the watershed (especially from Lake Winnipesaukee, the direct shoreline of Lake Winnisquam, Dolloff Brook[3], and Jewett Brook), greater atmospheric dust, more septic systems, and enhanced internal loading (Table 6). The total phosphorus load coming from the direct Winnipesaukee River sub-watershed (excluding input from Lake Winnipesaukee) showed minimal change because the small sub-watershed in Laconia is already largely built-out. The model predicted higher (worse) phosphorus (12.9 ppb), higher (worse) chlorophyll-a (3.6 ppb), and lower (worse) water clarity (3.3 m) compared to current conditions for Lake Winnisquam (Table 5). Predicted water quality was especially poor for Lake Wicwas, which would exhibit characteristics of a hypereutrophic lake that blooms throughout much of the year (267 days; Table 5). Even if the internal phosphorus load to Lake Wicwas were eliminated (either via an in-lake treatment or assuming the build-out assumptions are overestimating the predicted increase in total phosphorus load to the lake), Lake Wicwas would still experience severely degraded water quality and be classified as a eutrophic lake.

[3] Note that the predicted increase in total phosphorus load from Dolloff Brook may be overestimated due to build-out assumptions. The build-out analysis for the portion of the Lake Winnisquam watershed in the Town of New Hampton (which feeds into Dolloff Brook and ultimately Lake Wicwas) did not account for New Hampton's complex zoning standards that adjust the allowable lot size based on soil drainage class and slope, along with a more nuanced "adjustment factor" for other considerations such as water supply and sewage disposal. Some of these standards were accounted for in areas with hydric soils and steep slopes but not for the complex graduations of other soil and slope types. It is likely that accounting for this complex zoning would reduce the number of projected buildings in the New Hampton portion of the study area and thus reduce the estimated phosphorus load increase to Lake Wicwas; the significance of that reduction is unknown. Additionally, a 139-acre parcel along Dolloff Brook in New Hampton was recently put into conservation (and not accounted for in the build-out analysis), which would further reduce the number of projected buildings.

Table 5. In-lake water quality predictions for Lake Wicwas, Lake Opechee, and Lake Winnisquam. TP = total phosphorus. Chl-a = chlorophyll-a. SDT = Secchi disk transparency. Bloom Days represent average annual probability of chlorophyll-a exceeding 10 ppb. Refer to FBE (2021a).

Model Scenario	Median TP (ppb)	Predicted Median TP (ppb)	Mean Chl-a (ppb)	Predicted Mean Chl-a (ppb)	Mean SDT (m)	Predicted Mean SDT (m)	Bloom Days
Lake Wicwas							
Pre-Development	--	2.4	--	0.3	--	11.9**	0
Current -2020	9.6 (11.5)	12.1	4.0	3.3	4.2	3.4	2
Future (2076)	--	35.9	--	15.4	--	1.5	267
Lake Opechee							
Pre-Development	--	1.6	--	0.2	--	16.3**	0
Current -2020	6.3 (7.5)	7.8	1.3	1.6	--	4.8	0
Future (2076)	--	11.8	--	3.1	--	3.5	2
Lake Winnisquam							
Pre-Development	--	1.5	--	0.2	--	16.4	0
Current -2020	7.1 (8.5)	8.3	1.7	1.8	7.1	4.5	0
Future (2076)	--	12.9	--	3.6	--	3.3	4

**Mean TP concentration (first value) represents current in-lake epilimnion TP from observed data. Median TP concentration (second value in parentheses) represents 20% greater than the observed mean value as the value used to calibrate the model. Most lake data are collected in summer when TP concentrations are typically lower than annual average concentrations for which the model predicts. It was argued in the 2012 Black Brook Watershed Management Plan that the "average summer concentrations are likely representative of annual average or average at spring overturn values" given the large and continuous load of phosphorus and water from the Winnipesaukee River. April 2021 data collected at the three lake deep spots confirm minimal difference in average total water column phosphorus with average summer epilimnion phosphorus. However, for this model, our modeled lake area included the Mohawk Island basin and its contributing sources, slightly lessening the total load percent contribution from the Winnipesaukee River; in addition, the load contribution from the Winnipesaukee River flows through two large lakes (Paugus Bay and Lake Opechee) and may elevate phosphorus concentrations in winter. More winter data would be needed to confirm.*

***Hit Bottom*

Table 6. Total phosphorus (TP) and water loading summary by model and source for Lake Winnisquam. Italicized sources sum to the watershed load. Refer to FBE (2021a).

SOURCE	PRE-DEVELOPMENT			CURRENT (2020)			FUTURE (2076)		
	TP (KG/YR)	%	WATER (CU.M/YR)	TP (KG/YR)	%	WATER (CU.M/YR)	TP (KG/YR)	%	WATER (CU.M/YR)
LAKE WICWAS									
ATMOSPHERIC	9.9	15%	897,352	15.6	5%	897,352	35.3	3%	897,352
INTERNAL	0.0	0%	0	78.8	23%	0	228.6	23%	0
WATERFOWL	8.5	13%	0	8.5	2%	0	8.5	1%	0
SEPTIC SYSTEM	0.0	0%	0	6.2	2%	5,243	9.3	1%	7,865
WATERSHED LOAD	48.6	72%	10,435,330	232.2	68%	10,318,434	713.7	72%	9,995,418
TOTAL LOAD TO LAKE	**66.9**	**100%**	**11,332,682**	**341.2**	**100%**	**11,221,029**	**995.4**	**100%**	**10,900,635**
LAKE OPECHEE									
ATMOSPHERIC	12.1	1.4%	1,095,975	19.0	0.4%	1,095,975	43.2	0.7%	1,095,975
INTERNAL	0.0	0.0%	0	0.0	0.0%	0	0.0	0.0%	0
WATERFOWL	10.4	1.2%	0	10.4	0.2%	0	10.4	0.2%	0
SEPTIC SYSTEM	0.0	0.0%	0	9.7	0.2%	8,128	14.2	0.2%	11,910
WATERSHED LOAD	825.3	97.4%	488,213,857	4,216.3	99.2%	487,954,357	6,340.4	98.9%	487,855,167
Paugus Bay-Lake Winnipesaukee	*799.1*	*94.3%*	*482,712,903*	*3,817.9*	*89.8%*	*482,712,903*	*5,792.6*	*91.2%*	*482,712,903*
Direct Land Use Load	*26.2*	*3.1%*	*5,500,954*	*398.4*	*9.4%*	*5,241,454*	*547.8*	*7.8%*	*5,142,264*
TOTAL LOAD TO LAKE	**847.7**	**100%**	**489,309,833**	**4,255.4**	**100%**	**489,058,460**	**6,408.2**	**100%**	**488,963,052**
LAKE WINNISQUAM									
ATMOSPHERIC	120.4	9%	10,913,507	189.1	3%	10,913,507	429.9	3%	10,913,507
INTERNAL	0.0	0%	0	112.7	2%	0	173.6	2%	0
WATERFOWL	103.2	7%	0	103.2	1%	0	103.2	1%	0
SEPTIC SYSTEM	0.0	0%	0	86.3	1%	71,094	98.5	1%	81,089
WATERSHED LOAD	1,161.9	84%	570,577,547	6,963.8	93%	568,655,087	10,686.7	93%	567,266,589
Lake Wicwas	*20.4*	*1%*	*9,066,146*	*101.8*	*1%*	*8,976,823*	*293.5*	*3%*	*8,720,508*
Lake Opechee	*782.9*	*57%*	*489,309,833*	*3,814.7*	*51%*	*489,058,460*	*5,769.8*	*50%*	*488,963,052*
Direct Land Use Load	*358.6*	*26%*	*72,201,569*	*3,047.3*	*41%*	*70,619,804*	*4,623.4*	*40%*	*69,583,029*
TOTAL LOAD TO LAKE	**1,385.4**	**100%**	**581,491,054**	**7,455.2**	**100%**	**579,639,688**	**11,491.8**	**100%**	**578,261,186**

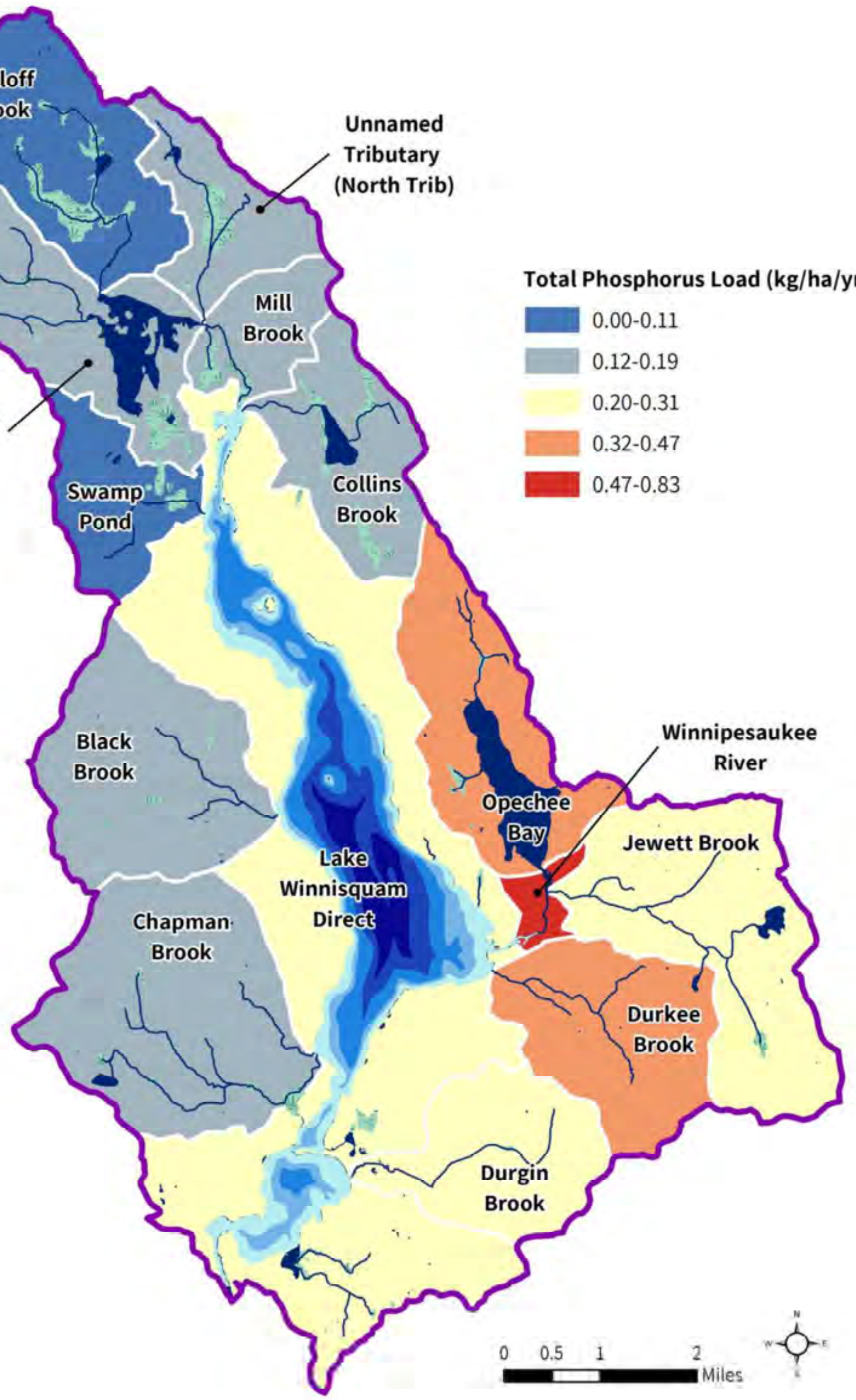


Figure 9. Map of current total phosphorus load per unit area (kg/ha/yr) for each sub-watershed in the Lake Winnisquam watershed. Higher phosphorus loads per unit area are concentrated in the more developed southern portion of the watershed. Refer to FBE (2021a).

2.3.2 Build-out Analysis

A full build-out analysis was completed for the direct Lake Winnisquam watershed for the municipalities of Belmont, Gilford, Laconia, Meredith, New Hampton, Sanbornton, and Tilton (FBE, 2021b). 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 extent permitted by local ordinances and zoning standards. Local ordinances and zoning standards are subject to change and the analysis requires simplifying assumptions and therefore the results of the build-out analysis should be viewed as planning-level estimates only for potential future outcomes from development trends. For example, current use (which lowers tax obligations on 10-acre or more parcels kept in a natural state) can be a deterrent to development because of the tax burden when parcels are removed from current use status.

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 extent permitted by local ordinances and zoning standards.

To determine where development may occur within the study area, the build-out analysis first subtracts land unavailable for development due to physical constraints, including environmental restrictions (e.g., wetlands, conserved lands, hydric soils), zoning restrictions (e.g., shoreland zoning, street Right-of-Ways (ROWs), and building setbacks), and practical design considerations (e.g., lot layout inefficiencies) (Appendix B, Map B-2). Existing buildings also reduce the capacity for new development.

Under current zoning regulations, 45% (15,027 acres) of the direct Lake Winnisquam watershed is buildable (Appendix B, Map B-3). The greatest acreages of land available for development include the Forestry and Rural District of Meredith (1,822 acres), the Forest Conservation Zone of Sanbornton (1,807 acres), and the Residential Rural Zone of Laconia (1,576 acres). New Hampton’s General Residential zone and Laconia’s Commercial zone are the most vulnerable to increased development potential with the highest percent increase from existing buildings to projected buildings at 2,461% and 1,500%, respectively (Table 7). FBE identified 8,456 existing buildings within the watershed, and the build-out analysis projected that an additional 6,734 buildings could be constructed in the future, resulting in a total of 15,190 buildings in the watershed (Appendix B, Map B-4). Currently, existing buildings are the densest along the shores of the lakes, as well as in Laconia. Major conservation lands in the watershed restrict existing and future development in rural areas of the watershed.

Table 7. Amount of buildable land and projected buildings by zone in the direct Lake Winnisquam watershed in Belmont, Gilford, Laconia, Meredith, New Hampton, Sanbornton, and Tilton, New Hampshire.

Zone	Total Area (Acres)	Buildable Area (Acres)	Percent Buildable Area	No. Existing Buildings	No. Projected Buildings	Total No. Buildings	Percent Increase
Belmont							
Commercial	653	248	38	136	88	224	65
Residential - Multi Family	113	22	19	53	10	63	19
Residential - Single Family	2,040	939	46	836	541	1,377	65
Rural	2,647	1,413	53	524	289	813	55
Gilford							
Industrial	119	42	35	15	20	35	133
Limited Residential	1,781	1,001	56	197	601	798	305
Natural Resource Residential	825	256	31	78	80	158	103
Professional Commercial	70	41	60	21	18	39	86
Single Family Residential	561	204	36	325	118	443	36
Laconia							
Commercial	164	113	69	5	75	80	1,500
Industrial	103	76	74	16	90	106	563
Industrial Park	129	86	67	19	20	39	105
Residential Apartment	157	136	87	70	117	187	167
Residential Rural	3,500	1,576	45	574	444	1,018	77
Residential Single-Family District	2,101	479	23	3,030	193	3,223	6
Urban Commercial District	428	257	60	651	738	1,389	113
Meredith							
Business Industrial District	14	5	37	7	3	10	43
Commercial District - Center	33	7	23	19	6	25	32
Forestry and Conservation	1,452	217	15	81	35	116	43
Forestry and Rural District	4,401	1,822	41	341	390	731	114
Residential District	1,133	605	53	186	337	523	181
Shoreline District	1,244	165	13	217	116	333	53
New Hampton							
General Residential	2,178	1,143	52	57	1,403*	1,460	2,461
Sanbornton							
Commercial (Lt. Manuf. Perm.)	123	45	36	60	57	117	95
Forest Conservation	3,563	1,807	51	121	204	325	169
General Agricultural	1,921	1,150	60	111	253	364	228
General Residence	1,141	720	63	180	246	426	137
Recreational	208	100	48	249	136	385	55
Tilton							
Medium Density Residential District	7	2	27	2	2	4	100
Mixed Use District	26	1	2	40	1	41	3
Resort Commercial	419	174	42	210	70	280	33
Rural Agricultural	303	173	57	25	33	58	132
Total	**33,555**	**15,027**	**45**	**8,456**	**6,734**	**15,190**	**80**

** Note on New Hampton's number of projected buildings: It is likely that accounting for New Hampton's complex zoning that adjusts allowable lot size based on soil drainage class and slope would reduce the number of projected buildings in the New Hampton portion of the study area; the significance of that reduction is unknown. Additionally, a 139-acre parcel along Dolloff Brook in New Hampton was recently put into conservation, which would further reduce the number of projected buildings.*

Three iterations of the TimeScope Analysis were run using compound annual growth rates (CAGR) for 20-, 30- and 50-year periods from 1990-2010 (1.09%), 1980-2010 (1.65%), and 1960-2010 (2.61%), respectively (Table 8). Full build-out is projected to occur in 2076 at the 20-year CAGR, 2057 at the 30-year CAGR, and 2044 for the 50-year CAGR (Figure 10). Note that the growth rates used in the TimeScope Analysis are based on town- or city-wide census statistics but have been applied here to a portion of the municipalities. Also note that the population growth rate in these municipalities is decreasing, so the 20-year estimate is likely more accurate than the 50-year estimate. Using census data to project population increase and/or development has inherent limitations. For instance, the building rate may increase at a different rate than population such as when considering commercial versus residential development. As such, the TimeScope Analysis might over or underestimate the time required for the study area to reach full build-out. Numerous social and economic factors influence population change and development rates, including policies adopted by federal, state, and local governments. The relationships among the various factors may be complex and therefore difficult to model.

Table 8. Compound annual growth rates for the seven municipalities within the direct watershed of Lake Winnisquam, used for the TimeScope Analysis. 2020 data were not available for towns with populations less than 5,000 at the writing of this plan. Data from US Census Bureau.

	Compound Annual Growth Rate		
Municipality	**50 yr. Avg. 1960-2010**	**30 yr. Avg. 1980-2010**	**20 yr. Avg. 1990-2010**
Belmont	2.69%	2.03%	1.20%
Gilford	2.53%	1.30%	0.98%
Laconia	0.08%	0.08%	0.07%
Meredith	1.90%	0.99%	1.28%
New Hampton	1.86%	1.85%	1.50%
Sanbornton	2.51%	1.91%	1.65%
Tilton	1.03%	0.17%	0.48%
Combined	**2.61%**	**1.65%**	**1.09%**

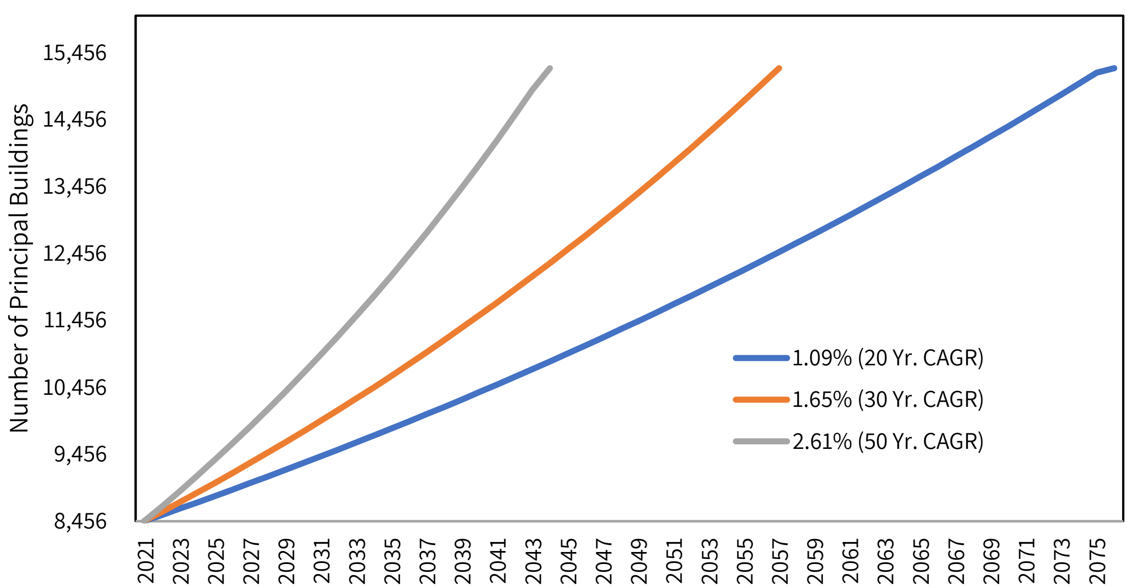


Figure 10. Full build-out time projections for the direct Lake Winnisquam watershed in Belmont, Gilford, Laconia, Meredith, New Hampton, Sanbornton, and Tilton, New Hampshire (based on compound annual growth rates reported in Table 8).

2.4 WATER QUALITY GOAL & OBJECTIVES

The model results revealed changes in total phosphorus loading and in-lake total phosphorus concentrations over time from pre-development through future conditions, showing that the water quality of Lake Winnisquam, Lake Wicwas, and Lake Opechee is threatened by current development activities in the watershed and will degrade further with continued development in the future. We can use these results to make informed management decisions and set an appropriate water quality goal for Lake Winnisquam, as well as Lake Wicwas and Lake Opechee. In-lake chlorophyll-a and total phosphorus concentrations are currently meeting state water quality criteria which would indicate that there is reserve capacity for the lakes to assimilate additional nutrients under a "business as usual" scenario. However, it is highly recommended that strong objectives be established to protect the water quality of these lakes over the long term, especially given that these lakes are not meeting other water quality criteria (e.g., turbidity, dissolved oxygen), are experiencing occasional cyanobacteria blooms, and are threatened by new development. The water quality goal and objectives were set by the Plan Development Committee with guidance from FBE.

The overarching goal of the Lake Winnisquam WBP is to improve the water quality of Lake Winnisquam such that it meets state water quality standards for the protection of ALI. This goal will be achieved by accomplishing the following objectives. Specific action items to achieve these objectives are provided in the Action Plan (Section 5). Refer to Section 5.2: Pollutant Load Reductions for more details on linking the established water quality objectives and needed pollutant load reductions with field-identified remediation opportunities.

- OBJECTIVE 1: Reduce pollutant loading from Hueber Brook to improve in-stream and in-lake turbidity concentration to <10 NTU. The drainage area of Hueber Brook is small and thus the possible pollutant sources from Hueber Brook are few. An investigation by FBE of the Hueber Brook sub-watershed was completed and identified sources of sedimentation to remediate. Meeting this objective will remove Lake Winnisquam's impaired listing for ALI due to excessive turbidity.

- OBJECTIVE 2: Mitigate (prevent or offset) phosphorus loading from future development in the direct watersheds to Lake Winnisquam, Lake Wicwas, and Lake Opechee to maintain in-lake total phosphorus concentration. The estimated total phosphorus direct watershed load increase from new development by 2076 was predicted at 1,576 kg/yr for Lake Winnisquam, 654 kg/yr for Lake Wicwas, and 149 kg/yr for Lake Opechee, equating to about 281 kg/yr, 117 kg/yr, and 27 kg/yr, respectively, in the next 10 years (by 2031). At a minimum, pollutant loading should be prevented or offset by 281 kg/yr, 117 kg/yr, and 27 kg/yr from the direct watershed areas to Lake Winnisquam, Lake Wicwas, and Lake Opechee, respectively, by 2031.

  Note: Objective 2 does not account for the additional load expected from Lake Winnipesaukee by 2031 given that the scope of management strategies for this plan is limited to the direct watershed of Lake Winnisquam. Other plans and management strategies are currently being implemented for the Lake Winnipesaukee watershed that will likely result in a lower-than-predicted increase in the total phosphorus load from Lake Winnipesaukee. Assuming an estimated increase of 314 kg/yr in the total phosphorus load from Lake Winnipesaukee via Lake Opechee to Lake Winnisquam in the next 10 years, the in-lake total phosphorus concentration for Lake Winnisquam may increase by 0.5 ppb, placing it within the 10% reserve assimilative capacity range. Because Lake Winnisquam is currently not impaired for ALI due to either of the trophic indicators, we recommend that this objective be re-evaluated after 5 and 10 years to determine the true increase in total phosphorus load from Lake Winnipesaukee and whether a more stringent objective should be set.

- OBJECTIVE 3: Reduce phosphorus loading from existing development by 4% (260 kg/yr) to Lake Winnisquam Pot Island Deep Spot [WINPLACD] to improve in-lake total phosphorus concentration to 7.2 ppb. Note: the target pollutant load reduction was calculated as 4% of the total phosphorus load to Lake Winnisquam (including Lake Winnipesaukee) minus the total phosphorus loads from the sub-watersheds of Chapman Brook, Durgin Brook, and roughly 50% of Lake Winnisquam Direct due to their downstream proximity to WINPLACD. Meeting this objective would be in addition to mitigation of the anticipated future phosphorus loading by 2031 (Objective 2) to achieve an in-lake total phosphorus concentration of 7.2 ppb at WINPLACD. Even though the response indicator (chlorophyll-a) meets ALI criteria, targeting additional pollutant load reductions to WINPLACD highlights the locally significant sedimentation and nutrient loading coming from the nearby Black Brook sub-watershed, which is estimated to contribute 151 kg/yr of phosphorus load to Lake Winnisquam.

The interim goals for each objective allow flexibility in re-assessing water quality objectives following more data collection and expected increases in phosphorus loading from new development in the watershed over the next 10 or more years (Table 9). Understanding where water quality will be following watershed improvements compared to where water quality should have been following no action will help guide adaptive changes to interim goals (e.g., goals are on track or goals are falling short). If the goals are not being met due to lack of funding or other resources for implementation projects versus 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 goals. For each interim goal year, WWN should update the water quality data and model and assess why goals are or are not being met. WWN will then decide on how to adjust the next interim goals to better reflect water quality conditions and practical limitations to implementation.

Table 9. Summary of water quality objectives for Lake Winnisquam, Lake Wicwas, and Lake Opechee. Interim goals/benchmarks are cumulative.

Water Quality Objective	Interim Goals/Benchmarks		
	2024	**2026**	**2031**
1. Reduce pollutant loading from Hueber Brook to improve in-stream and in-lake turbidity concentration to <10 NTU.			
	Remediate sources of sediment to Hueber Brook	Remediate sources of sediment to Hueber Brook; re-evaluate water quality and track progress	Remediate sources of sediment to Hueber Brook; re-evaluate water quality and track progress
2. Mitigate (prevent or offset) pollutant loading from future development in the direct watersheds to Lake Winnisquam, Lake Wicwas, and Lake Opechee to maintain in-lake total phosphorus concentration			
	Prevent or offset 70 kg/yr in TP loading from new development to Lake Winnisquam	Prevent or offset 141 kg/yr in TP loading from new development to Lake Winnisquam; re-evaluate water quality and track progress	Prevent or offset 281 kg/yr in TP loading from new development to Lake Winnisquam; re-evaluate water quality and track progress
	Prevent or offset 29 kg/yr in TP loading from new development to Lake Wicwas	Prevent or offset 59 kg/yr in TP loading from new development to Lake Wicwas; re-evaluate water quality and track progress	Prevent or offset 117 kg/yr in TP loading from new development to Lake Wicwas; re-evaluate water quality and track progress
	Prevent or offset 8 kg/yr in TP loading from new development to Lake Opechee	Prevent or offset 16 kg/yr in TP loading from new development to Lake Opechee; re-evaluate water quality and track progress	Prevent or offset 27 kg/yr in TP loading from new development to Lake Opechee; re-evaluate water quality and track progress
3. Reduce pollutant loading from existing development by 4% (298 kg/yr) to Lake Winnisquam Pot Island Deep Spot [WINPLACD] to improve in-lake total phosphorus concentration to 7.2 ppb.			
	Achieve 0.25% (16 kg/yr) reduction in TP loading	Achieve 2% (130 kg/yr) reduction in TP loading; re-evaluate water quality and track progress	Achieve 4% (260 kg/yr) reduction in TP loading; re-evaluate water quality and track progress

3 POLLUTANT SOURCE IDENTIFICATION

This section describes sources of excess phosphorus to Lake Winnisquam. Sources of phosphorus to lakes can include stormwater runoff, shoreline erosion, construction activities, fertilizers, illicit connections, failed or improperly functioning septic systems, leaky sewer lines, fabric softeners and detergents in greywater, and pet, livestock, and wildlife waste. These external sources of phosphorus to lakes can then circulate within lakes and settle on lake bottoms, contributing to internal nutrient 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 (lawns). Climate change 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

NPS pollution comes from many diffuse sources on the landscape and is more difficult to identify and control than point source pollution. NPS pollution can result from contaminants transported by overland runoff (e.g., agricultural runoff or runoff from suburban and rural areas), groundwater flow, or direct deposition of pollutants to receiving waters. Examples of NPS 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 urban areas, malfunctioning septic systems, excessive fertilizer application, unmitigated agricultural activities, pet waste, and wildlife waste.

3.1.1 Development History of Lake Winnisquam

Lake Winnisquam, meaning "pleasant waters", was once considered part of Lake Winnipesaukee until the late 1800s. Maps of Lake Winnisquam from the early 1800s label the waterbody as "Great Bay", an extension of Lake Winnipesaukee. Many Native American tribes resided in the Lakes Region of New Hampshire until the mid-1700s when the European settlers arrived and established townships throughout the area, bringing in industries such as blacksmithing, tanneries, gristmills, and sawmills. By 1795, there were sawmills at Meredith Center, Meredith Bridge, and Lake Village. The Lakeport Dam was constructed on the Winnipesaukee River in 1851 to provide power to the mills in the area.

The most significant change that allowed the Lakes Region of New Hampshire to become the bustling recreation destination that it is today was the introduction of railways in the 1800s. In August 1848, the Boston, Concord, and Montreal Railroad opened its route between Concord and Meredith Bridge, right along Lake Winnisquam. This route allowed travelers from other areas to visit New Hampshire's Lakes Region and establish the area as a vacation destination. The railway was extended over time to Montreal, and passengers could ride the train to Canada until the 1950s when passenger travel ceased, and the railroad was used only to transport freight until 1965.

One notable feature of Lake Winnisquam are its islands, including Pot Island, Three Islands, Loon Island, Hog Island, and Mohawk Island. Mohawk Island was once a peninsula known as Mohawk Point. In 1910, the Lochmere Dam was constructed, and the water level rose so that the island became permanently separated from the land. Mohawk Island was given its name because it was the site of a famous battle in 1685 between Mohawk warriors and an alliance of Pennacook and Pequaket warriors. In this battle, the Mohawk warriors hid behind part of the peninsula and then ambushed their enemy, eventually leading to their victory.

According to local legend, on the night of Halloween in 1931, a group of local youngsters got their hands on some dynamite that was being used to create new roads in the area. They rowed out to Pot Island and set the dynamite to blow up the island. The culprits made it out alive, but only one fourth of the original Pot Island remains because of this explosion.

The Winnisquam Bridge, commonly known as Mosquito Bridge, was built between 1840 and 1844 and eventually replaced in 1916 and again in 1974. This bridge is known as Mosquito Bridge not because it was infested with mosquitos but because the old bridge's humped shape resembled the back of a mosquito.

What is now known as Waldron Bay, a lakeside community in Meredith, was once Camp Waldron, a boy's camp on the shore of the lake. The camp was run by the Boston Missionary School Society, which owned an extensive amount of land along Lake

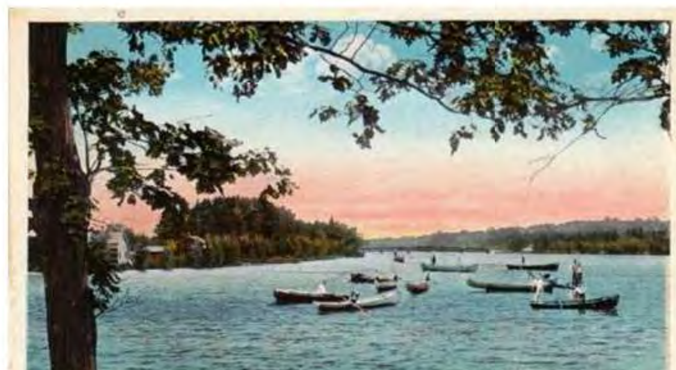
Winnisquam and also operated a girl's camp (Camp Andover) on the other side of the cove. These camps were created to provide outdoor opportunities to impoverished children from the Boston area. Camp Waldron was operational from the early 1900s until the 1970s.

Many of the residences along the shores of Lake Winnisquam were once primitive camps with no electricity or running water. In the 1950s and 1960s, many of these homes were converted to larger, year-round cottages with plumbing and running water. In the early 1980s, motorboats became increasingly popular, and lakefront properties were in high demand. Since then, development along the shoreline of the lake has continued to increase as people purchase their second homes in the area.


The Mills at Meredith Center in 1913.


Mohawk Island.


Pot Island, Lake Winnisquam, Laconia.


Winnisquam Bridge.


Mosquito Bridge, Laconia.


Development along Lake Opechee in 1963.

3.1.2 Watershed Assessments

Several watershed assessments to identify and document sources of NPS pollution have been completed in the Lake Winnisquam watershed. As part of the development of this plan, information was obtained through interviews with local partners, review of municipal documents and property records, desktop analysis of aerial imagery, record searches through online databases, review of publicly available GIS data, review of prior studies and reports, and field survey investigations.

3.1.2.1 Hueber Brook Investigation (2021)

In 2007, NHDES measured elevated turbidity in Hueber Brook, a small tributary that flows into Lake Winnisquam in Belmont. This turbidity was initially attributed to construction along Route 3/11. NHDES resampled Hueber Brook in 2015 after construction had been completed, yet turbidity remained elevated above acceptable water quality standards and the lake remains listed as impaired for ALI due to excessive turbidity. FBE performed a special investigation of the Hueber Brook watershed in 2021 to help prioritize next steps for remediation to remove the lake's ALI impairment listing. The investigation identified four potential sources of high turbidity to the brook. Problems identified included stormwater runoff, erosion, lack of filtration, degraded culverts, and lack of vegetated riparian buffer.

Stormwater runoff from within the Hueber Brook watershed in Belmont (Figure 11) is diverted into the brook through a series of roadside ditches, drains, and catch basins and appears to be the main source of flow for the brook. The flow path of Hueber Brook has been altered greatly by the installation of stormwater infrastructure such as culverts and catch basins. The brook also flows into a constructed wetland system along Sun Lake Drive in Belmont. Hueber Brook outlets into a retention pond, which discharges to Lake Winnisquam. The color of water flowing into and from Hueber Brook is orange. This may be due to naturally occurring iron and iron-oxidizing bacteria or due to degraded and rusting stormwater infrastructure, specifically metal culvert pipes, which were observed throughout the watershed. It should be noted that this rusty color was also observed in another small watercourse that flows parallel to Sun Lake Drive, into a catch basin, and then into the retention pond.

(TOP) Outflow from retention pond into Lake Winnisquam following a rain event. (BOTTOM LEFT) Rusty color and oil sheen flowing in Hueber Brook. (BOTTOM RIGHT) Rusty colored flow from small watercourse parallel to Sun Lake Drive.

(1) STORMWATER RUNOFF FROM LOTS ALONG ROUTE 3/11

Observations: Most of the land use in the portion of the Hueber Brook drainage area that is along Route 3/11 is industrial and/or commercial with impervious cover that carries stormwater runoff with any sediment and/or other particles (oils, etc.) directly into Hueber Brook.

Recommendations: Improve stormwater controls through the construction and implementation of stormwater runoff treatment measures, such as bioretention cells.

(2) SEDIMENT/GRAVEL DUMP SITE ON OLD STATE ROAD

Observations: There is a large sediment/gravel dump site along Old State Road. This site is situated atop a steep slope, with Old State Rd at the bottom of the slope. The bank of the elevated dump site is eroding into the road and is potentially washing down the road and into Hueber Brook during a storm event.

Recommendations: Remove sand and sediment from the site. Install erosion control measures along bank, such as an increased buffer and silt fences.

(3) OLD STATE ROAD

Observations: Old State Rd is a dirt road that runs parallel to Route 3/11 on the Lake Winnisquam side. This road is steeply sloped on both sides, with commercial and industrial land uses occurring atop both banks. Stormwater runs off impervious surfaces and down a ditch along Old State Road. Orange/rusty colored water was observed flowing down this ditch.

Recommendations: Enhance buffer and erosion controls on both sides of road. Improve stormwater runoff treatment.

(4) FAILING CULVERTS THROUGHOUT HUEBER BROOK DRAINAGE AREA

Observations: Multiple culverts within the drainage area were observed to be failing. Failures included rust, blockages, and algae build up.

Recommendations: Replace culverts.

Figure 11. Map depicting identified sites and features of note during the 2021 investigation of Hueber Brook in Belmont.

3.1.2.2 Black Brook Watershed Surveys (2012, 2020-2022)

Black Brook has been long impacted by excessive sediment loading from the gravel roads throughout the sub-watershed, largely in Sanbornton. This sediment load is transported out into Lake Winnisquam where a visible 300-ft radius sediment delta has formed over the years (pictured right). Local groups have prioritized investigation and remediation of road erosion in the watershed. Large-scale improvements in erosion and sedimentation in the Black Brook watershed are needed to improve the water quality of Black Brook and Lake Winnisquam.

Aerial view of a 300-ft radius sediment delta at the outlet of Black Brook as it enters Lake Winnisquam.

In 2012, the *Black Brook Watershed Management Plan* was created for the Town of Sanbornton by AECOM. The plan set a water quality goal for reducing the annual phosphorus load entering Lake Winnisquam from the Black Brook sub-watershed. A watershed survey was conducted to identify sites likely contributing disproportionate concentrations of sediment and phosphorus. BMPs were recommended for each site. The 38 identified sites were found in four general locations within the Black Brook sub-watershed: along Woodman Rd near Black Brook (south branch) (*n*=5), along Huse Rd (*n*=12), along Kaulback Rd (near the intersection of Roxbury Road) (*n*=16), and along Black Brook Rd (*n*=4). BMP recommendations for sites along these roadways included methods of runoff diversion, retention, and infiltration. It was recommended that the road shoulders and surfaces be re-graded to discourage the channelization of stormwater runoff where it gains velocity and discharges directly into Black Brook. Turnouts and rip rap lined retention areas were also recommended. Unpaved and steeply sloped roads typical for this area, particularly Huse Rd and Kaulback Road, are notorious for contributing to sediment and nutrient loads to tributaries and the lake. Routine maintenance was identified as being critical for the success of these proposed BMPs due to the highly erodible nature of the area's gravel roads.

The *Sanbornton Roadway Evaluation* (Underwood Engineers, Inc., 2020) created a detailed strategy for prioritizing road fixes in the Town of Sanbornton, which includes the Black Brook watershed. The strategy considered traffic flow, road widths, road conditions, among other parameters (but not including impact to water quality) for the 68 miles of the town's Class V roads, 50% of which are unpaved, gravel roads. Fixing all the roads was estimated to cost $26 million or $1.34 million per year over 20 years. Huse, Roxbury, and Woodman roads were among the highest priority roads targeted for immediate remediation.

Sedimentation evident at a new box culvert along Black Brook at the Black Brook Rd crossing. Photo courtesy of Lang (2021).

In 2021, BCCD hired an engineer (G. Lang, P.E.) to review and assess environmental issues affecting the water quality of Black Brook with emphasis on assessing the cause of sedimentation altering flow conditions at a newly installed box culvert at the Black Brook Rd crossing. Previous studies reviewed in preparation for the field assessment included the 2012 *Black Brook Watershed Management Plan* (AECOM, 2012) and the 2020 *Summary and Final Documentation, Sanbornton Roadway Evaluation* (Underwood Engineers, Inc., 2020). Lang (2021) found sediment loading issues coming from Huse Road, Kaulback Road, Woodman Road, and Black Brook Road. Lang (2021) also assessed sedimentation at the new box culvert on Black Brook Rd, as well as significant trash and organic material blocking a stop-log structure downstream of the box culvert, and recommended that the stream be surveyed for proper channel grade and backwater effects from the blockage. Lang (2021) recommended that the existing sediment at the box culvert be removed down to the design gravel bottom before opening up the stop-log dam to prevent the sediment from washing into Lake Winnisquam with normal flows restored. A bypass channel may need to be considered to prevent the situation from reoccuring in the future.

In 2022, FBE was hired by BCCD to perform a quantitative evaluation of 11 erosion and sedimentation sites in the Black Brook watershed, based on review of sites identified in the 2012 *Black Brook Watershed Management Plan* (AECOM, 2012) and the 2021 *Black Brook Watershed Assessment Update Report* (Lang, 2021). The evaluation results were used to prioritize the 11 sites for implementation and ultimately to serve as supporting documentation for future grant funding applications (site locations identified in Figure 12 and pictured on the next page). During the field visits, FBE evaluated the severity of erosion, collected measurements (length, width, depth) for screening-level erosion volume estimates, noted distance to the nearest surface water, flow condition, and sediment type (silt, sand, and/or gravel), and took representative photos of the sites. These observations were input to the Water Erosion Prediction Project (WEPP) model for estimating pollutant loading from each site. Site prioritization integrated WEPP model results and field observations through a quantitative ranking method (refer to FBE, 2022 for details). The three highest priority sites occurred along Huse Rd where runoff drains to Black Brook south branch, followed closely by Kaulback Rd where most runoff drains to Black Brook north branch. Both roads are unpaved gravel roads on steep slopes, transporting sediment to nearby surface waters.

Site 1a. Lower Huse Road

Site 1b. Huse Road crossing

Site 2. Upper Huse Road

Site 3. Kaulback-Roxbury Inter

Site 4. Kaulback Road West

Site 5. Kaulback Road East

Site 6. Kaulback Road Far N

Site 7. Black Bk Rd Crossing

Site 8. Woodman Rd Crossing

Site 9. Union Cemetery

Site 10. Roxbury Road

Photos of 11 evaluated and prioritized remediation sites in the Black Brook sub-watershed in Sanbornton. See FBE (2022) for more details. Refer to Figure 12 for site locations.

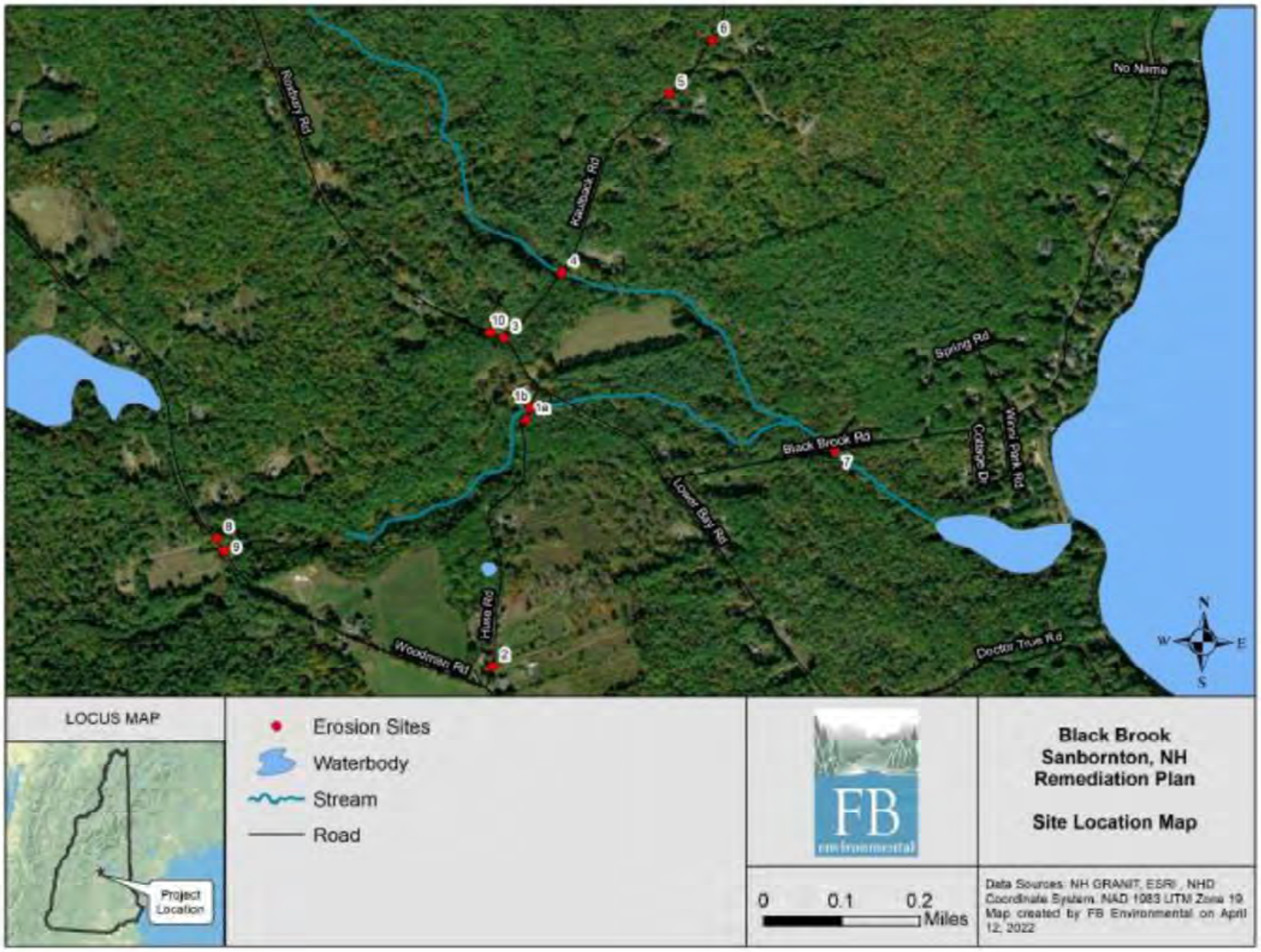


Figure 12. Map of documented and prioritized remediation sites in the Black Brook sub-watershed. Refer to site photos on the previous page as well as FBE (2022) for more details.

3.1.2.3 Lake Winnisquam Watershed Survey (2021)

A watershed survey of the Lake Winnisquam watershed was completed by technical staff from HW and FBE. The objective of the watershed survey was to identify and characterize sites contributing NPS pollution and/or providing opportunities to mitigate NPS pollution in the watershed.

Prior to the field work, HW, FBE, and WWN solicited input from community members and municipal staff about locations with known NPS pollution. HW and FBE also analyzed aerial images and GIS data for land use/land cover, roads, municipal drainage system, public properties, waterbodies, and other features. This information enabled the team to better plan for the survey (e.g., to target known or likely high-polluting sites, such as unpaved roads, beaches, waterfront parks, highly impervious areas, and public works facilities) and to inform recommended solutions.

Plume of sediment washing into Lake Winnisquam from Batchelder Hill Rd in Meredith in the 1990s. The problem has since been remediated when the Town paved the road and installed a sediment forebay.

HW and FBE conducted the watershed survey in April and May 2021. For each location, field staff recorded site data and photographs on tablets. Information collected included location description and GPS coordinates; NPS problem description and measurements (e.g., gully dimensions); receiving waterbody; discharge type (direct or indirect/limited); and preliminary recommendations to mitigate the NPS problem. Field staff accessed sites throughout the watershed from public roads and waterfront access points.

Example of a road ditch with accumulated sediment and vegetation scraped out to maintain hydraulic capacity, as part of the town's maintenance practices.

HW and FBE identified over 100 problem sites in the watershed (Appendix B, Map B-5). The main issues found were unpaved road and ditch erosion; waterfront park and beach erosion; buffer clearing; and untreated urban stormwater runoff. For the sites with recommended stormwater treatment, erosion control, and/or buffer restoration practices, HW estimated the potential pollutant removal that could be achieved by implementing recommendations. Pollutant load reductions were calculated using the MS4 Permit methodology for stormwater treatment systems[4], Region 5 model for gully stabilization[5], and NH Green Buffer methodology for buffer restoration[6]. Table 10 summarizes the potential sediment and total phosphorus reduction by sub-watershed. A list of all identified sites is provided in Appendix C.

Table 10. Estimated pollutant reduction for structural BMPs by sub-watershed. Only those sites with a measurable reduction in pollutant loading from recommended remediation are included.

		Potential Pollutant Reduction	
Sub-watershed	**Number of Sites with Recommended Improvements**	**Average Annual Sediment Load (kg/yr)**	**Average Annual Total Phosphorus Load (kg/yr)**
Black Brook	7	15,948	7.3
Chapman Brook	4	10,741	4.8
Collins Brook	1	1,089	0.5
Dolloff Brook	3	239	0.1
Durgin Brook	8	2,559	1.2
Durkee Brook	9	5,764	2.8
Jewett Brook	7	5,293	2.6
Lake Wicwas Direct	6	4,356	1.9
Lake Winnisquam Direct	25	28,541	14.7
Mill Brook	4	1,872	0.9
Lake Opechee	3	1,051	1.0
Swamp Pond	16	26,593	11.5
Unnamed Tributary (North Trib)	5	6,653	2.8
Winnipesaukee River	3	575	1.0
Total	**101**	**111,274**	**52.9**

[4] Load reduction for stormwater treatment systems was estimated using the methodology presented in the NH MS4 General Permit Appendix F, Attachment 3

[5] For bank or gully stabilization, load reduction was estimated using EPA Region 5 Model for Estimating Pollutant Load Reductions.

[6] For restored or constructed buffers, load reduction was estimated using the methodology presented in UNH Stormwater Center "Pollutant Removal Credits for Restored or Constructed Buffers in MS4 Permits", 2019.

3.1.2.4 Culvert Assessments (2016, 2020, 2021)

The New Hampshire Geological Survey (NHGS), NHDES, New Hampshire Department of Transportation (DOT), NHFGD, and Division of Security and Emergency Management (DOS) have been working together to identify the most vulnerable stream crossings in the State of New Hampshire to allocate resources for replacement. Culvert assessment data collected in the field by trained personnel are stored on the Statewide Asset Data Exchange System (SADES) database and are used by NHGS, NHDES, NHDOT, NHFGD, and DOS to rank crossing structures for their risk of overtopping and failure, degree of aquatic organism passage, and impacts to stream geomorphology.

In 2016, the LRPC and Plymouth State University (PSU) interns conducted an inventory of 101 culverts on Class V roads not served by storm drains in Laconia. The inventory followed protocols for data collection according to the SADES Data Collection Specification Guide for Culverts. Most of the culverts inventoried were old, concrete features with evidence of degradation through spalling or corrosion (in the case of metal culverts), as well as deformation and joint separation (LRPC, 2016).

In October 2020, 11 stream crossings along Black Brook were assessed by Trout Unlimited, as funded through the BCCD. Using the NHDES Stream Crossing Initiative Protocol, culverts were assessed for their risk of failure due to an undersized passage, degree of aquatic organism passage, and the crossing's impacts to stream geomorphology. A table of Trout Unlimited's findings can be found in their 2020 *Black Brook Stream Crossing Assessment Summary* (Trout Unlimited, 2020). Four (4) of the 11 stream crossings intercepted Woodman Road, with two containing no passage, one with reduced passage, and the fourth with only adult trout passage. The Steele Hill Rd stream crossing also contained no passage, while Roxbury and Eagle Ledge Roads contained reduced passages. Four (4) of the 11 stream crossings contained full passage. Five (5) of the stream crossings received geomorphic compatibility scores of "partially compatible," while three were "mostly compatible" and two were "fully compatible". The Eagle Ledge Rd reduced passage stream crossing did not receive a geomorphic compatibility score.

In April 2021, Trout Unlimited conducted 32 stream crossing assessments in the Lake Winnisquam watershed. The NHDES Wetlands Mitigation Program also committed their seasonal employees to survey the remaining crossing structures in the watershed (namely the two urban streams in Laconia) in summer 2021. The assessments followed the NHDES Stream Crossing Initiative protocol. Scoring for hydraulic vulnerability, geomorphic compatibility, and aquatic organism passage were not yet available at the time of this publication.

3.1.2.5 Stream Geomorphic & Habitat Assessment (2010)

A stream geomorphic assessment of the Jewett Brook watershed was completed in 2010 by Bear Creek Environmental, LLC for the New England District of the US Army Corps of Engineers. The assessment was used to identify stressors on the stream's ecosystem health and recommend restoration projects for the stream. Six miles of stream channel divided into 14 reaches were assessed following the Vermont Agency of Natural Resources Protocols. The study found that the major issues along Jewett Brook included "*undersized stream crossings, corridor encroachments, increased stormwater runoff from impervious surfaces, channel straightening associated with the construction of roads and development, lack of riparian buffers, and degraded water quality*" (Bear Creek Environmental, LLC, 2011). Geomorphic conditions along the downstream portion of Jewett Brook were rated as "fair" due to evidence of adjustment processes, aggradation, widening, and planform migration. Jewett Brook has been and is currently "*undergoing a channel evolution process in response to large scale changes in its sediment, slope, and/or discharge associated with the human influences on the watershed*." Habitat condition throughout Jewett Brook was generally rated fair to poor, indicating major or severe departures from reference habitat conditions. Thirty (30) potential restoration projects were identified, including "*river corridor protection through conservation easements or adoption of fluvial erosion hazard zones, replacing undersized structures causing localized channel instability, improving riparian buffers and water quality through landowner education and outreach, and improved stormwater treatment*" (Bear Creek Environmental, LLC, 2011).

3.1.3 Shoreline Survey

With assistance from FBE, WWN volunteers conducted a shoreline survey of Lake Winnisquam in the summer of 2020. The shoreline survey uses a simple scoring method to highlight shoreline properties around the lake that exhibit significant erosion. This method of shoreline survey is a rapid technique to assess the overall condition of properties within the shoreland zone and prioritize properties for technical assistance or outreach.

Eight volunteer teams were used for surveying parcels with lake frontage, documenting the condition of the shoreline for each parcel using a scoring system that evaluates vegetated buffer, presence of bare soil, extent of shoreline erosion, distance of structures to the lake, and slope. The ratings were evaluated and adjusted by technical staff at FBE to remove potential biases among the teams. These scores were summed to generate an overall “Shoreline Disturbance Score” and “Shoreline Vulnerability Score” for each parcel, with high scores indicating poor or vulnerable shoreline conditions. Photos were taken at each parcel and were cataloged by tax map-lot number. These photos will provide project stakeholders with a valuable tool for assessing shoreline conditions over time. It is recommended that a shoreline survey be conducted in mid-summer every five years to evaluate changing conditions.

A total of 725 parcels were evaluated along the shoreline of Lake Winnisquam in Belmont, Laconia, Meredith, Sanbornton, and Tilton (Appendix B, Map B-6). The average Shoreline Disturbance Score (Buffer, Bare Soil, and Shoreline Erosion) for the entire lake was 6.2 (Table 11). About 42% of the shoreline (or 302 parcels) scored 7 or greater. A disturbance score of **7 or above** indicates shoreline conditions that may be detrimental to lake water quality. These shoreline properties tended to have inadequate buffers, evidence of bare soil, and shoreline erosion. The average Shoreline Vulnerability Score (Distance and Slope) was 3.9 (Table 11). About 82% (or 593 parcels) scored 4 or greater. A vulnerability score of **4 or greater** indicates that the parcel may have a home less than 150 ft. from the shoreline and a moderate or steep slope to the shoreline. Parcels with a vulnerability score of 4 or greater are more prone to erosion issues whether or not adequate buffers and soil coverage are present.

Table 11. Average scores for each evaluated condition criterion and the average Shoreline Disturbance Score and average Shoreline Vulnerability Score for Lake Winnisquam. Lower values indicate shoreline conditions that are effective at reducing erosion and keeping excess nutrients out of the lake.

Evaluated Condition	Average Score
Buffer (1-5)	3.1
Bare Soil (1-4)	1.8
Shoreline Erosion (1-3)	1.3
Shoreline Disturbance Score (3-12)	**6.2**
Distance (0-3)	2.5
Slope (1-3)	1.4
Shoreline Vulnerability Score (1-6)	**3.9**

The pollutant loading estimates are based on the shoreline survey disturbance scores. Twenty (20) parcels with a score of 11 or greater generate approximately 39 kg of phosphorus load to Lake Winnisquam annually[7]. If shoreline landowners were to create adequate buffers and install other shoreline BMPs on these properties (at a 50% BMP efficiency rate), the annual reduction would be 20 kg of phosphorus. The 282 parcels with scores 7-10, are contributing approximately 82 kg of phosphorus annually[8]. Remediation efforts on these properties using a 50% BMP efficiency rate could result in the annual reduction of 41 kg of phosphorus.

Certain site characteristics, such as slope, can cause shorelines to be naturally more vulnerable to erosion. For example, parcels along the Sanbornton shoreline scored higher for slope, indicating that the western shores of Lake Winnisquam are more steeply sloped, and thus, more vulnerable to stormwater runoff and erosion. Tilton in the southern portion of Lake Winnisquam contains Route 3, which diverts near the lake for a portion of the road’s length resulting in more impacted shoreline buffer scores (less natural and more patchy buffers). Other site characteristics such as structure distance to the lake, are often a direct consequence of the historic development on that parcel and cannot be easily changed. Shoreline buffers and amount of exposed soil are more easily changed to strengthen the resiliency of the shoreline to disturbance in the watershed. In summary, the overall average shoreline condition of Lake Winnisquam is good (average disturbance score below 7) for erosion issues, with 302 properties (42%) needing to address erosion issues that are impacting the lake. Lake

[7] Based on Region 5 model bank stabilization estimate for silt loams, using 100 ft (length) by 5 ft (height) and moderate lateral recession rate of 0.2 ft/yr.

[8] Based on Region 5 model bank stabilization estimate for silt loams, using 50 ft (length) by 3 ft (height) and moderate lateral recession rate of 0.1 ft/yr.

Winnisquam is also generally more prone to erosion issues because many homes are located close to shore and on moderate to steep slopes (average vulnerability score is 3.9).

Scores should 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 BMP along their shoreline, particularly in areas of bare soil, will help mitigate erosion and reduce sediment and nutrient loading to the lake.

3.1.4 Soil & Shoreline Erosion

Erosion can occur when 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 or cultural eutrophication. 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 surrounding Lake Winnisquam reflect 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, 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, 1951). Erosion has further modified and shaped this parent material over the last 200 million years.

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

The unique geological formation in this area formed the Winnipesaukee River Basin Stratified Drift Aquifer - one of the cleanest and most productive aquifers in the region. Seventeen (17) major aquifers comprise the Winnipesauke River Basin Stratified Drift Aquifer; one of which is within the Lake Winnisquam watershed (Durkee Brook Aquifer) (Ayotte, 1997). The aquifer's saturated thickness measured between 20 to 40 ft and the aquifer's transmissivity was recorded at less than 1,000 ft^2/day. By receiving groundwater from the Durkee Brook Aquifer (along with other smaller aquifers), Lake Winnisquam is a discharge point for the Winnipesaukee River Basin Stratified Drift Aquifer. Any contamination in the aquifer will move quickly to surface waters such as Lake Winnisquam due to the high transmissivity of the material. Therefore, protection of the aquifer is vital to the protection of the lake.

3.1.4.2 Soils and Erosion Hazard

The soils in the Lake Winnisquam watershed (Appendix B, Map B-7) are a direct result of geologic processes. Of the 42 different soil series present within the Lake Winnisquam watershed (excluding soils beneath waterbodies), the most prevalent soil group in the watershed is Tunbridge-Lymann Becket complex, very stony (7,190 acres, 20%), followed by Millsite-Woodstock-Henniker complex, very stony (5,978 acres, 17%), Canterbury Fine Sandy Loam, very stony (2,969 acres, 8%), Gilmanton Fine Sandy Loam, very stony (1,750 acres, 5%), and Pillsbury Sandy Loam, very stony (1,464 acres, 4%). These soils are all classified with having very stony material and are well drained (Tunbridge-Lymann, Millsite, and Canterbury). The remaining 45% of the watershed (excluding the lake area) is a combination of 37 additional soil series ranging from 4% to 0.01% 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 et al., 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 Lake Winnisquam watershed was determined from the associated slope and soil erosion factor K_w[9] used in the Universal Soil Loss Equation (USLE). The USLE 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 the lake area, "severe" and "very severe" erosion hazard areas account for 45% of the Lake Winnisquam watershed (15,897 acres) and are mostly concentrated in the Meredith and New Hampton portions of the watershed (Appendix B, Map B-8). Moderate erosion hazard areas account for 39% of the watershed land area (13,764 acres). Slight erosion hazard areas account for 16% (5,592 acres), and 118 acres or 1% are not rated. Development should be restricted in areas with severe and very severe erosion hazards due to their inherent tendency to erode at a greater rate than what is considered tolerable soil loss. Since a highly erodible soil can have 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.

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 to the biological communities, lakes can experience physical impacts on water quality from changes in lake level. Frequent lake level fluctuations can impact the shoreline, leading 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, so 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.

For about a week in early August 2021, WWN reported that lake water level was very high, about 8 inches above the normal high water level, causing docks and raised beaches to be flooded and shorelines to be eroded. The record-high rainfall in July in the Lake Winnisquam area (and across New England) caused severe dirt road erosion, which moved large amounts of sediment and organic material into the water, causing beach closures and reduced water clarity. Residents were particularly concerned about the enhanced shoreline erosion caused by boat wakes while the lake was experiencing abnormally high water level. Since the start of the pandemic, residents have also reported an increase in the number of boaters on the lake and a corresponding increase in shoreline erosion exposing tree roots.

3.1.5 Wastewater

Untreated discharges of sewage (domestic wastewater) are prohibited regardless of source. An example of an NPS 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 (depending on the development and maintenance of an effective biomat, the adsorption capacity of the underlying native soils, and proximity to a restrictive layer or groundwater). Age, overloading, or poor maintenance can result in system failure and the release of nutrients and other pollutants into surface waters (EPA, 2016). Nutrients from insufficient septic systems can enter surface waters through surface overflow or breakout, stormwater runoff, or groundwater. Cesspools

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

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.

Lake Winnisquam was historically impacted by the dumping of untreated effluent from the City of Laconia's primary wastewater treatment plant, which was built in 1952 to collect wastewater from homes and businesses in the rapidly developing area. The excessive nutrients in the untreated effluent spurred severe blooms in the lake throughout the 1950s and 1960s. In 1959, the Lakes Region Clean Waters Association was formed and through many years of persistent grassroots efforts from community members, a $1 million dollar grant was secured from the EPA under the CWA Construction Grants Program to establish the Winnipesaukee River Basin Program (WRBP), a state-owned sewer system with a wastewater treatment plant in Franklin. The sewer system went online in 1976 and processed sewage from several municipalities in the area. The plant is located outside the watershed, but there are several pump-out stations and a maintenance facility in the watershed, along with the connecting sewer lines. The sewer system serves over 14,500 residential connections in 10 communities. WRBP owns and maintains the main sewer line and pump stations that convey the sewage from each community to the plant. The sewer infrastructure that connects homes and businesses to the main sewer line is owned and maintained by each respective municipality or by private owners. WRBP is funded by each municipality through the sewer tax bill collected. **Nearly half of the shoreline area of Lake Winnisquam is serviced by sewer systems, which represents a potential vulnerability if the sewer systems are old or damaged and leaking wastewater into groundwater near the lake.**

In 2021, WWN compiled septic system data for Lake Winnisquam shoreline properties (within 250 ft of Lake Winnisquam), including date house built, date of most recent septic installation or upgrade, number of bedrooms, and seasonal or year-round use, if available (otherwise assumed year-round). For the towns of Tilton, Belmont, Meredith, and Sanbornton, WWN visited town offices and reviewed tax record information to glean relevant septic system information not found through online records. The City of Laconia provided septic system data to WWN directly. Septic system survey findings are summarized in Table 12. WWN identified 1,027 parcels within 250 ft of Lake Winnisquam (includes all developed and vacant parcels), 365 of which were found to be using septic systems for wastewater treatment. **An estimated 39% of those septic systems were over 25 years old. The public survey conducted by WWN (see Section 1.4.3) also found that many systems were not up to code and were likely cesspools.** WWN's online survey noted cesspools on Mohawk Island as concerning for water quality.

Shoreline septic systems were estimated to contribute 86 kg/yr of total phosphorus loading to Lake Winnisquam, comprising 1% of the total load to the lake (refer to Section 2.3.1 and FBE, 2021a). Despite the relatively minor load estimated for septic systems around the lake, numerous 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.

Table 12. Summary of septic system data for properties along the shoreline of Lake Winnisquam. Note: The number of shoreline parcels within 250 ft of Lake Winnisquam (and subsequent percentages) include vacant lots.

Municipality	Shoreline Parcels (within 250 Ft of Lake Winnisquam)	Number Of Shoreline Properties on Septic	Percent Of Shoreline Properties on Septic	Number Of Septic Systems Older Than 25 Years	Percent Of Septic Systems Older Than 25 Years
TILTON	101	0	0%	0	0%
BELMONT	180	8	4%	Unknown	Unknown
MEREDITH	173	157	91%	36	23%
SANBORNTON	182	63	35%	38	60%
LACONIA	391	137	35%	69	50%
TOTAL	**1,027**	**365**	**36%**	**143**	**39%**

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.

WWN's online survey showed that about 42% of respondents used fertilizers on their lawns, with 33% applying 1-2 times per year, 7% applying 3-4 times per year, and 2% applying five or more times per year. Most respondents (53%) were not using different application practices near shoreland areas. Tardiff Park along Jewett Brook was identified as a potential source of nutrients due to observation of grass clippings in the channel and minimal buffer between the stream and park lawn (fertilizer use unknown), downstream of which was a significant algal bloom in the stream (Bear Creek Environmental, LLC, 2011). The municipalities of New Hampton, Meredith, Laconia, and Tilton indicated that no fertilizers are used on public land. Sanbornton hires Swain Landscaping, who likely does not use fertilizer, for maintaining public land in town. Gilford hired Boucher Landscape Company for mowing and clipping and Belknap Landscape for lawn and garden treatments at the town hall, fire department, Department of Public Works (DPW) facility, and cemeteries. Treatment at cemeteries is conducted in May/June and September/October with a broad leaf weed control and slow release fertilizer. Treatment at the town hall is conducted with Holganix 100% organic bionutritional fertilizer for turf.

There are also several golf courses within the Lake Winnisquam watershed that use fertilizer: (1) Oak Hill Golf Course uses Opti-45 fertilizer on the greens; (2) Laconia Country Club & Golf Course uses low or zero phosphorus products of blended organic and synthetics of historically granular but now liquid form (for direct feeding); and (3) Lakeview Golf Course was closed and sold in April 2021 to Stone Bluff Property Holdings LLC of Northfield, NH and reopened as a golf course again in late 2021; they currently use Nature Safe 8-35 Stress Guard fertilizer with 3% available phosphate.

3.1.7 Agriculture

Agriculture in the Lake Winnisquam watershed includes cropland and livestock grazing pasture. 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 and facilities with the potential to contribute to nutrient impairment include:

- Plowing and earth moving;
- Fertilizer and manure storage and application;
- Livestock grazing;
- Animal feeding operations and barnyards;
- Paddock and exercise areas for horses and other animals; and
- Leachate from haylage/silage storage bunkers.

Diffuse runoff of farm animal waste from land surfaces (whether from manure stockpiles or cropland where manure is spread), as well as direct deposition of fecal matter from farm animals standing or swimming in surface waters, are significant sources of agricultural nutrient pollution in surface waters. Farm activities like plowing, livestock grazing, vegetation clearing, and vehicle traffic can also result in soil erosion which can contribute to nutrient pollution.

Excessive or ill-timed application of fertilizer or poor storage which allows nutrients to wash away with precipitation not only endangers lakes and other waters, it also means those nutrients are not reaching the intended crop. 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 and restore nutrients to the land. 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. BCCD was unaware of any active issues with agricultural practices impacting water quality in the watershed and noted that farmers may not be working with Natural Resource Conservation Service (NRCS) to review agricultural practices unless they are receiving NRCS funding. A respondent through WWN's online survey noted that horse waste may be impacting a stream along Oak Hill Rd in Sanbornton. Hunkins Pond is also very likely impacted by agricultural runoff.

3.1.8 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 (CWP, 1999). If pet feces are not properly disposed, these nutrients can be washed off the land and transported to surface waters by stormwater runoff. Pet feces can also enter surface waters by direct deposition of fecal matter from pets standing or swimming in surface waters. Dog waste left along Collins Brook Rd in Meredith and along the fire access road between Weed Rd and Waldron Bay Association was noted in WWN's online survey as a problem area.

3.1.9 Future Development

Understanding population growth, and ultimately development patterns, provides critical insight to watershed management, particularly as it pertains to lake water quality. After a declining population trend from 1860 to 1900, the population of the seven watershed municipalities started growing, especially Laconia which grew rapidly from 1870 to 1950 and continued growing steadily over the last 50 years (US Census Bureau, 2022). The other six municipalities started growing significantly in population from 1970 to 2020 (Figure 13). The Lake Winnisquam watershed area has long been treasured as a recreational haven for both summer vacationers and year-round residents. The area is among the oldest summer vacation spots in New Hampshire and offers fishing, hiking, boating, sailing, canoeing, kayaking, and swimming in the summer, and ice fishing, cross-country skiing, snowshoeing, and snowmobiling in the winter. The desirability of Lake Winnisquam and the greater Lake Winnipesaukee area as a recreational destination will likely stimulate continued population growth in the future. Growth figures and estimates suggest that these seven 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 increases the potential for water quality decline.

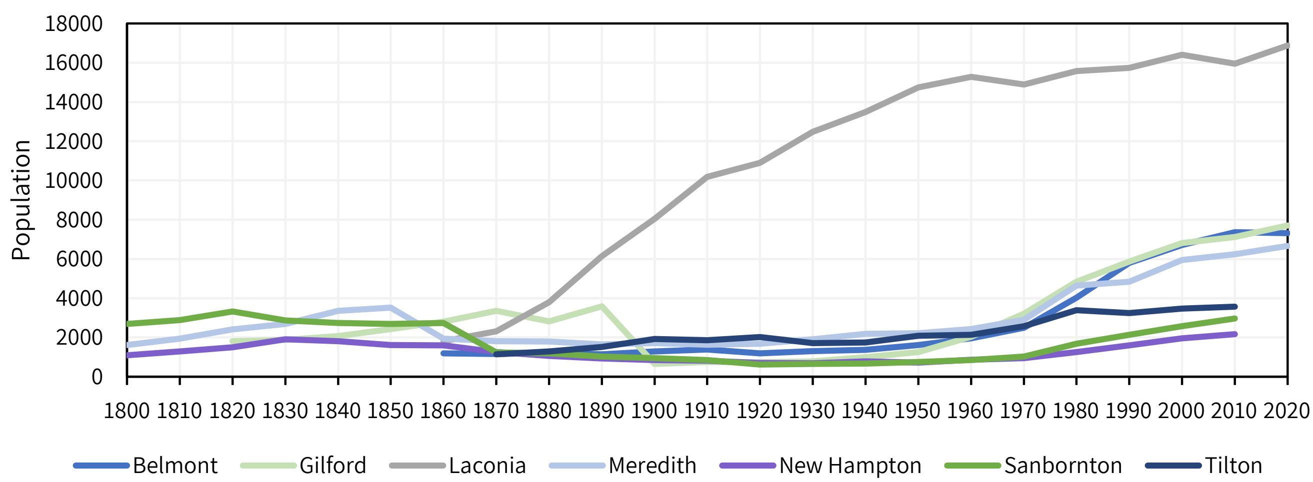


Figure 13. Historical demographic data for the municipalities of Belmont, Gilford, Laconia, Meredith, New Hampton, Sanbornton, and Tilton in the Lake Winnisquam watershed. The population of this community has grown dramatically over the last 50 years. **2020 official census data is only available for municipalities with populations greater than 5,000 people, as of the writing of this plan.*

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 treatment plant, permitted stormwater outfall, or a regulated animal feeding operation, making this type of pollution relatively easy to identify. Section 402 of the CWA requires all such discharges to be regulated under the NPDES program to control the type and quantity of pollutants discharged. NPDES 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 CWA.

NHDES operates and maintains the OneStop database and data mapper, which houses data on Potential Contamination Sources (PCS) within the State of New Hampshire. Identifying the types and locations of PCS within the watershed may help identify sources of pollution and areas to target for restoration efforts. Downloaded and filtered for the Lake Winnisquam watershed, these data identify potential sources of pollution to the Lake Winnisquam (Figure 14). On 1/05/2020, FBE downloaded datasets for aboveground storage tanks, underground storage tanks, automobile salvage yards, solid waste facilities, hazardous waste sites, local potential contamination sources, NPDES outfalls, and remediation sites.

3.2.1 Above and Underground Storage Tanks

Above and underground storage tanks include permitted containers with oil and hazardous substances such as motor fuels, heating oils, lubricating oils, and other petroleum and petroleum-contaminated liquids. There are 39 aboveground storage tanks within the Lake Winnisquam watershed. Two can be found in Belmont, one in Gilford, 30 in Laconia, five in Sanbornton, and one in Tilton. There are 139 underground storage tanks within the Lake Winnisquam watershed. Eight can be found in Belmont, eight in Gilford, 109 in Laconia, one in Meredith, five in Sanbornton, and five in Tilton. Ownership of these tanks range from auto salvage yards, auto dealerships, commercial industries, hospitals, industrial facilities, marinas, petroleum distributors, utilities, municipal, local, and state governments, and more.

3.2.2 Automobile Salvage Yards

There are two automobile salvage yards within the Lake Winnisquam watershed that either contain at least 12 “end-of-life” vehicles annually or at least 25 vehicles for more than 60 days at a time. The Reed’s Auto Wrecking Co. located in Laconia and Al’s Used Parts in Belmont are currently registered with the NHDES Greenyards Program as active.

3.2.3 Solid Waste Facilities

There are two solid waste facilities within the Lake Winnisquam watershed. One, the Frank Bean Rd Site, is a closed, unlined landfill no longer under operation, while the other is the Laconia Transfer Station which is currently under operation for collection, storage, and transfer of waste.

3.2.4 Hazardous Waste Sites

Hazardous waste generating facilities are identified through the EPA’s Resource Conservation and Recovery Act (RCRA) and either require federal or state regulation. Only 41 of the 135 hazardous waste generating facilities within the Lake Winnisquam watershed are listed as active; the remaining facilities are classified as either inactive (64), declassified (22), classified (7), or non-notifier (1). Of the 41 active hazardous waste sites, six can be found in Belmont, two in Gilford, 30 in Laconia, two in Sanbornton, and one in Tilton.

3.2.5 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 PCS identified in this section. Of the 26 local potential contamination sources within the Lake Winnisquam watershed, nine can be found in Belmont, three in Gilford, 10 in Laconia, one in Meredith, and three in Tilton.

3.2.6 NPDES Outfalls

Of the nine NPDES outfalls that discharge pollutants directly to a surface water within the Lake Winnisquam watershed, only one is actively discharging (General Permit #NH0022730). Located along Durkee Brook, the Scotia Technology facility is characterized as a facility that processes wastewater, although the water discharging from the outfall is “Non-Contact Cooling Water” and “no toxic discharge, so no dilution factor” is needed (NHDES Outfalls Metadata).

3.2.7 Remediation Sites

The 295 remediation sites present within the Lake Winnisquam watershed consist of leaking storage facilities that contain fuel or oil, sites with chlorinated solvents and other non-petroleum products, non-hazardous and non-sanitary holding tanks, initial spill response sites, historical dump sites, leaking residential or commercial oil tanks for heating or motor oil tanks, underground injection control of wastewaters not requiring a groundwater discharge permit, unlined wastewater lagoons, or a flagged groundwater sample for contamination but with no direct connection to a source of contamination. Of the 295 remediation sites, 58 are identified in Belmont, 24 in Gilford, 170 in Laconia, 15 in Meredith, one in New Hampton, 16 in Sanbornton, and 11 in Tilton.

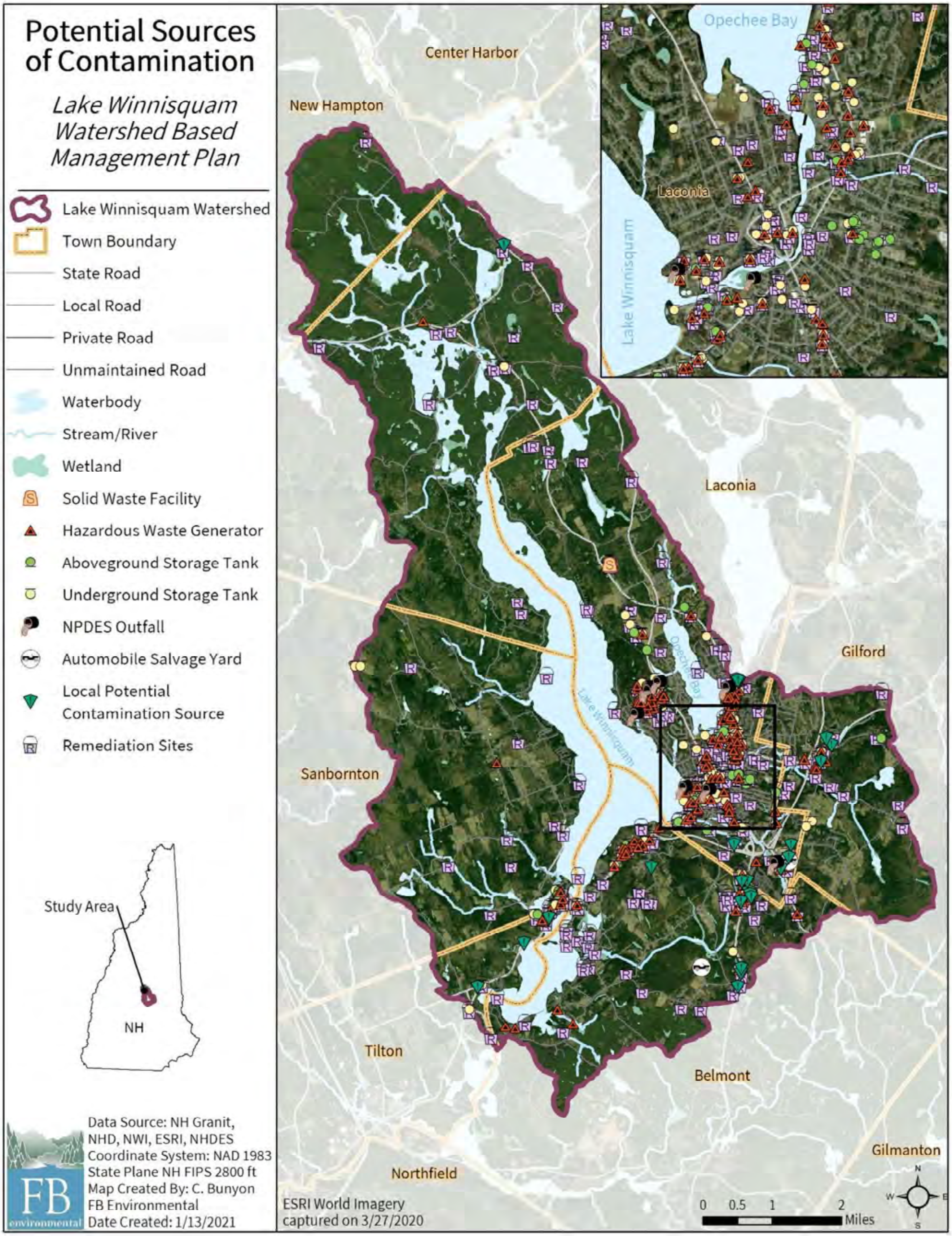


Figure 14. Potential sources of contamination in the Lake Winnisquam watershed.

3.3 WILDLIFE

Fecal matter from wildlife such as geese, gulls, other birds, and beaver may be a significant source of nutrients in some watersheds. This is particularly true when human activities, including the direct and indirect feeding of wildlife and habitat modification, result in the congregation of wildlife (CWP, 1999). 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 (such as at Opechee Park, Laconia Country Club, or Oak Hill Golf Course) 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) and gulls along shorelines increase phosphorus concentration in beach sand pore water that then enters surface waters through groundwater transport and wave action (Staley et al. 2018). 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 et al., 2019). On a global scale, fluxes of nitrogen and phosphorus from seabird populations have been estimated at 591 Gg N per year and 99 Gg P per year, respectively (with the highest values derived from arctic and southern shorelines) (Otero et al., 2018). 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 et al., 2010). The model estimated that waterfowl are likely contributing 8.5 kg/yr (4%) of the total phosphorus load to Lake Winnisquam (FBE, 2021a).

3.4 CLIMATE CHANGE

Climate change will have important implications for water quality that should be considered and incorporated into WBPs. In the last century, New England has already 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 record likely due to the increase in frequency of extreme precipitation and total annual precipitation in the region. In 79 years of recorded flooding in the Oyster River in Durham, NH, three of the four highest floods occurred in the past 10 years (Ballestero et al., 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 likely continue to impact both water quality and quantity. Climate change models predict a 10-40% 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 15,027 acres is still developable and up to 6,734 new buildings could be added to the watershed at full build-out based on current zoning standards. Lake Winnisquam is at risk for water quality degradation because of new development in the watershed unless climate change resiliency and **low impact development** (LID) 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 restoration techniques, as well as outreach and education and an adaptive management approach. A key component of these strategies is the idea that existing and future development can be remediated or conducted in a manner that sustains environmental values. All stakeholder groups have the capacity to be responsible watershed stewards, including citizens, businesses, the government, and others. Specific action items are provided in the Action Plan (Section 5).

4.1 STRUCTURAL NONPOINT SOURCE (NPS) RESTORATION

Structural NPS 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 BMPs 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 & Shoreline BMPs

Over 100 NPS sites identified during the 2021 watershed survey and 302 high/medium impact rated shoreline properties from the 2020 shoreline survey were documented to have some impact to water quality through the delivery of phosphorus-laden sediment (refer to Section 3.1.2 and 3.1.3). As such, structural BMPs to reduce the external watershed phosphorus load are a necessary and important component for the protection of water quality in the watershed.

Example of structural BMPs installed at the Sanbornton Town Beach.

The following series of BMP implementation action items are recommended for achieving Objectives 1 and 3 (see Action Plan in Section 5 for more details):

- Remediate stormwater runoff through infrastructure rehabilitation in the Hueber Brook sub-watershed to Lake Winnisquam to remove Lake Winnisquam's ALI impairment listing.
- Address the top 24 high priority sites (and the remaining 84 medium and low priority sites as opportunities arise) identified during the 2021 watershed survey. The 108 sites were ranked based on phosphorus load reduction and waterbody proximity. Table 13 presents the recommended improvements and corresponding pollutant load reductions for the top 24 high priority sites. The full prioritization matrix is provided in Appendix C. Conceptual designs for three of the top 24 high priority sites are provided below. Design and implementation for these three sites are currently underway through a NHDES 319 Watershed Assistance Grant (2022-23) awarded to WWN. These sites will be used as models for other similar sites in the watershed.
- Address road erosion control measures identified in Lang (2021) and FBE (2022). BCCD and WWN plan to pursue grant funding for the design and remediation of erosion sites in the Black Brook sub-watershed.
- Provide technical assistance and/or implementation cost sharing to 20 high impact shoreline properties identified during the 2020 shoreline survey. Encourage landowners to implement stormwater and erosion controls on the 282 medium impact shoreline properties identified during the 2020 shoreline survey. Workshops and tours of demonstration sites can help encourage landowners to utilize BMPs on their own property. Conduct regular shoreline surveys to continue prioritizing properties for technical follow-up. WWN will be working with NH Lakes through the LakeSmart Program to educate homeowners on lake-friendly landscaping and stormwater control practices.

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

Table 13. Top 24 high priority structural BMP sites in the Lake Winnisquam watershed.

				Potential Pollutant Reduction	
Site ID	**Site Description**	**Municipality**	**Recommendations**	**Average Annual Sediment Load (kg/yr)**	**Average Annual TP Load (kg/yr)**
1-12	Gale Ave - small pocket park with access to lake	Laconia	Install a bioretention basin within the park to treat runoff from Gale Ave. Stabilize eroded areas, improve buffer.	2,282	1.6
2-05	Swain Rd at Jewett Brook crossing	Gilford	Armor ditch with stone or grass, Install turnout, Reshape ditch, Stabilize banks, Install runoff diverter, Plant/improve buffer	1,361	0.8
3-10	Chemung Rd	Meredith	Armor ditch with stone or grass, Reshape ditch, Reshape or crown road, Reshape/vegetate shoulder	1,633	0.7
3-11	Roxbury Rd	Meredith	Armor ditch with stone or grass, Reshape ditch, Reshape or crown road, Reshape/vegetate shoulder	2,195	0.9
3-12	Stoney Brook Rd	Meredith	Reshape or crown road, Reshape/vegetate shoulder, Clean out and stabilize plow pile area	3,024	1.3
3-13	Stoney Brook Rd, crossing with river	Meredith	Armor ditch with stone or grass, Reshape ditch, Reshape or crown road, Reshape/vegetate shoulder, Investigate geomorphic stability of river	1,597	0.7
3-14	Deer Park Association beach on Weed Rd	Meredith	Reshape or crown road, Reshape/vegetate shoulder, Restore sediment forebay, Install rain garden, tiered landscaping, infiltration steps; Improve buffer, Install turnouts on south access road to lake	1,597	0.7
3-16	Weed Rd	Meredith	Armor ditch with stone or grass, Reshape ditch, Reshape or crown road, Reshape/vegetate shoulder, Improve buffer	1,814	0.8
3-20	New road construction off Batchelder Hill Rd	Meredith	Armor ditch with stone or grass, Reshape ditch, Reshape or crown road, Reshape/vegetate shoulder	1,996	0.8
3-21	Eagle Ledge Rd intersection with Batchelder Hill Rd	Meredith	Armor ditch with stone or grass, Reshape ditch, Reshape or crown road, Reshape/vegetate shoulder	3,592	1.5
3-22	Eagle Ledge Rd, Black Brook crossing	Sanbornton	Stabilize inlet and/or outlet, Armor ditch with stone or grass, Reshape ditch, Reshape or crown road, Reshape/vegetate shoulder	2,395	1.0
3-23	Kaulback Rd and Roxbury Rd	Sanbornton	Stabilize inlet and/or outlet, Replace/enlarge culvert, Armor ditch with stone or grass, Reshape ditch, Reshape or crown road, Reshape/vegetate shoulder	3,393	1.4
3-24	Lower Bay Rd and Huse Rd	Sanbornton	Armor ditch with stone or grass, Reshape ditch, Reshape or crown road, Reshape/vegetate shoulder	2,776	1.4
3-25	Woodman Rd	Sanbornton	Stabilize inlet and/or outlet, Armor ditch with stone or grass, Reshape ditch, Reshape/vegetate shoulder	2,159	1.1
3-26	Woodman Rd	Sanbornton	Armor ditch with stone or grass, Reshape ditch, Reshape/vegetate shoulder, Divert driveway runoff, Enhance and stabilize buffer between road and stream	1,597	0.7

Site ID	Site Description	Municipality	Recommendations	Potential Pollutant Reduction: Average Annual Sediment Load (kg/yr)	Potential Pollutant Reduction: Average Annual TP Load (kg/yr)
3-28	Woodman Rd intersection with Steele Hill Rd	Sanbornton	Stabilize inlet and/or outlet, Armor ditch/turnouts with stone or grass with check dams, Reshape ditch, Reshape or crown road, Reshape/vegetate shoulder	3,629	1.5
3-30	Chapman Rd	Sanbornton	Stabilize inlet and/or outlet, Armor ditch with stone or grass, Reshape ditch, Reshape or crown road, Reshape/vegetate shoulder	1,996	0.8
3-31	Philbrook Rd	Sanbornton	Stabilize inlet and/or outlet, Armor ditch with stone or grass, Reshape ditch/turnouts, Reshape or crown road, Reshape/vegetate shoulder	2,395	1.0
3-32	Philbrook Rd	Sanbornton	Stabilize inlet and/or outlet, Armor ditch with stone or grass, Reshape ditch/turnouts, Reshape or crown road, Reshape/vegetate shoulder	1,361	0.8
3-34	Bay Rd	Sanbornton	Stabilize parking area, pull-off area, and access ramps	4,990	2.1
3-36	Doctor True Rd and Maple Circle	Sanbornton	The Town is considering paving Dr True Rd and Maple Circle to address erosion and travel issues. If paving moves forward, evaluate BMPs to manage sand and salt from newly paved roads.	9,273	4.6
4-06	Old Stage Rd culvert	Meredith	Install turnout, Reshape ditch, Reshape/vegetate shoulder, Reshape or crown road, Install runoff diverter	1,814	0.8
4-08	Intersection of Rt 104 and Hatch Corner Rd	Meredith	Remove winter sand, Install erosion controls (e.g., silt fence), Armor ditch with stone or grass	1,814	0.8
4-09	Dow Rd, near intersection with Rt 104	Meredith	Armor ditch with stone or grass, Install erosion controls (e.g., silt fence)	1,814	0.8

4.1.2 Conceptual Designs for Select Priority Structural BMP Sites (2021)

For sites ranked as high priority for structural BMPs, WWN consulted with landowners and municipalities to assess their willingness to implement the recommended stormwater improvements. The team then selected three high priority sites to carry forward for conceptual design. In addition to water quality performance and municipal/landowner support, these sites were selected based on their potential to demonstrate replicable solutions for the key NPS issues observed in the watershed: urban stormwater runoff, unpaved road and ditch erosion, and private waterfront erosion. The conceptual designs presented herein represent planning level recommendations for stormwater management improvements at each site, along with planning level estimates of costs[10] and potential phosphorus load reduction[11]. The overarching goal of proposed improvements is to reduce phosphorus loading into Lake Winnisquam. These designs seek to accomplish phosphorus reduction by reducing erosion and by treating stormwater runoff using structural stormwater control measures (SCMs). Secondarily, these designs aim to demonstrate replicable NPS management practices, maintain existing site uses, preserve and enhance ecological resources, minimize long-term maintenance requirements, and educate the public about water quality and stormwater management. Construction-ready design and implementation for these three sites are currently underway through a NHDES 319 Watershed Assistance Grant (2022-23) awarded to WWN. WWN plans to work with local partners to complete the designs at each site.

[10] Planning-level costs were estimated using EPA Region 1 (2016) *Methodology for Developing Cost Estimates for Opti-Tool*, NHDOT and MassDOT unit prices, and best professional judgement. Costs include 25% contingency and are expressed in 2021 dollars.

[11] Phosphorus reduction was estimated using NH MS4 Permit Appendix F, EPA Region 5 Erosion Control Model, and UNH Stormwater Center (2019) *Pollutant Removal Credits for Restored or Constructed Buffers in MS4 Permits*.

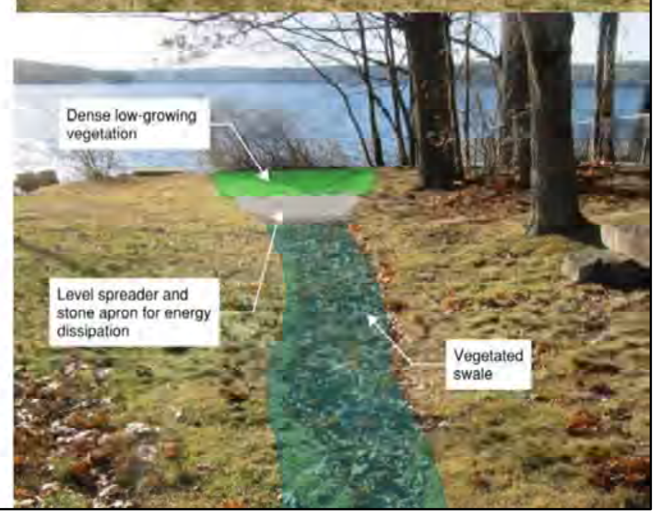
Gale Ave Park, Laconia, NH


Shoreline of Gale Ave Park.

Existing Site Description: Gale Ave Park is a small public park on Lake Winnisquam at the end of Gale Ave in Laconia. The park is accessed from Gale Ave by sidewalks that extend into the park to the south and north. The park features two stone benches and a lawn area. Along the 80-ft shoreline, there is a concrete block remaining from a former wharf, a small, vegetated area, and a small beach-like section that slopes down to the water. The Laconia Department of Parks and Recreation is developing plans for a shoreline retaining wall, an accessible paved path, and a kayak launch. Stormwater runoff from Gale Ave and adjacent residential properties appears to bypass storm drains along Gale Ave and flow into shallow swales along the north and south edges of the park. Further investigations are needed to determine the cause(s) and amount of bypass. The swales are significantly eroded, particularly at the end of the swale to the south. A drainage outfall is located to the north of the park. A sanitary sewer extends from Gale Ave into the park, where there are two sewer manholes. Soils at the site are categorized as hydrologic soil group (HSG) C, indicating moderate infiltration capacity.

SITE SUMMARY

Owner: City of Laconia
Receiving Water: Lake Winnisquam
Estimated Phosphorus Load Reduction: 1.6 kg/year
Estimated Costs: Capital costs: $39,000-$47,000
Annual operation and maintenance costs: $2,000
20-year life cycle cost: $83,000



Proposed Improvements:

- Collect stormwater runoff entering the park with a paved inlet flume and route flow into a sediment forebay and bioretention basin to manage low-flow storm events. The bioretention basin will include an overflow spillway to route excess flows into a vegetated swale to the north. Plantings for the bioretention basin will include generally low-growing and low-maintenance species.
- Convert the eroded swale to the north into a vegetated swale to carry flow from the bioretention basin to the lake. Plantings for the swale will include low maintenance grasses, sedges, and rushes such as Common Rush (*Juncus effuses*), Prairie Dropseed (*Sporobolus heterolepis*), and Northern Sea Oats (*Chasmanthium latifolium*).
- Transition the swale to meet a level spreader and stone apron for energy dissipation. Between the stone apron and the shoreline, plant dense groundcover vegetation.
- Restore the eroded swale to the south with loam and seed to match surrounding lawn.
- Install educational signage about water quality and stormwater management.
- Integrate the bioretention and swale design with park improvements planned by Laconia Parks and Recreation.

Operation and Maintenance: Operation and maintenance (O&M) for the proposed bioretention basin and swale is anticipated to incur 20 hours annually. Typical O&M includes routine inspections, preventative maintenance, and corrective actions, such as the following:

1) Clean out trash, debris, and accumulated sediment from inlet, forebay, bioretention basin, spillway, and swale.
2) Maintain vegetation (weeding, replanting, etc.) and water plants during establishment period.
3) Check for erosion within and downstream of facility; stabilize areas of erosion, if found.
4) Check for standing water (lack of drainage) in the bioretention basin. Investigate and correct clogging if the basin does not drain within 48 hours following a rain event.

Operation and maintenance for bioretention systems, as provided in EPA Region 1 (2016) *Methodology for Developing Cost Estimates for Opti-Tool*

Deer Park Beach, Meredith, NH

Existing Site Description: Deer Park Beach is a private beach and boat launch on Lake Winnisquam in Meredith. The beach is accessed via granite steps off Weed Rd, opposite Heritage Rd, and an unpaved driveway to the south. The beach is owned by Deer Park Association, which consists of 28 member households. The beach is used primarily for boat launching. The driveway is gated and only members have the lock combination. Daily use rarely exceeds 10 people on any given day. Some members use golf carts to access the beach, a few use cars, and many walk to the site. The beach features an unpaved parking area, a permanent canoe/kayak rack, a sandy beach, and a paved boat ramp. The parking area is located to the north of the driveway. Cars typically park nose-in toward the post and beam fence. The parking area is not heavily used, and neither the driveway nor parking area are maintained during the winter. It appears that sediment-laden runoff from Heritage Rd, an unpaved private way, bypasses catch basins at the intersection with Weed Rd and continues downhill toward the granite steps into Deer Park Beach. Erosion is evident alongside the steps, likely caused both by runoff and pedestrian traffic. Runoff from Weed Rd collects in a shallow swale on the east side of Weed Rd and flows south. This runoff was formerly diverted into a sediment forebay at the top of the slope just north of the access driveway. Due to sediment buildup at the diversion point on Weed Rd, the runoff now continues along Weed Rd to the beach driveway, where it turns the corner and flows down the drive. The driveway frequently erodes. Two deep gullies formed along the driveway during heavy rains in July 2021. Erosion is also evident on the north side of the paved boat ramp and along the sandy beach. Soils at the site are categorized as HSG A, indicating good infiltration capacity.

SITE SUMMARY

Owner: Deer Park Association
Receiving Water: Lake Winnisquam
Estimated Phosphorus Load Reduction: 0.7 kg/year
Estimated Costs: Capital costs: $65,000-$79,000
Annual operation and maintenance costs: $3,000
20-year life cycle cost: $132,000

Proposed Improvements:

- Improve and formalize the existing footpath opposite Heritage Rd with the addition of infiltrating steps and vegetation. Revegetate the eroded slope using low-maintenance native plants.
- Create terraced landscaping above eroded beach areas to slow and infiltrate runoff from Weed Rd and the steep slope above the beach.
- Improve the existing forebay at the top of slope by removing sediment and stone and installing a concrete paver mat underlain with crushed stone. The concrete paver mat will allow stormwater to pond and infiltrate through the crushed stone, prevent scour erosion, and will make it easier to remove accumulated sediment.
- On the driveway, install waterbars to divert runoff into a swale to the north. The swale will have a turnout at the base of the vegetated slope to divert runoff into an infiltrating forebay and bioretention basin. The basin will include a level-spreader emergency spillway for large storm events.
- At the end of the swale, install a level spreader and stone apron to slow and spread out flows into a restored vegetated buffer. The vegetated buffer will be located downhill from the parking area, between the boat ramp and the tree. It will be planted densely with low-growing plants.

Operation and Maintenance: O&M for the proposed stormwater improvements is anticipated to incur 30 hours annually. O&M includes routine inspections, preventative maintenance, and corrective actions, such as the following:

1) Clean out trash, debris, and accumulated sediment from inlets, forebays, bioretention basin, spillway, swale, and infiltrating steps.
2) Maintain vegetation (weeding, replanting, etc.) and water plants during establishment period.
3) Check for erosion within and downstream of stormwater facilities; stabilize areas of erosion, if found.
4) Check for standing water (lack of drainage) in the bioretention basin and infiltrating steps. Investigate and correct clogging if ponded water does not drain within 48 hours following a rain event. If the crushed stone in the infiltration steps become filled with sediment over time, remove the stone, clean out the sediment, and replace.

Operation and maintenance for bioretention systems, as provided in EPA Region 1 (2016) *Methodology for Developing Cost Estimates for Opti-Tool*

Kaulback Rd, Sanbornton, NH

Erosion along Kaulback Road.

Existing Site Description: The focus area is a 1,100 ft segment of Kaulback Road from the intersection with Roxbury Rd to approximately 500 ft north of the Black Brook crossing. The road is unpaved and has eroding shoulders and ditches on both sides, rills, sediment buildup, and small berms at the road edge caused by road maintenance with graders (aka grader berms). Soils at the site are categorized as HSG A (to the south of Black Brook) and HSG C (to the north).

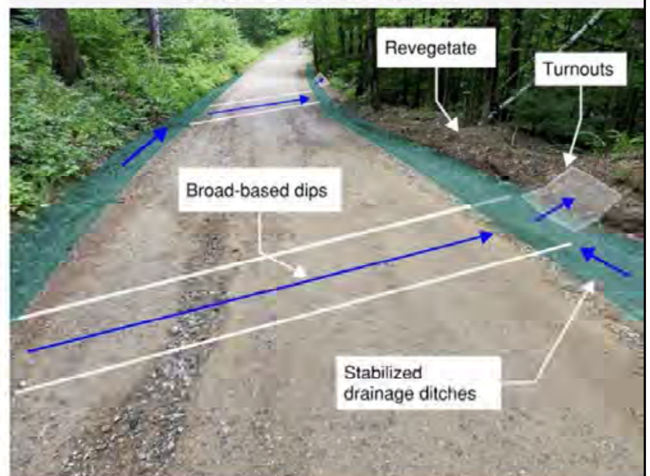
SITE SUMMARY

Owner: Town of Sanbornton

Receiving Water: Black Brook, tributary to Lake Winnisquam

Estimated Phosphorus Load Reduction: 1.5 kg/year

Estimated Costs: Capital costs: $32,000-$40,000
Annual operation and maintenance costs: $1,500
20-year life cycle cost: $66,000



Proposed Improvements:

- Regrade the road with broad-based dips to break up the drainage area and divert runoff to stabilized ditches and turnouts into the downgradient forest.
- Create shallow drainage ditches/swales on both sides of the road, with stabilized turnouts. Along the steeper section to the north (> 5% slope), install stone check dams in the ditches to reduce flow velocity. Remove grader berms and revegetate shoulders where needed.
- Divert runoff into the forest via turnouts before it reaches the Black Brook crossing. Restore eroded areas at the stream crossing. Where runoff cannot be diverted before reaching the crossing, install sediment forebay(s) to settle out sediment and to slow and spread out flows.

Operation and Maintenance:

In addition to typical maintenance for unpaved roads (which typically includes annual or more frequent grading, removal of sediment from turnouts and periodic correction of eroded areas), O&M for the proposed stormwater improvements is anticipated to incur 15 hours annually. O&M includes routine inspections, preventative maintenance, and corrective actions, such as the following:

1) Clean out trash, debris, and accumulated sediment from check dams, ditches, and sediment forebays.
2) Inspection and backfilling of edges of broad-based dips where erosion has occurred. Broad-based dips made of concrete are most effective and long lasting; other materials typically require more frequent maintenance.
3) In restoration areas, water plants during establishment period.

4.2 NON-STRUCTURAL NONPOINT SOURCE (NPS) RESTORATION

Non-structural NPS 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, stream restoration, zoning and ordinance updates, land conservation, septic system regulation, fertilizer use prohibition, proper agricultural practices, pet waste management, and nuisance wildlife controls.

4.2.1 Pollutant Reduction Best Practices

Pollutant reduction best practices include recommendations and strategies for improving road management and municipal operations for the protection of water quality. Following standard best practices for road maintenance and drainage management protects both infrastructure and water quality through the reduction of sediment and other pollutant transport. Refer to the "Kaulback Rd, Sanbornton, NH" conceptual design (Section 4.1.2) and the *New Hampshire Stormwater Manual* (NHDES, 2008) for standard road design and maintenance best practices.

Even though none of the seven watershed municipalities are required to comply with the six minimum control measures under the New Hampshire Small MS4 General Permit, each municipality could consider instituting the permit's key measures, such as street sweeping, catch basin cleaning, and road/ditch maintenance. 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/or training for residents, municipal staff, and stormwater operators, all of which are aimed at minimizing polluted runoff to surface waters.

Each municipality employs the following best practices:

- In New Hampton, the DPW inspects (and cleans, as needed) stormwater outfalls and culverts regularly mostly in the spring and summer. Street sweeping is conducted once in the spring. No landscaping material is disposed of from municipal lands except leaves at the transfer station. The Town uses both sand and salt for winter road maintenance (salt is kept in an enclosed facility). LRPC assisted the Town with a culvert inventory that the Town uses to prioritize work. The Town maintains, monitors, and regrades as needed 26 miles of gravel roads.
- In Meredith, street sweeping occurs every spring. Catchbasins are inspected and cleaned once per year. The Town uses an ice control protocol to determine whether sand and/or salt is needed for winter road maintenance. Culverts are inspected regularly. The Town maintains 36 miles of gravel roads.
- In Laconia, cleaning and inspecting of stormwater infrastructure is completed on an as-needed basis. Street sweeping is conducted about three times in the summer. Any landscaping material/leaves are brought to Gilford for composting. The City typically uses sand with some salt on gravel roads and largely salt on paved roads for winter road maintenance practices, depending on the storm type and severity. There is no City-wide culvert inventory for prioritized replacement. The City maintains about 5 miles of gravel roads, which are regraded multiple times per year, especially following heavy rain events. For road maintenance, the City digs out ditches and applies a seed mix.
- In Sanbornton, catchbasins are inspected once per year and cleaned as needed. There is no street sweeping. Sand is used on gravel roads and salt/sand is used on paved roads in the winter. The Town maintains 40 miles of gravel roads, which are regraded twice per year. Huse Rd is their most problematic gravel road because it washes out frequently.
- In Tilton, catch basins and culverts are cleaned 4-5 times per year and inspected twice per year. Street sweeping occurs once in the spring. Landscaping/leaf/grass clippings are composted at the dump. Salt and sand are both used for winter road maintenance, and the salt is stored in a covered garage. There is no formal culvert inventory for the Town. The Town does not maintain any gravel roads.
- In Belmont, an outside engineering firm assists the Town with prioritizing and replacing culverts. The Town uses both salt and sand on roads for winter road maintenance. Gravel roads are maintained as needed and are usually regraded in spring each year.
- In Gilford, catch basin cleaning occurs once each year, and culverts are inspected as needed or as part of road projects. Street sweeping is conducted every spring. Landscaping material is brought to Gilford for composting. Salt is mainly used for winter maintenance on paved roads. The Town uses a magnesium chloride solution sprayed on the salt to work faster and better at lower temperatures. DPW drivers have indicated that they are using half the salt they usually do with this new system. Sand is used for winter maintenance on unpaved roads. Salt is stored inside a

building. The Town does not currently have a culvert inventory but plans to complete one in the future. Culverts were last inspected in 2016. The Town maintains three gravel roads and plans to pave them all within the next five years.

4.2.2 Stream Restoration

Ecosystem restoration, such as buffer and wetland enhancement, stream restoration, and floodplain reconnection are also management practices that can provide nutrient and sediment reduction benefits. Large wood in streams is important for natural function of the stream and reduces water velocity, traps sediment, and creates habitat for Eastern brook trout and other aquatic species. BCCD with Trout Unlimited completed a one mile stream restoration project (felling large woody material) in Black Brook in August 2021. This work was funded by a National Fish and Wildlife Foundation grant and Demonstration Project funding through the NHACC.

The felling of large woody material was completed in a one mile segment of Black Brook as part of a stream habitat restoration project in 2021 by the BCCD and Trout Unlimited.

4.2.3 Zoning and Ordinance Updates

Regulations through municipal zoning and ordinances such as LID strategies that prevent polluted runoff from new and re-development projects in the watershed are equally important as implementing structural BMPs on existing development. In fact, in most lake watersheds, local land use planning and zoning ordinances can be the most critical components of watershed protection strategies.

WWN completed a preliminary ordinance review of natural resource protections for the seven municipalities in the Lake Winnisquam watershed (Table 14). Many of these municipalities have already incorporated into their ordinances important regulations for shoreland protection, cluster and open space development, LID standards, erosion control, and steep slopes. A more robust review of these ordinances is encouraged for municipal-specific recommendations for improving ordinances and regulations related to natural resource protection. Each municipality should also consider its staffing capacity to enforce existing and proposed regulations.

Local land use planning and zoning ordinances should consider incorporating climate change resiliency strategies for protecting water quality and improving stormwater infrastructure based on temperature changes, precipitation, water levels, wind loads, storm surges, wave heights, soil moisture, and groundwater levels (Ballestero et al., 2017). There are nine strategies which can aid in minimizing the adverse effects associated with climate change and include the following (McCormick and Dorworth, 2019).

- **Installing Green Infrastructure and Nature-Based Solutions:** Planning for greener infrastructure requires that we think about 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 (banks of a water course) buffers, and floodplains; all of which already exist to various extents in the watershed and have minimized the damage created by intense storms. As future development occurs, these natural barriers must be maintained or even increased to reduce runoff of pollutants into freshwaters. See also Section 4.2.4: Land Conservation.
- **Using LID Strategies:** Use of LID 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 of 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 (vegetated) buffers and filter strips along waterways should be preserved and/or created to slow runoff and filter pollutants.
- **Protecting and Re-establishing Wetlands:** Wetlands are increasingly important for preservation because wetlands hold water, reduce flooding, recharge groundwater, and mitigate water pollution.
- **Encouraging Tree Planting:** Trees help manage stormwater by reducing runoff and mitigating erosion along surface waters. Trees also provide critical shading and cooling to streams 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 et al., 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 waterbars can divert water into vegetated areas for infiltration. Water running off roofs can be channeled into infiltration fields and drainage trenches.
- **Coordinating Infrastructure, Housing, and Transportation Planning**: Coordinate planning for infrastructure, housing, and transportation to minimize impacts on natural resources. Critical resources including groundwater must be conserved and remain free of pollutants especially as future droughts may deplete groundwater supplies.

Table 14. Ordinance review summary of regulatory and non-regulatory tools for natural resource protection for the seven watershed municipalities of the Lake Winnisquam watershed.

	STRATEGY	MEREDITH	LACONIA	GILFORD	BELMONT	TILTON	SANBORNTON	NEW HAMPTON
Regulatory Tools	**Shoreland Zoning**	Zoning Ord. Art.V,D.4, Shoreline District - setbacks from high water mark on shorefront properties	Zoning Ord. Art. IV, Sec. 235-19, Shoreland Protection District	Zoning Ord. Art. 2, 2.4, Island and Shore Frontage Dist.	Zoning Ord. Art.8.D, Shorefront Development	Zoning Regs. Art. VII, App. C, Dimensional Regs., ref. NH Shoreland Protection Act	Zoning Ord. Art. 14, Shorefront District	
	Cluster development and/or open space provisions for subdivisions	Zoning Ord. Art. XXI, Conservation Subdivision Design - requires 50% of tract to remain as Open Space	Zoning Ord. Art. VII, Sec. 235-40.B, Cluster Development - 50% of buildable area required as Open Space	Zoning Ord. Art. 11, 4.4.3, Cluster Development, 4.4, Planned Unit Development	Zoning Ord. Art.6, Open Space Residential Development	Subdivision Regs. Amendment, Cluster Residential Development (pg. 61)	Zoning Ord. Art.4.T, Cluster Development Zoning, 50% of tract req. as Open Space	Subd. Regs. Section VII.C, Cluster Dev., tracts >20 AC
	Septic Regulations	Zoning Ord. Art. V, D.9, Water Resources Conservation Overlay District, D.10, Lake Waukewan Watershed Overlay District - leach field setbacks	Zoning Ord. Art.IV, Sec. 235-17.J., Sec. 235-19.E	Zoning Ord. Art. 6.9, Sanitary Regs.		Zoning Regs. Art. XIV.14.4.1	Zoning Ord. Art. 4.H, Art. 14.C.3, Art. 15	Zoning Ord. Art.V.C, Sewage Disposal
	Zoning Districts that address environmental protection	Zoning Ord. Art. V, D.1, D.2, D.4, D.9, D.10, Art. XIV	Zoning Ord. Art. IV, Sec. 235-17, Sec. 235-19, Sec. 235-44, Site Plan Review Regs.	Zoning Ord. Art. 2, 2.2, 2.4, Art. 19, Aquifer Protection District, Subd. Regs., Site Plan Regs.	Zoning Ord. Art.7, Aquifer Protection, Wetlands Ordinance, Earth Excavation Regs, Site Plan Regs., Subd. Regs	Zoning Regs., Art.XIV, Wetlands Conservation Dist., Art. XV, Groundwater Protection Dis.	Zoning Ord. Art.7, Forest Conservation Dist., Art. 12, Aquifer Conservation Dist., Art. 13, Floodplain Conservation Dist., Art. 14, Shorefront Dist., Art. 15, Wetlands Conservation Dist.	Zoning Ord. Art.IV.G., Flood Hazard Dist., IV.H. Pemigewasset Overlay Dist., IV.I. Lake Waukewan Overlay Dist.
	Zoning Districts that address wetland conservation	Zoning Ord. Art. V, D.9, Water Resources Conservation Overlay District	Zoning Ord. Art. IV, Sec. 235-17, Wetlands Conservation and Water Quality Overlay District	Zoning Ord. Art. 11, Wetlands District	Wetlands Ordinance	Zoning Regs. Art. XIV, Wetlands Conservation Dist.	Zoning Ord. Art. 15 Wetlands Cons. Dist.	
	Erosion Control Regulations	Zoning Ord., Art.XIV, Erosion and Sediment Control Ordinance	Zoning Ord. Art. I, Sec. 235-44, Erosion and Sediment Control, Subdivision Regs.	Subd. Regs. Sec. VII.A, Sedimentation and Erosion Control	Site Plan Regs., Subdiv. Regs. Earth Excavation Regs.	Subd. Regs. Sec.6.E	Zoning Ord. Art.4.M, Site Plan Regs. Sec.V.E.	
	Zoning Districts that protect groundwater	Zoning Ord., Art. V, D.9, Water Resources Conservation Overlay District	Zoning Ord. Art.IV, Sec. 235-17.J, Wetlands Conservation and Water Quality Overlay District, Sec. 235-22, Water Supply Protection Overlay District	Zoning Ord. Art. 19, Aquifer Protection District	Zoning Ord. Art.7, Aquifer Protection, Wetlands Ord., Earth Excavation Regs., Site Plan Regs., Subd. Regs.	Zoning Regs. Art.XV, Groundwater Protection Dist.	Zoning Ord. Art.4.H, Art. 12, Art. 15.C.3(c),	Zoning Ord. Art. IV.I, Lake Waukewan Overlay Dist.

	STRATEGY	MEREDITH	LACONIA	GILFORD	BELMONT	TILTON	SANBORNTON	NEW HAMPTON
	Protection of steep slopes	Zoning Ord. Art. XXI, Conservation Subdivision Design - slopes>25% considered not buildable	Zoning Ord.Art. VII, Sec. 235-44.2, Steep Slope Protection, Site Plan Review 7.12	Zoning Ord. Art. 5.1.1(e), Sub. Regs Sec. IX.B.9.d.10	Zoning Ord. Art. 6, Site Plan Regs.,Sec. 9.B	Subd. Regs. Sec.6.C	Zoning Ord. Art. 16	
	Nutrient loading analysis required for fresh waterbodies						Site Plan Regs. Sec.V.J.	
	Low impact development requirements and standards	Zoning Ord. Art. XXI	Zoning Ord. Art. VII, Sec. 235-40.B, Cluster Development, Sec. 235-44.2 Steep Slope Protection	Zoning Ord. Art. 11, 4.3, 4.4	Zoning Ord. Art. 6		Zoning Ord. Art. 4.T	Subd. Regs. Sec. VII.C
	Fertilizer and pesticides ordinances		Zoning Ord. Art.IV, Sec. 235-19.D.2	Zoning Ord. Art. 15.5.1			Zoning Ord. Art.12.D	
	Stormwater Management Plan implementation and enforcement	Zoning Ord. Art. XIV, Site Plan Review Regs., Subdivision Regs.	Zoning Ord. Art. VII, Sec. 235-40.B, Cluster Development, Sec. 235-44.2 Steep Slope Protection, Major Site Plan Review, Subdivision Regs.	Zoning Art. 19, Sub. Regs. Sec. VII.A, Sec. IX	Site Plan Regs. Sec.9.E.d, 9.Q, Subd. Regs. Sec.9.D	Zoning Regs. Art. XV.I.8 Groundwater Protection performance standards	Zoning Ord. Art. 4.M, Art. 12.E.2.c, Art. 16	Site Plan Regs. Sec. X.J, Subd. Regs. Sec. VI.C.1, VII.C.G
Non-Regulatory Tools	**Open Space Plan**	Included in Community Plan, 2002	2007 Master Plans mentions Open Space	2016 Master Plan mentions Open Space	2002 Master Plan, Ch. 7	2013 Master Plan mentions Open Space		Completed 2019
	Master Plan addresses natural resources and environmental protection	Yes	Yes	Master Plan 2016 Ch. 5	2002 Master Plan, Ch. 7	2013 Master Plan Sec. 3	2012 Master Plan Sec. III.E	2021 Master Plan references Open Space Plan
	Municipality-wide natural resources inventory	Completed 2005	Completed 2009	Completed 2021	Completed 2007	Completed 2007		
	Incentive-based programs for voluntary low impact development implementation	Zoning Ord. Art. XXI	Zoning Ord. Art.IV, Sec. 235-40.B(6)(e)					

4.2.4 Land Conservation

Land conservation is essential to the health of a region, particularly for the protection of water resources, enhancement of recreation opportunities, vitality of local economies, and preservation of wildlife habitat. Land conservation is one of many management tools for protecting water quality for future generations. About 2,718 acres (7%) of the Lake Winnisquam watershed is currently conserved, and major conserved areas (greater than 100 acres) include the Chemung State Forest, multiple Meredith town forests, the Huston-Morgan State Forest, Ahern State Park, and Prescott State Park (refer to Appendix B, Map B-9). Local groups should continue to pursue opportunities for land conservation in the Lake Winnisquam watershed.

Areas for land conservation can be prioritized based on the highest valued habitat identified by the NHFGD, which often includes riparian areas and wetlands critical to water quality protection. NHFGD ranks habitat based on value to the State, biological region (areas with similar climate, geology, and other factors that influence biology), and supporting landscape. These habitat rankings are published in the State's 2015 Wildlife Action Plan (with updated statistics and data layers released in January 2020), which serves as a blueprint for prioritizing conservation actions to protect Species of Greatest Conservation Need in New Hampshire. The Lake Winnisquam watershed is part of the Sebago-Ossipee Hills and Plains ecoregional subsection of the biological region (NHFG, 2015). Over 8,031 acres (39%) of the Lake Winnisquam watershed are considered Highest Ranked Habitat in New Hampshire. This habitat includes Lake Winnisquam and a 200-meter buffer surrounding the lake. A map of priority habitats for conservation based on the Wildlife Action Plan can be found in Appendix B, Map B-10.

4.2.5 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 recycled in plant growth but is not removed entirely from the watershed system. Nutrient removal can only be achieved through more expensive, alternative septic systems. Proper design, installation, operation, maintenance, and replacement considerations include the following:

- Proper **design** includes adequate evaluation of soil conditions, seasonal high groundwater or impermeable materials, proximity of sensitive resources (e.g., drinking water wells, surface waters, wetlands, etc.);
- 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, oils and grease in large volumes, and garbage, can adversely affect the function and design life of the system, resulting in treatment failure and potential health threats; proper operation also includes how the property owner protects the system; allowing vegetation with extensive roots to grow above the system will clog the system; 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 is dependent on the use and total volume entering the system. A typical 3-bedroom, 1,000 gallon tank should be pumped every 3-4 years;
- Proper **replacement** of failed systems, which may include programs or regulations to encourage upgrades of conventional systems (or grandfathered cesspools and holding tanks) to more innovative alternative technologies.

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

4.2.6 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 (if not already in place) to inspect and evaluate their sanitary sewer system and reduce identified leaks and overflows, especially in areas near waterbodies.

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 a surface water. Outside of 25 feet, property owners can get their soil tested before considering application of fertilizers to their lawns and gardens to determine whether nutrients are needed and if so in what quantity or ratio. A soil test kit can be obtained through the UNH Cooperative Extension. Many New England communities are starting to adopt local regulations prohibiting the use of both fertilizers and pesticides, most especially near critical waterbodies. The seven watershed municipalities could consider a similar prohibition, at the very least for a watershed zoning overlay of major lakes and ponds, some of which already have:

- In Meredith, NH Rule 502.04 requires a permit to apply pesticides or fertilizers (including manure or compost) within 250 feet of surface waters in the Lake Waukewan watershed, unless in strict conformance with the *Manual of Best Management Practices for Agriculture in New Hampshire* (New Hampshire Department of Agriculture, Markets, and Food, 2017).
- In Laconia, no phosphorus-based fertilizers or herbicides/pesticides can be applied within 250 feet of any waterbody in the City.
- In Sanbornton, in the Aquifer Conservation District (areas delineated as having medium-high potential to yield groundwater by the USGS), spraying or spreading of chemical fertilizers or pesticides may be permitted subject to approval of the Zoning Board of Adjustment.
- In Tilton, fertilizers (except for lime and wood ash) cannot be applied within the Wetlands Conservation Overlay District. Fertilizers must be stored within a structure designed to prevent generation and escape of contaminated runoff or leachate in conformance with the *Manual of Best Management Practices for Agriculture in New Hampshire* (New Hampshire Department of Agriculture, Markets, and Food, 2017).
- In Belmont, fertilizers cannot be applied within the Aquifer and Groundwater Protection District. Fertilizers must be stored within a structure designed to prevent generation and escape of contaminated runoff or leachate in conformance with the *Manual of Best Management Practices for Agriculture in New Hampshire* (New Hampshire Department of Agriculture, Markets, and Food, 2017).
- In Gilford, fertilizers cannot be applied within the Aquifer Protection District. Fertilizers must be stored within a structure designed to prevent generation and escape of contaminated runoff or leachate in conformance with the *Manual of Best Management Practices for Agriculture in New Hampshire* (New Hampshire Department of Agriculture, Markets, and Food, 2017). Fertilizer is listed as a household hazardous waste and must be disposed of properly.

4.2.8 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 both small hobby farms and larger-scale operations in the watershed. The NRCS is a great resource for such outreach and education to farmers. Larger-scale agricultural operations can work with the NRCS to complete a Comprehensive Nutrient Management Plan (CNMP). 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 (by conducting soil tests and determining proper calibration of nutrient application equipment), and ensuring the proper 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 plan is an ongoing process because it is a working document that changes over time.

4.2.9 Pet Waste Management

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

4.2.10 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 modification of habitat 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 to water quality. Public education and outreach on prohibiting waterfowl or other wildlife feeding is an important step to reducing the impact of nuisance wildlife on the lake.

The Oak Hill Golf Course does not employ any large bird deterrents but will have employees drive down to where the geese are congregating and scare them off. The Laconia Country Club & Golf Course had a geese problem in the past and used a herding dog to chase them off. Geese congregation has not been an issue in recent years at the Laconia Country Club & Golf Course, but the Superintendent indicated that they would use a herding dog again if geese became an issue again.

4.3 OUTREACH & EDUCATION

Awareness through education and outreach is a critical tool for protecting and restoring water quality. Most people want to be responsible watershed stewards and not cause harm to water quality, but many are unaware of best practices to reduce or eliminate contaminants from entering surface waters. WWN is the primary entity for education and outreach campaigns in the watershed and for development and implementation of the plan. WWN and other key watershed protection groups should continue all aspects of their education and outreach strategies and consider developing new ones or improving existing ones to reach more watershed residents. Refer to Section 5: Action Plan. Examples include providing educational materials to existing and new property owners, as well as renters, by distributing them at various locations and through a variety of means, such as websites, newsletters, social media, community events, or community gathering locations. Additionally, WWN should continue to engage with local stakeholders such as BCCD, conservation commissions, land trusts, municipalities, businesses, and landowners. Educational campaigns should include raising awareness of water quality, septic system maintenance, fertilizer and pesticide use, pet waste disposal, waterfowl feeding, invasive aquatic species, boat pollution, shoreline buffer improvements, gravel road maintenance, and stormwater runoff controls.

4.4 ADAPTIVE MANAGEMENT APPROACH

An adaptive management approach, to be employed by a committee, is highly recommended for protecting Lake Winnisquam. 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 BMP performance testing and watershed monitoring activities. Adaptive management features establishing an ongoing program that provides adequate funding, stakeholder guidance, and an 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 through the WWN should be assembled to coordinate watershed management actions. This group can include representatives from state and federal agencies or organizations, municipalities, local businesses, 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 BMPs. 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 & 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 & Objectives for interim milestones.

5 ACTION PLAN

5.1 ACTION PLAN

The Action Plan (Table 15) outlines responsible parties, approximate costs[12], an implementation schedule, and potential funding sources for each recommendation within the following major categories: (1) Watershed & Shoreline BMPs; (2) Road Management; (3) Municipal Operations; (4) Municipal Land Use Planning & Zoning; (5) Land Conservation; (6) Septic System Management; (7) Agricultural Practices; and (8) Education and Outreach. The plan is designed to be implemented from 2022-2031 and is flexible to allow for new priorities throughout the 10-year implementation period as additional data are acquired.

Table 15. Action Plan for the Lake Winnisquam watershed.

Action Item	Responsible Party	Estimated Cost / Schedule	Potential Funding Sources
Watershed & Shoreline BMPs			
Further investigate sources of turbidity in Hueber Brook. Recommend and implement mitigation measures. Cost assumes stormwater retrofit inventory and stormwater mitigation designs completed along Route 3/11 (no construction costs). **Achieves Objective 1.**	WWN, Belmont	$75K 2022-25	Belmont, CWSRF, Grants (319)
Complete design and construction of mitigation measures at the top 24 high priority sites identified in the watershed survey. Three sites will be remediated through a NHDES 319 Watershed Assistance Grant (2022-23) awarded to WWN. **Achieves 11% (29 kg/yr P of 260 kg/yr P) of Objective 3.**	WWN, BCCD, Municipalities, private landowners	$400K-$800K 2022-27	CWSRF, Grants (319, Moose Plate, NFWF 5-Star, ILFP), Municipalities, private landowners
Complete design and construction of mitigation measures at 84 medium and low priority sites identified in the watershed survey as opportunities arise (refer to Appendix C for complete list). **Achieves 9% (24 kg/yr P of 260 kg/yr P) of Objective 3.**	WWN, BCCD, Municipalities, private landowners	$100K-$200K 2022-31	CWSRF, Grants (319, Moose Plate, NFWF 5-Star, ILFP), Municipalities, private landowners
Within the Black Brook sub-watershed, implement unpaved road erosion control measures recommended in Lang (2021) and FBE (2022).	WWN, BCCD, Municipalities	TBD 2022-27	CWSRF, Municipalities, Grants (Moose Plate, NFWF 5-Star)
Promote the LakeSmart program evaluations and certifications through NH Lakes to educate property owners about lake-friendly practices such as revegetating shoreline buffers with native plants, avoiding large grassy areas, and increasing mower blade heights to 4 inches. Coordinate with NHDES Soak Up the Rain NH program for workshops and trainings. Cost assumes coordination of and materials for up to 10 workshops.	WWN, BCCD, NH Lakes, NHDES Soak Up the Rain NH, Municipalities	$10K 2022-31	NH Lakes, NHDES Soak Up the Rain NH, Grants (319, Moose plate), CWSRF, Municipalities

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

Action Item	Responsible Party	Estimated Cost / Schedule	Potential Funding Sources
Provide technical assistance and/or implementation cost sharing to watershed/shoreline property owners to install stormwater and/or erosion controls such as rain gardens and buffer plantings. Prioritize high impact properties identified during the shoreline survey. Cost assumes technical assistance and implementation cost sharing provided to the 20 high impact shoreline properties. **Achieves 8% (20 kg/yr P of 260 kg/yr P) of Objective 3.**	WWN, BCCD, Municipalities	$200K 2022-25	Grants (319, Moose plate), CWSRF
Implement stormwater and erosion controls on watershed/shoreline properties. Prioritize medium impact properties identified during the shoreline survey. Cost assumes landowner implementation costs (budget: $3K each) for 282 medium impact shoreline properties. **Achieves 16% (41 kg/yr P of 260 kg/yr P) of Objective 3.**	Landowners	$850K 2022-31	Landowners
Conduct a shoreline survey for Lake Wicwas and Lake Opechee. Use the results to target education and technical assistance for high impact sites. Cost assumes hired technical review and summation of shoreline survey results. Surveys to be performed by volunteers.	WWN, LWA, LOPA, Municipalities	$5K 2025	Municipalities, Grants (Moose plate), CWSRF
Repeat the shoreline surveys in 5-10 years when updating the WBP. Use the results to target education and technical assistance for high impact sites. Cost assumes hired technical review and summation of shoreline survey results. Surveys to be performed by volunteers.	WWN, Municipalities	$8K 2025, 2030	Municipalities, Grants (Moose plate), CWSRF
Road Management			
Review practices for road and drainage maintenance currently used for each municipality and road association and determine areas for improvement.	Municipalities, WWN, BCCD	$10K 2023	CWSRF, Municipalities, Grants (Moose Plate, NFWF 5-Star)
Develop and/or update a written protocol for road maintenance best practices.	Municipalities, WWN, BCCD	$20K 2023	CWSRF, Municipalities, Grants (Moose Plate, NFWF 5-Star)
Provide education and training to contractors and municipal staff on protocols for road maintenance best practices. Cost assumes one workshop for all seven municipalities.	Municipalities, WWN, BCCD	$15K 2024	CWSRF, Municipalities, Grants (Moose Plate, NFWF 5-Star)
Incorporate water quality considerations and strategies into roadway evaluations and action plans (e.g., Sanbornton Roadway Evaluation[13]).	Municipalities, WWN, BCCD	N/A 2022-31	Municipalities
Establish inspection and maintenance agreements for private unpaved roads. Cost does not include the implementation of proper road maintenance by private landowners and assumes that municipalities can accommodate this additional effort in current budgets.	Municipalities, private landowners	N/A 2022-31	Municipalities, private landowners

[13] https://www.sanborntonnh.org/sites/g/files/vyhlif3776/f/uploads/sanbornton_roadway_evaluation_-_summary_report_and_final_documentation_0.pdf

Action Item	Responsible Party	Estimated Cost / Schedule	Potential Funding Sources
Hold informational workshops on proper road management and winter maintenance and provide educational materials for homeowners about winter maintenance and sand/salt application for driveways and walkways. Cost assumes up to five workshops.	WWN, BCCD, Municipalities, private landowners	$10K 2022-31	CWSRF, Municipalities, Grants (Moose Plate, NFWF 5-Star), private landowners
Municipal Operations			
Review and optimize MS4 compliance for all municipalities (regardless of MS4 designation), including infrastructure mapping, erosion and sediment controls, illicit discharge programs, and good housekeeping practices. Sweep municipal paved roads and parking lots two times per year (spring and fall).	Municipalities (Public Works/Highway)	TBD 2022-31	Municipalities
Participate in Green SnowPro training. Become Green SnowPro Certified once program rules for municipalities have been adopted by the Joint Legislative Committee on Administrative Rules.	Municipalities (Public Works/Highway)	Est. $150-$250/person 2022-31	Municipalities
Review and update winter operations procedures to be consistent with Green SnowPro best management practices for winter road, parking lot, and sidewalk maintenance.	Municipalities (Public Works/Highway)	N/A 2023	Municipalities
In Sanbornton, Belmont, and Gilford, adopt policies to either eliminate fertilizer applications on town properties or implement best practices for fertilizer management (to minimize application and transport of phosphorus). Consider extending these regulations to private properties as well.	Municipalities (Public Works/Highway)	N/A 2022-25	Municipalities
For Sanbornton, Belmont, and Tilton, adopt a program to accept residential yard waste at respective transfer stations for composting. (Other municipalities currently accept yard waste for no fee.)	Municipalities (Public Works/Highway)	TBD 2022-25	Municipalities
Develop best practice design standards for stormwater control measures, including deep sump catch basins.	Municipalities (Public Works/Highway)	N/A 2023	Municipalities
Municipal Land Use Planning & Zoning			
Present WBP recommendations to Select Boards/City Council and Planning Boards in Meredith, Laconia, Gilford, Belmont, Tilton, Sanbornton, and New Hampton.	WWN	$3K 2022	Grants (319), CWSRF
Meet with municipal staff to review recommendations to improve or develop ordinances addressing setbacks, buffers, lot coverage, low impact development, and open space.	WWN, Municipalities	$7K 2022-25	Municipalities, Grants (319), CWSRF
Incorporate WBP recommendations into municipal master plans and encourage regular review of the WBP action plan.	Municipalities	N/A 2022-25	Municipalities

Action Item	Responsible Party	Estimated Cost / Schedule	Potential Funding Sources
Adopt/strengthen zoning ordinance provisions and enforcement mechanisms: 1) to promote low impact development practices; 2) to require stormwater regulations that align with MS4 Permit requirements; 3) to promote or require vegetative buffers around lake shore and tributary streams; 4) to require shorefront "tear down and replace" home construction to be no more non-conforming than existing structures; 5) to require shorefront seasonal to year-round conversions of homes to demonstrate no additional negative impacts to lake water quality; 6) to establish a lake protection overlay zoning ordinance that prohibits erosion from sites in sensitive areas (e.g., lake shorefront, along lake tributaries, steep slopes); and 7) to enhance performance standards for unpaved roads to prevent erosion and protect lake water quality.	Municipalities	N/A 2022-31	Municipalities
Increase municipal staff capacity for inspections and enforcement of stormwater regulations on public and private lands.	Municipalities	TBD 2022-31	Municipalities
Update the New Hampton portion of the watershed in the build-out analysis to better reflect current zoning standards. New Hampton's zoning standards adjust allowable lot size by slope and drainage conditions that were not fully reflected in the 2021 build-out analysis.	WWN, New Hampton	$3K 2022-25	Grants, CWSRF, New Hampton
Land Conservation			
Conduct a Natural Resources Inventory (NRI) in Sanbornton. Update the NRIs from 2007 in Belmont and Tilton. (Meredith, Laconia, Gilford, and New Hampton have recent NRIs).	Municipalities, Conservation Commissions	$8-16K per municipality 2022-25	Municipalities, Grants (NFWF NEFRG), CWSRF
Create a priority list of watershed areas that need protection based on NRIs. Refer to Section 4.2.4 to understand current conservation lands and valuable habitats and wildlife in the watershed that can be used to help identify potential areas to target for conservation.	WWN, Municipalities, Conservation Commissions, Lakes Region Conservation Trust or other local land trusts	$4-8K 2022-25	Grants (NFWF NEFRG, NAWCA), CWSRF, Municipalities
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.	WWN, Municipalities, Conservation Commissions, Lakes Region Conservation Trust or other local land trusts	N/A 2022-25	Grants (Moose Plate, LCHIP, RCCP, NAWCA, LWCF, ACEP, CSP, EQIP)

Action Item	Responsible Party	Estimated Cost / Schedule	Potential Funding Sources
Maximize conservation of intact forest and other ecologically important properties though education, zoning, and public or private conservation.	WWN, Municipalities, Conservation Commissions, Lakes Region Conservation Trust or other local land trusts, private landowners	TBD 2022-31	Grants (Moose Plate, LCHIP, RCCP, NAWCA, LWCF, ACEP, CSP, EQIP, NFWF NEFRG), Municipalities, private landowners
Septic System Management			
Distribute educational materials to property owners about septic system function and maintenance.	Municipalities, WWN	$7K 2022, 2027, 2031	Municipalities, Grant (319), CWSRF
Look into whether any septic pumping companies would give a quantity discount or a discount to members to incentivize septic system pumping.	WWN	N/A 2022-25	Grants
Evaluate locations of older and/or noncompliant septic systems to identify clusters where conversion to community septic systems might be desirable.	WWN, Municipalities	TBD 2022-25	Grants, CWSRF, Municipalities
Require inspection for all home conversions (from seasonal to permanent residences) and property sales to ensure systems are sized and designed properly. Require upgrades if needed. Consider modeling an ordinance on Meredith's septic system regulations pertaining to the Lake Waukewan watershed.	Municipalities	N/A 2022-31	Municipalities
Develop and maintain a septic system database for the watershed to facilitate code enforcement of any septic system ordinances.	Municipalities	$5-10K per municipality 2022-25	Municipalities, Grants, CWSRF
Institute a minimum pump-out/inspection interval for shorefront septic systems (e.g., once every 3-5 years). Require cesspools to be pumped every 1-2 years. Pump-outs (~$250 per system) are the responsibility of the owner.	Municipalities	N/A 2022-25	Municipalities
If not already in place, develop a program to evaluate the sanitary sewer system and reduce leaks and overflows, especially in the areas near waterbodies. Include periodic inspections of the sewer line.	Municipalities	N/A 2022-31	Municipalities
Agricultural Practices			
Work with NRCS to implement soil conservation practices such as cover crops, no-till methods, and others which reduce erosion and nutrient pollution to surface waters from agricultural fields.	NRCS, farm owners	TBD 2022-31	Grants, NRCS
Education & Outreach			
Share additional/dynamic information on the WWN website, such as water quality data, weather conditions, and webcam, to generate more traffic to the website.	WWN	TBD 2022-25	Grants

Action Item	Responsible Party	Estimated Cost / Schedule	Potential Funding Sources
Educate managers of private boat launches about invasive species management, in addition to the existing lake host program that operates at public boat launches.	WWN	$10K 2022-25	Grants (NHDES AIPC)
Offer workshops for landowners with 10 acres or more for NRCS assistance with land conservation. Cost assumes up to two workshops.	WWN	$5K 2022-25	Grants (RCCP, ACEP, CSP, EQIP)
Encourage private property owners to hire Green SnowPro certified commercial salt applicators.	WWN, BCCD, Municipalities	N/A 2022-31	Grants, Municipalities
Educate contractors and municipal staff about erosion and sediment control practices required on plans. Work with municipalities to ensure that there are sufficient resources to enforce permitting conditions.	Municipalities, WWN, BCCD	$10K 2022-25	Municipalities, Grants (319), CWSRF
Create flyers/brochures or other educational materials through printed or online mediums, regarding topics such as stormwater controls, road maintenance, buffer improvements, fertilizer and pesticide use, pet waste disposal, boat pollution, invasive aquatic species, waterfowl feeding, and septic system maintenance. Consider creating a "watershed homeowner" packet that covers these topics and is distributed (mailed separately or in tax bills or posted at community gathering locations or events) to existing and new property owners, as well as renters. Hold 1-2 informational workshops per year to update the public on restoration progress and ways that individuals can help. Cost is highly variable.	Municipalities, WWN, BCCD	$50K-$100K 2022-31	Municipalities, Grants (319), CWSRF
Collaborate with NH Lakes on legislative or advocacy issues such as cyanobacteria, septic systems, and wake boat impacts.	WWN, NH Lakes	N/A, 2022-31	Grants

5.2 POLLUTANT LOAD REDUCTIONS

To meet the water quality goal and state water quality standards for oligotrophic waterbodies, Objective 3 set a target phosphorus load reduction of 260 kg/yr to achieve an in-lake total phosphorus concentration of 7.2 ppb at Lake Winnisquam Pot Island Deep Spot [WINPLACD]. The following opportunities for phosphorus load reductions to achieve Objective 3 were identified in the watershed based on field and desktop analyses:

- Remediating the over 100 watershed survey sites could prevent up to **53 kg/yr** of phosphorus load from entering Lake Winnisquam.
- Treating shoreline sites could reduce the phosphorus load to Lake Winnisquam by **20 kg/yr** for the 20 high impact sites (disturbance score 11+) and by **41 kg/yr** for the 282 medium impact sites (disturbance score between 7-10) identified from the shoreline survey.
- Upgrading the 198 shorefront septic systems older than 25 years is estimated to reduce the phosphorus load to Lake Winnisquam by **29 kg/yr**.

Addressing these field-identified phosphorus load reduction opportunities (i.e., watershed and shoreline sites and shorefront septic systems) could reduce the phosphorus load to Lake Winnisquam by 143 kg/yr, meeting about half of the estimated 260 kg/yr phosphorus load reductions needed to achieve Objective 3 (Table 16). Because Lake Winnisquam is considered a Tier 2 High Quality Water, additional phosphorus load reductions to fully achieve Objective 3 may not be necessary and should be re-evaluated after 5-10 years of plan implementation.

Objective 2 (preventing or offsetting additional phosphorus loading from anticipated new development) can be met through ordinance revisions that implement LID strategies 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 on 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, 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 BMPs installed. These reductions can be tracked to help assess long-term response.

Table 16. Breakdown of phosphorus load sources to Lake Winnisquam and modeled water quality for current and target conditions that meet the water quality goal (Objective 3) for Lake Winnisquam and that reflect all field identified reduction opportunities in the watershed. Reduction percentages are based out of the current condition value for each parameter.

Parameter	Unit	Current Condition	WQ Goal & Estimated Reduction Needed		Field Identified Reduction Opportunities	
			Target Condition	Reduction (Unit, %)	Target Condition	Reduction (Unit, %)
Total P Load (All Sources)[3]	kg/yr	7,455	7,195	-260 (4%)	7,312	-143 (2%)
(A) Background P Load[1]	kg/yr	1,385	1,385	0 (0%)	1,385	0 (0%)
(B) Disturbed (Human) P Load[2]	kg/yr	6,070	5,810	-260 (4%)	5,927	-143 (2%)
(C) Developed Land Use P Load	kg/yr	5,871	5,640	-231 (4%)	5,757	-114 (2%)
(D) Septic System P Load	kg/yr	86	57	-29 (34%)	57	-29 (34%)
(E) Internal P Load	kg/yr	113	113	0 (0%)	113	0 (0%)
In-Lake TP*	ppb	7.5	7.2	-0.3 (4%)	7.4	-0.1 (1%)
In-Lake Chl-a*	ppb	1.7	1.6	-0.1 (6%)	1.6	-0.1 (6%)
In-Lake SDT*	meters	7.7	8.0	+0.3 (NA)	7.9	+0.2 (NA)
In-Lake Bloom Probability*	days	0	0	0 (0%)	0	0 (0%)

[1] Sum of forested/water/natural land use load, waterfowl load, and atmospheric load (i.e., pre-development load)
[2] Sum of developed land use load (including additional atmospheric load), shorefront septic system load, and internal load (B = C+D+E)
[3] Total P Load (All Sources) = A + B
** Water quality parameters were sourced from the model, but total phosphorus and chlorophyll-a were adjusted to match the Assimilative Capacity analysis (which uses a slightly different time period for averaging data).*

6 PLAN IMPLEMENTATION & 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 largely by WWN with assistance from a diverse stakeholder group, including representatives from the municipalities (e.g., select boards, planning boards, and conservation commissions), state and federal agencies or organizations, nonprofits, land trusts, schools and community groups, local business leaders, and landowners. WWN will need to meet regularly and work hard 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 BMP sites, volunteers, funding received, etc.) should be tracked by WWN.

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

- **WWN** will be responsible for plan oversight and implementation. WWN will conduct water quality monitoring, facilitate outreach activities and watershed stewardship, and raise funds for stewardship work.
- **Municipalities** will work to address NPS 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 (Section 5). Each municipality will likely have a unique response or implementation approach to the recommendations in the Action Plan (Section 5), and thus, the execution of the actions may take a decentralized path. WWN and other local 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 (Section 5).
- **BCCD** will provide administrative capacity and help acquire grant funding for BMP implementation projects and education/outreach to watershed residents and municipalities.
- **NHDES** will provide technical assistance, permit approval, and the opportunity for financial assistance through the 319 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 impact 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 no easy task, and because there are many diffuse sources of phosphorus reaching the rivers, lakes, and ponds from existing development, roads, septic systems, and other land uses in the watershed, it will require an integrated and adaptive approach across many different parts of the watershed community to be successful.

6.2 ESTIMATED COSTS

The strategy for reducing pollutant loading to Lake Winnisquam to meet the water quality goal and objectives set in Section 2.4 will be dependent on available funding and labor resources but 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 are revising local ordinances such as setting LID 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 grant or local funding, it is possible to achieve the target phosphorus reductions and meet the established water quality goal for Lake Winnisquam in the next 10 years. **The cost of successfully implementing the plan is estimated**

at $2.1-$3.2 million over the next 10 or more years (Table 17). However, many costs are still unknown or were roughly 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 reflected in the estimate.

Table 17. Estimated pollutant reduction (TP) in kg/year and estimated total and annual 10-year costs for implementation of the Action Plan (Section 5) to meet the water quality goal and objectives for Lake Winnisquam. The light gray shaded planning actions are necessary to achieve the water quality goal. Other planning actions are important but difficult to quantify for TP reduction and costs, the latter of which were roughly estimated here as general placeholders.

Planning Action	TP Reduction (kg/yr)	Estimated Total Cost	Estimated Annual Cost
Watershed & Shoreline BMPs	**114**	$1,648,000-$2,148,000	$164,800-$214,800
Road Management	TBD	$55,000	$5,500
Municipal Operations	TBD	TBD	TBD
Municipal Land Use Planning & Zoning	**281***	$13,000	$1,300
Land Conservation		$12,000-$24,000	$1,200-$2,400
Septic System Management	**29**	$42,000-$77,000	$4,200-$7,700
Agricultural Practices	TBD	TBD	TBD
Education & Outreach	TBD	$75,000-$125,000	$7,500-$12,500
Monitoring	NA	$250,0000-$750,000	$25,000-$75,000
Total	**424**	**$2,095,000-$3,192,000**	**$209,500-$319,200**

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

6.3 FUNDING STRATEGIES

It is important that WWN 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 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 property owners. 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 WWN with future water quality and watershed work on Lake Winnisquam.

Funding Options:

- **EPA/NHDES 319 Grants (Watershed Assistance Grants)** – This NPS grant is designed to support local initiatives to restore impaired waters (priorities identified in the NPS Management Program Plan, updated 2014) and protect high quality waters. 319 grants are available for the implementation of watershed-based plans and typically fund $50,000 to $150,000 projects over the course of two years. https://www.des.nh.gov/business-and-community/loans-and-grants/watershed-assistance
- **NH State Conservation Committee (SCC) Grant Program (Moose Plate Grants)** – County Conservation Districts, municipalities (including commissions engaged in conservation programs), and qualified nonprofit organizations are eligible to apply for the SCC grant program. Projects must qualify in one of the following categories: Water Quality and Quantity; Wildlife Habitat; Soil Conservation and Flooding; Best Management Practices; Conservation Planning; and Land Conservation. The total SCC grant request per application cannot exceed $24,000. https://www.mooseplate.com/grants/
- **Land and Community Heritage Investment Program (LCHIP)** – This grant provides matching funds to help municipalities and nonprofits protect the state's natural, historical, and cultural resources. https://www.lchip.org/index.php/for-applicants/general-overview-schedule-eligibility-and-application-process
- **Aquatic Resource Mitigation Fund (ARM)** – This grant provides funds for projects that protect, restore, or enhance wetlands and streams to compensate for impacted aquatic resources. The fund is managed by the NHDES Wetlands Bureau that oversees the state In-Lieu Fee (ILF) compensatory mitigation program. 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. https://www.des.nh.gov/climate-and-sustainability/conservation-mitigation-and-restoration/wetlands-mitigation

- **New England Forest and River Grant (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. https://www.nfwf.org/newengland/Pages/home.aspx
- **Aquatic Invasive Plant Control, Prevention and Research Grants (NHDES AIPC)** – Funds are available each year for projects that prevent new infestations of exotic plants, including outreach, education, Lake Host Programs, and other activities. https://www.des.nh.gov/business-and-community/loans-and-grants/rivers-and-lakes
- **Clean Water State Revolving Fund (NHDES CWSRF)** – This fund provides low-interest loans to communities, nonprofits, and other local government entities to improve and replace wastewater collection systems with the goal of protecting public health and improving water quality. A portion of the CWSRF program is used to fund NPS pollution prevention, watershed protection and restoration, and estuary management projects that help improve and protect water quality in NH. https://www.des.nh.gov/business-and-community/loans-and-grants/clean-water-state-revolving-fund
- **Regional Conservation Partnership Program (RCCP) -** This NRCS grant provides conservation assistance to producers and landowners for projects carried out on agricultural land or non-industrial private forest land to achieve conservation benefits and address natural resource challenges. Eligible activities include land management restoration practices, entity-held easements, and public works/watershed conservation activities. https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/rcpp/
- **Agricultural Conservation Easement Program (ACEP) -** This NRCS grant protects the agricultural viability and related conservation values of eligible land by limiting nonagricultural uses which negatively affect agricultural uses and conservation values, protect grazing uses and related conservation values by restoring or conserving eligible grazing land, and protecting, restoring, and enhancing wetlands on eligible land. Eligible applicants include private landowners of agricultural land, cropland, rangeland, grassland, pastureland, and non-industrial private forestland. https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/easements/acep/
- **Conservation Stewardship Program (CSP) -** This NRCS grant helps agricultural producers maintain and improve their existing conservation systems and adopt additional conservation activities to address priority resource concerns. Eligible lands include private agricultural lands, non-industrial private forestland, farmstead, and associated agricultural lands, and public land that is under control of the applicant. https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/csp/
- **Environmental Quality Incentives Program (EQIP) -** This NRCS grant provides financial and technical assistance to agricultural producers and non-industrial forest managers to address natural resource concerns and deliver environmental benefits. Eligible applicants include agricultural producers, owners of non-industrial private forestland, water management entities, etc. https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/eqip/
- **National Fish and Wildlife Federation (NFWF) Five Star and Urban Waters Restoration Grants (NFWF 5-Star) -** Grants seek to address water quality issues in priority watersheds, such as erosion due to unstable streambanks, pollution from stormwater runoff, and degraded shorelines caused by development. Eligible projects include wetland, riparian, in-stream and/or coastal habitat restoration; design and construction of green infrastructure BMPs; water quality monitoring/assessment; outreach and education. https://www.nfwf.org/programs/five-star-and-urban-waters-restoration-grant-program
- **North American Wetlands Conservation Act (NAWCA) Grants -** The U.S. Standard Grants Program is a competitive, matching grants program that supports public-private partnerships carrying out projects in the United States that further the goals of the North American Wetlands Conservation Act (NAWCA). These projects must involve long-term protection, restoration, and/or enhancement of wetlands and associated uplands habitats for the benefit of all wetlands-associated migratory birds. https://www.fws.gov/service/north-american-wetlands-conservation-act-nawca-grants-us-standard
- **National Park Service - Land and Water Conservation Fund Grant Program (LWCF) -** Eligible projects include acquisition of parkland or conservation land; creation of new parks; renovations to existing parks; and development of trails. Municipalities must have an up-to-date Open Space and Recreation Plan. Trails constructed using grant funds must be ADA-compliant. https://www.nhstateparks.org/about-us/community-recreation/land-water-conservation-fund-grant

6.4 MONITORING PLAN

A long-term water quality monitoring plan is critical to evaluate the effectiveness of implementation efforts over time. WWN, in concert with VLAP and LLMP, has implemented the Lake Winnisquam Tiered Monitoring Plan since 2017 and should continue the following annual monitoring protocol:

- VLAP monitors three deep spot stations in Lake Winnisquam (Three Island, Pot Island, and Mohawk Island) and LLMP monitors two nearshore stations in Lake Winnisquam (10 Waldron and 30 Bartlett), three to five times each summer for total phosphorus (epilimnion, metalimnion, and hypolimnion), chlorophyll-a (composite or epilimnion), Secchi disk transparency, and dissolved oxygen-temperature-conductivity profiles.
    - Ensure that dissolved oxygen-temperature profiles are being collected concurrently with sampling of lake deep spot stations.
    - Work with LOPA to consider monitoring the same parameters at the same frequency at the Lake Opechee deep spot.
- VLAP also monitors the deep spot, west cove, east cove, and the Route 104 inlet to Lake Wicwas once each year for total phosphorus, chlorophyll-a, Secchi disk transparency, and/or dissolved oxygen-temperature-conductivity profiles.
    - Work with Lake Wicwas Association to consider increasing the sampling frequency to at least three times per summer.
- Volunteers collect additional Secchi disk transparency readings at the three deep spot stations in Lake Winnisquam throughout the summer season (ideally every other week).
    - Consider collecting Secchi disk transparency readings every other week in summer at the deep spot stations for Lake Wicwas and Lake Opechee.
- WWN through VRAP monitors total phosphorus and chloride in nine tributary or outlet stations in the watershed, two to five times per year each summer. Stations include Black Brook, Winnipesaukee River inlet to the lake, Lake Wicwas outlet, Durkee Brook, Collins Brook, two branches of Chapman Brook, Durgin Brook, and the outlet of Lake Winnisquam.
    - Consider adding Mill Brook (WINTLACM), Hueber Brook, and Jewett Brook. Measure turbidity at Hueber Brook and total phosphorus at all three streams. Mill Brook (WINTLACM) is located at its outlet to Lake Winnisquam and would be helpful for calibration during future model updates.
    - Consider monitoring the same parameters at the same frequency at major inflows to Lake Opechee, especially the inflow from the Winnipesaukee River to Lake Opechee.
    - Consider collecting flow measurements or estimates concurrently with grab samples at all tributary stations for better calculation of nutrient loading.

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 Lake Winnisquam watershed (Table 18). These benchmarks represent short-term (2023), mid-term (2026), and long-term (2031) 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. WWN 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 revised because the targets are not being met.

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 the improvement of water quality. Programmatic indicators are indirect measures of watershed protection and restoration activities. Rather than indicating that water quality reductions are being met, these programmatic measurements list actions intended to meet 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 18. Environmental, programmatic, and social indicators for the Lake Winnisquam Watershed-Based Plan. Environmental indicator milestones determined from Assimilative Capacity Analysis in Section 2.2 and FBE (2021a). Programmatic and social indicator milestones estimated from best professional judgement.

Indicators	Milestones*		
	2023	2026	2031
ENVIRONMENTAL INDICATORS			
Achieve an in-stream (Hueber Brook) and in-lake (Lake Winnisquam) turbidity concentration < 10 NTU	10 NTU+	< 10 NTU	<10 NTU
Maintain or achieve an average summer deep spot epilimnion total phosphorus concentration of 7.2 ppb at the deep spot stations in Lake Winnisquam and Lake Opechee (as well as Lake Wicwas despite being beholden to only the mesotrophic threshold of 11.6 ppb for total phosphorus)	<7.2 ppb	<7.2 ppb	<7.2 ppb
Maintain an average summer deep spot epilimnion chlorophyll-a concentration of less than 3.0 ppb at the deep spot stations in Lake Winnisquam and Lake Opechee	<3.0 ppb	<3.0 ppb	<3.0 ppb
Maintain an average summer deep spot epilimnion chlorophyll-a concentration of less than 4.8 ppb at the deep spot station in Lake Wicwas	<4.8 ppb	<4.8 ppb	<4.8 ppb
Eliminate the occurrence of cyanobacteria or algal blooms in Lake Winnisquam, Lake Opechee, and Lake Wicwas (milestones based on model results)	0-2 day/yr	0-2 day/yr	0 days/yr
Maintain an average summer water clarity of 7 m or deeper at the deep spot stations in Lake Winnisquam and Lake Opechee	7 m+	7 m+	7 m+
Achieve an average summer water clarity of 5 m or deeper at the deep spot station in Lake Wicwas	4.2 m	4.5 m	5.0 m
Prevent and/or control the introduction and/or proliferation of invasive aquatic species all waterbodies	Absence of invasives	Absence of invasives	Absence of invasives
PROGRAMMATIC INDICATORS			
Amount of funding secured from municipal/private work, fundraisers, donations, and grants	$500,000	$1,500,000	$3,000,000
Number of NPS sites remediated (108 identified)	10	25	75
Linear feet of buffers improved in the shoreland zone	500	1,000	2,000
Percentage of shorefront properties with LakeSmart certification	25%	50%	75%
Number of watershed/shoreline properties receiving technical assistance for implementation cost sharing	5	25	50
Number of workshops and trainings for stormwater improvements to residential properties (e.g., NHDES Soak Up the Rain NH program)	2	5	10
Number of updated or new ordinances that target water quality protection	1	5	10
Number of new municipal staff for inspections and enforcement of regulations	1	3	5
Number of voluntary or required septic system inspections (seasonal conversion and property transfer)	5	25	50
Number of septic system upgrades	5	25	50
Number of informational workshops and/or trainings for landowners, municipal staff, and/or developers/landscapers on local ordinances, watershed goals, and/or best practices for road management and winter maintenance	2	10	20
Number of parcels with new conservation easements or number of parcels put into permanent conservation	2	5	15

Indicators	**Milestones***		
	2023	**2026**	**2031**
Number of copies of watershed-based educational materials distributed or articles published	500	750	1,000
Number of new best practices for road management and winter maintenance implemented on public and private roads by the municipalities	5	20	50
Number of best practice design standards for stormwater control measures created and implemented by the watershed municipalities	5	20	50
Number of municipalities accepting residential yard waste at transfer stations	4	5	7
Number of municipalities fully implementing key aspects of the MS4 program	2	5	7
Number of meetings and/or presentations to municipal staff and/or boards related to the WBP	10	50	100
Number of CNMPs completed or NRCS technical assistance provided for farms in the watershed	1	2	5
SOCIAL INDICATORS			
Number of new association members	5	20	50
Number of volunteers participating in educational campaigns	15	25	50
Number of people participating in informational meetings, workshops, trainings, BMP demonstrations, or group septic system pumping	50	200	500
Number of watershed residents installing conservation practices on their property and/or participating in LakeSmart	10	100	200
Number of municipal DPW staff receiving Green SnowPro training	5	10	20
Number of groups or individuals contributing funds for plan implementation	50	100	200
Number of newly trained water quality and invasive species monitors	3	5	10
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 BCCD	1	2	5
Number of daily visitors to the WWN website	20	250	500

**Milestones are cumulative starting at year 1.*

ADDITIONAL RESOURCES

Buffers for wetlands and surface waters: a guidebook for New Hampshire municipalities. Chase, et al. 1997. NH Audubon Society. Online: https://www.nh.gov/oep/planning/resources/documents/buffers.pdf

Conserving your land: options for NH landowners. Lind, B. 2005. Center for Land Conservation Assistance / Society for the Protection of N.H. Forests. Online: https://forestsociety.org/sites/default/files/ConservingYourLand_color.pdf

Environmental Fact Sheet: Erosion Control for Construction within the Protected Shoreland. New Hampshire Department of Environmental Services, SP-1, 2020. https://www.des.nh.gov/sites/g/files/ehbemt341/files/documents/2020-01/sp-1.pdf

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APPENDIX A: PUBLIC WORKSHOP

The following tables (A-1, A-2, A-3) summarize feedback received from participants in break-out sessions during a virtual public workshop held on May 18, 2021. Each break-out session focused on a specific topic related to known or potential NPS sources to Lake Winnisquam.

Table A-1. Public Workshop: Issues and Challenges

Discussion Topic	Challenges and Issues Identified
Land Conservation and Municipal Planning	• Lack of information and knowledge about how landowners can conserve land • Inconsistent policies/regulations across municipalities in the watershed • Lack of economic opportunity, need for grant funding for municipalities with smaller budgets • Issue with land clearing to improve views

Road Erosion	• Lack of established vegetation in ditches leads to erosion
	• Small streams contributing contaminants from roads and other NPS sources
	• Need for funding to fix roads and other sites
	• Specific locations with known erosion:
	    ○ Tucker Mountain Rd at/upgradient of Hamlin-Eames conservation land
	    ○ Deer Park Association Beach
	    ○ Culvert under Collins Brook Rd (at the north end) right where it turns to dirt

Stormwater Management	• Erosion and sediment control during construction • Controls are not well maintained and are different from what was on approved plans • Enforcement is difficult for small communities with limited staff capacity • Lack of state follow up on approved timber cutting plans • Clearing within 25' natural buffer on shoreline properties • Need for homeowner education and support for addressing stormwater runoff • Trash and sediment contributions from Winnipesaukee River
Septic Systems	• Need for upgrades to older and failing septic systems • How to get cooperation of property owners? Need for public outreach and education • Cost and water quality tradeoffs for septic upgrades versus sewer • Unknown age of systems, inventories in each municipality • Question of whether you can put in a viable system on very small lots around Winnisquam
Other water quality concerns	• Need for better coordination between the state, Planning Commissions, Public Works, and others • Many roads dead-end at the lake, conveying stormwater directly into the lake, e.g., Fenton Ave • DPW grading of road and ditches continues to be source of sediment to lake • Shoreline erosion issues due to wake from boats and other recreational watercraft • Messages about "don't do this, don't do that" do not resonate or translate into interest and action.

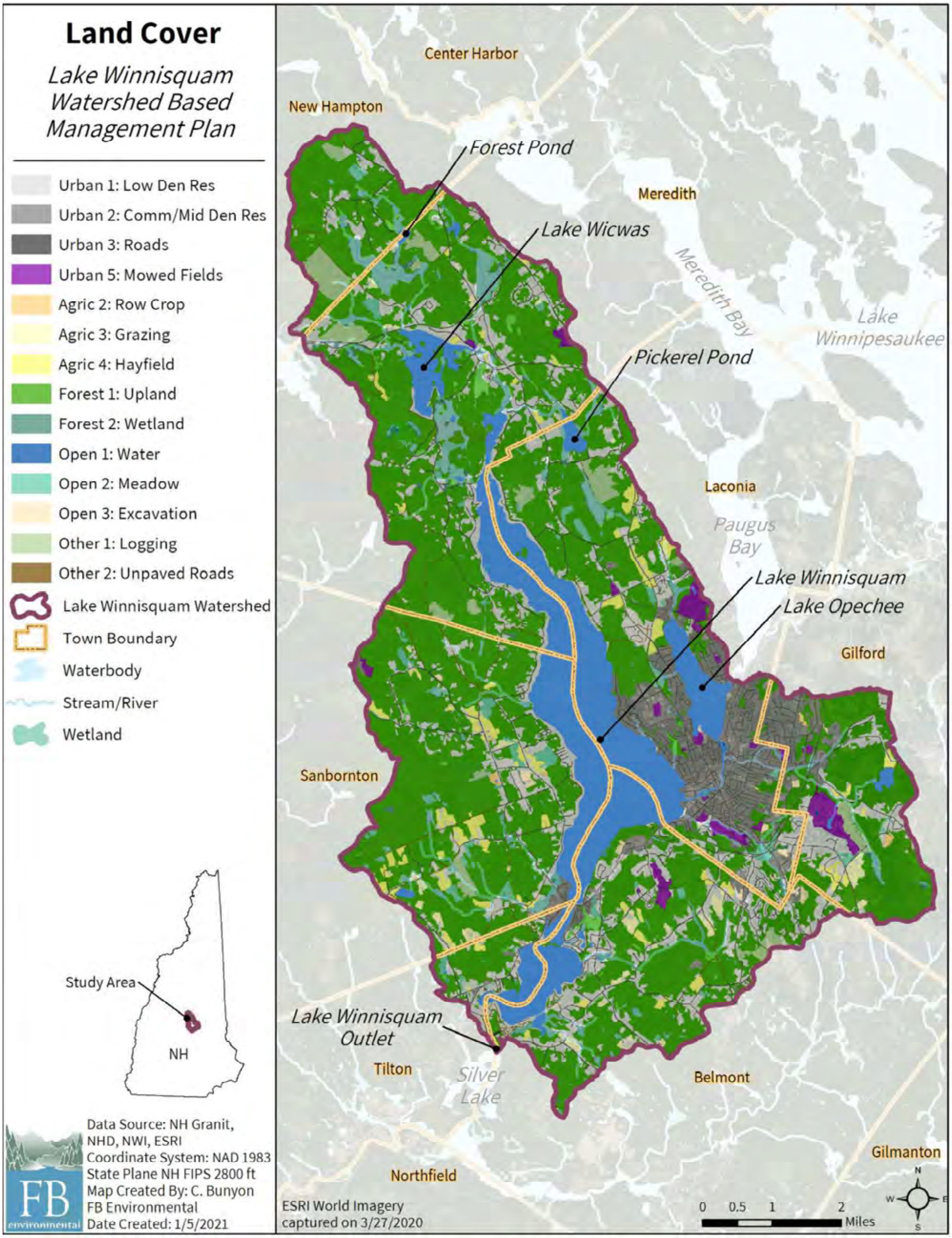
Table A-2. Public Workshop: Potential Solutions

Discussion Topic	Potential Solutions Suggested by Participants
Land Conservation and Municipal Planning	• Improve enforcement of regulations at the state and municipal level • Collaborate with local conservation partners on land conservation initiatives within the watershed. Assign a liaison to communicate with conservation groups.
Road Erosion and Maintenance	• Demonstration projects – present DPWs with options and ideas for trial or demonstration site • Help DPWs pursue grant funding
Stormwater Management	• Work with waterfront property owners to install rain gardens and restore vegetated buffers. • Access resources through NH Soak up the Rain, NH Lakes - Lake Smart Lake Friendly Living program, and Belknap County Conservation District. • Educate homeowners about low-growing plants for shoreline restoration without blocking view • Encourage soil tests to ensure that fertilizer applications are appropriate and proportional to site needs. • Manage trash in Winnipesaukee River – in the past, done by volunteers and BCCD • Promote/implement BMPs; increase use of permeable pavements, rain gardens • Engage school kids to do cleanups, learn about runoff going into streams • Improve inspections and enforcement; focus on increasing staff capacity • Increase setback requirements for shoreline buffer – e.g., Meredith requires 65' setback to structure
Septic Systems	• Enforce occupancy limits and have septic system inventories in Master Plans. • Consider septic system ordinances that require regular pump-outs and inspections to ensure proper functioning. E.g., Meredith's Health Ordinance and Moultonborough Draft Health Ordinance Pertaining to Evaluation and Replacement of Certain Subsurface Wastewater Disposal Systems in Moultonborough • Work with real estate agents to distribute pamphlet on how to maintain a septic system • In Mass, septic systems need to be functioning before property sale. Consider a similar requirement.
Other water quality concerns	• Install stormwater BMPs, restore shoreline buffers on roads that dead-end at the lake. • Educate DPW staff about invasive species. • Share additional/dynamic info on WWN website; e.g., water quality, weather, webcam. See Kezar Lake Watershed Association website for example. North end of Winnisquam could be potential location for a webcam.

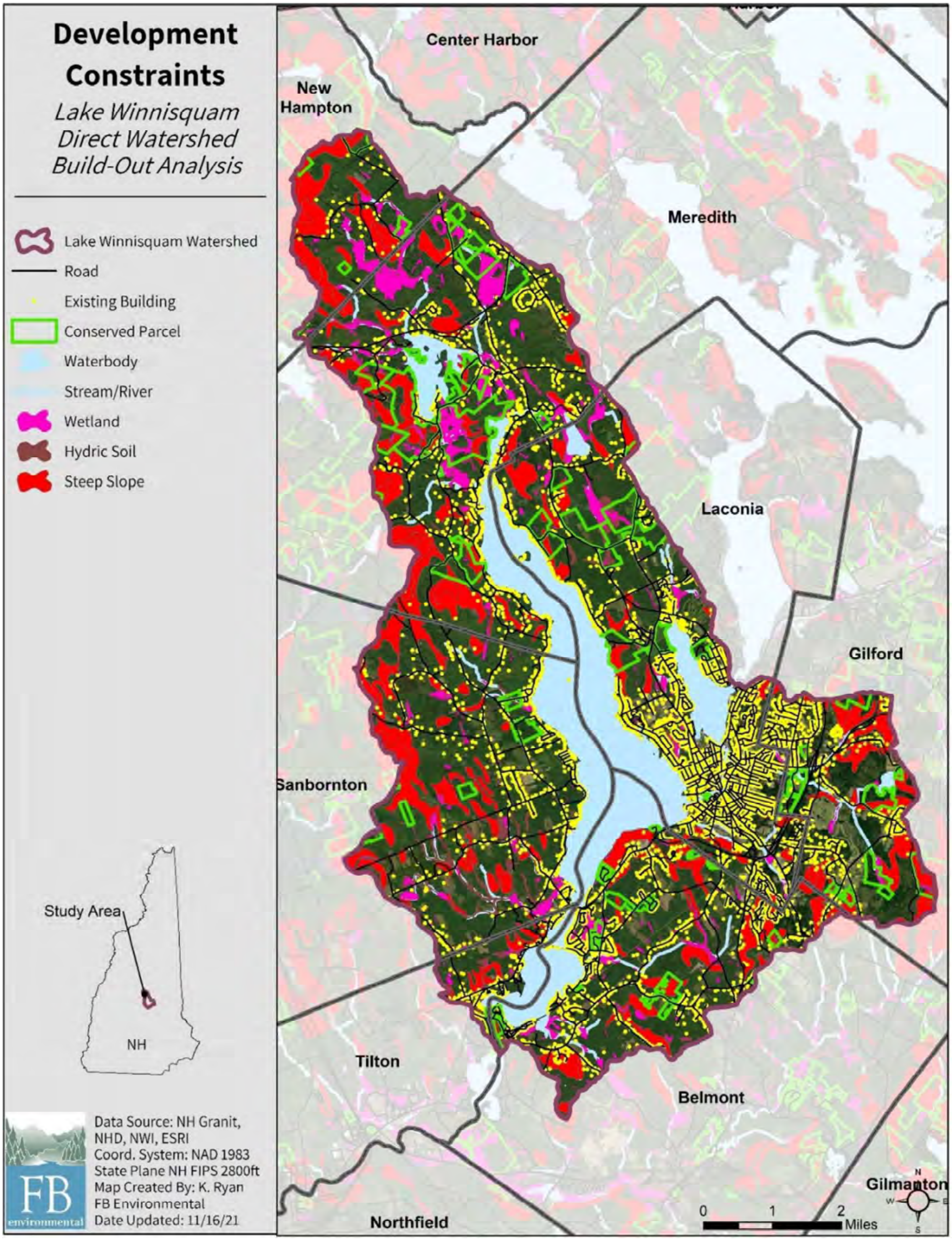
Table A-3. Public Workshop: Priority Actions

Discussion Topic	Priority Actions
Land Conservation and Municipal Planning	• Create a priority list of watershed areas that need protection based on natural resource inventories and identify potential conservation buyers and property owners interested in easements within the watershed. • Zoning and enforcement
Road Erosion & Maintenance	• Education and outreach to DPWs. • Provide guide/written protocol for road installation and maintenance best practices to DPW. Train public works staff on best practices for unpaved road maintenance. • Go to DPW with options and ideas for demonstration sites to show them the type of work that will create win/win to improve water quality and help them save time and money in the long run. Help to obtain grant funding. • Review road installation and maintenance practices currently used for each municipality and determine areas for improvement. • Establish inspection and maintenance agreements for private unpaved roads.
Stormwater Management	• Educate contractors and municipal staff about erosion and sediment control practices • Increase municipal staff capacity for inspections and enforcement • Educate and provide technical support to waterfront property owners to install rain gardens and restore vegetated buffers.
Septic systems	• Distribute educational materials about septic system function and maintenance. • Require inspection for all home conversions (from seasonal to permanent residences), property sales – make sure systems are sized and designed properly, require upgrades if needed. • Develop and maintain a septic system database for the watershed to facilitate code enforcement.
Other water quality concerns in the watershed	• Close the gap, improve coordination between planning commissions, public works, and water quality stakeholders. • Install stormwater BMPs, restore shoreline buffers on roads that dead-end at the lake. • Share additional/dynamic info on WWN website; e.g., water quality, weather, webcam. • Change messaging from “don’t do this” to “here’s what you can do” and “get involved”.

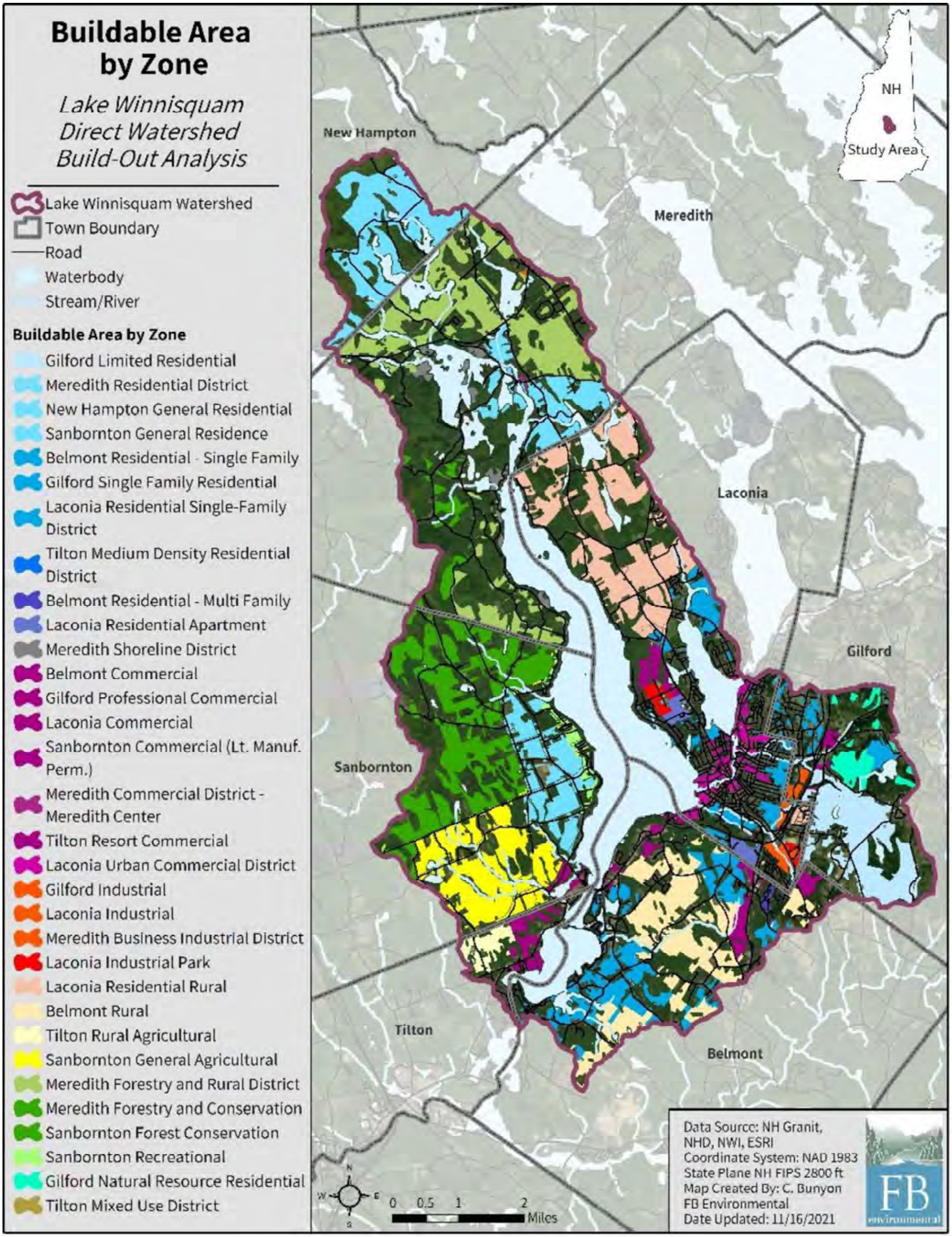
APPENDIX B: SUPPORTING MAPS



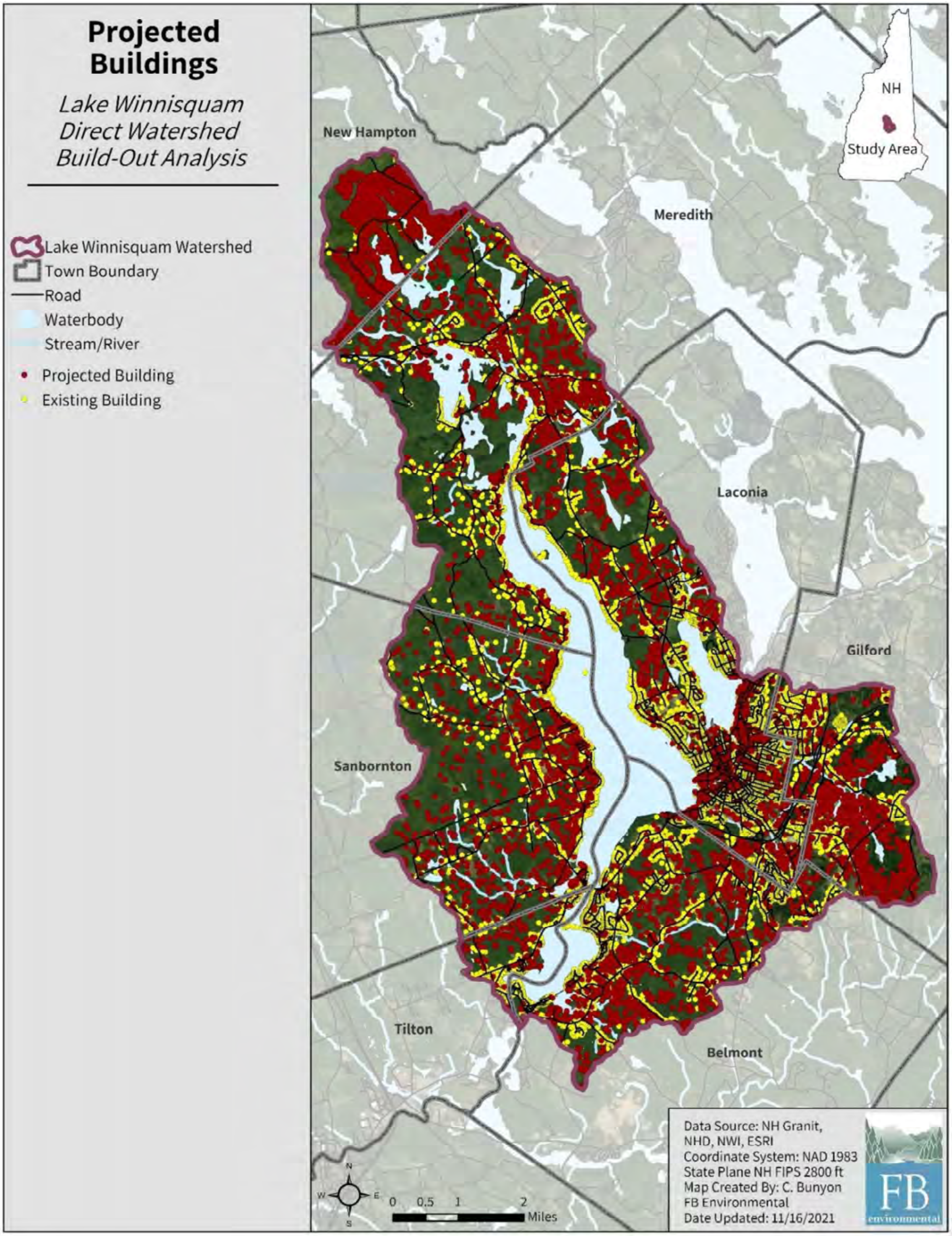
Map B-1. Land cover in the direct Lake Winnisquam watershed.



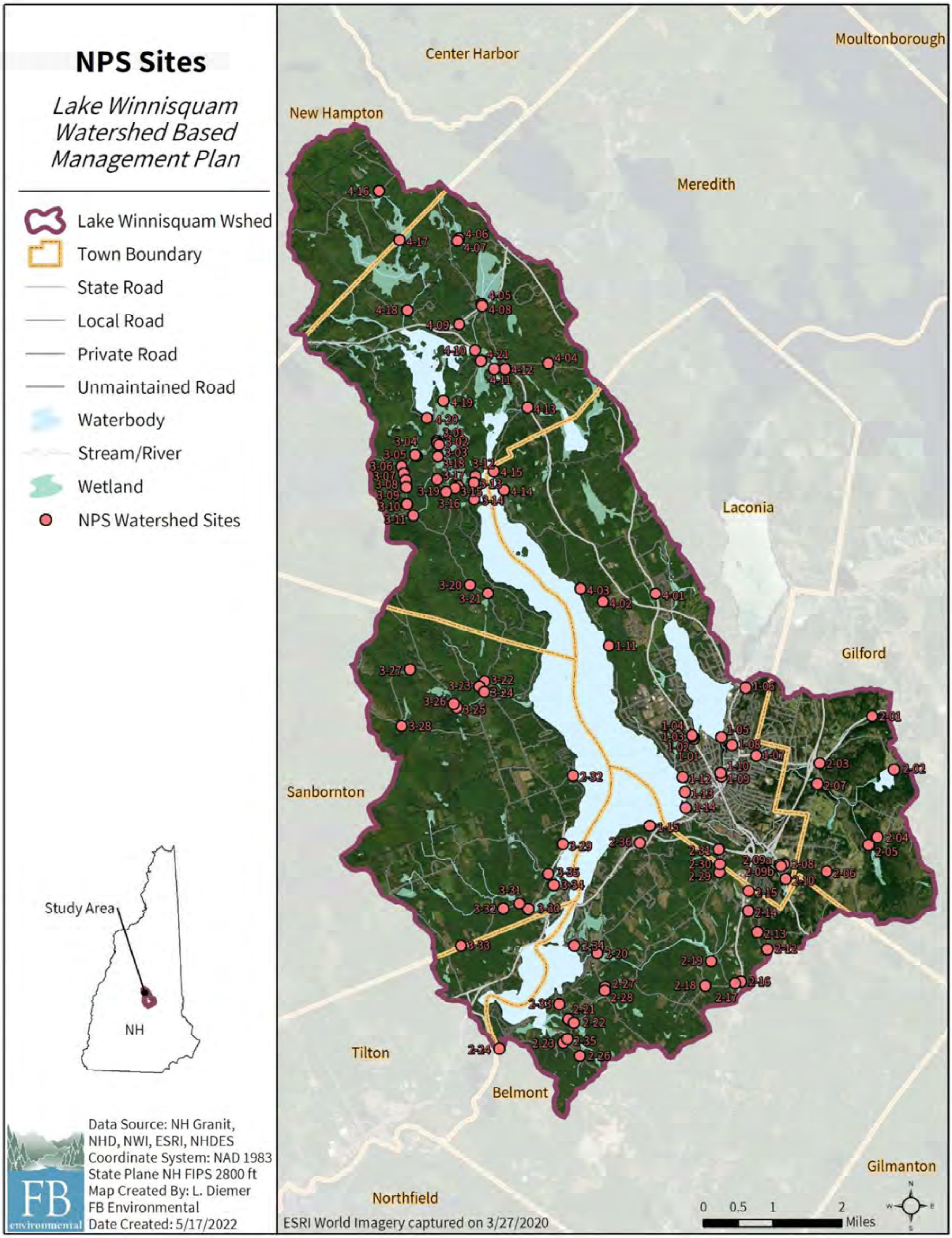
Map B-2. Development constraints (including existing buildings) in the direct watershed of Lake Winnisquam in Belmont, Gilford, Laconia, Meredith, New Hampton, Sanbornton, and Tilton, New Hampshire.



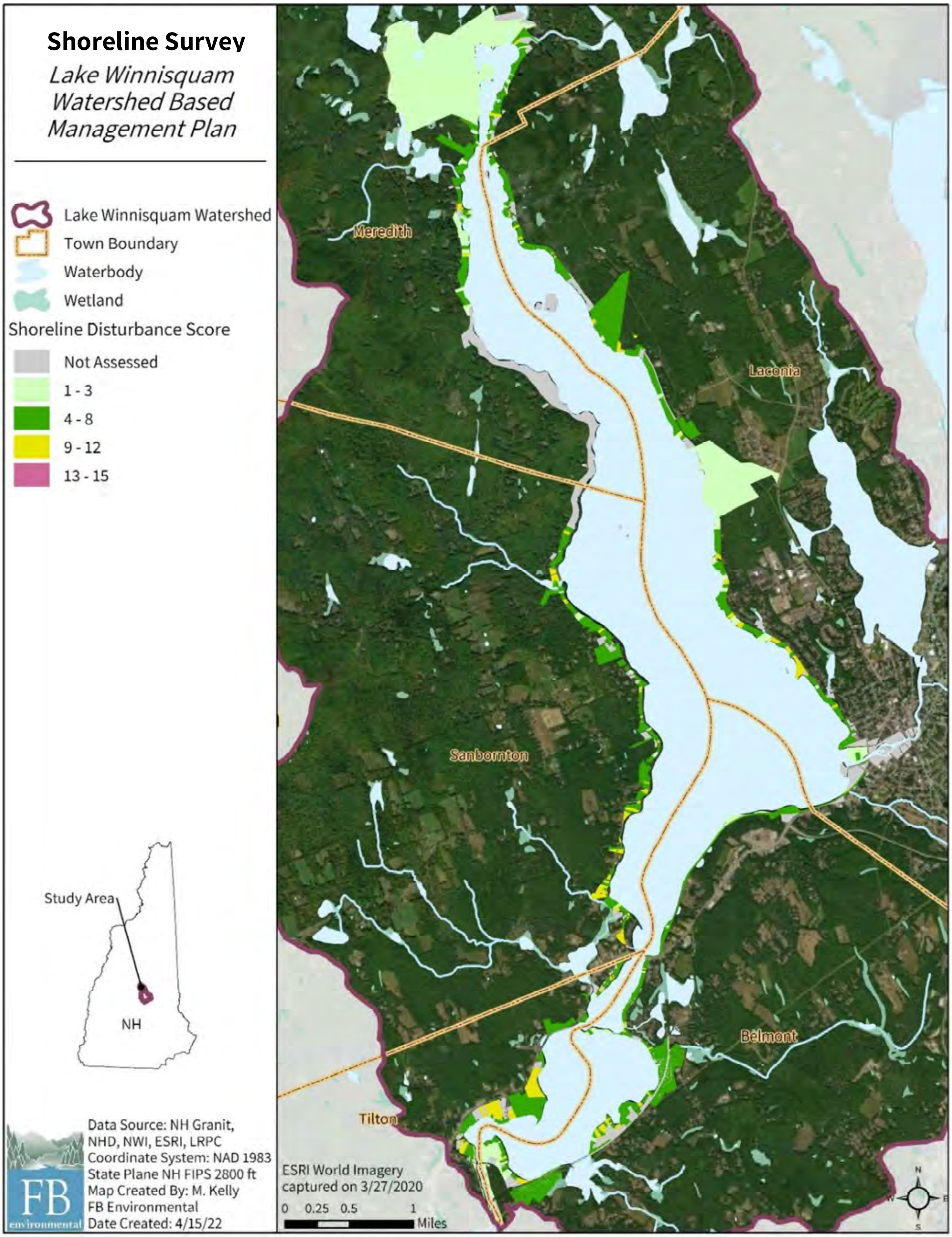
Map B-3. Buildable area by municipal zone in the direct Lake Winnisquam watershed in Belmont, Gilford, Laconia, Meredith, New Hampton, Sanbornton, and Tilton, New Hampshire.



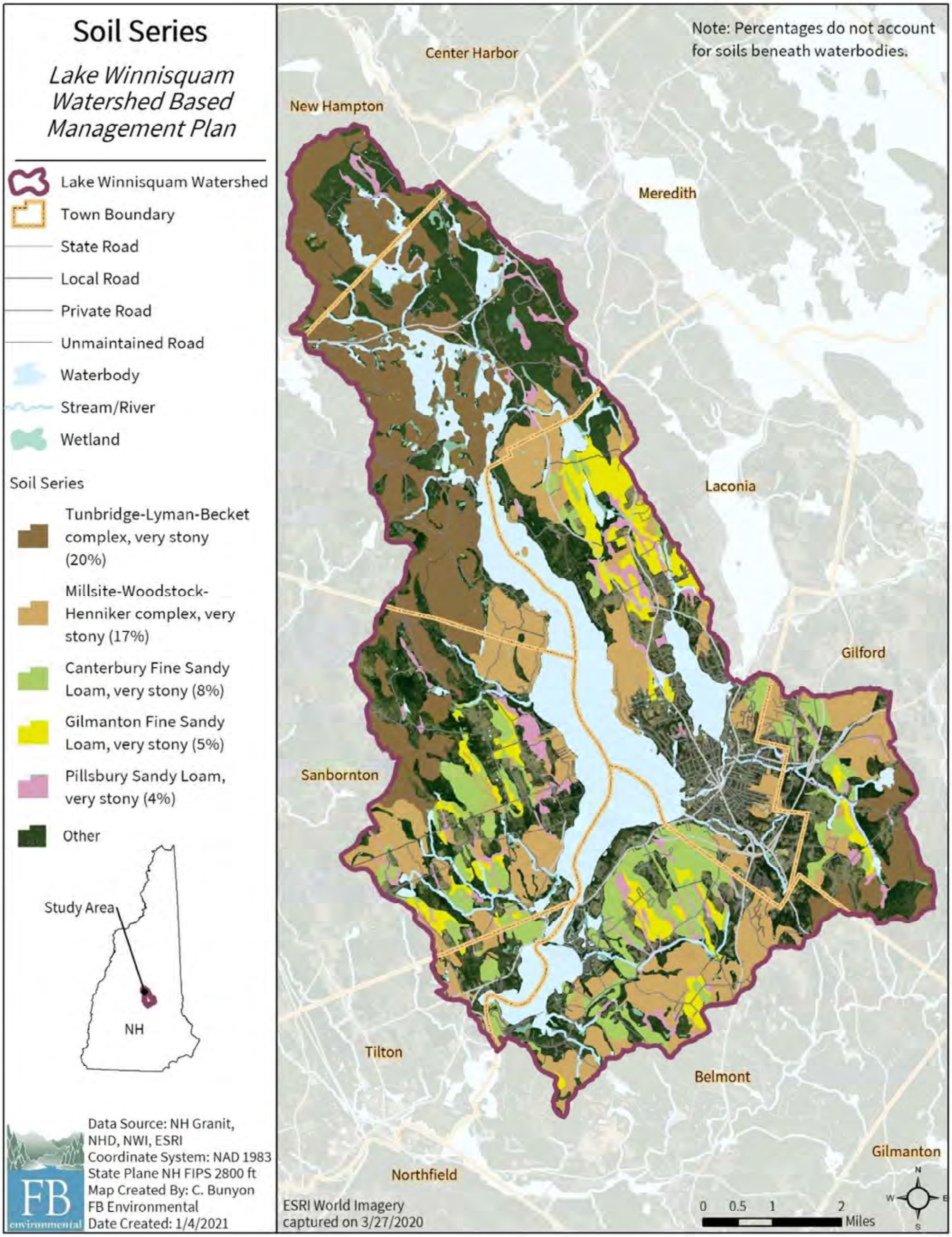
Map B-4. Projected and existing buildings in the direct Lake Winnisquam watershed in Belmont, Gilford, Laconia, Meredith, New Hampton, Sanbornton, and Tilton, New Hampshire.



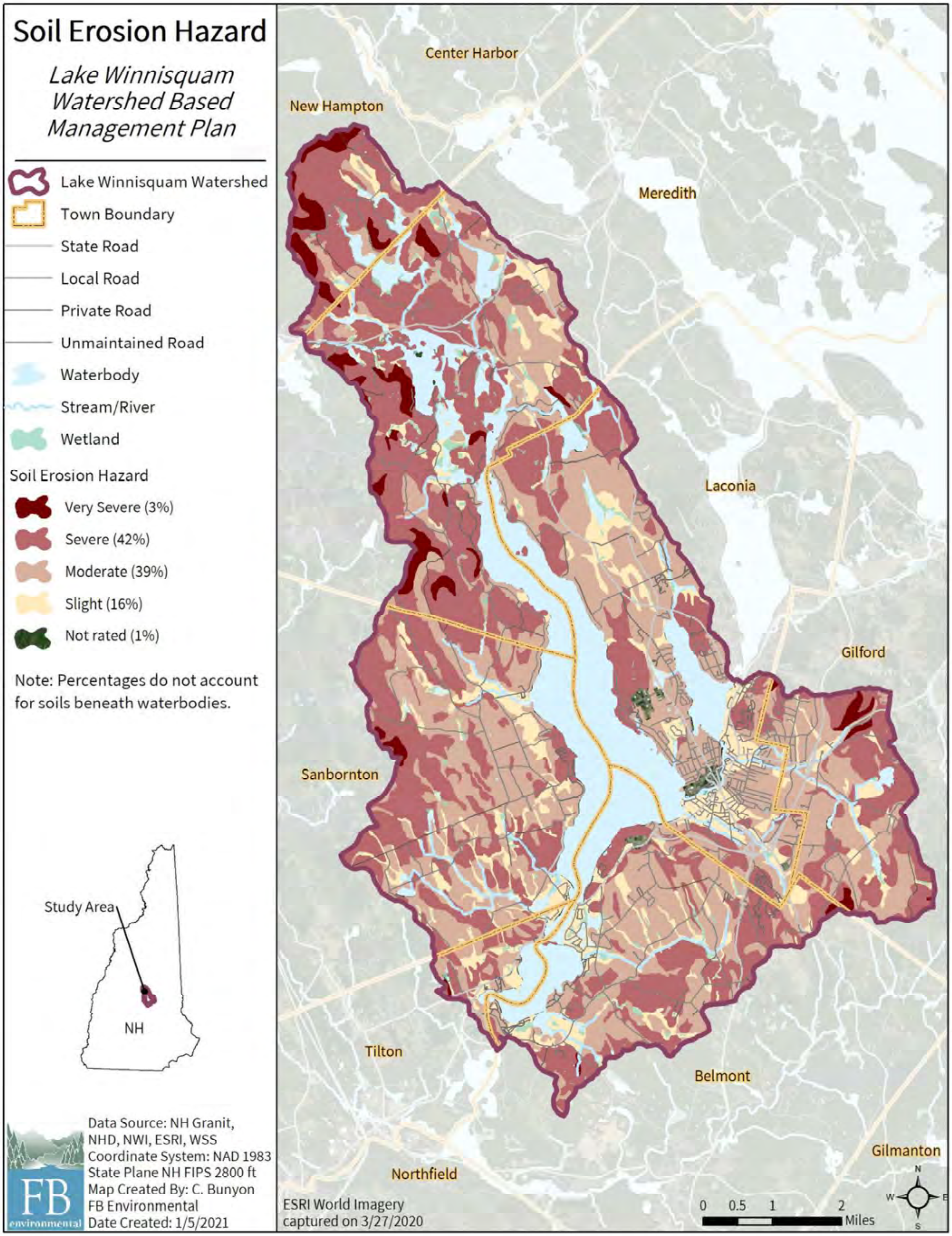
Map B-5. NPS sites identified during the 2021 watershed survey in the direct Lake Winnisquam watershed.



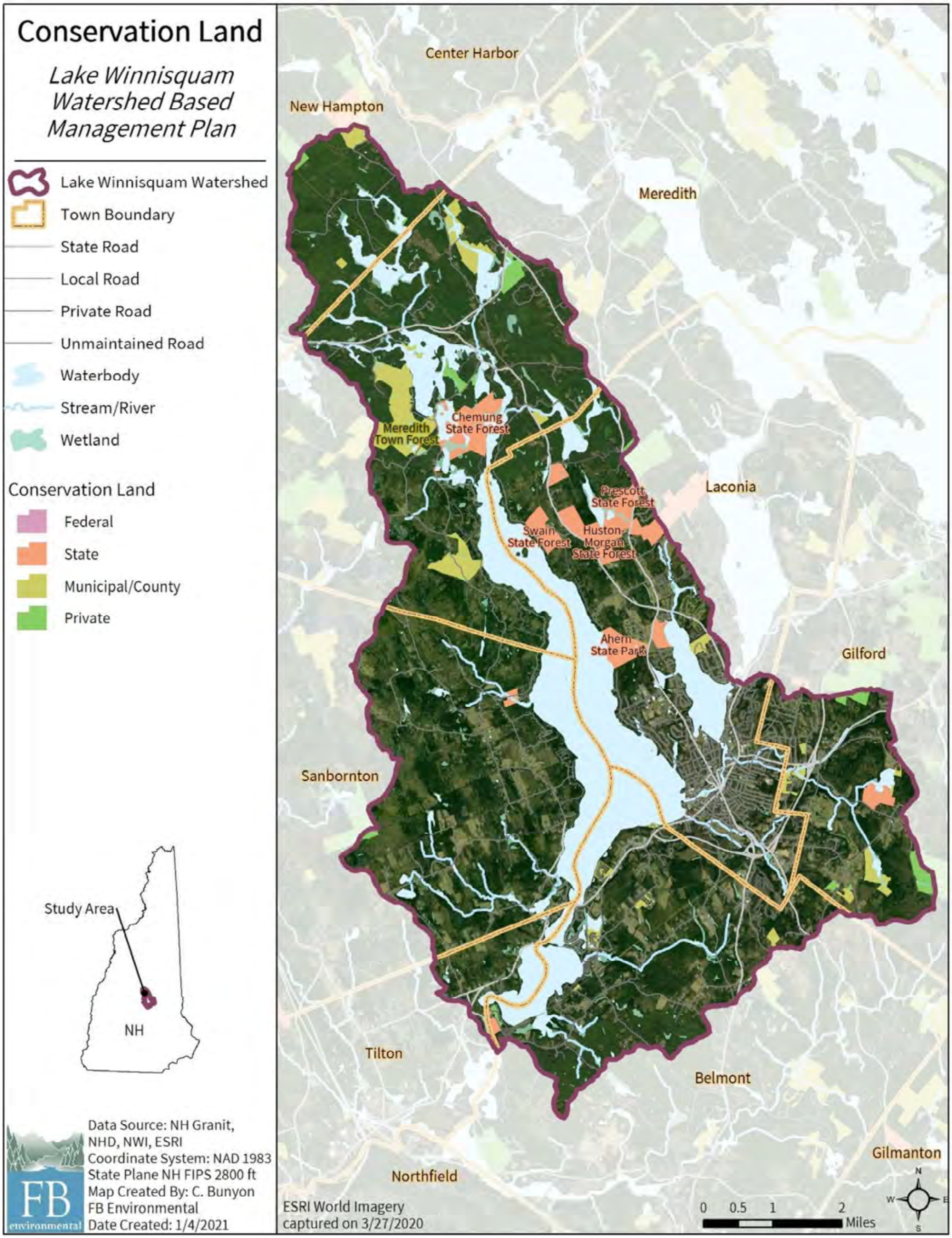
Map B-6. Shoreline Disturbance Score for parcels with frontage on Lake Winnisquam, as rated during the 2020 shoreline survey by WWN volunteers.



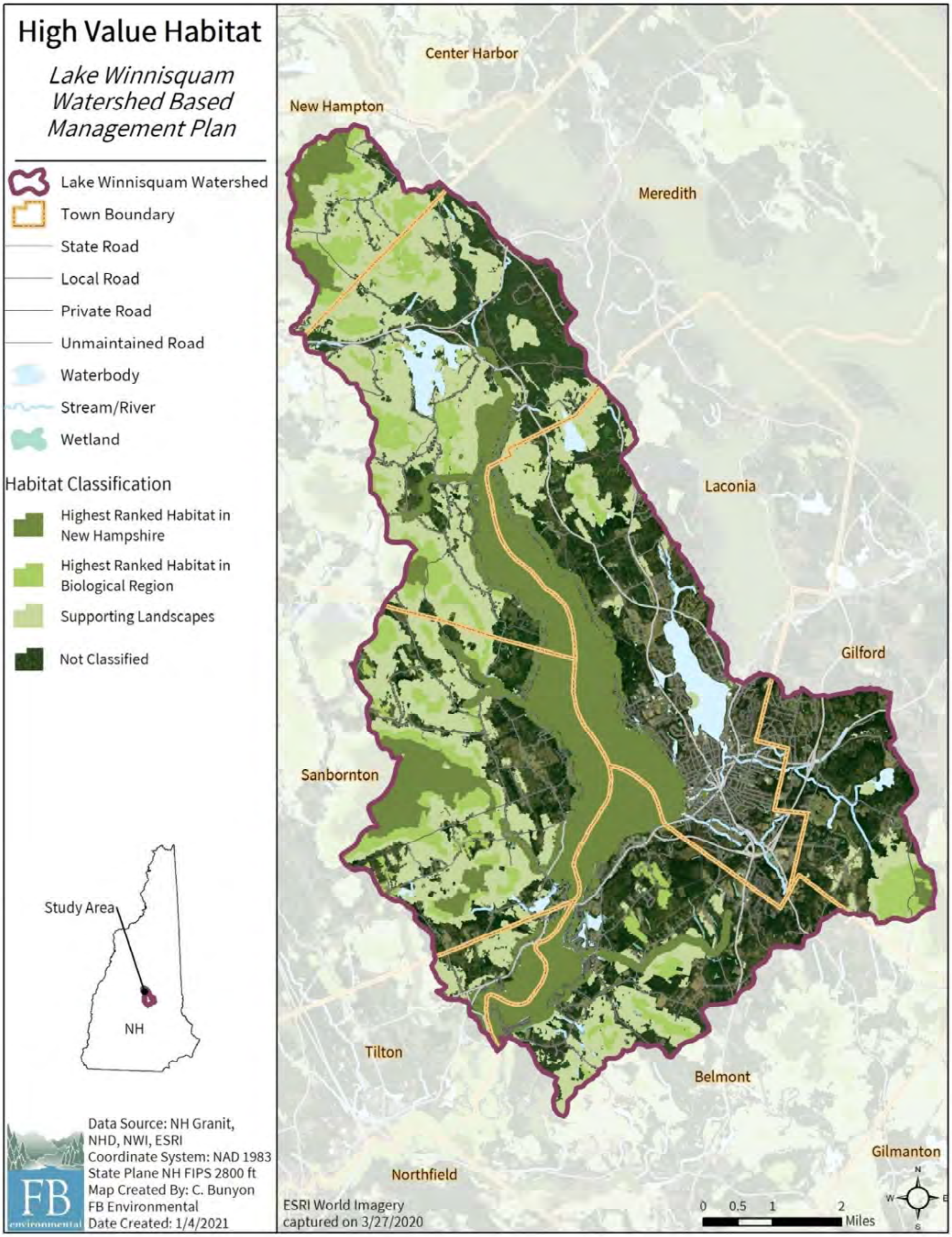
Map B-7. Soil series in the direct Lake Winnisquam watershed.



Map B-8. Soil Erosion Hazard in the direct Lake Winnisquam watershed.



Map B-9. Conservation land within the direct Lake Winnisquam watershed.



Map B-10. High value habitat according to the 2015 New Hampshire Wildlife Action Plan in the direct Lake Winnisquam watershed.

APPENDIX C: BMP MATRIX

Site ID	Site Descr.	Municipality	Subbasin	Description of Problem	Recommendations	Primary Recommended Actions	Total Average Annual Sediment Load Removed (kg/yr)	Total Average Annual TP Load Removed (kg/yr)	Direct or Indirect/Limited Discharge to Waterbody	Priority
3-36	Doctor True Rd and Maple Circle, Sanbornton	Sanbornton	Lake Winnisquam Direct	Identified by Sanbornton Selectman. Dr. True Rd and Maple Circle are impassable during mud season, with ruts up to a foot deep and large sections of unpassable mud. Sediment flows to lake.	Town is considering paving Dr True Rd and Maple Circle to address erosion and travel issues. BMPs will be needed to manage runoff and pollutants (including sand, salt) from newly paved roads.	Stabilization	9,273	4.6	Direct	High
3-34	Bay Rd	Sanbornton	Chapman Brook	Loose sediment and erosion observed along unpaved parking area, access ramp, and pull-off area at stream crossing (downstream side), private property sign posted	Stabilize parking area, pull-off area, and access ramps	Stabilization	4,990	2.1	Direct	High
1-12	Gale Ave - small pocket park with access to lake	Laconia	Lake Winnisquam Direct	Two gullies directly to water, reports of trash. Sheet flow from crowned road goes into gullies.	Route flow into bio use existing ditch to north because it is more stable	Treatment, Stabilization	2,282	1.6	Direct	High
3-28	Woodman Rd intersection with Steele Hill Rd	Sanbornton	Black Brook	Road shoulder/ditch erosion, Unstable culvert inlet/outlet, Concentrated stormwater flow paths evident, Winter sand, Steep slope from road to stream (large boulders and riprap in place for stabilization)	Stabilize inlet and/or outlet, Armor ditch/turnouts with stone or grass with check dams, Reshape ditch, Reshape or crown road, Reshape/vegetate shoulder	Stabilization	3,629	1.5	Direct	High
3-21	Eagle Ledge Rd intersection with Batchelder Hill Rd	Meredith	Lake Winnisquam Direct	Road shoulder/ditch erosion, Unstable culvert inlet/outlet, Concentrated stormwater flow paths evident, Construction site uphill on Eagle Ledge Rd without controls in place	Armor ditch with stone or grass, Reshape ditch, Reshape or crown road, Reshape/vegetate shoulder	Stabilization	3,592	1.5	Direct	High

Site ID	Site Descr.	Municipality	Subbasin	Description of Problem	Recommendations	Primary Recommended Actions	Total Average Annual Sediment Load Removed (kg/yr)	Total Average Annual TP Load Removed (kg/yr)	Direct or Indirect/Limited Discharge to Waterbody	Priority
3-23	Kaulback Rd and Roxbury Rd, trib to Black Brook crossing	Sanbornton	Black Brook	Road shoulder/ditch erosion, Unstable culvert inlet/outlet, Concentrated stormwater flow paths evident, Plow pile area, Loose sediment, Grader berms	Stabilize inlet and/or outlet, Replace/enlarge culvert, Armor ditch with stone or grass, Reshape ditch, Reshape or crown road, Reshape/vegetate shoulder	Stabilization	3,393	1.4	Direct	High
3-24	Lower Bay Rd and Huse Rd, trib to Black Brook crossing	Sanbornton	Black Brook	Road shoulder/ditch erosion, Concentrated stormwater flow paths evident, Loose sediment	Armor ditch with stone or grass, Reshape ditch, Reshape or crown road, Reshape/vegetate shoulder	Stabilization	2,776	1.4	Direct	High
3-12	Stoney Brook Rd	Meredith	Swamp Pond	Unpaved road with poor crown and minimal road shoulder to ditch with direct contact with water, plow pile area with loose sediment adjacent to wetland	Reshape or crown road, Reshape/vegetate shoulder, Clean out and stabilize plow pile area	Stabilization	3,024	1.3	Direct	High
3-25	Woodman Rd	Sanbornton	Black Brook	Road shoulder/ditch erosion, Unstable culvert inlet/outlet, rill formation from road shoulder to culvert inlet/outlet	Stabilize inlet and/or outlet, Armor ditch with stone or grass, Reshape ditch, Reshape/vegetate shoulder	Stabilization	2,159	1.1	Direct	High
3-22	Eagle Ledge Rd, Black Brook crossing	Sanbornton	Black Brook	Road shoulder/ditch erosion, Unstable culvert inlet/outlet, Concentrated stormwater flow paths evident, Minimal road shoulder at culvert crossing, Plow pile area, Loose sediment, Grader berms	Stabilize inlet and/or outlet, Armor ditch with stone or grass, Reshape ditch, Reshape or crown road, Reshape/vegetate shoulder	Stabilization	2,395	1.0	Direct	High
3-31	Philbrook Rd	Sanbornton	Chapman Brook	Road shoulder/ditch erosion, Unstable culvert inlet/outlet, Concentrated stormwater flow paths evident, Loose sediment, Turnouts lead directly to stream	Stabilize inlet and/or outlet, Armor ditch with stone or grass, Reshape ditch/turnouts, Reshape or crown road, Reshape/vegetate shoulder	Stabilization	2,395	1.0	Direct	High
3-11	Roxbury Rd	Meredith	Swamp Pond	Road shoulder/ditch erosion along both sides of road leading to culvert stream crossing	Armor ditch with stone or grass, Reshape ditch, Reshape or crown road, Reshape/vegetate shoulder	Stabilization	2,195	0.9	Direct	High

Site ID	Site Descr.	Municipality	Subbasin	Description of Problem	Recommendations	Primary Recommended Actions	Total Average Annual Sediment Load Removed (kg/yr)	Total Average Annual TP Load Removed (kg/yr)	Direct or Indirect/Limited Discharge to Waterbody	Priority
3-20	New road construction off Batchelder Hill Rd	Meredith	Lake Winnisquam Direct	New road construction up steep grade, minimal controls in place to prevent loose gravel and sediment from eroding, ponding water on south side, runoff directed to stream on north side that flows under Batchelder Hill Rd and to the lake	Armor ditch with stone or grass, Reshape ditch, Reshape or crown road, Reshape/vegetate shoulder	Stabilization	1,996	0.8	Direct	High
3-30	Chapman Rd	Sanbornton	Chapman Brook	Road shoulder/ditch erosion, Unstable culvert inlet/outlet, Concentrated stormwater flow paths evident, Loose sediment	Stabilize inlet and/or outlet, Armor ditch with stone or grass, Reshape ditch, Reshape or crown road, Reshape/vegetate shoulder	Stabilization	1,996	0.8	Direct	High
2-05	Stream crossing	Gilford	Jewett Brook	Road shoulder/ditch erosion, Unstable culvert inlet/outlet, Excessive trash, Severe streambank erosion/failure	Armor ditch with stone or grass, Install turnout, Reshape ditch, Stabilize banks, Install runoff diverter, Plant/improve buffer	Stabilization	1,361	0.8	Direct	High
3-32	Philbrook Rd	Sanbornton	Chapman Brook	Road shoulder/ditch erosion, Unstable culvert inlet/outlet, Concentrated stormwater flow paths evident, Loose sediment, Turnouts lead directly to stream	Stabilize inlet and/or outlet, Armor ditch with stone or grass, Reshape ditch/turnouts, Reshape or crown road, Reshape/vegetate shoulder	Stabilization	1,361	0.8	Direct	High
3-16	Weed Rd	Meredith	Swamp Pond	Road shoulder/ditch erosion along both sides of Weed Rd leading to wetland, road shoulder material eroding into woodline/wetland	Armor ditch with stone or grass, Reshape ditch, Reshape or crown road, Reshape/vegetate shoulder, Improve buffer	Stabilization	1,814	0.8	Direct	High
4-06	Old stage rd. culvert	Meredith	Unnamed Tributary (North Trib)	Road surface erosion, Road shoulder/ditch erosion	Install turnout, Reshape ditch, Reshape/vegetate shoulder, Reshape or crown road, Install runoff diverter	Stabilization	1,814	0.8	Direct	High

Site ID	Site Descr.	Municipality	Subbasin	Description of Problem	Recommendations	Primary Recommended Actions	Total Average Annual Sediment Load Removed (kg/yr)	Total Average Annual TP Load Removed (kg/yr)	Direct or Indirect/Limited Discharge to Waterbody	Priority
4-08	Intersection of route 104 and Hatch Corner Road	Meredith	Unnamed Tributary (North Trib)	Road shoulder/ditch erosion with erosion channels leading to stream.	Remove winter sand, Install erosion controls (e.g. silt fence), Armor ditch with stone or grass	Stabilization	1,814	0.8	Direct	High
4-09	Dow Road, near intersection with Rte.104	Meredith	Unnamed Tributary (North Trib)	Road shoulder/ditch erosion directly to stream/pond	Armor ditch with stone or grass, Install erosion controls (e.g. silt fence)	Stabilization	1,814	0.8	Direct	High
3-10	Chemung Rd	Meredith	Swamp Pond	Road shoulder/ditch erosion along both sides of road leading to culvert stream crossing, groundwater spring at culvert inlet, multiple turnouts were noted on the east ditch up road slope with significant sediment deposits	Armor ditch with stone or grass, Reshape ditch, Reshape or crown road, Reshape/vegetate shoulder	Stabilization	1,633	0.7	Direct	High
3-13	Stoney Brook Rd, crossing with river	Meredith	Swamp Pond	Geomorphic instability of river downstream of road crossing, large trees uprooted from bank with fresh soil exposed, multiple concentrated stormwater flow paths from Stoney Brook Rd entering river	Armor ditch with stone or grass, Reshape ditch, Reshape or crown road, Reshape/vegetate shoulder, Investigate geomorphic stability of river	Stabilization	1,597	0.7	Direct	High
3-14	Deer Park Association beach on Weed Rd	Meredith	Lake Winnisquam Direct	Road surface erosion, Road shoulder/ditch erosion from Heritage Rd and Weed Rd causing rill formation on road surface and gully formation on the beach, beach is positioned on a steep grade leading to the lake	Armor ditch with stone or grass, Reshape ditch, Reshape or crown road, Reshape/vegetate shoulder, Improve buffer, Consider tiered landscaping for infiltration practices, Install turnouts on south access road to lake	Stabilization	1,597	0.7	Direct	High
3-26	Woodman Rd	Sanbornton	Black Brook	Road shoulder/ditch erosion, Concentrated stormwater flow paths evident from ditch and residential driveway, Minimal buffer between road and stream	Armor ditch with stone or grass, Reshape ditch, Reshape/vegetate shoulder, Divert driveway runoff, Enhance and stabilize buffer between road and stream	Stabilization	1,597	0.7	Direct	High

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3-05a	Hamlin Rec and Cons area parking lot	Meredith	Swamp Pond	Parking area surface erosion leads to road shoulder/ditch erosion, runoff from Chemung Rd evident and causing the rill formation	Build up road/ add surface material, Install runoff diverter, Armor ditch with stone or grass, Reshape road crown	Stabilization	3,402	1.4	Limited	Medium
4-03	Dirt road with pot holes on Eastman Shore Rd N	Laconia	Lake Winnisquam Direct	Road surface erosion, Road shoulder/ditch erosion, Unstable culvert inlet/outlet, Unstable construction site, Excessive build-up of sediment, Buried culvert, Surface sheet erosion from a new construction lot and unpaved dirt driveway to an unpaved road. Culvert under driveway apron is buried in sediment from an unpaved steep driveway with construction at the top. No sediment control practices are visible and sediment is spilling out all over the private roadway and into the drainage ditch.	Clean out culvert, Armor ditch with stone or grass, Install erosion controls (e.g. silt fence), Reshape/vegetate shoulder, Reshape or crown road	Stabilization	2,468	1.2	Limited	Medium
2-33	Jefferson Rd	Belmont	Lake Winnisquam Direct	Road shoulder/ditch erosion, Road surface erosion, The full road is a soft unpaved sandy material	Build up road/ add surface material, Reshape or crown road	Stabilization	1,996	0.8	Limited	Medium
3-07	Chemung Rd	Meredith	Swamp Pond	Road shoulder/ditch erosion along both sides of road leading to culvert crossing, runoff from east side ditch overtops culvert, gully formation evident, flowing water through culvert	Armor ditch with stone or grass, Reshape ditch, Reshape or crown road, Reshape/vegetate shoulder	Stabilization	1,814	0.8	Limited	Medium
3-19	Camp Waldron Rd	Meredith	Swamp Pond	Road shoulder/ditch erosion, Unstable culvert inlet/outlet, rill formation from road shoulder to culvert inlet/outlet	Stabilize inlet and/or outlet, Armor ditch with stone or grass, Reshape ditch, Reshape or crown road, Reshape/vegetate shoulder	Stabilization	1,814	0.8	Limited	Medium

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2-04	Swain Rd	Gilford	Jewett Brook	Road shoulder/ditch erosion	Reshape/vegetate shoulder, Armor ditch with stone or grass	Stabilization	1,542	0.8	Limited	Medium
2-06	Garden Hill Drive	Gilford	Durkee Brook	Road shoulder/ditch erosion	Install erosion controls (e.g. silt fence), Reshape/vegetate shoulder, Armor ditch with stone or grass, The ditch is armored with riprap but is getting filled in from the smaller stone lining the roadway.	Stabilization	1,542	0.8	Limited	Medium
3-08	Chemung Rd	Meredith	Swamp Pond	Road shoulder/ditch erosion along both sides of road leading to culvert crossing, runoff from east side ditch overtops culvert, gully formation evident, flowing water through culvert, grader berms evident	Armor ditch with stone or grass, Reshape ditch, Reshape or crown road, Reshape/vegetate shoulder	Stabilization	1,542	0.8	Limited	Medium
2-01	Savage Rd	Gilford	Jewett Brook	Road shoulder/ditch erosion	Armor ditch with stone or grass, Install ditch, Reshape ditch, Remove winter sand, Reshape/vegetate shoulder, Plant/improve buffer	Stabilization	1,597	0.7	Limited	Medium
3-15	Weed Rd	Meredith	Swamp Pond	Road shoulder/ditch erosion along both sides of Weed Rd leading to wetland, road adjacent to wetland with minimal buffer, ditch scraping maintenance evident	Armor ditch with stone or grass, Reshape ditch, Reshape or crown road, Reshape/vegetate shoulder, Improve buffer	Stabilization	1,451	0.6	Direct	Medium
3-09	Chemung Rd	Meredith	Swamp Pond	Road shoulder/ditch erosion along both sides of road leading to culvert stream crossing, green PVC pipes under road may be directing water from west to east side ditch	Armor ditch with stone or grass, Reshape ditch, Reshape or crown road, Reshape/vegetate shoulder	Stabilization	1,080	0.5	Direct	Medium

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3-05b	Chemung Rd to Hamlin Rec and Cons area trail head	Meredith	Swamp Pond	Road surface runoff down steep grade concentrates in turnout at bend in road, turnout leads down steep slope through the woods to the trail head and crossing with a stream, significant material movement and soil erosion, severe gully formation, erosion impacting trail stability, sediment/soil depositing directly into stream	Reshape/vegetate shoulder, Reshape or crown road, Install runoff diverter, Armor ditch and turnout with stone or grass, Stabilize trail	Stabilization	1,270	0.5	Direct	Medium
2-35	Union Rd stream crossing	Belmont	Lake Winnisquam Direct	Lack of buffer flowing through agricultural fields. Horses do not have access to stream itself	Plant/improve buffer	Buffer	0	0.5	Direct	Medium
3-02	Camp Waldron Rd near intersection with Chemung Rd	Meredith	Lake Wicwas Direct	Significant road shoulder/ditch erosion along south side of Chemung Rd and both sides of Camp Walton Rd; significant gully formation in west side ditch leading to culvert	Stabilize inlet and/or outlet, Armor ditch with stone or grass, Reshape ditch, Stabilize banks, Reshape/vegetate shoulder	Stabilization	1,197	0.5	Direct	Medium
3-06	Tucker Mtn Rd	Meredith	Swamp Pond	Road surface erosion, Road shoulder/ditch erosion to culvert crossing under Tucker Mtn Rd, culvert conveys small flowing stream	Armor ditch with stone or grass, Reshape ditch, Reshape or crown road, Reshape/vegetate shoulder	Stabilization	1,179	0.5	Direct	Medium
2-24	Across from drinking water protection area	Belmont	Lake Winnisquam Direct	Road shoulder/ditch erosion, Trash	Armor ditch with stone or grass, Install check dams	Stabilization	925	0.5	Direct	Medium
2-10	Province Rd	Laconia	Durkee Brook	Stockpiled soil, Road surface erosion, Source of sand is a private driveway	Install erosion controls (e.g. silt fence),Install runoff diverter, The sand that spills out onto the state road shoulder isn't leading to anywhere just piling up on itself. This could be a residential fix if it becomes connected to a waterbody or catch basin	Maintenance	1,331	0.6	Limited	Low

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4-07	Hatch Corner Rd north of Old Stage Rd	Meredith	Unnamed Tributary (North Trib)	Road surface erosion, Road shoulder/ditch erosion	Armor ditch with stone or grass	Stabilization	1,210	0.5	Limited	Low
4-04	Livingston Rd	Meredith	Mill Brook	Road surface erosion, Road shoulder/ditch erosion, Unstable culvert inlet/outlet. Road shoulder eroding down to the drainage ditch with gullies.	Clean out culvert, Armor ditch with stone or grass, Stabilize inlet and/or outlet, Reshape ditch, Reshape/vegetate shoulder	Stabilization	1,028	0.5	Limited	Low
3-04	Chemung Rd, across from Hamlin Rec and Cons parking area	Meredith	Swamp Pond	Road shoulder/ditch erosion down steep grade with flowing water along south side of Chemung Rd, driveway culvert small	Reshape/vegetate shoulder, Reshape ditch, Armor ditch with stone or grass, Replace culvert	Stabilization	1,179	0.5	Limited	Low
2-30	Mile Hill Rd	Belmont	Durkee Brook	Road shoulder/ditch erosion, Unstable culvert inlet/outlet	Clean out culvert, Install plunge pool, Stabilize inlet and/or outlet, Armor ditch with stone or grass, Install ditch, Reshape ditch	Stabilization	925	0.5	Limited	Low
4-13	Corner of Collins Brook Rd and Meredith Center Rd	Meredith	Collins Brook	Road shoulder/ditch erosion	Armor ditch with stone or grass, Reshape ditch	Stabilization	1,089	0.5	Limited	Low
4-20	Wicwas Shores Rd culvert	Meredith	Lake Wicwas Direct	Road surface erosion, Road shoulder/ditch erosion	Armor ditch with stone or grass, Install erosion controls (e.g. silt fence), Check dams	Stabilization	1,089	0.5	Limited	Low
1-10	City hall parking lot - north	Laconia	Winnipesaukee River	Depression filled with sediment	Retrofit basin into attractive bio with Forebay. Check property lines. Only upper basin is city owned. Might be able to include private. Do not remove parking.	Treatment	0	0.4	Direct	Low
2-23	Near Hurricane Rd, Union Rd intersection	Belmont	Lake Winnisquam Direct	Road shoulder/ditch erosion, Buried culvert partially	Reshape ditch, Armor ditch with stone or grass	Stabilization	998	0.4	Direct	Low

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1-01	Opechee Park parking lot, picnic/play area, and beach	Laconia	Lake Opechee	Goose habitat, parking lot runoff erosion. Existing vegetated swale.	Buffer planting, enhance veg swale along beach, swale along parking edge conveying to terrace with infiltration under picnic tables with timber ties. Slide tables away from oak.	Treatment, Stabilization	0	0.4	Direct	Low
3-17	Camp Waldron Rd	Meredith	Swamp Pond	Road shoulder/ditch erosion, Unstable culvert inlet/outlet, gully and rill formation from road shoulder to culvert inlet/outlet, Stormwater flow path noted entering stream at inlet end	Stabilize inlet and/or outlet, Armor ditch with stone or grass, Reshape ditch, Reshape or crown road, Reshape/vegetate shoulder	Stabilization	798	0.3	Direct	Low
3-18	Camp Waldron Rd	Meredith	Swamp Pond	Road shoulder/ditch erosion, Unstable culvert inlet/outlet, rill formation from road shoulder to culvert inlet/outlet	Stabilize inlet and/or outlet, Armor ditch with stone or grass, Reshape ditch, Reshape or crown road, Reshape/vegetate shoulder	Stabilization	798	0.3	Direct	Low
4-10	Meredith Center Rd by house 27 (Lake Wicwas outflow?)	Meredith	Lake Wicwas Direct	Road shoulder/ditch erosion, Severe streambank erosion/failure, lack of stable buffer, no buffer.	Stabilize banks, Plant/improve buffer, Reshape/vegetate shoulder	Stabilization	798	0.3	Direct	Low
1-04	Opechee Park and N Main St/Rt 106- Overland flow and outfall from road	Laconia	Lake Opechee	Large outfall. Road runoff (N. Main St) overtops at CB, flows overland through park toward Opechee, causing erosion.	To treat road runoff: Cap CB, curb cut and divert runoff into vegetated infiltration swale. For outfall, evaluate if it would be possible to add DMH with perforated laterals to divert first flush into subsurface sand filters. Would likely encounter issues with high groundwater.	Treatment, Stabilization	370	0.3	Direct	Low

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1-08	Highway garage, equipment storage, salt sheds	Laconia	Winnipesaukee River	Sand buildup. Degraded stream. Snow storage next to stream. Erosion and dead grass where runoff flows overland from north parking lot entrance into stream. Erosion and sediment-laden runoff from parking area along stream.	Sediment forebay and level spreader at north entrance where runoff flows overland into stream. Cap CB.	Treatment, Stabilization	575	0.3	Direct	Low
3-03	Camp Waldron Rd	Meredith	Lake Wicwas Direct	Road shoulder/ditch erosion, gully formation on sloping road shoulder; road shoulder material slumping evident; lack of proper road crown	Reshape/vegetate shoulder, Reshape or crown road	Stabilization	748	0.3	Direct	Low
1-11	Ahern State Park beach	Laconia	Lake Winnisquam Direct	Eroding road and parking lot	Swale/stabilized channel of drivable grass across fire road to redirect run-on from above lot, into bio. Bio in area of standing water to south of lot. Water bar across lot to direct flow to it.	Stabilization	679	0.3	Direct	Low
1-09	City Hall parking lot - south	Laconia	Winnipesaukee River	Existing small biobasin for large parking lot, not well maintained	Enlarge bio, add grasspave forebay, plants that are easier to maintain	Treatment	0	0.3	Direct	Low
2-02	Salt marsh pond NHFGD boat ramp	Gilford	Jewett Brook	Road surface erosion, lack of vegetated buffer	Reshape or crown road, Install erosion controls (e.g. silt fence), Install runoff diverter, Install water bars over driveway, and before boat ramp, Plant/improve buffer	Stabilization	514	0.3	Direct	Low
2-21	Jefferson Rd	Belmont	Lake Winnisquam Direct	Road shoulder/ditch erosion, Excessive build-up of sediment, Severe streambank erosion/failure, Buffer not wide enough, Poor/degraded buffer	Plant/improve buffer, Reshape/vegetate shoulder	Stabilization	599	0.3	Direct	Low
3-29	Lower Bay Rd	Sanbornton	Lake Winnisquam Direct	Minimal buffer between road and lake, Unstable bank in some areas	Stabilize bank with living shoreline techniques	Buffer	0	0.2	Direct	Low

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3-01	Chemung Rd at intersection with Camp Waldron Rd, across from white house with blue roof #157	Meredith	Lake Wicwas Direct	Significant road shoulder/ditch erosion along Chemung Rd; drainage from Chemung Rd feeds into collapsed undersized culvert; significant rill and gully formation off road shoulder around culvert outlet	Replace and enlarge culvert, Stabilize inlet and/or outlet, Armor ditch with stone or grass, Reshape ditch, Stabilize banks, Reshape/vegetate shoulder	Stabilization	499	0.2	Direct	Low
2-22	Jefferson Rd at Union Rd stream crossing	Belmont	Lake Winnisquam Direct	very slight road shoulder erosion. Culvert looks great.	Regrade and stabilize road shoulder	Stabilization	366	0.2	Direct	Low
3-27	Woodman Rd, open field	Sanbornton	Black Brook	Minimal stream buffer through open field, landowners mow grass right to stream bank edges.	Enhance buffer with shrubs, Establish a minimum 50 ft no-mow zone around stream	Buffer	0	0.1	Direct	Low
4-18	Chase Rd stream crossing	Meredith	Dolloff Brook	Road shoulder/ditch erosion, Lack of stream shading, Buffer not wide enough, unstable road shoulder.	Stabilize inlet and/or outlet, Stabilize banks, Reshape/vegetate shoulder, Bank stabilization	Stabilization	239	0.1	Direct	Low
2-26	Hurricane Rd stream crossing	Belmont	Lake Winnisquam Direct	Lack of stream buffer. Buffer not wide enough/or present. Culvert itself and stabilization rip rap look great.	Improve stream buffer near the slope to the roadway and downstream on private property with the large lawn.	Buffer	0	0.1	Direct	Low
2-20	Union Rd stream crossing	Belmont	Durgin Brook	Bank/channel downcutting/incision, Severe streambank erosion/failure	Bank stabilization	Stabilization	160	0.1	Direct	Low
2-07	Country Club Rd stream crossing	Gilford	Jewett Brook	Road shoulder/ditch erosion, Only slight road shoulder erosion leading to stream crossing, Excessive trash, Buffer not wide enough, Poor/degraded buffer	Reshape/vegetate shoulder, Plant/improve buffer	Stabilization	120	0.1	Direct	Low
4-19	Chemung Rd near a wetland crossing	Meredith	Lake Wicwas Direct	Road shoulder/ditch erosion, Buffer not wide enough	Armor ditch with stone or grass, Plant/improve buffer	Stabilization	24	0.0	Direct	Low

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1-13	End of Water St, town land and outfall	Laconia	Lake Winnisquam Direct	Tons of trash, partially buried outfall. Some trash blows in and some from homeless camps.	Trash cans and regular cleanups. Remove pavement and restore buffer, with plantings to discourage water access and keep trash from blowing/washing into water. Evaluate feasibility of constructed wetland; potential soil contamination.	Buffer, Maintenance	0	0.0	Direct	Low
2-19	Hubble Rd	Belmont	Durgin Brook	Road shoulder/ditch erosion, Excessive build-up of sediment	Armor ditch with stone or grass, Install turnout, Reshape ditch, Reshape/vegetate shoulder, Install runoff diverter, Install erosion controls (e.g. silt fence)	Stabilization	907	0.4	Limited	Low
2-15	Logan Dr	Belmont	Durkee Brook	Road shoulder/ditch erosion	Armor ditch with stone or grass, Install check dams	Stabilization	771	0.4	Limited	Low
2-31	Mile Hill Rd	Laconia	Durkee Brook	Road surface erosion, Road shoulder/ditch erosion, Unstable culvert inlet/outlet, Bare soil/fields, 2 catch basins are like this	Clean out culvert, Install plunge pool, Remove winter sand, Build up road/ add surface material, Clean out ditch	Stabilization	771	0.4	Limited	Low
4-01	On State Route 106 just north of the Meredith Center Rd intersection	Laconia	Lake Opechee	Road shoulder/ditch erosion leading to a catch basin	Armor ditch with stone or grass, Reshape ditch	Stabilization	681	0.3	Limited	Low
2-13	Plummer Hill Rd	Belmont	Durgin Brook	Road shoulder/ditch erosion, Stockpiled soil, This entire road has really sandy shoulders which may be from winter sand not being swept up	Armor ditch with stone or grass, Reshape ditch, Remove berms created by road grader, Remove winter sand	Stabilization	463	0.2	Limited	Low
2-27	Union Rd	Belmont	Lake Winnisquam Direct	Road shoulder/ditch erosion, About 2' deep, Poor/degraded buffer	Armor ditch with stone or grass, Plant/improve buffer	Stabilization	463	0.2	Limited	Low

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4-14	Leighton Ave N	Laconia	Lake Winnisquam Direct	Road shoulder/ditch erosion, Stream ditch channel has check dams. Leaves need to be cleaned out	Armor ditch with stone or grass, Stabilize banks	Stabilization	544	0.2	Limited	Low
4-02	Eastman Rd	Laconia	Lake Winnisquam Direct	Road surface erosion, Road shoulder/ditch erosion leading to an unpaved driveway toward the lake	Install ditch, Install turnout, Reshape ditch, Remove winter sand, Reshape/vegetate shoulder, Install runoff diverter, Plant/improve buffer	Stabilization	411	0.2	Limited	Low
4-21	Intersection of Chemung and Meredith Center Road	Meredith	Mill Brook	Road shoulder/ditch erosion	Armor ditch with stone or grass	Stabilization	435	0.2	Limited	Low
2-17	Dutile Rd	Belmont	Durgin Brook	Road shoulder/ditch erosion	Armor ditch with stone or grass, Install check dams	Stabilization	399	0.2	Limited	Low
4-11	Meredith Center Rd between Meredith Center Coop MHP and Baywoods Rd	Meredith	Mill Brook	Road shoulder/ditch erosion	Reshape/vegetate shoulder, Reshape ditch, Armor ditch with stone or grass	Stabilization	363	0.2	Limited	Low
2-08	Frank Bean Rd	Laconia	Durkee Brook	Road shoulder/ditch erosion, Bare soil/fields	Armor ditch with stone or grass, Install turnout	Stabilization	308	0.2	Limited	Low
2-12	Plummer Hill Rd	Belmont	Durgin Brook	Road shoulder/ditch erosion, Unstable culvert inlet/outlet, To house 141	Armor ditch with stone or grass, Clean out culvert, Reshape/vegetate shoulder, Reshape ditch	Stabilization	308	0.2	Limited	Low
2-18	Hubble Rd	Belmont	Durgin Brook	Road shoulder/ditch erosion, Until house 39	Remove berms created by road grader, Install ditch, Reshape ditch, Armor ditch with stone or grass	Stabilization	154	0.1	Limited	Low
2-28	Hurricane Rd	Belmont	Lake Winnisquam Direct	Road shoulder/ditch erosion	Reshape ditch, Armor ditch with stone or grass	Stabilization	154	0.1	Limited	Low

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2-03	Sawmill Rd and Country Club Rd intersection on Bank of NH corner	Gilford	Jewett Brook	Road shoulder/ditch erosion	Reshape ditch, Armor ditch with stone or grass	Stabilization	160	0.1	Limited	Low
2-29	Mile Hill Rd	Belmont	Durkee Brook	Road shoulder/ditch erosion	Install ditch, Armor ditch with stone or grass, Install turnout, Reshape ditch, Install plunge pool	Stabilization	116	0.1	Limited	Low
4-15	Leighton Ave N and Collins Brook Rd	Laconia	Lake Winnisquam Direct	Road surface erosion, Road shoulder/ditch erosion	Install ditch, Armor ditch with stone or grass, Reshape ditch, Reshape/vegetate shoulder, Reshape or crown road, Check dams	Stabilization	121	0.1	Limited	Low
2-14	Plummer Hill Rd	Belmont	Durgin Brook	Road shoulder/ditch erosion, Road shoulder sediment sliding down hill perpendicular to road with flow channels	Install erosion controls (e.g. silt fence), Armor ditch with stone or grass, Reshape/vegetate shoulder	Stabilization	91	0.0	Limited	Low
2-16	Dutile Rd	Belmont	Durgin Brook	Road shoulder/ditch erosion	Armor ditch with stone or grass, Reshape/vegetate shoulder	Stabilization	77	0.0	Limited	Low
2-32	Lakeside of Lakeshore Drive	Sanbornton	Lake Winnisquam Direct	Road shoulder/ditch erosion, Road surface erosion. The road is a soft unpaved sandy material.	Build up road, add surface material, reshape or recrown road.	Stabilization	77	0.0	Limited	Low
4-12	Near Meredith town park playground on Meredith Center Rd	Meredith	Mill Brook	Road surface erosion, Road shoulder/ditch erosion	Remove winter sand, Reshape ditch, Armor ditch with stone or grass	Stabilization	45	0.0	Limited	Low

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1-02	Opechee Park- Point where parking lot runoff could be diverted to infiltration under picnic area	Laconia	Lake Opechee	Goose habitat, parking lot runoff erosion. Existing vegetated swale.	Propose swale to infiltration under picnic table terrace	NA	0	0.0	Direct	Low
1-03	Opechee Park - Swale along beach	Laconia	Lake Opechee	Goose habitat, parking lot runoff erosion. Existing vegetated swale.	Swale could be expanded/enhanced to provide additional treatment	NA	0	0.0	Direct	Low
1-05	Messer St boat ramp	Laconia	Lake Opechee	Contaminated site, capped. Gravel drive, two paved spaces near ramp. Owned by Eversource.	Buffer plantings but probably not a feasible site due to ownership and contamination.	NA	0	0.0	Direct	Low
1-14	Bartlett Beach	Laconia	Lake Winnisquam Direct	Gravel/sand parking lot. Graded away from lake into what looks like was meant to be a swale. Wetland at back of lot.	No recommendations except perhaps to ensure maintenance of swale along back of lot.	Maintenance	0	0.0	Direct	Low
1-15	Leslie Beach, Belmont	Belmont	Lake Winnisquam Direct	No issues - stormwater and erosion appear well managed		NA	0	0.0	Direct	Low
2-09b	Province Rd	Laconia	Durkee Brook	Road shoulder/ditch erosion, Unstable culvert inlet/outlet, Bare soil/fields	Stabilize inlet and/or outlet, Install plunge pool, Clean out culvert, Reshape/vegetate shoulder, Armor ditch with stone or grass	Stabilization	0	0.0	Direct	Low
2-34	Linda Drive	Belmont	Lake Winnisquam Direct	Lots of private large and very green lawns with little to no buffers.	Target this neighborhood for sustainable lawn maintenance and buffer practices.	Buffer, Education	0	0.0	Direct	Low

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3-33	Philbrook Rd	Sanbornton	Lake Winnisquam Direct	Green algae observed in ponded water area, water is conveyed through a culvert under the road, small stream flowing into ponded area, drains residential and agricultural land, residential home nearby, may be lawn fertilizer, faulty septic, or manured fields	Investigate source of nutrients in drainage area	Other	0	0.0	Direct	Low
3-35	Lower Bay Rd Bay Rd intersection	Sanbornton	Chapman Brook	No noticeable channelization from the roadway. There is a rip rapped drainage/slope stabilization perpendicular to the stream but the stream banks themselves are natural. Did not walk on private property.	No major problems observed so no recommendations.	NA	0	0.0	Direct	Low
4-05	Stream crossing from an unnamed pond under Hatch Corner Rd	Meredith	Unnamed Tributary (North Trib)	Downstream of a beaver wetland, Hanging culvert (no fish passage), Icky smell, undetermined if its sewage or just a high organic content. Trash around stream. Pedestrian said it sometimes has a strong sulfur smell.	Re-align, repair, or upgrade culvert	Other	0	0.0	Direct	Low
1-06	Sanborn Park	Laconia	Lake Opechee	Urban runoff to closed drainage	Green space. Potential to divert from drainage structure on Clinton St but at top of catchment area, not great opportunity.	NA	0	0.0	Limited	Low
1-07	Tributary to Jewett Brook at Gilford Ave	Laconia	Jewett Brook	Mowed to edge of stream on one side, stockpile on other side. Minor erosion.	Generally, encourage stream buffers	Buffer, Education	0	0.0	Limited	Low
2-09a	Province Rd	Laconia	Durkee Brook	Road shoulder/ditch erosion, Unstable culvert inlet/outlet, Bare soil/fields	Stabilize inlet and/or outlet, Install plunge pool, Clean out culvert, Reshape/vegetate shoulder, Armor ditch with stone or grass	Stabilization	0	0.0	Limited	Low

Site ID	Site Descr.	Municipality	Subbasin	Description of Problem	Recommendations	Primary Recommended Actions	Total Average Annual Sediment Load Removed (kg/yr)	Total Average Annual TP Load Removed (kg/yr)	Direct or Indirect/Limited Discharge to Waterbody	Priority
2-36	Belmont Mall	Belmont	Lake Winnisquam Direct	Large paved parking area with stores. Increases stormwater runoff temperature	Install parking lot stormwater controls and infiltration areas (need more investigation, info on existing BMPs)	NA	0	0.0	Limited	Low
4-16	Straits Rd	New Hampton	Dolloff Brook	Winter sand lining the road	Remove winter sand	Maintenance	0	0.0	Limited	Low
4-17	Forest Pond Rd	New Hampton	Dolloff Brook	So much winter sand still on the road	Remove winter sand	Maintenance	0	0.0	Limited	Low

Appendix H:

Black Brook Remediation Plan Memorandum dated April 2022

MEMORANDUM | BLACK BROOK REMEDIATION PLAN

TO: Donna Hepp, Belknap County Conservation District (BCCD)
FROM: Cayce Dalton and Cam Twombly, FB Environmental Associates (FBE)
SUBJECT: Black Brook (Sanbornton, NH) Remediation Plan, Technical Memorandum
DATE: April 15, 2022
CC: Lisa Eggleston, Winnisquam Watershed Network (WWN); Forrest Bell, FBE

INTRODUCTION

FB Environmental Associates (FBE) created for Belknap County Conservation District (BCCD), with input from Winnisquam Watershed Network (WWN), the following Remediation Plan for the Black Brook watershed in Sanbornton, NH. The Remediation Plan quantitatively evaluates a series of erosion and sedimentation sites in the Black Brook watershed, and prioritizes the sites in terms of protecting the water quality in Lake Winnisquam and its tributary Black Brook.

FBE understands that BCCD and WWN will use this Remediation Plan to support water quality protection and restoration efforts, and that the New Hampshire Department of Environmental Services (NHDES) and the US Environmental Protection Agency (USEPA) may ultimately consider this work as supporting documentation for an application to fund water quality restoration.

The site evaluation methods used in this study combined sediment transport modeling and field observations. The NHDES Simple Method was considered for use in this study to model sediment transport; however, that model doesn't consider slope, and many of the Black Brook watershed erosion sites involve steep hillslopes that are a driving factor of the erosion occurring at these sites. NHDES feedback indicated there was flexibility in which methods to use. Therefore, after careful review of available erosion estimation tools, the Water Erosion Prediction Project (WEPP) model was chosen for sediment yield modeling. WEPP is discussed in more detail under "Model Description" below. Field observations complemented the modeling by documenting real world conditions, including estimates of eroding sediment volumes, and detecting types of erosion not considered by the WEPP model, such as gullies and road erosion. See the "Site Observations" section below. Finally, the two evaluation methods (modeling and field observations) were quantitatively integrated as described in the "Site Prioritization" section.

SITE SELECTION AND DESCRIPTIONS

FBE selected eleven potential remediation sites, representing locations where erosion and sedimentation appeared likely to threaten the water quality of Black Brook, and its downstream receiving water, Lake Winnisquam. Sites are presented in Table 1 and Figure 1.

In selecting sites in the Black Brook watershed, the following literature on Black Brook was consulted:

- *Black Brook Watershed Management Plan*, September 2012.
- *Black Brook Assessment*, by BCCD and Gerry Lang, December 2021.

The *Black Brook Watershed Management Plan* was written before a large twin box culvert was installed at the most downstream road crossing (Black Brook Road) over Black Brook. Therefore, FBE relied more heavily on the recent *Black Brook Assessment* in which erosion sites were described and photographed. Site selection rationale is addressed for each site in the "Site Observations" section below. BCCD and WWN also provided valuable feedback on site selection based on their local knowledge of the watershed.

Two sites on Huse Road were intended to address different catchment areas, but were so close together that recommended best management practices (BMPs) were expected to overlap, so the two sites were named 1a and 1b and were modeled as one site. Similarly, Site 3 (Kaulback-Roxbury intersection) and Site 10 (Roxbury Road) were modeled as one location due to their close proximity. However, Site 10 refers to the entire length of Roxbury Road, while Site 3 refers to the area immediately around the intersection and stream crossing.

Table 1: Site locations, descriptions, and geographic coordinates.

Site ID and Name	Description	Location via Google Maps
1a. Lower Huse Rd	Steep portion of Huse Road described in WMP 2012. Huse Road overall cited as major sediment source by Lang 2021. WEPP sediment yield model will be identical to Site 1b, but field observations will focus on all the erosion happening along the upgradient portion of Huse Road.	43.54562, -71.53708
1b. Huse Rd crossing	Area immediately around road-stream crossing was a minor source of sediment, Lang 2021. WEPP sediment yield model will be identical to Site 1a, but field observations will focus on the Huse Rd-Black Brook crossing itself.	43.54609, -71.53696
2. Upper Huse Rd	Less steep portion of Huse Road, WMP 2012 indicates roadside ditch erosion. Lang 2021 does not differentiate upper from lower Huse Road.	43.54308, -71.53752
3. Kaulback-Roxbury intersection	Intersection of Kaulback-Roxbury roads, cited as erosion area in WMP 2012, described as minor sediment source by Lang 2021.	43.54744, -71.53761 modeled using: 43.54932, -71.53709
4. Kaulback Rd west	Crosses north branch Black Brook, and road is a narrow-elevated berm within floodplain, stream channel flows through pipe culverts. Erosion site in WMP 2012 and major sediment source in Lang 2021.	43.54864, -71.53614
5. Kaulback Rd east	Crosses unnamed tributary to north branch Black Brook, and road is narrow elevated berm within floodplain. Erosion site in WMP 2012 and major sediment source in Lang 2021.	43.55155, -71.53455
6. Kaulback Rd far north	Two driveway erosion sites in WMP. Not mentioned in Lang 2021.	43.55258, -71.53312
7. Black Brook Rd crossing	Where Black Brook Road crosses Black Brook, site of twin box culverts installed in 2012 (after the 2012 WMP was released). Lang 2021 indicated erosion at road crossing cited in WMP 2012 had been addressed.	43.54545, -71.52908
8. Woodman Rd crossing	Where Woodman Road crosses south branch Black Brook. Minor roadside erosion sites in WMP 2012, undersized culvert Lang 2021.	43.54357, -71.54505
9. Union Cemetery	Minor erosion and undersized culvert, WMP 2012, and Lang 2021.	43.54269, -71.54467
10. Roxbury Road	Road slopes down to this point, which will be used for sediment yield modeling. The length of the road will be visited in the field. Minor erosion cited by Lang 2021.	43.54755, -71.53806 modeled using: 43.54932, -71.53709

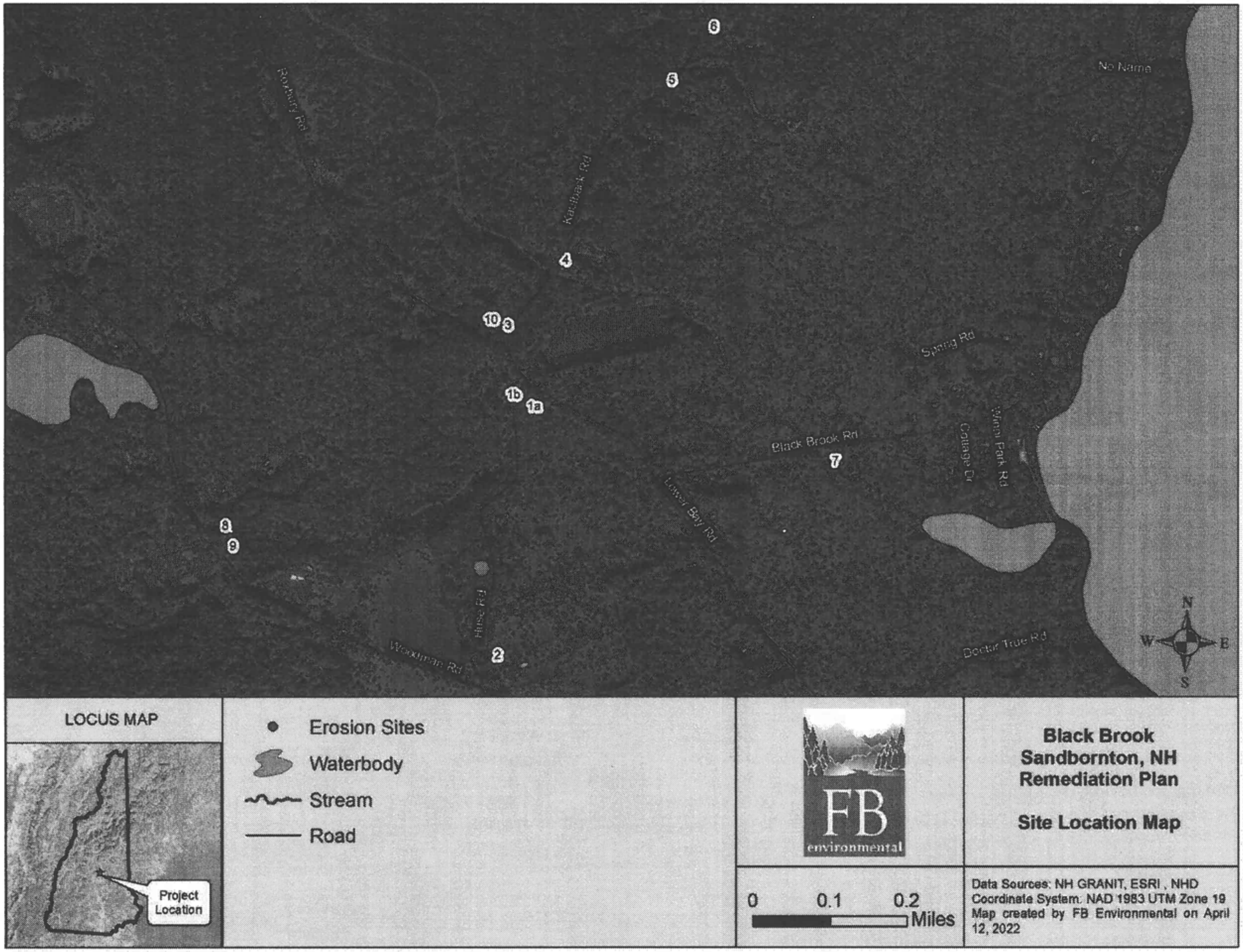

Figure 1: Site locations map.

MODEL DESCRIPTION AND RESULTS

The Water Erosion Prediction Project (WEPP) model was used to evaluate sediment yields associated with the selected Black Brook erosion sites. Although WEPP is frequently used to model post-wildfire landscapes, it is also intended for use in undisturbed landscapes. WEPP does not model mass wasting or gully erosion, which in this effort was accomplished in during FBE's field observations and incorporated into the final site prioritization.

WEPP incorporates terrain and slope, land use, soils, and climate to model stream channel flow paths, runoff volume, and sediment yield. WEPP delineates stream channels within the chosen study area using digital elevation models (DEMs). The modeler then chooses an outlet location along one of the delineated stream channels. The model delineates a watershed area for the chosen outlet and divides the larger watershed into numerous subcatchments. Model results are presented for the entire watershed at the outlet location, as well as for the smaller subcatchment areas.

The specific WEPP software used was the WEPPcloud implementation[1], "WEPPcloud-(Un)Disturbed for United States" version. WEPPcloud aggregates Soil Survey Geographic Database (SSURGO) soils data from USDA, long term climate data from a network of weather stations including CLIGEN and NASA's Daymet service, USGS terrain and land use data, among others. WEPPcloud is hosted and maintained by the University of Idaho Research Computing and Data Services, with support and collaboration from US Forest Service, US Department of Agriculture, Natural Environment Research Council (UK), and others.

Within WEPP, the following model parameters were used:

- Outlets were set as the coordinates listed in Table 1 above. Note that:
  - If outlets were not located along a delineated stream channel, the model moved them to closest location along a channel.
  - Due to this feature, Sites 1a (Lower Huse Road) and 1b (Huse Road Crossing) were indistinguishable at the resolution used in the model, and thus they were modeled as one outlet point and share model results.
  - The modeled outlet for Site 10 (Roxbury Road) was adjusted from an upland location to the Black Brook stream channel (see "modeled as" coordinates in the table). This involved moving the modeled outlet slightly north, so the catchment area was predominantly the northeast facing slope that Roxbury Road traverses.
  - Site 3 (Kaulback-Roxbury Intersection) shared model results with Site 10, because the sites were indistinguishable at the scale of modeling.
- Land Use and Soils were both "determined per hillslope."
- Climate was set using "Multi-Factor Ranking (Considers Distance, Elevation, and Climate)," and the "PRISM Modified" model was used to simulate 100 years of intraday climate.
- Under WEPP, the following options were run:
  - Flowpaths
  - Hourly Seepage
  - Penman-Monteith estimation of evaporation and transpiration, "PMET"
  - Frost
  - Snow
  - Variable channel critical shear as a function of channel slope
- Model results of sediment discharge (tons/year) at the modeled outlets were used.

A summary of modeled sediment discharge is provided below in Table 2. The result "Sediment discharge (ton/year)" was incorporated into the prioritization method, see the Prioritized Sites section below. Detailed model results were saved to the spreadsheet "BlackBrook_WEPP_results_2022-03-30.xlsx" provided with this report.

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[1] WEPPcloud is online at https://wepp.cloud/, with documentation at https://doc.wepp.cloud

Table 2: Sediment discharge and other key parameters as modeled by WEPP.

Site ID and Name	Area (acre)	Stream discharge (ft^3/year)	Total hillslope soil loss (ton/year)	Total channel soil loss (ton/year)	Sediment discharge (ton/year)
1a. Lower Huse Road & 1b. Huse Road crossing	1400	99,000,000	4	0.99	4.4
2. Upper Huse Road	1400	99,000,000	4	0.55	3.9
3. Kaulback-Roxbury intersection & 10. Roxbury Road	740	50,000,000	0.33	0	0.44
4. Kaulback Road west	760	51,000,000	0.33	0.11	0.33
5. Kaulback Road east	210	14,000,000	0	0	0
6. Kaulback Road far north	41	2,700,000	0	0	0
7. Black Brook Road crossing	2600	180,000,000	3.4	0.44	2.9
8. Woodman Road crossing	1000	74,000,000	4.6	0.11	3.5
9. Union Cemetery	300	21,000,000	0.33	0	0.22

FIELD VISIT DESCRIPTION

FBE staff visited the 11 identified erosion sites (see map on page 2) within the Black Brook watershed on April 6, 2022. The weather was partially sunny with a high of 58 °F. Road conditions were wet and muddy, with Kaulback Road closed to non-resident traffic due to the wet conditions. A local resident of Kaulback Road stated that many of the local dirt roads (Kaulback, Roxbury, etc.) had been filled and repaired one or two days prior to the field visit (April 4th or 5th).

FBE staff visited each of the 11 sites, where they took representative photos, evaluated the severity of erosion, and took measurements (length, width, estimated depth) to calculate a screening-level volume of erosion present at the time of the site visit. A measuring tape and measuring wheel were used to estimate the length and width of areas of erosion. Additionally, an estimate of the depth of erosion was collected at each site. Other parameters such as distance to stream, flow condition, and sediment type (silt, sand, and/or gravel present) were also documented at each site. The severity of erosion was estimated at each site using a 1 to 10 scale, with 1 representing no erosion and 10 representing the highest level of erosion. A summary of the site visit results is presented in Table 3.

SITE OBSERVATIONS

1a. Lower Huse Road

This site represents the northern, steep portion of Huse Road that leads to the Black Brook stream crossing. This section of road is described in the Watershed Management Plan (WMP) published by AECOM in 2012. Additionally, Lang (2021) listed all of Huse Road as a major sediment source to Black Brook.

During the site visit, road surface rill erosion and roadside ditch erosion were observed. While conditions were wet from antecedent precipitation events, there was no surface runoff occurring at this site during the site visit. Black Brook appeared to have moderate flow at the crossing, approaching bankfull flow. The southern branch of Black Brook runs parallel to lower Huse Road for a short distance. There were three sections of the road that had very little roadside buffer with steep banks leading down to Black Brook. It appeared that sediment from the road had the potential to be transported directly to Black Brook in these areas. There were a few roadside turnouts that had significant sediment build up and had started to erode. The sediment type observed at this site was sand and gravel.

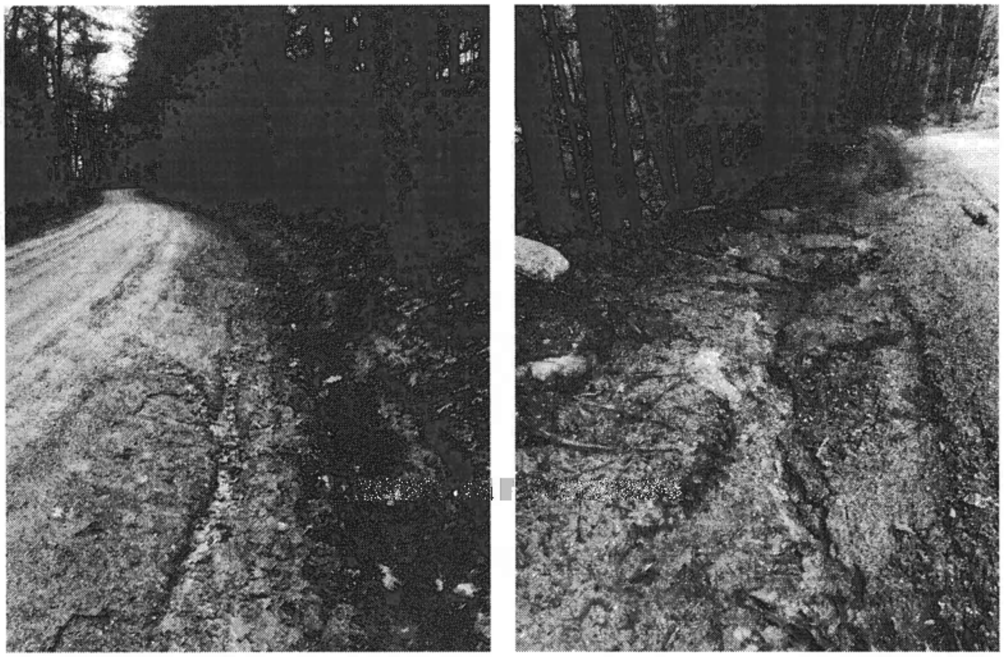


Figure 2. (Left) View of roadside ditch erosion along lower Huse Road. (Right) Gully erosion above steep riverbank of Black Brook.

1b. Huse Road Crossing

This site represents the area surrounding the Huse Road-Black Brook crossing located near the intersection of Huse Road and Lower Bay Road. The area immediately around the road-stream crossing was listed as a minor source of sediment by Lang (2021).

During the site visit, there was a significant buildup of sediment on the road shoulders at the inlet and outlet of the crossing. Roadside ditch turnouts located at the crossing inlet and outlet, on the southern side of the crossing, were severely eroded and appeared to be transporting sediment directly into Black Brook. Indeed, sand and gravel were observed in the stream below.

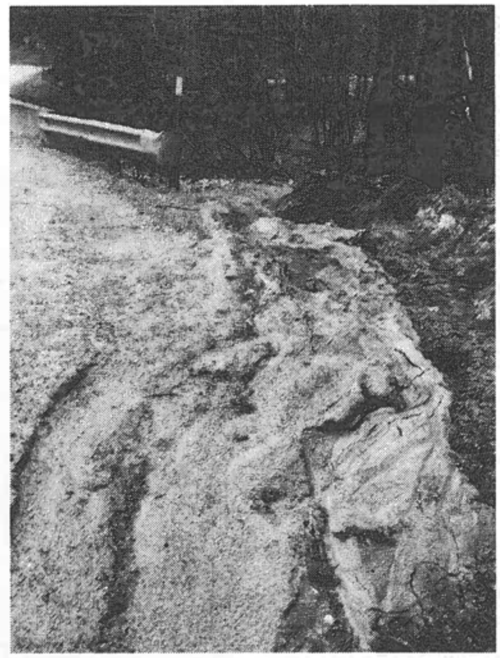
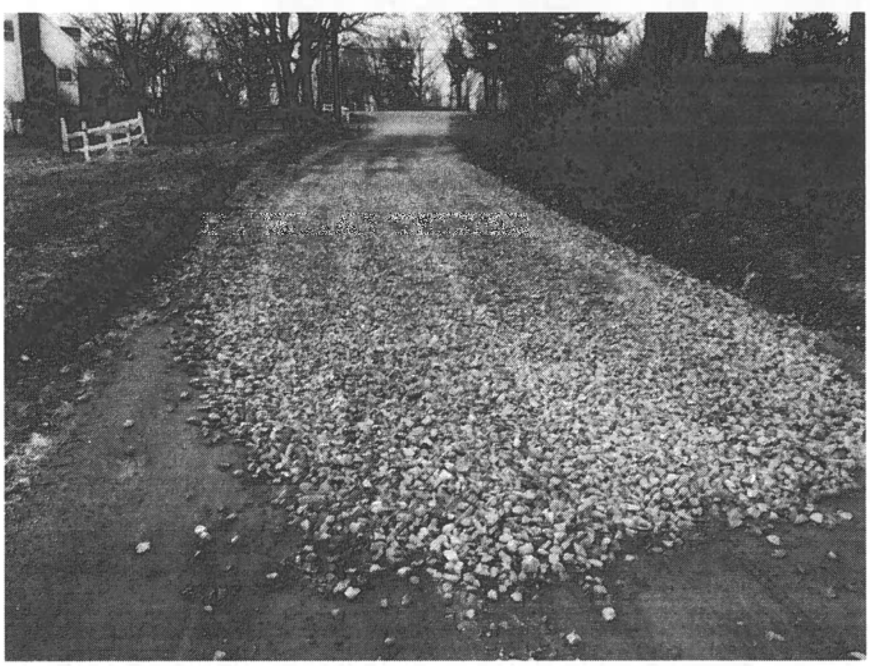


Figure 3. (Left) View of Huse Road-Black Brook crossing. (Right) Eroding turnout at the crossing outlet.

2. Upper Huse Road

The upper (southern) portion of Huse Road, near Woodman Road, is less steep than the lower portion. The section of Huse Road adjacent to the intersection with Woodman Road, had large areas of eroded road surface that had recently been filled with stone. Additionally, some significant roadside ditch erosion was apparent. Roadside turnouts were filled with sediment and eroding. The sediment type observed at this site included gravel, sand, and silt.



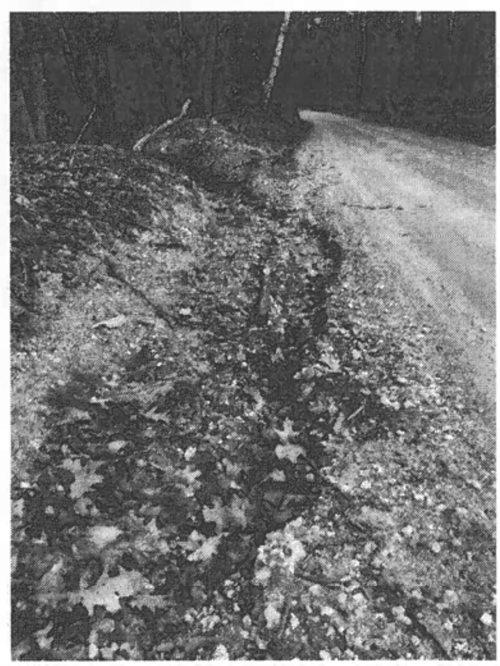


Figure 4. (Left) Area of road surface erosion recently filled with stone. (Right) Roadside ditch erosion leading to turnout.

3. Kaulback-Roxbury Intersection

The area surrounding the intersection of Kaulback Road and Roxbury Road was listed in the WMP as an area of erosion and Lang (2021) cited it as a site of minor erosion. A tributary to Black Brook runs under Roxbury Road near the intersection with Kaulback Road.

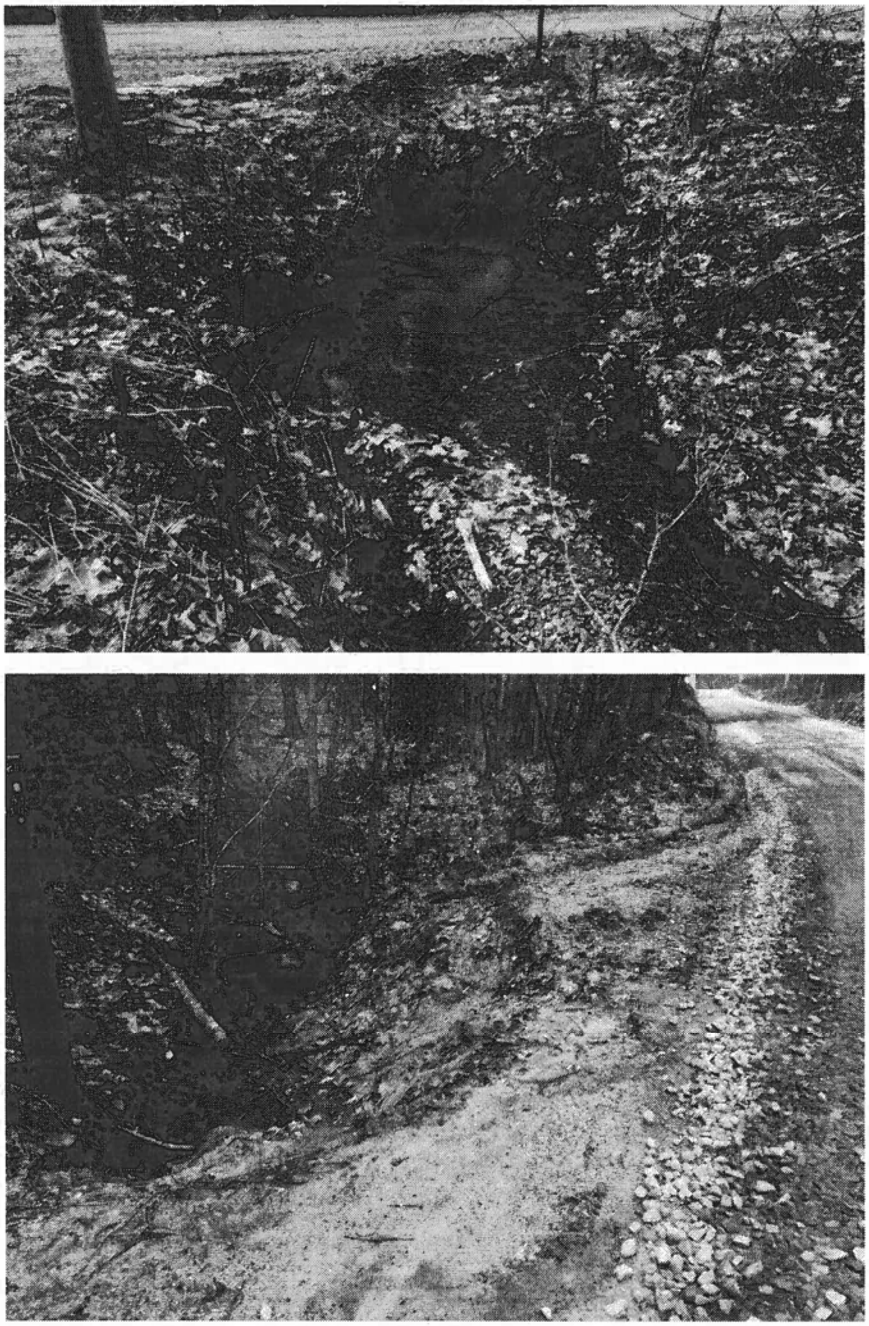


Figure 5. (Top) Outlet of the culvert under Roxbury Rd. (Bottom) Erosion at inlet of crossing.

Severe erosion of the road shoulder was observed at the inlet and the outlet of the crossing, which had no vegetative buffer. A roadside ditch turnout at the inlet of the crossing was severely eroded, transporting sediment directly into the stream. The inlet of the culvert was almost completely buried in sediment and was not visible. The sediment type observed at this site included gravel and sand.

4. Kaulback Road West

This site represents the area around the Kaulback Road-Black Brook crossing and the sections of road that drain to the crossing. This site was included as an erosion site in the WMP and was listed as a major source of sediment by Lang (2021).

Black Brook flows under Kaulback Road via two sets of pipe culverts. No surface runoff was present during the site visit. The road shoulder along the crossing inlet and outlet was lacking any vegetative buffer. Erosion from the road surface and ditches was significant. Ditch turnouts at the crossing inlet and outlet were eroding and transporting sediment directly into Black Brook. The turnout to the southeast of the crossing was in particularly bad condition, and a local resident stated that this turnout was regularly a source of sediment to the river. Erosion was observed in the roadside ditches on the stretches of road to either side of the crossing. The sediment types observed at this site were sand and silt.

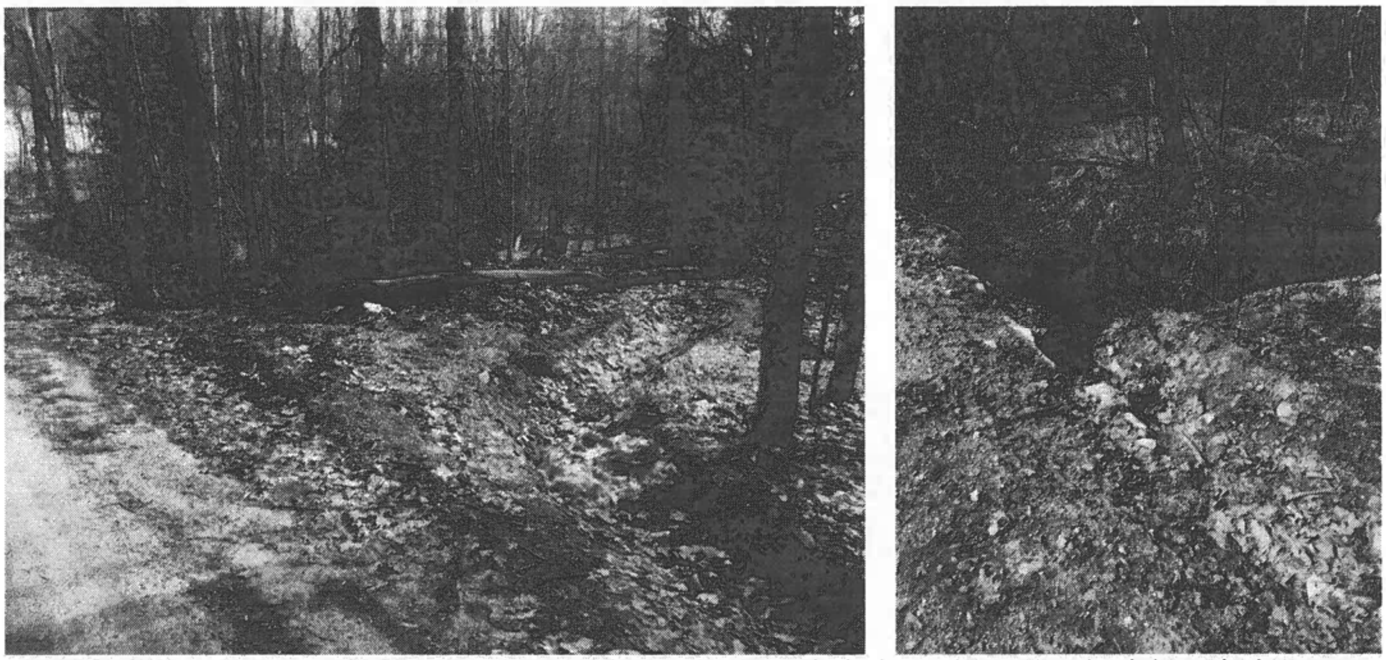


Figure 6. (Left) Eroding turnout to the southeast of the Kaulback Road-Black Brook crossing. (Right) Roadside erosion into Black Brook.

5. Kaulback Road East

An unnamed tributary to Black Brook flows under Kaulback Road to the north of the Black Brook crossing. This site represents the area surrounding the unnamed tributary crossing and was included as an erosion site in the WMP and was listed as a major source of sediment by Lang (2021).

During the site visit, there was runoff flowing in the ditches on either side of the road in this area. The road surface conditions were very wet and there was severe surface and ditch erosion. The section of road along the crossing had no vegetative buffer and was eroding directly into the stream. A turnout above the crossing was overflowing with sediment and eroding directly into the unnamed stream. This section of road is steeper than Kaulback West, with more severe erosion. However, this area of road does not discharge directly to Black Brook. The sediment types observed at this site were sand and silt.

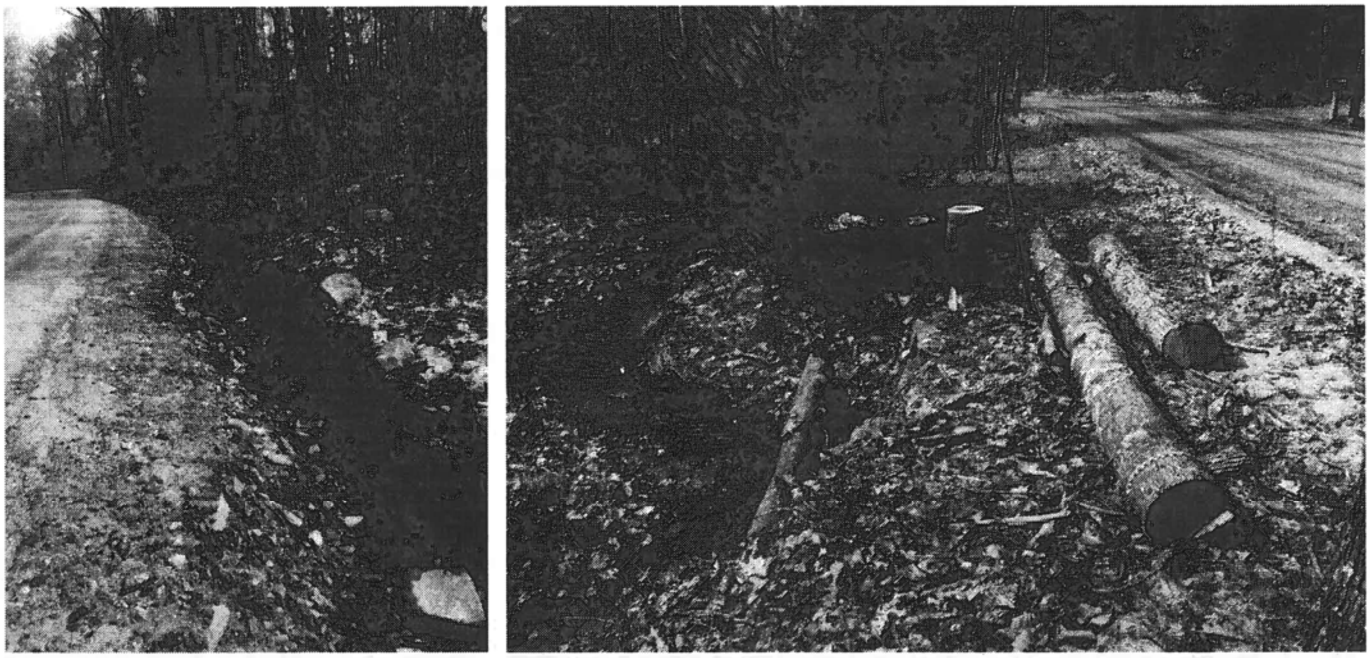


Figure 7. (Left) Ditch erosion along Kaulback Road East. (Right) View of the outlet of the Kaulback Road-unnamed stream crossing.

6. Kaulback Road Far North

This site represents a steep section of Kaulback Road to the north of Kaulback Road East. Two steep driveways intersect with Kaulback Road in this area. This site was listed as a site of erosion in the 2012 WMP.

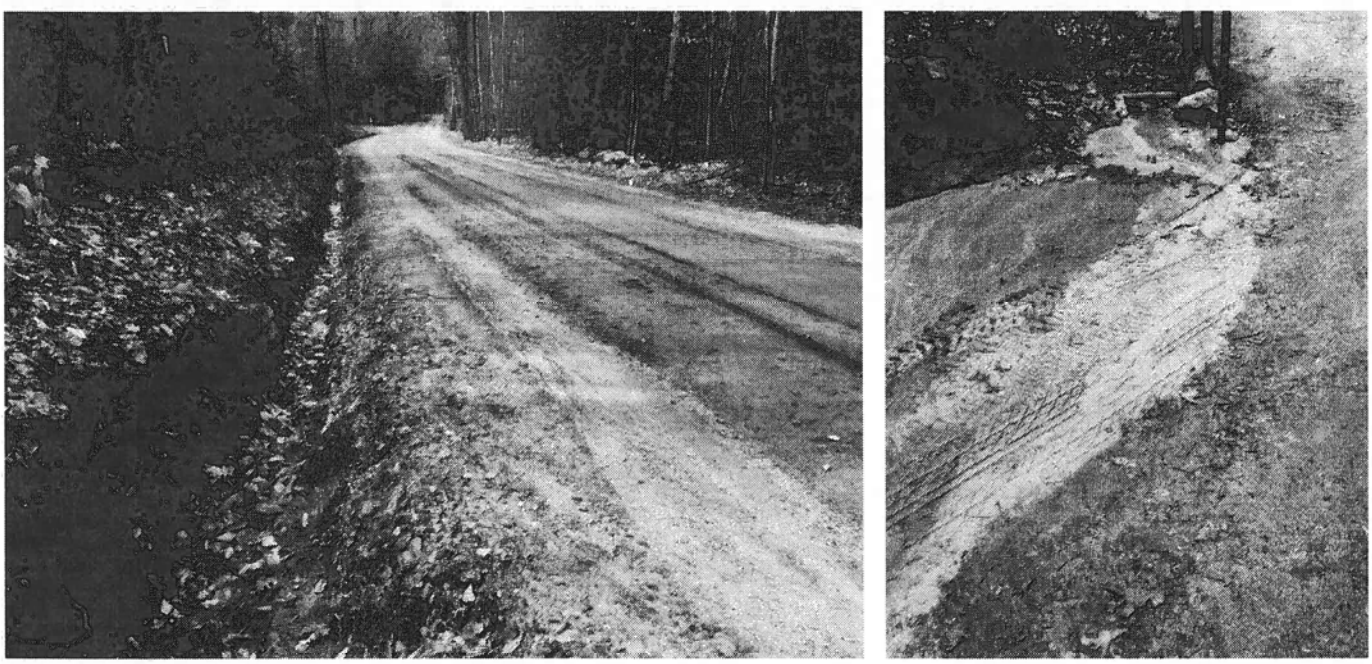


Figure 8. (Left) View of the roadside ditch erosion present along Kaulback Road far north. (Right) Erosion at the base of the steep driveways.

During the site visit, there was runoff flowing in the ditches on either side of the road in this area. The two steep driveways did not appear to have much road surface erosion. Some erosion was observed at the bottom of the driveways where they intersect with Kaulback Road. The section of road to the north of the driveways is very steep and was experiencing severe roadside ditch erosion. Flow from this area appeared to drain to the unnamed stream crossing located at site 5 (Kaulback Road East). The sediment types observed at this site included gravel and sand.

7. Black Brook Road Crossing

Black Brook flows under Black Brook Road via twin box culverts that were installed in 2012 after the completion of the WMP. The WMP listed this site as a source of erosion, however Lang (2021) stated that the erosion problems listed in the WMP had been addressed.

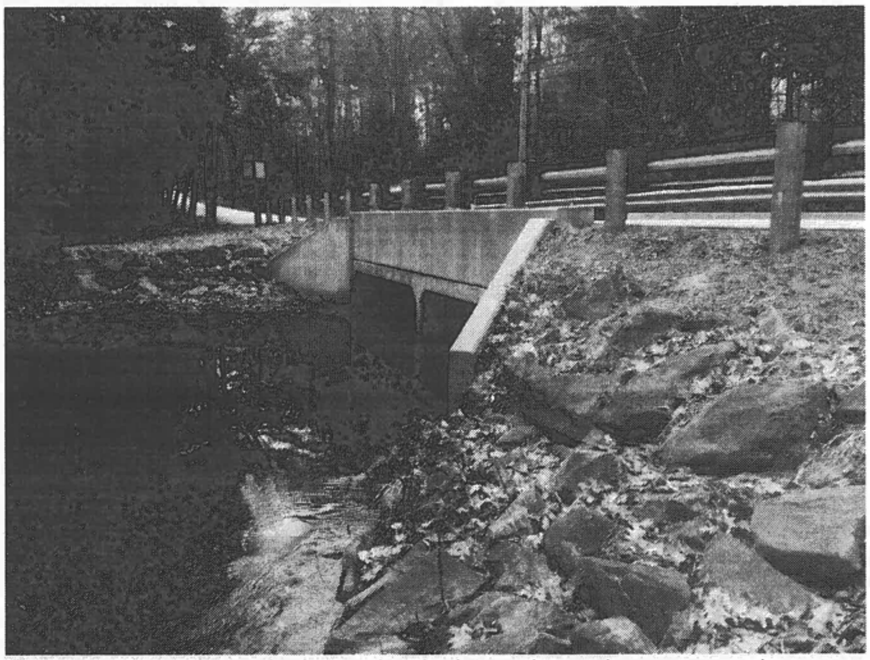


Figure 9. View of the Black Brook- Black Brook Road crossing outlet.

The road in this area is very flat and paved, with little evidence of erosion. The road shoulders at the inlet and outlet of the stream crossing appeared to be well stabilized. Black Brook had a moderate flow during the site visit. The bed of the stream was very sandy with some gravel and leaves in the stream near the crossing outlet. Mid-channel sand bars were present just above and below the crossing, potentially remnant of the previously undersized crossing. The sediment types observed at this site included gravel and sand.

8. Woodman Road Crossing

The south branch of Black Brook flows under Woodman Road via a HDPE culvert. This site was listed as a minor source of erosion in the 2012 WMP. Lang (2021) stated that the culvert was undersized.

The south branch of Black Brook runs parallel to Woodman Road upstream of the crossing. The road shoulder in this area had very little buffer vegetation. No vegetation was present at the immediate inlet and outlet of the crossing. Runoff and erosion in these areas discharges directly to the stream. The culvert outlet is perched with some scouring of the streambed. A small culvert that runs under a driveway is situated to the northwest of the crossing. Discharge from this driveway culvert had created an eroded channel that flows directly into Black Brook.

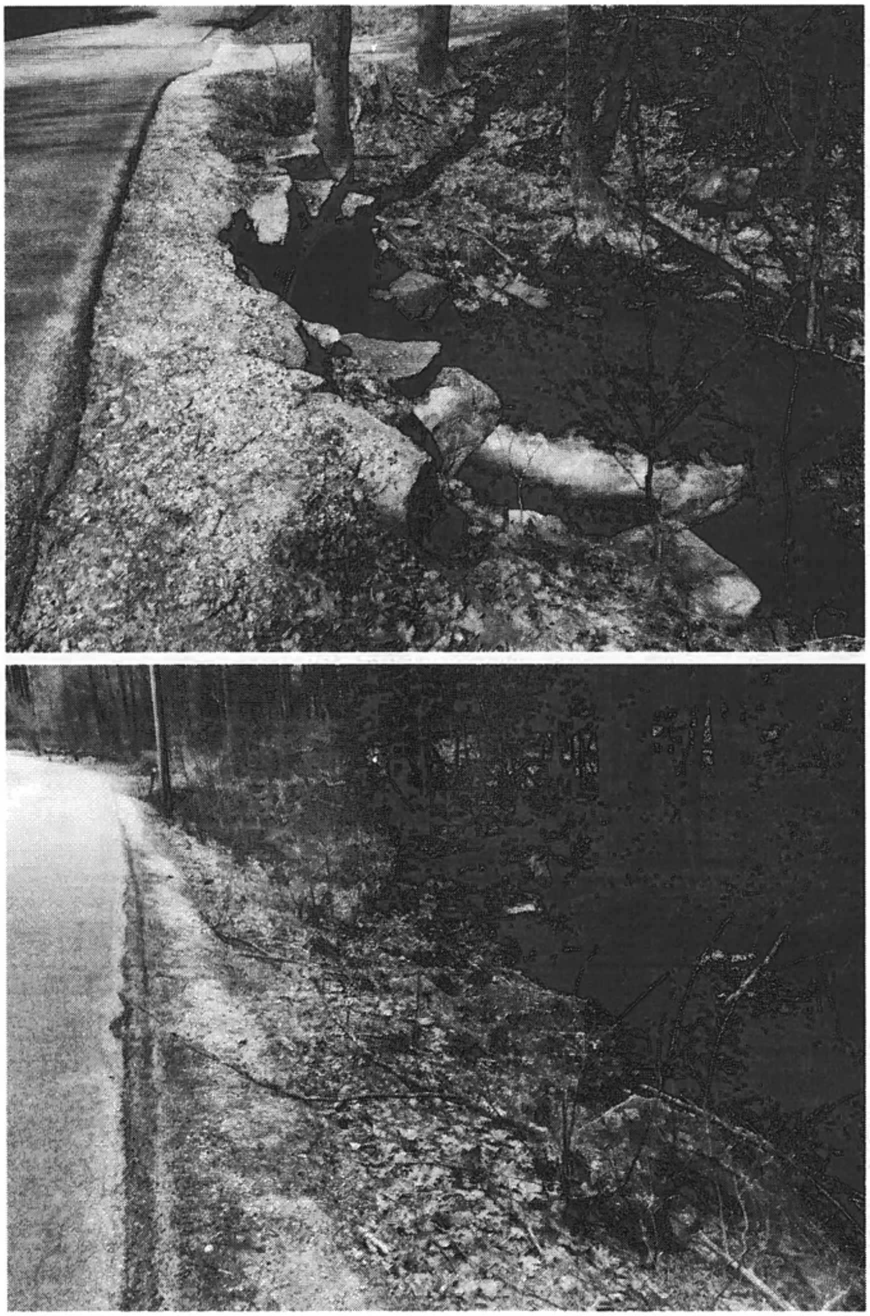


Figure 10. (Top) View of the Woodman Road-Black Brook crossing outlet. (Bottom) Road shoulder above crossing.

9. Union Cemetery

A tributary to Black Brook flows under Woodman Road near the Union Cemetery. This site is listed as a minor source of erosion with an undersized culvert by the WMP, 2012 and Lang (2021).

The road in the area of the crossing is paved. There is a steep section of road to the south of the crossing, where runoff causes some erosion of the road shoulder. There was no buffer at the inlet or outlet of the crossing and some erosion of sand and gravel into the stream was observed during the site visit. A small culvert runs under the cemetery road just upstream of the crossing. Some ponding was observed above this culvert and there was an eroded channel at the outlet that flowed directly into the stream.

Figure 11. (Left) View of Woodman Road-unnamed stream crossing outlet. (Right) Eroded channel at the outlet of small culvert under the Union Cemetery Road.

10. Roxbury Road

This site represents the steep southern portion of Roxbury Road above the intersection with Kaulback Road. This area was cited by Lange, 2021 as a minor source of erosion.

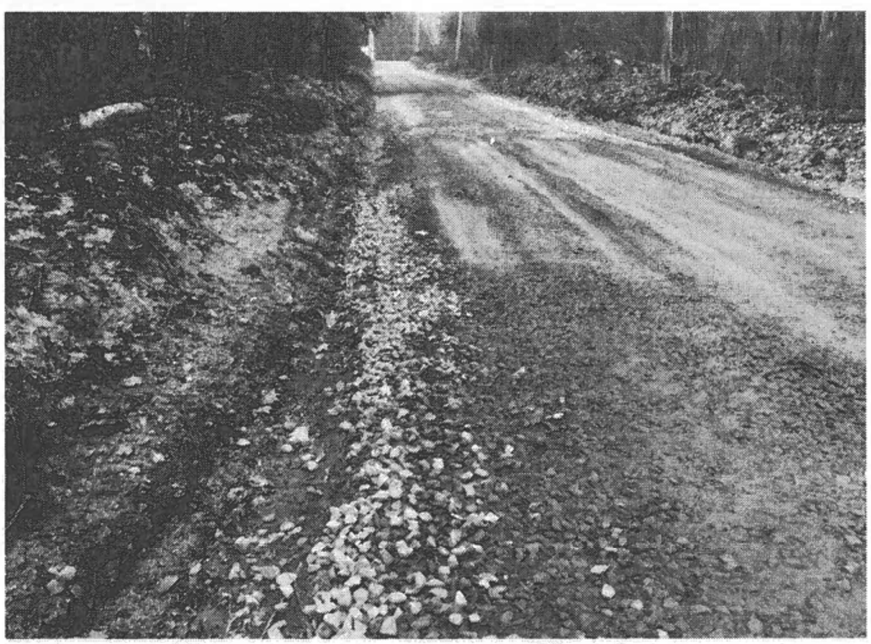


Figure 12. View of road shoulder, road surface, and ditch erosion along Roxbury Road.

Figure 13. View of eroding turnout on Roxbury Road.

The section of Roxbury Road above the Roxbury-Kaulback intersection is very steep and had large areas of road surface erosion that had been recently filled with stone. The road shoulders are raised above the road surface for much of this length of road. The raised road shoulders and ditches had signs of significant erosion. There is an eroding turnout on Roxbury Road approximately 150 feet above the Kaulback Road intersection.

Table 3. Summary of results from the field visit conducted by FBE staff on April 6, 2022.

Site ID and Name	Eroded Sediment Volume (ft^3)	Transport to Black Brook	Sediment type	Erosion Severity
1a. Lower Huse Road	8,000	Close to channel	Gravel, Sand	7
1b. Huse Road Crossing	1,200	Direct transport	Gravel, Sand	6
2. Upper Huse Road	6,000	Limited transport	Gravel, Sand, Silt	5
3. Kaulback-Roxbury Intersection	5,000	Direct to tributary	Gravel, Sand	7
4. Kaulback Road West	6,000	Direct transport	Sand, Silt	5
5. Kaulback Road East	5,600	Direct to tributary	Sand, Silt	6
6. Kaulback Road Far North	8,000	Upland from channel	Gravel, Sand	7
7. Black Brook Road Crossing	60	Direct transport	Sand, Silt	2
8. Woodman Road Crossing	575	Direct transport	Gravel, Sand	4
9. Union Cemetery	1,000	Direct transport	Gravel, Sand	4
10. Roxbury Road	5,000	Close to channel	Gravel, Sand	7

SITE PRIORITIZATION

The results from the WEPP sediment transport model and the field observations were integrated through a quantitative ranking method, detailed below. These results provide a screening-level prioritized site list for remediation efforts aimed at protecting water quality in Black Brook, and its downstream receiving water, Lake Winnisquam. The following ranking method was used:

Modeled Annual Sediment Discharge

Sediment discharge (ton/year) as determined by the WEPPcloud model was used to summarize sediment transport.

Observed Sediment Volume

Eroding sediment volume was estimated by multiplying the field measurements of length * width * depth. For very long sites (e.g., Roxbury Road), length was estimated using GIS mapping. Calculated sediment volumes across the sites ranged from 60 ft^3 to 8000 ft^3. Sites were given an erosion weight from 1 to 4. Weights for observed sediment volume were assigned as follows:

1 = 0-2,000 ft^3
2 = 2,001-4,000 ft^3
3 = 4,001-6,000 ft^3
4 = 6,001-8,000 ft^3

Observed Transport to Black Brook

Degree of sediment transport to Black Brook was observed and weighted as follows:

1 = upland from Black Brook (i.e., limited transport)
1.25 = erosion to tributary to Black Brook
1.5 = erosion occurs on road surface, shoulder, or ditch that flows to Black Brook,
2 = erosion occurs at Black Brook stream crossing (i.e., direct transport)

Observed Sediment Type

Observed sediment types were gravel, sand, and/or silt. Sites with silt in the sediment were given a weight of 1.25 (i.e., 25% increase). Sites without silt were given a rank of 1.

Observed Erosion Severity

Severity of erosion observed at each site was evaluated on a scale of 1 (least severe) to 10 (most severe). Erosion severity observed ranged from 2-7 across the sites (range of 5). Severity was re-scaled and weighted to range from 1 to 2, with the re-weighted erosion severity scores being 1, 1.2, 1.4, 1.6, 1.8 and 2.

Modeled Priority

The modeled sediment discharge was used to create a "Modeled Priority" (ranked list) of the sites.

Field Priority

A ranked list of sites based on field observations was created by summing the following:

- Sediment volume weight (possible values were 1-4)
- Transport to Black Brook weight (possible values were 1, 1.25, 1.5, and 2)
- Sediment Type weight (possible values were 1 and 1.25)
- Erosion Severity weight (possible values were 1, 1.2, 1.4, 1.6, 1.8 and 2)

Overall Priority

The overall priority was the sum of each site's rank for "Modeled Priority" and "Field Priority." The highest priority sites were those with the lowest scores. Tie-breaking rules were as follows:

- The site with the higher Modeled Annual Sediment Discharge was the higher priority. The rationale is that the model considers soils and slopes, which are longer-term factors than field observations on a single day.
- If the tie persisted, the site with the larger area was higher priority.

All of the above parameters (as weighted) are shown in Table 4, and are in a spreadsheet provided with this memo (BlackBrook_SitePrioritization_2022-04-14.xlsx).

Table 4: Summary of modeled and weighted field observed parameters, intermediate priority calculations, and final overall site priority using color bars (above), and as a text list (below).

Site ID and Name	Modeled Annual Sediment Discharge (tons/year)	Observed Sediment Volume (weighted)	Transport to Black Brook (weighted)	Observed Sediment Type (weighted)	Observed Erosion Severity (weighted)	Total Field Score	Modeled Priority	Field Priority	Priority Sum	Overall Priority	Tie Breaker
1a. Lower Huse Rd	4.4	4	1.5	1	2	12.0	1	1	2	1	
1b. Huse Rd crossing	4.4	1	2	1	1.8	3.6	1	6	7	2	modeled sediment discharge
2. Upper Huse Rd	3.9	3	1	1.25	1.6	6.0	2	5	7	3	modeled sediment discharge
4. Kaulback Rd west	0.33	3	2	1.25	1.6	12.0	6	1	7	4	
10. Roxbury Road	0.44	3	1.25	1	2	7.5	5	4	9	5	larger site area
3. Kaulback-Roxbury intersection	0.44	3	1.25	1	2	7.5	5	4	9	6	
8. Woodman Rd crossing	3.5	1	2	1	1.4	2.8	3	7	10	7	modeled sediment discharge
5. Kaulback Rd east	0	3	1.25	1.25	1.8	8.4	8	2	10	8	
6. Kaulback Rd far north	0	4	1	1	2	8.0	8	3	11	9	
7. Black Brook Rd crossing	2.9	1	2	1.25	1	2.5	4	8	12	10	
9. Union Cemetery	0.22	1	2	1	1.4	2.8	7	7	14	11	

Priority	Site ID and Name
1	1a. Lower Huse Road
2	1b. Huse Road crossing
3	2. Upper Huse Road
4	4. Kaulback Road west
5	10. Roxbury Road
6	3. Kaulback-Roxbury intersection
7	8. Woodman Road crossing
8	5. Kaulback Road east
9	6. Kaulback Road far north
10	7. Black Brook Road crossing
11	9. Union Cemetery

Appendix I:

Black Brook Watershed Assessment Update Report dated December 2021

BLACK BROOK WATERSHED ASSESSMENT UPDATE REPORT

Prepared by

Belknap County Conservation District

and

Gerald J. Lang, PE

December 2021

Index

Introduction

In June 2020, the Belknap County Conservation District requested my assistance in reviewing and assessing environmental issues affecting the water quality in Black Brook flowing through the Town of Sanbornton into Lake Winnisquam. Particularly emphasis was placed on the sediment being transported by the stream affecting the flow conditions in a recently installed new box culvert in Black Brook Road and discharging sediment and nutrients into Lake Winnisquam. Also, evaluation of other sites within the Black Brook Watershed causing water quality problems was requested to help determine priority for addressing issues.

This report is an assessment of what was observed from field visits and reviewing previously developed reports and assessments. The goal was to identify potential immediate sites where significant improvements could be made to improve watershed conditions within the Town of Sanbornton. The emphasis is on projects that could be developed quickly to seek available funding for implementation within the next few years. It should be noted that the following suggestions and recommendations are based on physical observations in the field and information derived from previous reports and studies. Two reports used to document what was observed in the field visits are: *Black Brook Watershed Management Plan* prepared by AECOM in September 2012, and *Summary and Final Documentation, Sanbornton Roadway Evaluation* prepared by Underwood Engineers, Inc. in March 2020. Both reports provided additional site details which helped with this assessment since time for more detailed surveys and analysis was not available.

Using all available information from previous reports and studies along with data gathered from my field review, the following is a list of observed problems and issues which have potential to be addressed as individual projects within a short time frame:

1. Sediment build-up in front of and within the new Box Culvert through Black Brook Road.
2. Significant trash and debris blocking the stop-log structure downstream of the box culvert.
3. Need for a more detailed survey of the Black Brook stream from approximately 500 feet downstream of the stop-log structure to approximately 500 feet upstream of the box culvert to determine what the channel grade should be and what the backwater effects are from the debris blockage.
4. Sediment feeding into the South Branch of Black Brook from the gravel surfaced Huse Road.
5. Sediment feeding into North Branch of Black Brook from Kaulback Road.
6. Minor sediment load from Roxbury Road near the intersection with Kaulback Road.
7. Minor sediment load from Woodman Road into South Branch of Black Brook mainly from gravel driveways.
8. Minor sediment (road sand) from Black Brook Road into Black Brook near the new Box Culvert location (identified in the 2012 study).

Analysis and Reviews Completed

Before evaluating potential solutions to identified issues, it was important to review the actual design and construction of the new Box Culvert through Black Brook Road and check the adequacy of the culvert for anticipated stormwater flows. The proposed design for twin 12 feet wide by 5.5 feet high box culverts through Black Brook Road was approved by DES in the fall of 2012 and constructed the next year. Sanbornton provided a copy of the construction plans used to install the box culvert which was reviewed for pertinent elevation and size information.

Using the Culvert design information and calculated peak discharges at Black Brook Road an analysis was made to check flow conditions through the culvert for different storm frequencies. “ StreamStats” Analysis software was used to compute peak discharges through the culvert for the 2-yr, 10-yr, 25-yr, 50-yr, and 100-yr storm frequencies. The software uses watershed or basin characteristics and stream gauge flow information derived from U. S. Geological Survey data for streams in New Hampshire. The computed discharges from the analysis are displayed as the predicted statistical average flow value, the predicted statistical lower value, and the predicted statistical upper value. Also shown in the StreamStats report is the Standard Error which ranges from 20 to 40 percent. Since this was a significant standard error (significant spread of the sample flow data between the upper and lower values) I decided to check the peak discharges using other software.

Other software commonly used to compute peak discharges from watershed areas is HydroCAD which uses the SCS methodology for watershed analysis. The primary parameters used in this software are - hydrologic conditions of soil types in the watershed, landcover and landuse in the watershed, travel times of water flowing through the watershed (based on flow path channel slopes), and the synthetic distribution of the total rainfall event over time. This method is well known and used primarily when designing dams, channels, culverts, and stormwater pipelines by computing the maximum peak discharge that must be conveyed through the structural device. Since detail watershed data was not easily available, a more global approach with (6 sub watershed areas flood routed to the box culvert and estimated ponded storage at the entrance to the box culverts) was used to quickly gather needed input data for the HydroCAD analysis. The total drainage area to the Black Brook Road box culvert is 4.18 square miles and the water course maximum travel distance from the culvert to the outer most point in the watershed is approximately 15,000 feet. See Figure 1 for global watershed and sub-watershed map used for the HydroCAD analysis.

The results of both the StreamStats and HydroCAD software analysis is displayed in Table A to compare results along with the approximate water surface elevation at the entrance to the box culvert. The bottom flow elevation in the culvert is at elevation 485.47, and the low point (overflow elevation) road elevation is at 492.00 derived from the construction drawings.

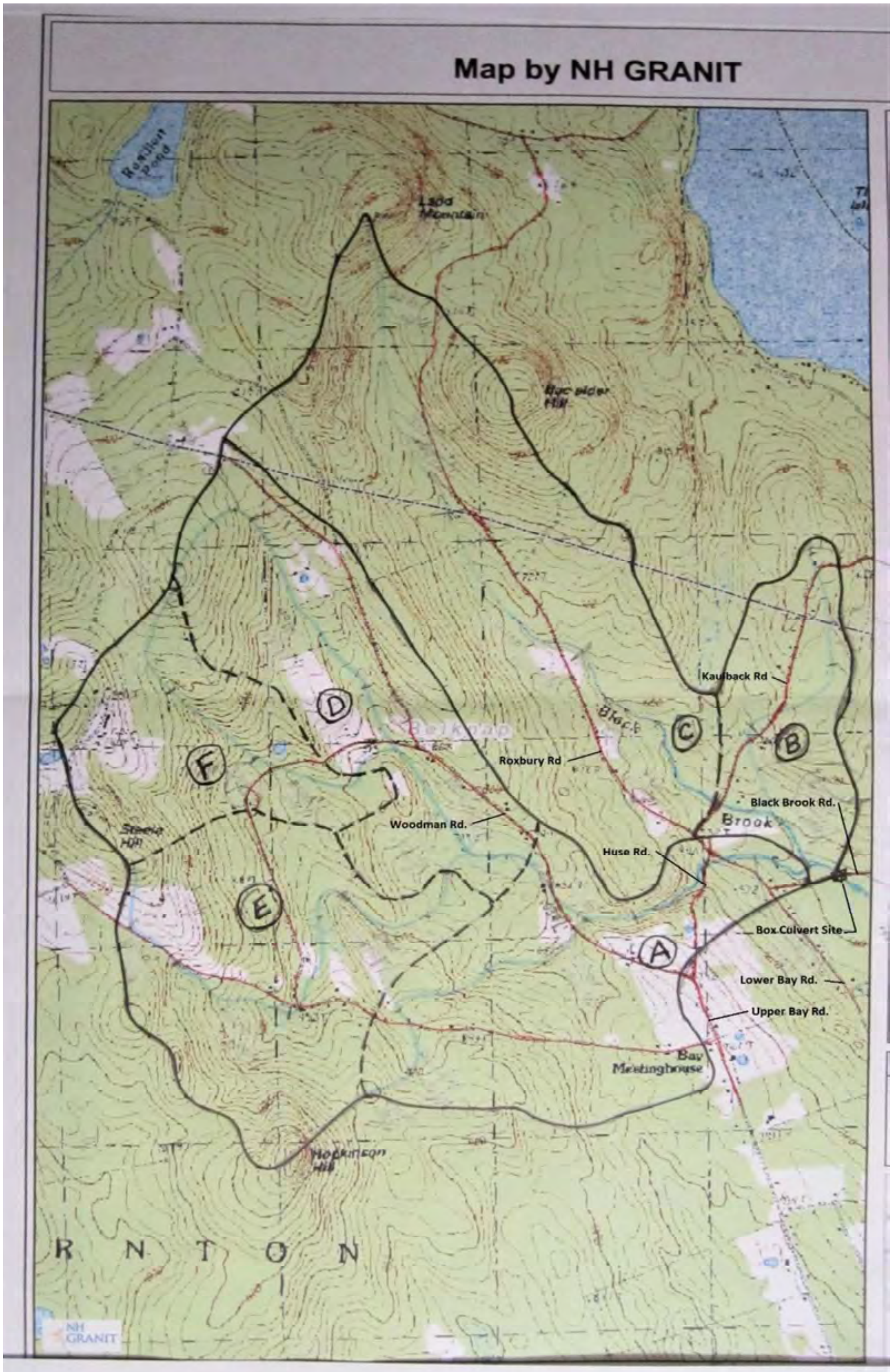


Figure 1- Preliminary HydroCAD Watershed Analysis Map

The differences displayed in Table A compares the StreamStats Average flows and water surface elevations verses the HydroCAD flows and water surface elevations. This analysis using HydroCAD does include accounting for estimated ponding of flows upstream of the box culvert which can cause lower water surface elevations but no other ponding areas within the watershed. A more detailed analysis would also look at smaller sub-watershed areas and ponding areas within the total watershed and compute discharges and travel times for those flows to come together at the box culvert. This more detailed sub-watershed analysis usually results in lower peak discharges because of the different flow travel times for the peak flows to reach the culvert from different parts of the watershed. The earlier flows can partially flow through the culvert before the later flows reach the culvert. Time did not allow for a more detailed analysis which was not the primary goal of this analysis.

Table A – Peak Flow Comparison

	2-yr Discharge	10-yr Discharge	25-yr Discharge	50-yr Discharge	100-yr Discharge
StreamStats Upper	332	762	1060	1310	1640
StreamStats Lower	126	270	350	411	480
StreamStats Ave	**204**	**454**	**608**	**735**	**887**
StreamStats Water Surface Elev.	487.67	498.23	490.02	490.69	491.40
HydroCAD value	**272**	**692**	**1052**	**1452**	**2059**
HydroCAD Water Surface Elev.	488.15	490.48	492.20	493.23	494.21
Differences SCS – Strmst ave Q (Elev)	68 (0.40)	238 (1.25)	444 (2.18)	717 (2.54)	1172 (2.81)

Note: The StreamStats Upper flow data more closely matches the HydroCAD discharge data for the more frequent storm events. The Standard Error was highest for the 100-yr storm event due to the lack of a significant number of events.

Potential Site Improvement Discussion

1. **Sediment filled Box Culvert in Black Brook Road and Debris blocking Downstream Stop-log Dam:**

   It appears that the debris blocking flow through the stop-log dam is causing a backup of flow upstream through the box culvert. This causes the sediment ladened flow to decrease in velocity and pond in the culvert. The twin box culvert was design to have one foot of stream bed material in the bottom. The present slope through the culverts based on the design drawings is relatively flat and with backwater ponded on the culvert outflow, sediment will drop out in and before flowing through the culvert. This is the likely reason sediment has built up in front of and in the box culvert. See Photos 1, 2, 3, and 4.

Photo 1 – Upstream Box Culverts

Photo 2 – Upstream Box Culverts

Photo 3 – Debris at Stop Log Dam

Photo 4- Stop Log Dam Closer

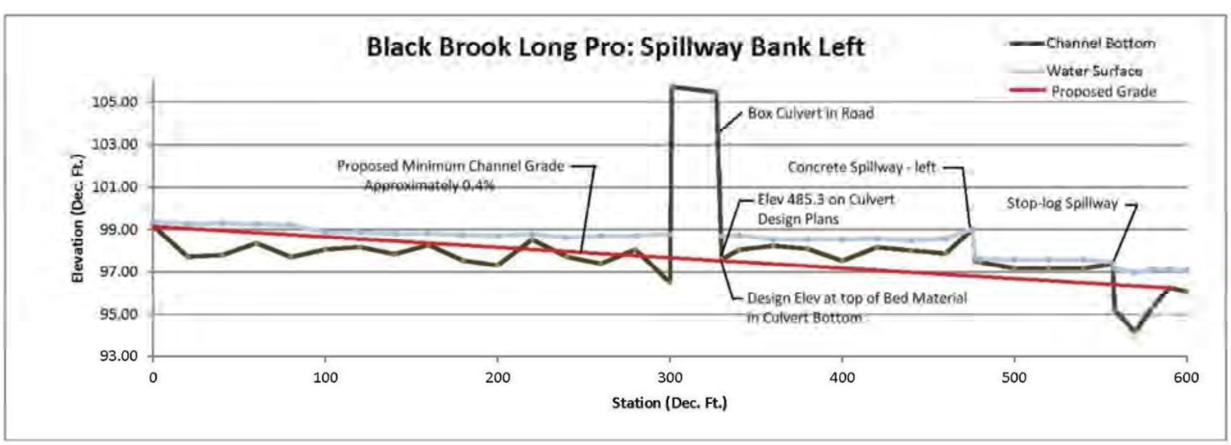
Removing the debris from the stop-log dam and opening up the full flow capacity of the dam may remove or lower the backwater to the culvert allowing normal flow to occur without a significant drop in velocity. Additional survey data of the dam, downstream channel, and channel slope through the box culvert is needed to verify viability of this solution.

The existing sediment in the upstream channel and in the box culvert should be removed back to the design gravel bottom to restore capacity of the culvert and protect the stream downstream of the culvert. If opening up the stop-log dam does not improve the slope gradient from the culvert downstream, then an appropriately designed by-pass channel may also be needed.

A preliminary planning survey was conducted of the stream channel bottom from 300’ upstream of the Road Box Culvert to 300’ downstream from the culvert. The following data table and profile plot show the results of the survey. The plot shows how each concrete structure downstream of the culvert is restricting because of blockage of the structures causing backwater on the culvert which causes sediment to settle out of the streamflow and buildup in the channel. A detailed survey with channel and floodplain cross sections are needed to complete a more detailed restoration plan.

Black Brook Long Pro: Spillway Bank Left - Date: 6/11/2021

Station	HI (in.)	HI (dec. ft.)	HI	Foresight (dec. ft.)	Elevation	Water Depth	Water Surface	
0	59.5	4.96	104.96	5.78	99.18	0.2	99.38	
20				7.24	97.72	1.55	99.27	
40				7.16	97.80	1.49	99.29	
60				6.6	98.36	0.90	99.26	
80				7.25	97.71	1.51	99.22	
100				6.9	98.06	0.80	98.86	
120				6.78	98.18	0.70	98.88	
140				7.12	97.84	0.95	98.79	
160				6.69	98.27	0.54	98.81	
180				7.42	97.54	1.20	98.74	
200				7.65	97.31	1.40	98.71	
220				6.43	98.53	0.25	98.78	
240				7.24	97.72	0.90	98.62	
240	60.5	5.04	105.04	11.02	97.72	0.90	98.62	
260				11.35	97.39	1.30	98.69	
280				10.68	98.06	0.65	98.71	
300				12.24	96.50	2.28	98.78	
301				3.02	105.72			US Headwall
327				3.27	105.47			DS Headwall
330				11.14	97.60	1.10	98.70	
340				10.7	98.04	0.68	98.72	
360				10.5	98.24	0.30	98.54	
380				10.65	98.09	0.45	98.54	
400				11.21	97.53	1.00	98.53	
400	59	4.91	104.91	8.09	97.53	1.00	98.53	
420				7.46	98.16	0.41	98.57	
440				7.6	98.02	0.48	98.50	
460				7.75	97.87	0.70	98.57	
476				6.58	99.04		99.04	Top of spillway
477				8.12	97.50	0.18	97.68	Bottom of spillway
480				8.16	97.46	0.15	97.61	
500				8.44	97.18	0.40	97.58	
520				8.43	97.19	0.40	97.59	
540				8.44	97.18	0.40	97.58	
540	59.5	4.96	104.96	8.7	97.18	0.40	97.58	
557				8.51	97.37	0.10	97.47	Top of spillway
558				10.68	95.20	1.96	97.16	Bottom of spillway
570				11.7	94.18	2.80	96.98	
580				10.56	95.32	1.80	97.12	
590				9.62	96.26	0.85	97.11	
600				9.8	96.08	1.00	97.08	



2. **Need more detailed survey data of the channel in the Black Brook box culvert area:**

   Removing the debris from the stop log dam downstream for the box culvert may help improve the flow conditions through the box culvert, but the detail survey data will help verify if existing and proposed conditions will be adequate. If the channel slope is not adequate to allow for continuous flow without the backwater effects, then a by-pass channel or other corrective activity may also be needed.

3. **Significant Sediment is flow into the South Branch of Black Brook from the gravel Huse Road:**

   Huse Road parallels a portion of the South Branch on a fairly steep grade draining primarily towards Roxbury Road where it crosses the South Branch. During the field visit in the summer of 2020 significant erosion of road material off the road and in the roadside ditch was observed, much of which was entering the brook. Some effort had been made to construct cut-out swales to try to divert the flows away from the road into the adjacent woodland. However, most of these areas were so steep that the flows continued down the slope through the woodland causing erosion in the woods with little or no filtering of the flow. None of the swales were vegetated and were on outlet slopes that continued to erode with the diverted flows. Some areas along the road did not have access to divert the flows away from the road into the woodland, so the flows continued in the roadside ditch for extensive lengths causing additional erosion in the ditch and on the road.

   There are several things that could be done to help modify and eliminate much of these problems. Some of these solutions will require significant funding and acceptance of the local residents and town officials. The following is a list of the proposed solutions along with some design considerations and guidance:

   - Consider paving Huse Road and constructing a paved roadside channel on the steeper sections of the road to carry flows to points of safe outlet away from the road in vegetated swales with level lip spreader to then overflow into the woods. The diverted flow needs to gently flow through the woodland towards the brook to minimize erosion and treat the flow. Where distances between adequate outlets exceeds 300 to 400 feet, consider installing catch basins with underground outlet pipes to an adequate outlet on either side of the road. Catch basins should be installed with deep sumps to collect road sand for removal as needed throughout the year. Where gravel driveways slope toward Huse Road, consider installing broad water bars to divert sediment ladened water into sediment basins beside the driveway which then overflow into the roadside ditch. The sediment basins would need periodic cleaning to maintain functionality. See Photo 5, 6, 7, and 8.

- If paving Huse Road is not an option, then consider installing stone lined roadside ditches to reduce erosion in the ditch. Outlet the ditch into properly designed vegetated swales which overflow from level lip spreaders into the woods. As recommended above, use deep sump catch basins where needed to collect the flows in the stone lined ditch to discharge off the road in adequately designed swales with level lip spreaders. The catch basin should be set in stone lined depressions to collect the flows without overtopping and continuing to flow down the road. Gravel driveways entering onto Huse Road should be modified as noted above with sediment basins.

Photo 5 – Huse Road above S Branch Black Brook

Photo 6 – Huse Road turnout above Brook

Photo 7 – Huse Road ditch turnout

Photo 8 – Huse Road Ditch and adjacent woodland

4. **Significant sediment is flowing into the North Branch of Black Brook from Kaulbank Road.**
   - Runoff from the gravel road entering the roadside ditches needs to be properly diverted into a vegetated swale which outlets into a properly sized and constructed level lip spreaders. The diverted flow needs to gently flow through the woodland towards the brook to minimize erosion and treat the flow. This portion of the North Branch of Black Brook has a broad flat floodplain through which Kaulbank Road is elevated above the floodplain for a significant length. As a gravel road across the floodplain, there is little area to trap and treat runoff from the road before it enters the brook. See Photos 9 and 10. Two alternatives may be possible to help minimize sediment from the road entering the brook:
     1. Lengthen the culverts if needed to create approximately 4 feet of vegetated shoulder on each side of the road passing over the culverts to filter sediment out of the runoff before it enters the brook. This shoulder area would need appropriate maintenance to keep the vegetation growing vigorously and not be damaged with road maintenance.
     2. Pave approximately 200 feet of the road over the culverts with appropriate curbs to divert flows from the road to locations where

adequate swales and level lip spreaders could be constructed to treat the runoff from the road both from the paved area and road sections beyond.

Photo 9 – Kaulback Road crossing North Branch Black Brook

Photo 10 – Kaulback Road turnout above North Branch Black Brook

- Further east on Kaulback Road, the road crosses a tributary to the North Branch of Black Brook. There is significant erosion from the road and sediment flowing into the brook. Flows in the roadside ditches should be diverted into the woods using properly designed vegetated swales and spreaders at intervals of 200 to 300 feet if possible. If longer flow lengths are required, then the swales may require riprapped bottoms to protect from erosion if the slopes are too steep. Under this condition, a sediment trap may also be needed to reduce the amount of sediment flowing through the swale and into the spreaders. Survey data will be needed in this road segment will be needed to develop more precise designs.

5. **Minor sediment load from Roxbury Road near the intersection with Kaulback Road.**
    - The Black Brook Watershed Management Plan documented this location for controlling sediment which flows directly into a tributary to the North Branch of Black Brook. Sediment off Roxbury Road into the roadside ditch needs to be directed into a properly constructed swale and level lip spreader into the

woods instead of flowing into the tributary. The road is incised within the land area on each side preventing discharging into swales on the sides. There may be some opportunity to cut a swale through the side bank with a swale and level lip spreader where the banks are low enough. At the lower end there is a need for a sediment basin flowing into a level lip spreader to control flows from the other side of the road. These recommendations are documented in the Watershed Management Report. A more detailed assessment along with survey data will be needed to adequately design the proper BMP's for this location in the watershed.

6. **Minor sediment load from Woodman Road into the South Branch of Black Brook.**
   - The Black Brook Watershed Management Plan documented this location where significant stormwater flowing off Woodman Road drains to a driveway culvert which then discharges to a tributary to the South Branch of Black Brook. The culvert appeared undersized and partially blocked causing erosion of the gravel driveway and shoulder of the Woodman Road. A bioretention system may be feasible at this site if the landowners give permission. The system could discharge treated water to the same outlet location as the driveway culvert.
   - Another site consists of runoff from a driveway that is impacting an undersized swale which allows flow to cross Woodman Road. As documented in the Watershed Management Plan, the swale needs to be enlarged along with a sediment basin to treat this flow before entering a culvert in the driveway to the cemetery.

7. **Minor sediment (road sand) from Black Brook Road into Black Brook near the new Box Culvert.**
   - The Black Brook Watershed Management Plan identifies sediment off of Black Brook as a concern for action to protect the water quality of Black Brook. This plan was written in 2012 and since then the circular culverts were

replaced with the two box culverts. During the construction process, the road was raised slightly with additional shoulder width added to the road. Runoff from the paved road now gets filtered through the vegetation on the shoulder as well as being directed farther away from the stream before it flows into the channel. Observations at the site did look like this issue was adequately addressed. However, when restoration work in the channel to remove the sediment is conducted, stability of the channel banks and adjacent floodplain will be critical to ensure flows and sediment from the road does not again create problems in the culverts. See Photo 11.

Photo 11 – Black Brook Road over new Culverts after construction completed

Summary

This assessment was prepared based on available information from onsite visits and existing data and reports along with professional knowledge of erosion and sedimentation processes that occur in stormwater flows. The intent was not to conduct detail site surveys and streambed sampling to determine this assessment. The goal was to determine potential restoration projects at specific sites where erosion, sedimentation, and/or water quality issues were observed and make recommendations to resolve observed issues and note where more data gathering is needed to confirm the viability of certain recommendations. To this end, the following list of prioritized projects is what I would recommend based on anticipated greatest gains to improving the water quality flowing from Black Brook into Lake Winnisquam:

1. Conduct a detail channel survey of Black Brook from approximately 500 feet upstream of the twin box culverts in Black Brook Road to approximately 500 feet downstream of the stop log dam in the channel downstream of the twin box culverts. The survey should focus on getting the channel bottom elevations to determine the grade through the box culverts, stop log dam, and channel downstream. Several cross sections both upstream and downstream of the road with significant floodplain width will help determine if and where a bypass channel could be placed if needed.
2. Removal of the debris in front of the stop log dam downstream from the box culverts in Black Brook Road and removal of the excess sediment upstream of and within the box culverts. Completion of this item should help re-establish the proper channel slope through and downstream of the box culverts to maintain proper culvert and channel flow hydraulics in this stream segment. Along with the debris removal, the sediment that is now blocking the design flow through the box culverts and the excess sediment in the channel upstream of the culverts should be removed to keep it from flowing downstream when the channel is reopened downstream. This will help protect the water quality in Lake Winnisquam.
3. Ensure that adequate vegetated shoulders and slopes are maintained on both sides of Black Brook Road over the culverts and for at least 500 feet in both directions from the culvert. This will reduce sediment from the road reaching the channel.
4. Major renovation of Huse Road displayed as two major alternatives based on expense of completing:
    a. Pave the gravel road with asphalt including paved ditches to collect the runoff and safely divert it into vegetated swales with level lip spreaders at appropriate intervals along the road. In locations where vegetated swales are not feasible, catch basins with underground outlets may be needed to direct the runoff into vegetated swales with level lip spreaders, or stone lined channels discharging into level lip spreaders. This treatment is recommended the whole length of Huse Road.

   b. If paving is not an option, then recommend installing rock lined ditches along the road directing runoff into vegetated swales with level lip spreaders. In locations where swales are not feasible, then recommend using catch basins with underground outlets discharging into vegetated swales with level lip spreaders. In locations where vegetated swales are not possible, then recommend using rock lines channels discharging into level lip spreaders. Again, this treatment is recommended the whole length of Huse Road.

5. Maintenance and restoration work on Kaulback Road where it passes over the North Branch of Black Brook and where is also passes over a major tributary flowing into the North Branch:
   a. At the North Branch crossing, more diversions of the flow from the road side ditches are needed and they need to discharge into vegetated swales which outlet into level lip spreaders. Also, the road is built up over the culverts for a significant length in the floodplain of North Branch so significant amounts of road sand and gravel erode off the road right into the channel. Two recommendations were proposed using pavement over a portion of the road with curbs or increasing the vegetated shoulder width to filter the road runoff as noted in the Site Improvement Discussion section.
   b. The crossing over the Tributary of North Branch also has sediment issues from the road runoff which can be solved with properly installed vegetated treatment swales and level lip spreaders at appropriate spacing.
6. Minor sediment loading from Roxbury Road near the intersection with Kaulback Road and Woodman Road into the South Branch of Black Brook both contribute sediment to the watershed system. Both of these locations were described in the Site Improvement Discussion section with proposed corrective action. Both locations do need some survey work to properly design the restoration and water quality improvement BMP’s for the site-specific issues.

Cost estimates were not included in this assessment since more site-specific survey data is needed to develop approximate designs for cost estimates to be computed. If, and when the surveys are completed and plotted, an addendum could be prepared to add to the information included in the assessment.

Prepared By: Gerald J. Lang, PE

ATTATCHMENTS

The following list of Sediment and Stormwater Control Measures are from the New Hampshire Stormwater Manual: Volume 2 and Volume 3 publications for information in describing what can be constructed to control stormwater runoff for Water Quality purposes:

Pre-Treatment Swales

Stone Berm Level Spreaders

Treatment Swales

Ditch Turn-out Buffer

Temporary Sediment Traps

3. PRE-TREATMENT SWALES

General Description

Pre-treatment swales are shallow, vegetated, earthen channels designed to convey flows, while capturing a limited amount of sediment and associated pollutants. A pre-treatment swale differs from a Treatment Swale in that the grass swale is not designed for a specified hydraulic residence time, but only for a minimum length. Therefore, pre-treatment swales do not necessarily provide sufficient time for the removal of pollutants other than those associated with larger sediment particles, and may only be used for pretreatment.

The Treatment Swale is described in this manual under Treatment Practices, and provides enhanced pollutant removal through filtration through vegetation, infiltration into underlying soils and physical settling.

General Requirements Applicable to Pre-treatment Swales

- Swales are prohibited in areas of RSA 482-A jurisdiction unless a wetlands permit has been issued
- Swales are prohibited in groundwater protection areas receiving stormwater from a high-load area unless an impermeable liner is provided
- Swale shape should be trapezoidal or parabolic
- Bottom of swale should not be within the seasonal high water table.
- Swale should be vegetated.

Design Considerations

- Pre-treatment swales must be designed so that the flow travels the full length to receive adequate pretreatment. For this reason, flow must be directed to the inlet end of the swale, rather than the swale collecting water continuously along its length.
- Vegetation should be selected based on site soil conditions, anticipated mowing requirements (height, frequency), and design flow velocities.
- All channels should be designed for *capacity* and *stability*. A channel is designed for capacity when it can carry the maximum specified design flow within the design depth of the channel (allowing for recommended freeboard). A channel is designed for *stability* when the channel lining (e.g., vegetation) will not be eroded under maximum design flow velocities. Analyses of these conditions must account for both the type of lining and its condition (for example, capacity analysis for a grassed channel must consider the resistance of the maximum height of grass, while the stability analysis must consider the grass under its shortest, mowed condition).

Maintenance Requirements

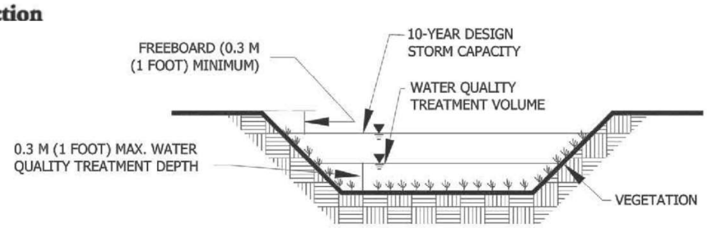
- Inspect annually for erosion, sediment accumulation, vegetation loss, and presence of invasive species.
- Perform periodic mowing; frequency depends on location and type of grass. Do not cut shorter than Water Quality Flow depth (minimum 4-inches)
- Remove debris and accumulated sediment, based on inspection.
- Repair eroded areas, remove invasive species and dead vegetation, and reseed with applicable grass mix as warranted by inspection.

Design References

- EPA (1999e)

Example Design

Section



Adapted from MassHighway (2004)

Design Criteria

Design Parameter	Criteria
Minimum Length	≥ 50 feet (not including portions in a roadside ditch)
Bottom Width	4 to 8 feet
Longitudinal Slope	0.5% to 2% without check dams 2% to 5% with check dams
Maximum Side Slopes	3:1
Flow Depth	4 inches maximum at the WQF
Design Discharge Capacity	10-year, 24-hour storm without overtopping

2. STONE BERM LEVEL SPREADERS

General Description

A stone berm level spreader is an outlet structure constructed at zero percent grade across a slope used to convert concentrated flow to "sheet flow." It disperses or "spreads" flow thinly over a receiving area, usually consisting of undisturbed, vegetated ground. The conversion of concentrated flow to shallow, sheet flow allows runoff to be discharged at non-erosive velocities onto natural ground. To stabilize the spreader outlet, a stone berm is provided to dissipate flow energy, and help disperse flows along the length of the spreader.

Level spreaders are not designed to remove pollutants from stormwater; however, some suspended sediment and associated phosphorous, nitrogen, metals and hydrocarbons will settle out of the runoff through settlement, filtration, infiltration, absorption, decomposition and volatilization.

General Requirements Applicable to Stone Berm Level Spreaders

- The spreader must discharge to a vegetated receiving area with capacity to convey the discharge without erosion;
- The receiving area must be stable prior to construction of level spreader.

Design Considerations

- It is critical to install level spreaders at a zero percent grade along the length of the discharge lip. Flow must discharge uniformly along the length of the spreader.
- Care must be exercised in siting the spreader, so that it discharges onto a gently sloping grade, where runoff exiting the spreader will not re-concentrate and cause erosion. A slope that is concave in shape (such as a shallow swale) is not suitable for receiving the discharge from a level spreader. Suitable slopes are planar or convex in shape, so that flow will continue as dispersed sheet flow across the site.
- It is essential to stabilize the outlet lip of the spreader, and to discharge onto a well stabilized receiving area (preferably undisturbed vegetation) to prevent erosion.

Maintenance Requirements

- Inspect at least once annually for accumulation of sediment and debris and for signs of erosion within approach channel, spreader channel or down-slope of the spreader.
- Remove debris whenever observed during inspection.
- Remove sediment when accumulation exceeds 25% of spreader channel depth.
- Mow as required by landscaping design. At a minimum, mow annually to control woody vegetation within the spreader.
- Snow should not be stored within or down-slope of the level spreader or its approach channel.
- Repair any erosion and re-grade or replace stone berm material, as warranted by inspection.
- Reconstruct the spreader if down-slope channelization indicates that the spreader is not level or that discharge has become concentrated, and corrections cannot be made through minor re-grading.

Design References

- Maine DEP (2006)

Design Criteria

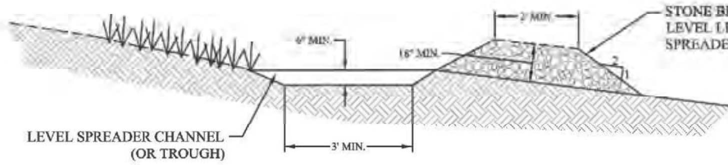
Design Parameter	Criteria
Slope of Receiving Area	< 15% (along flow path)
Level Spreader Grade	Bottom of spreader channel, and base and top of berm should be 0% grade
Spreader Channel Cross Section	6-inch deep trapezoidal trough
Spreader Channel Bottom Width	≥ 3 feet
Side Slopes	2:1 or flatter (level spreader channel and berm)
Berm Top Width	≥ 2 feet
Berm Height	≥ 18 inches
Stone Gradation	See Table 4-13
Length of Spreader	When part of a Treatment Practice, the length should be as required for that practice. If not, the length should be no less than 5 feet.

Table 4-13. Gradation of Stone for Level Spreader Berm

Sieve Designation	Percent by Weight Passing Square Mesh Sieve
12-inch	100%
6-inch	84% - 100%
3-inch	68% - 83%
1-inch	42% - 55%
No. 4	8% – 12%

Example Design

Profile



5. TREATMENT SWALES

General Description

Treatment swales are designed to promote sedimentation by providing a minimum hydraulic residence time within the channel under design flow conditions (Water Quality Flow). This BMP may also provide some infiltration, vegetative filtration, and vegetative uptake. Conventional grass channels and ditches are primarily designed for conveyance. Treatment swales, in contrast, are designed for hydraulic residence time and shallow depths under water quality flow conditions. As a result, treatment swales provide higher pollutant removal efficiencies. Pollutants are removed through sedimentation, adsorption, biological uptake, and microbial breakdown.

Treatment swales also differ from practices such as underdrained swales (for example, "dry swales" and "bioretention swales"), which are essentially filtration practices, and "wet swales," which are similar in function to pocket ponds.

General Requirements Applicable to Treatment Swales

- Swales are prohibited in areas of RSA 482-A jurisdiction unless a wetlands permit has been issued
- Swales are prohibited in groundwater protection areas receiving stormwater from a high-load area unless an impermeable liner is provided
- Swale shape should be trapezoidal or parabolic
- Swale must have ≥ 85% vegetated growth prior to receiving runoff
- Bottom of swale must be above seasonal high water table

Design Considerations

- Flow-Through Swales must be designed so that the flow travels the full length to receive adequate treatment. For this reason, flow must be directed to the inlet end of the swale, rather than the swale collecting water continuously along its length.
- All channels should be designed for capacity and stability. A channel is designed for capacity when it can carry the maximum specified design flow within the design depth of the channel (allowing for recommended freeboard). A channel is designed for stability when the channel lining (vegetation, riprap, or other material) will not be eroded under maximum design flow velocities. Analyses of these conditions must account for both the type of lining and its condition (for example, capacity analysis for a grassed channel must consider the

resistance of the maximum height of grass, while the stability analysis must consider the grass under its shortest, mowed condition).

- Vegetation should be selected based on site soils conditions, planned mowing requirements (height, frequency), and design flow velocities.
- The roughness coefficient, n, varies with the type of vegetative cover and flow depth. At very shallow depths, where the vegetation height is equal to or greater than the flow depth, the n value should be approximately 0.15. This value is appropriate for flow depths up to 4 inches typically. For higher flow rates and flow depths, the n value decreases to a minimum of 0.03 for grass channels at a depth of approximately 12 inches. The n value must be adjusted for varying flow depths between 4" and 12" (see chart below).

Maintenance Requirements

- Inspect annually for erosion, sediment accumulation, vegetation loss, and presence of invasive species.
- Perform periodic mowing; frequency depends on location and type of grass. Do not cut shorter than Water Quality Flow depth (maximum 4-inches)
- Remove debris and accumulated sediment, based on inspection.
- Repair eroded areas, remove invasive species and dead vegetation, and reseed with applicable grass mix as warranted by inspection.

Design References

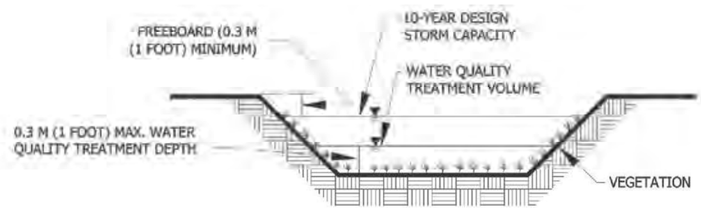
- Minton (2005)

Design Criteria

Design Parameter	Criteria
Minimum Length	≥ 100 feet (not including portions in a roadside ditch)
Bottom Width	4 to 8 feet (widths up to 16 feet are allowable with dividing berm/structure such that neither channel width exceeds 8 feet)
Longitudinal Slope	0.5% to 2% without check dams 2% to 5% with check dams
Maximum Side Slopes	3:1
Flow Depth	4 inches maximum at the WQF
Hydraulic Residence Time	≥ 10 minutes during the WQF
Design Discharge Capacity	10-year, 24-hour storm without overtopping

Example Design

Section



Adapted from MassHighway (2004)

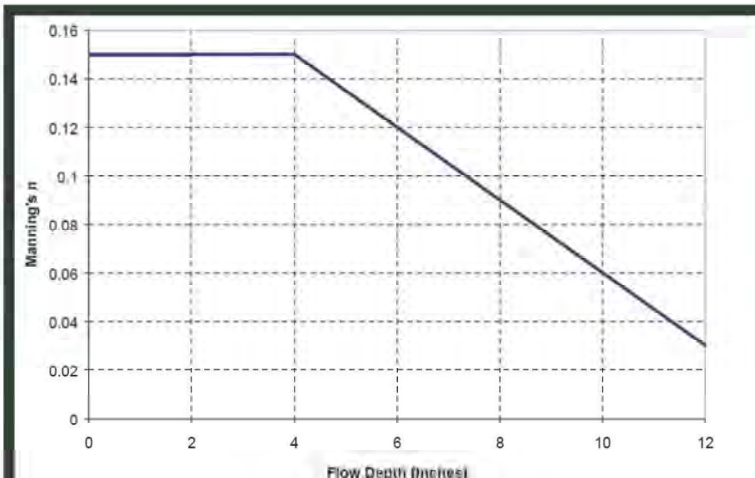


Figure 4-3. Manning's n Value with Varying Flow Depth (Source: Claytor and Schueler, 1986)

6D. Ditch Turn-out Buffer

A ditch turn-out buffer diverts runoff collected in a roadside ditch into a buffer. A combination of check dams and bermed level lip spreaders convert the concentrated ditch flows into sheet flow. The sheet flow distributes across the top of the buffer.

Design Considerations

- Proper grading is essential to establish the level spreader along the contour, so that the outlet of the device is level and distributes discharge as sheet flow over the width of the buffer.
- Soil stabilization measures should be implemented to prevent erosion and local rill and gulley formation until permanent vegetation is established.

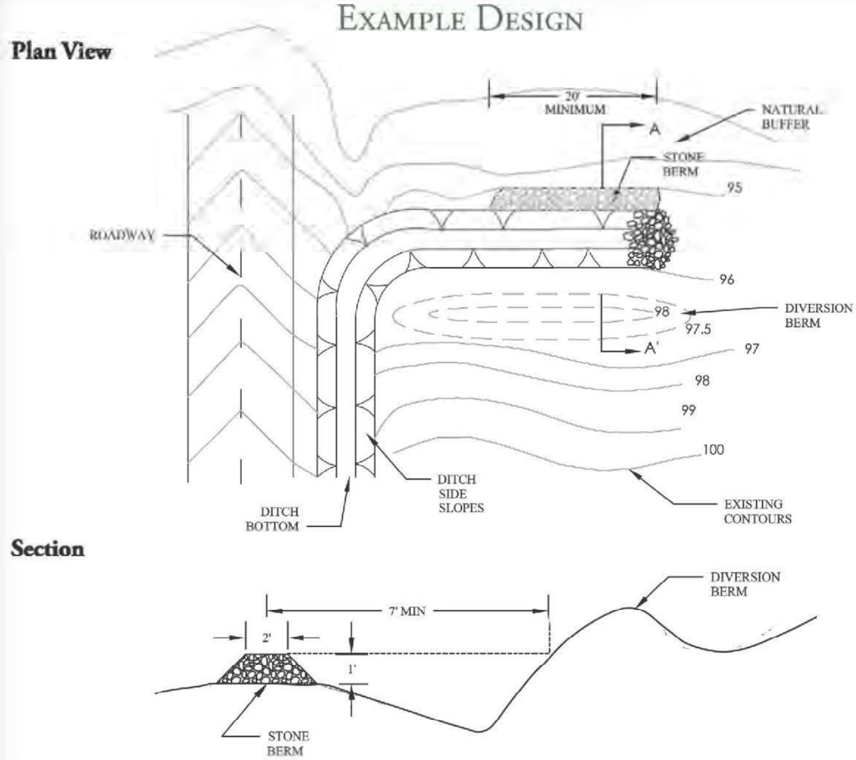
Maintenance Requirements

- Inspect level spreader and buffer at least annually for signs of erosion, sediment buildup, or vegetation loss.
- If a meadow buffer, provide periodic mowing as needed to maintain a healthy stand of herbaceous vegetation.
- If a forested buffer, then the buffer should be maintained in an undisturbed condition, unless erosion occurs.
- If erosion of the buffer (forested or meadow) occurs, eroded areas should be repaired and replanted with vegetation similar to the remaining buffer. Corrective action should include eliminating the source of the erosion problem, and may require retrofit with a level spreader.
- Remove debris and accumulated sediment, based on inspection.

Design References

- Maine DEP (2006)

Example Design



Design Criteria

Design Parameter	Criteria
Allowable Contributing Area	• No areas other than road surface, shoulder, and road ditch • ≤ 500 feet of 1 travel lane + ditch • ≤ 250 feet of 2 travel lanes + ditch • ≤ 6,000 sq. ft. of pavement, if > 2 lanes + ditch are directed to the buffer
Maximum Slope	15 %, slope must be uniform
Length and Width of Buffer	Size flow length of buffers per Tables 4-10 and 4-11.
Minimum Level Spreader Length	20 feet
Stone Berm Level Spreader	Must meet the requirements for level spreaders described in Section 4.6

Table 4-10. Required Buffer Flow Path Length per Length of Road or Ditch with 0% to 8% Buffer Slope			
Hydrologic Soil Group of Soil in Buffer	Maximum Length of a One Lane road or Ditch Draining to a Buffer (feet)	Length of Flow Path for Forested Buffer (feet)	Length of Flow Path for Meadow Buffer (feet)
A or B	200	50	70
	300	50	85
	400	60	100
D	200	60	100
	300	75	120
	400	100	Not Applicable
D	200	100	150

Table 4-11. Required Buffer Flow Path Length per Length of Road or Ditch with Greater than 8% to 15% Buffer Slope			
Hydrologic Soil Group of Soil in Buffer	Maximum Length of a One Lane road or Ditch Draining to a Buffer (feet)	Length of Flow Path for Forested Buffer (feet)	Length of Flow Path for Meadow Buffer (feet)
A or B	200	60	85
	300	60	100
	400	70	120
C	200	70	120
	300	90	145
	400	120	Not Applicable
D	200	120	180

TEMPORARY SEDIMENT TRAP

General Description

A sediment trap is a small, temporary ponding area to intercept sediment-laden runoff from small disturbed areas. Intercepted runoff is retained long enough to allow for settling of the coarser sediment particles. A sediment trap is usually installed in a drainage swale or channel, at a storm drain or culvert inlet, or other points of discharge from a disturbed area.

Considerations

- A sediment trap should be installed as close as possible to the disturbed area or sediment source.
- Sediment traps should be used in drainage ways with small watersheds (contributing drainage area less than 5 acres). For larger contributing areas, engineered sediment basins should be used instead.
- Sediment traps should be installed where runoff from undisturbed areas can be excluded from the trap.
- Traps should be located to obtain maximum storage benefit from the terrain, as well as for ease of removal and disposal of accumulated sediment.

Maintenance Requirements

- Sediment traps should be inspected at least weekly during construction and after every storm (or daily during prolonged rainfall periods), to insure that they are functioning properly and are not damaged. Repairs should be made immediately.
- Sediment should be removed and the trap restored to original capacity when sediment has accumulated to 50% of the original volume.
- The materials removed from the trap should be properly disposed of and stabilized.
- Sediment trap outlets should be examined at the time of inspection for any damage, and repaired immediately if any such damage is observed.
- Geotextile fabric or stone used around a pipe-outlet riser should be checked periodically and replaced when the material has become clogged with sediment.

Specifications

Temporary sediment traps should meet the following requirements:

- Sediment traps should be located so that they can be installed prior to disturbing the area they are to protect.
- The trap should be installed as close to the disturbed area or source of sediment as possible.
- The maximum contributing drainage area to the trap should be less than 5 acres.
- The minimum volume of the trap should be 3,600 cubic feet of storage for each acre of drainage area.
- The side slopes of the trap should be 3:1 or flatter, and should be stabilized immediately after their construction.

Embankments:

- The maximum height of the sediment trap embankment should be 4 feet when measured from the lowest point of natural ground on the downstream side of the embankment.
- The minimum top width of the embankment should be 6 feet.

Outlets (General Requirements):

- The outlet should be designed, constructed and maintained in such a manner that sediment does not leave the trap and that erosion at or below the outlet does not occur.
- Outlets should be designed so that the top of the embankment is a minimum of 1 foot above the crest elevation of the outlet. The outlet of the trap should be a minimum of one foot below the crest of the trap
- The outlet should discharge to a stabilized area. The outlets must empty onto undisturbed ground, into a watercourse, stabilized channel or a storm sewer system.
- Outlets may be constructed as earth spillways, stone outlets, or pipe outlets.

Earth Outlets:

- An earth outlet sediment trap has a discharge point that is either over natural ground or cut into natural ground.
- The outlet width should be equal to 6 times the drainage area in acres.
- The embankment and outlet should be vegetated within 3 days of construction.

Stone Outlets:

- A stone outlet sediment trap has an outlet consisting of a crushed stone section in the embankment.

- The stone section should be located at the low point of the natural ground, as determined at the downstream side of the embankment.
- The outlet should be constructed of minimum size 1 ½" crushed stone.

Pipe Outlet:

- A pipe outlet sediment trap has a pipe through the embankment, with an inlet consisting of a perforated riser.
- The pipe and riser should be constructed of corrugated metal. Plastic pipe (polyvinyl chloride or high-density polyethylene) may be considered, if the piping is located where it will not be subject to damage from vehicle traffic or from ice and frost conditions.
- The top 2/3 of the riser should be perforated with 1-inch diameter holes spaced 8 inches vertically and 10 to 12 inches horizontally around the pipe.
- Anchoring Weight: The riser should have a base with sufficient weight to prevent flotation of the riser. Two approved bases are: (1) A concrete base 12 inches thick with the riser embedded 9 inches into the concrete base, or (2) 1/4" minimum thickness steel plate attached to the riser by a continuous weld around the circumference of the riser to form a watertight connection. The plate should have 2.5 feet of stone, gravel, or earth placed on it to prevent flotation. In either case, each side of the square base measurement should be the riser diameter plus 24 inches.
- In order to increase the efficiency of the trap, the riser can be wrapped with a geotextile fabric held in place by woven wire and secured by strapping. The cloth should cover an area at least six (6) inches above the highest hole and six (6) inches below the lowest hole. The top of the riser pipe should not be covered with filter cloth.
- Crushed stone can also be used around the riser to increase trap efficiency.

- The minimum pipe sizes should be determined as provided in the following table:

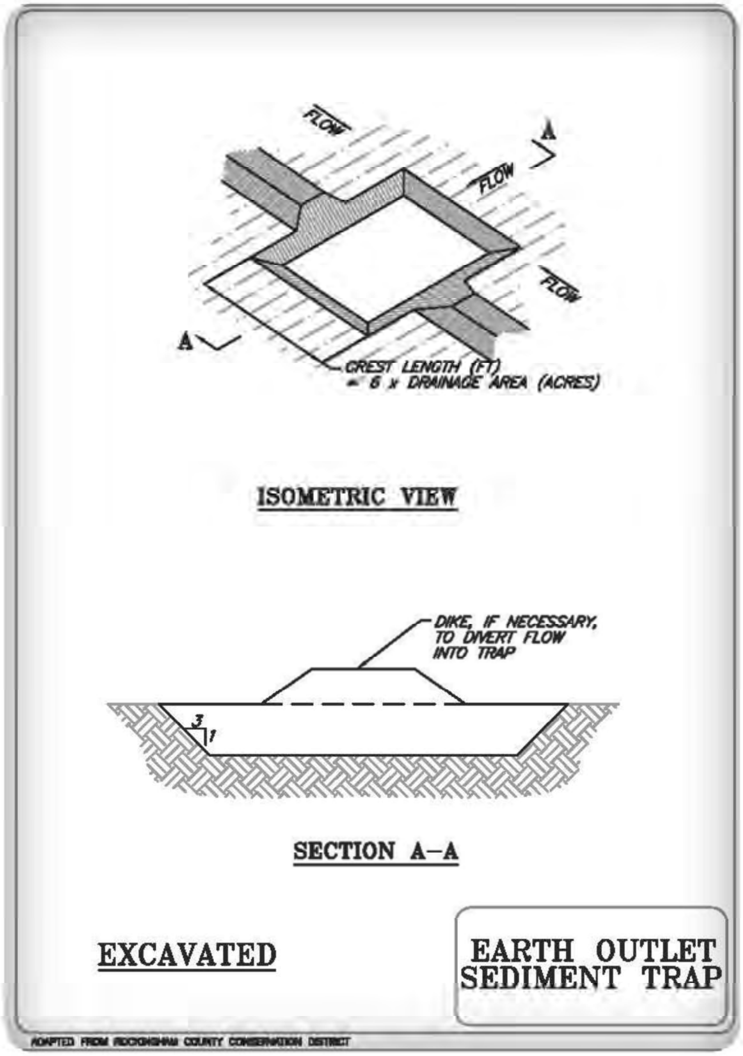
Maximum Drainage Area (acres)	Minimum Barrel Diameter (inches)	Minimum Riser Diameter (inches)
1	15	21
2	18	24
3	21	30
4	24	30
5	30	36

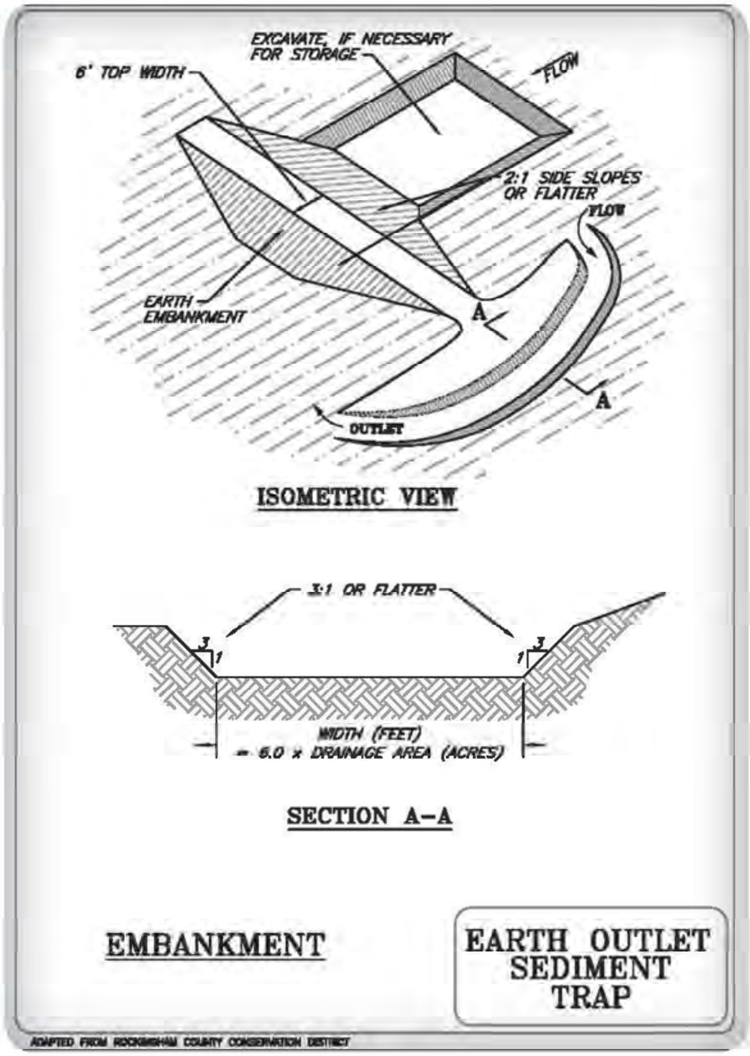
Combination of Earth, Stone, or Pipe Outlets:

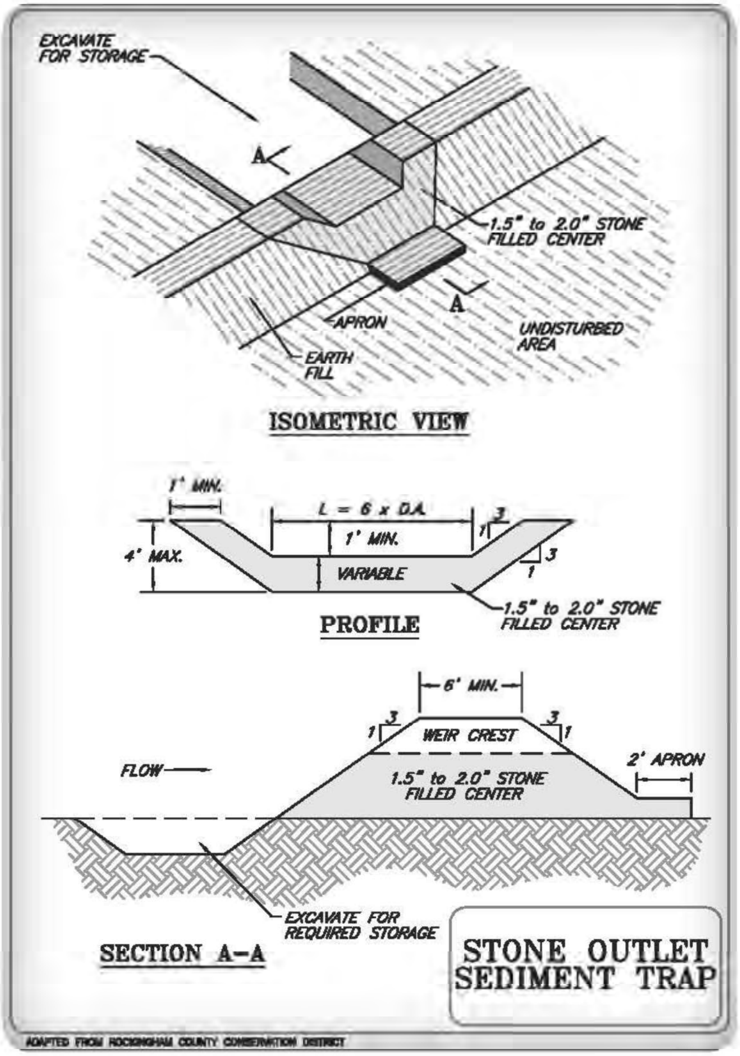
- A temporary sediment trap may have a combination of outlets. For instance, a 16.5-foot earth spillway outlet (adequate for 3 acres) and a pipe outlet with an 18" CMP barrel with a 24" CMP riser (adequate for 2 acres) could be used for the maximum drainage area of 5 acres.

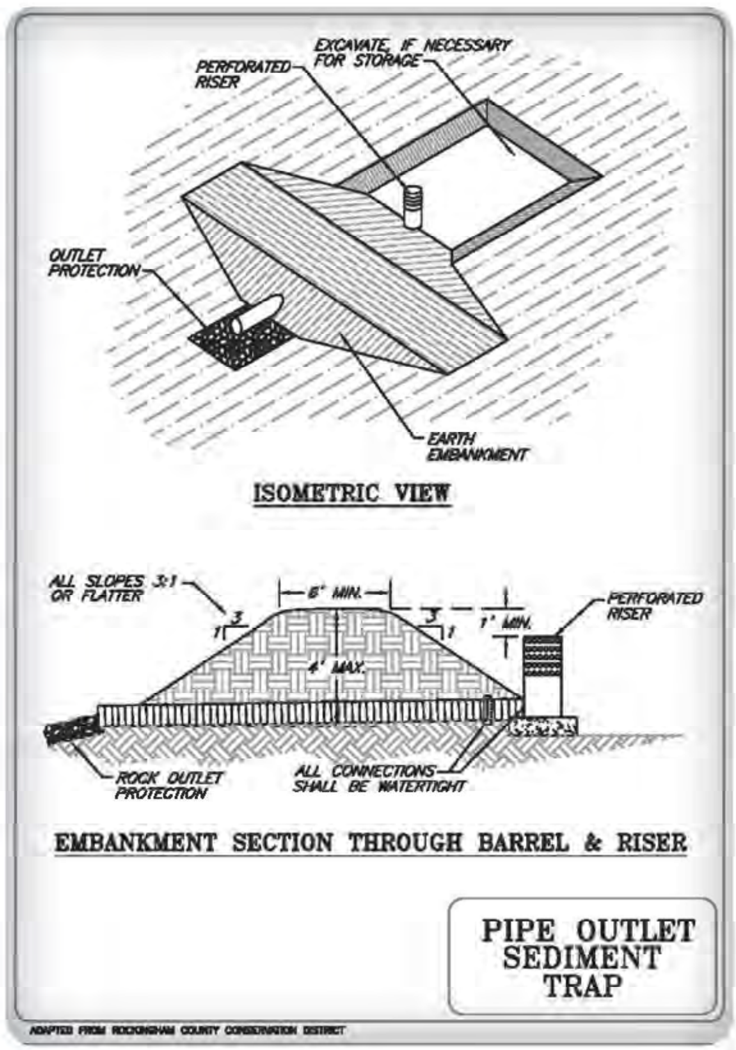
Vegetation:

- All embankments, earth spillways, and disturbed areas below the structure should be vegetated within 72 hours of completion of the construction of the structure.
- If the structure is not planned for more than one vegetative growing season, the structure may be vegetated using the recommendation of the Temporary Vegetation Best Management Practice described in this manual.
- Basins that will be carried over the winter and into the next vegetative growing season should be vegetated using the recommendations for Permanent Vegetation Best Management Practice


FLOW
A
FLOW
FLOW
A
CREST LENGTH (FT)
= 6 x DRAINAGE AREA (ACRES)
ISOMETRIC VIEW
DIKE, IF NECESSARY,
TO DIVERT FLOW
INTO TRAP
3
1
SECTION A–A
EXCAVATED
EARTH OUTLET
SEDIMENT TRAP
ADAPTED FROM ROCKINGHAM COUNTY CONSERVATION DISTRICT


EXCAVATE, IF NECESSARY FOR STORAGE
6' TOP WIDTH
FLOW
2:1 SIDE SLOPES OR FLATTER
FLOW
EARTH EMBANKMENT
A
A
OUTLET
ISOMETRIC VIEW
3:1 OR FLATTER
3
1
1
3
WIDTH (FEET) = 6.0 x DRAINAGE AREA (ACRES)
SECTION A-A
EMBANKMENT
EARTH OUTLET SEDIMENT TRAP
ADAPTED FROM ROCKINGHAM COUNTY CONSERVATION DISTRICT


EXCAVATE FOR STORAGE
A
1.5" to 2.0" STONE FILLED CENTER
A
APRON
UNDISTURBED AREA
EARTH FILL
ISOMETRIC VIEW
1' MIN.
L = 6 x D.A.
3
1
1' MIN.
4' MAX.
3
1
VARIABLE
1.5" to 2.0" STONE FILLED CENTER
PROFILE
6' MIN.
3
1
WEIR CREST
3
1
FLOW
2' APRON
1.5" to 2.0" STONE FILLED CENTER
EXCAVATE FOR REQUIRED STORAGE
SECTION A-A
STONE OUTLET SEDIMENT TRAP


EXCAVATE, IF NECESSARY FOR STORAGE
PERFORATED RISER
OUTLET PROTECTION
EARTH EMBANKMENT
ISOMETRIC VIEW
ALL SLOPES 3:1 OR FLATTER
6' MIN.
3
1
1' MIN.
4' MAX.
PERFORATED RISER
ROCK OUTLET PROTECTION
ALL CONNECTIONS SHALL BE WATERTIGHT
EMBANKMENT SECTION THROUGH BARREL & RISER
PIPE OUTLET SEDIMENT TRAP
ADAPTED FROM ROCKINGHAM COUNTY CONSERVATION DISTRICT

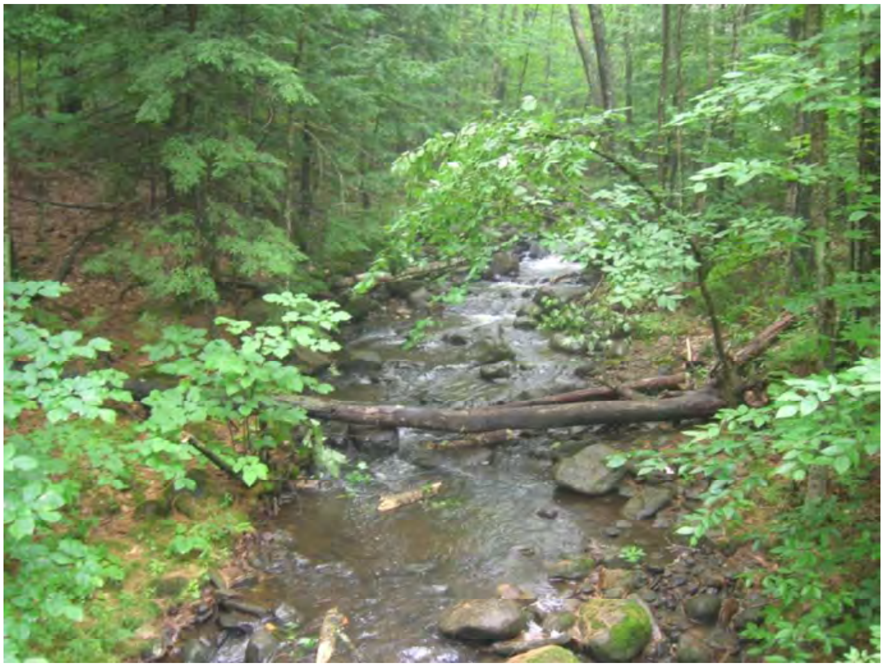
Appendix J:

Black Brook Watershed Management Plan dated September 2012

Environment

Prepared for:
Town of Sanbornton

Prepared by:
AECOM
Manchester, NH
60163921
September 2012



Black Brook
Watershed Management Plan

Environment

Prepared for:
Town of Sanbornton

Prepared by:
AECOM
Manchester, NH
60163921
September 2012

Black Brook
Watershed Management Plan

Prepared By:
Don Kretchmer and Al Pratt

Reviewed By:
Jake San Antonio

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Executive Summary

A watershed management plan was prepared for Black Brook Watershed, New Hampshire. Black Brook is a tributary to Lake Winnisquam. Lake Winnisquam is a high quality lake but has experienced threats to water quality in recent years. This effort included the construction of a nutrient budget and setting a target value for phosphorus loading for the Black Brook watershed that would not cause algal blooms and preserve the lake as the high quality water it has been in recent history. Limiting phosphorus concentrations and associated algal growth should be sufficient to maintain water quality throughout the lake. While the Black Brook watershed is only a small part of the greater Lake Winnisquam watershed, the development of a plan for this watershed is expected to serve as a model for additional watersheds around the lake. The phosphorus loads are allocated among all sources of phosphorus to the lake such that resultant in-lake phosphorus concentrations meet the target and Lake Winnisquam supports its designated uses. The portion of the load that comes from Black Brook is then evaluated in more detail.

The analysis suggests that the current loads of phosphorus to Lake Winnisquam should be maintained at the current in-lake phosphorus concentration. However, the target value 6.4 μg/L should be coupled with a short-term goal of 6.1 μg/L to allow for some inevitable future increases in phosphorus without compromising water quality. The plan puts primary emphasis on reducing watershed phosphorus sources over other sources due to the relative load contribution from the watershed and practical implementation considerations. It is expected that these reductions would be phased in over a period of several years. Successful implementation of this watershed management plan will be based on maintenance of in lake total phosphorus concentrations at or below the phosphorus target. Specific targeted measures to control phosphorus inputs to the lake are presented and discussed. Guidance for obtaining additional Clean Water Act (Section 319) funding for nonpoint source control is presented in Section 11.0. Suggestions for enhancement of the current monitoring program to monitor progress and effectiveness of control measures are provided.

1.0 Introduction and Water Quality Summary

Lake Winnisquam is a 4264 acre lake with a watershed that encompassed much of the Lakes Region of New Hampshire. The majority of the flow to Lake Winnisquam comes from the Winnipesaukee River which drains Lake Winnipesaukee, the largest lake in the state.(NHDES 2009). The Black Brook watershed comprises less than 10% of the direct watershed of Lake Winnisquam and just over 1% of the entire watershed with the Winnipesaukee River watershed included. Black Brook drains to the Pot Island Basin of Lake Winnisquam, one of three basins in the lake. Characteristics of Lake Winnisquam are presented in Table 1-1. The watershed and the Black Brook subwatershed are shown in Figure 1-1. The amount of impervious cover (i.e., development) within a watershed is correlated with water quality. Poor water quality and significant changes in hydrology are typically experienced in watersheds where impervious cover is at or greater than 10% of the total area (CWP 2003). In areas where impervious cover is greater than 25% (CWP 2003) waters are typically of poor quality and may not support such uses as swimming, and drinking. Although the Black Brook watershed is below the 10% threshold, localized, short-term or periodic water quality problems have been observed.

Table 1-1: Characteristics of Lake Winnisquam, NH

Parameter	Value
Pot Island Basin Area (acres)	3,039
Whole Lake Area (acres)	4,264
Pot Island Basin Volume (m^3)	243,214,210
Whole Lake Volume (m^3)	275,026,320
Black Brook Watershed Area (square miles)	4.6
Pot Island Watershed Area (square miles)	19.9
Lake Winnisquam Direct Watershed without Winnipesaukee River (square miles)	57
Lake Winnisquam Watershed Area with Winnipesukee River (square miles)	430
Mean Depth (ft)	32.2
Max Depth (ft)	173.9
Flushing Rate (yr^{-1})	2.24

Recent water quality data from the New Hampshire Volunteer Lake Assessment Program website were reviewed in the 2009 VLAP report (NHDES 2010). Epilimnetic (upper layer) total phosphorus (TP), Secchi transparency and chlorophyll a (a measure of the amount of algae) concentrations have shown considerable variability over years but a review of the data suggests that mean concentrations are relatively low and have not changed significantly over time. A cyanobacteria warning was issued by NHDES in 2008. Cyanobacteria can release toxins that can be potentially harmful to animals and humans. Deep lakes in the northern temperate region typically undergo thermal stratification. During stratification, oxygen in bottom waters can get depleted by organic matter decomposition processes. In the absence of oxygen, phosphorus can be released from iron in the bottom sediments and be circulated into the water column becoming available for algal uptake. In Lake Winnisquam, concentrations of phosphorus from the hypolimnion (deep layer) have decreased over time suggesting that the lake is continuing to recover since the elimination of wastewater discharges to the lake in the 1970's.

Lake Winnisquam supports a cold water fishery as well as a number of warm water fish species. According to New Hampshire Fish and Game (2011) the lake supports rainbow trout (stocked), lake trout, salmon, largemouth bass, smallmouth bass, white perch, bluegill, chain pickerel and hornpout.

Cyanobacteria were reported in Lake Winnisquam in 2008 (NHDES 2008a). Cyanobacteria and other algal species typically increase in numbers in response to nutrient enrichment. Phosphorus is the primary limiting nutrient in northern temperate lakes, hence algal growth is likely directly related to phosphorus concentrations. Nitrogen can also play a role in determining the type of algae present and the amount of algal growth in a waterbody since some cyanobacteria can fix nitrogen from the atmosphere. A watershed management plan for total phosphorus (TP) as a surrogate for chlorophyll *a* (chl *a*) and cyanobacteria has been prepared for Lake Winnisquam and the results are presented in this report.

The New Hampshire Department of Environmental Services (NH DES) conducted water quality monitoring in the Pot Island Basin of Lake Winnisquam in 1979, 1984, 1990, and 2001 for Lake Trophic Studies (NHDES 2009). Lake Winnisquam has participated in the Volunteer Lake Assessment Program (VLAP) since 1987 (NH DES 2009). Lake Winnisquam also participates in the Lake Host program (NHDES 2009) to educate boaters and examine boats and trailers for exotic plants entering or leaving lakes.

The mean, median and range of selected water quality parameters from each sampling location from the most recent data available (2001-2010) are summarized in Table 1-2. Secchi disk transparencies (SDT), a measure of water clarity, are high, ranging from 6.0 to 10.3 m with a mean of 8.3 m. Chlorophyll a (chl *a*) concentrations, a measure of algal productivity, are low over this time period range from 0.5 to 3.6 µg/L. Total phosphorus (TP) concentrations (the primary nutrient for algal growth) in the epilimnion (surface layer) range from 2.5 to 12 µg/L with a mean of 4.9 µg/L. Hypolimnetic (deep layer) TP concentrations are similar to epilimnetic concentrations ranging from <5.0 to 9.1 µg/L with a mean of 6.6 µg/L. Similar surface and bottom concentrations during the summer stratification period suggest that there is currently little to no sediment release of TP. NHDES (2009) concluded through a statistical evaluation of water quality data collected since 1987 that summer composite chl *a* concentrations, Secchi transparencies and TP concentrations have not changed over that period. Hypolimnetic (deep) concentrations of total phosphorus have significantly decreased throughout the period suggesting that the lake is still improving since the diversion of wastewater from the lake in the 1970's. All of these measures showed that Lake Winnisquam water quality was much better than the typical NH lake and better than most similar high quality lakes.

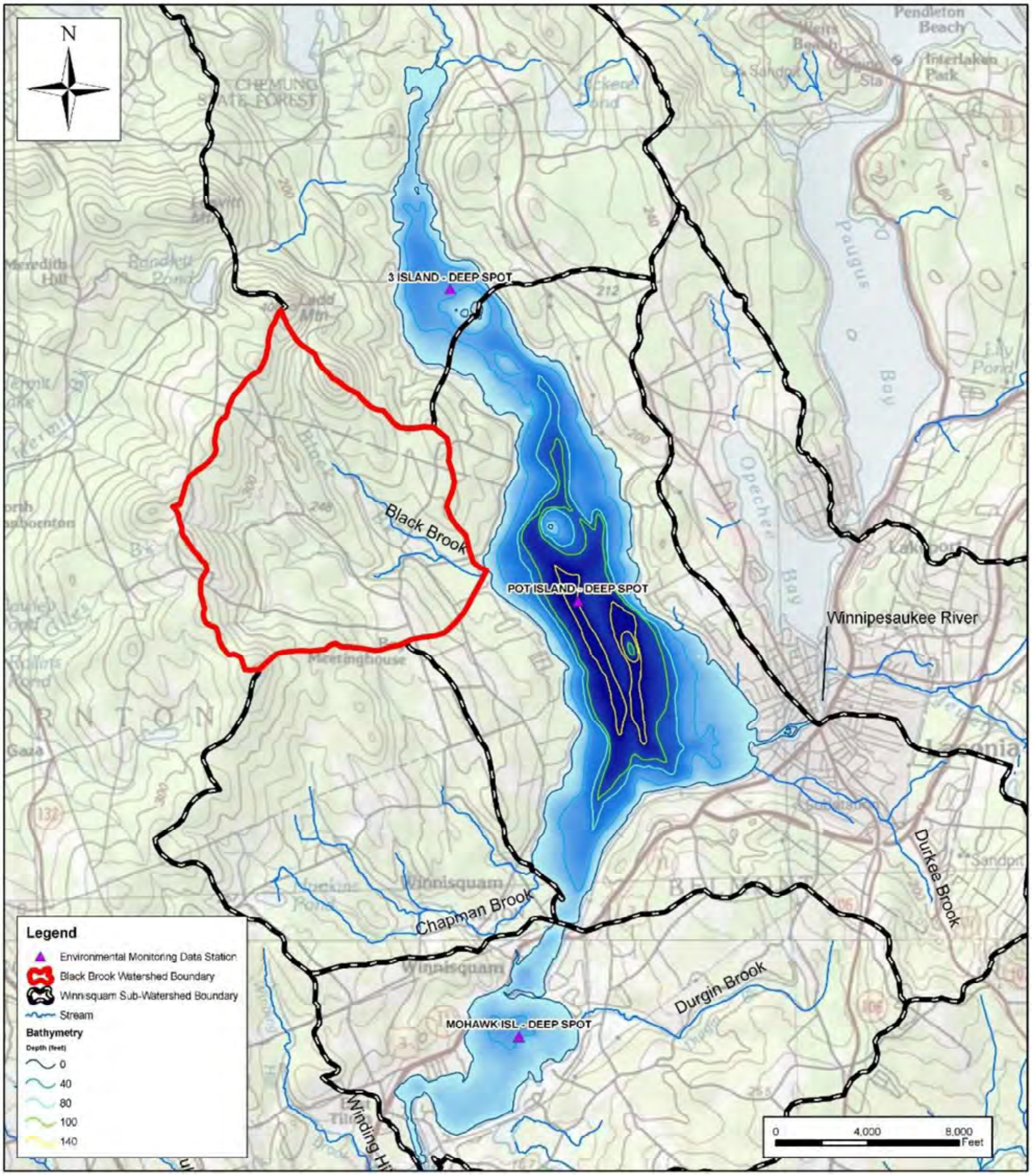


Figure 1-1: Lake Winnisquam Location and Bathymetry

Table 1-2: Lake Winnisquam - Pot Island Basin
Summer Water Quality Summary Water Quality Data 2001-2010

Statistic	Pot Island Station					Black Brook	Winnipesaukee River
	TP Epi	TP Meta	TP Hypo	SDT	Chl *a*	TP	TP
Units	µg/L	µg/L	µg/L	m	µg/L	µg/L	µg/L
Min	<5.0	<5.0	<5.0	6.0	0.5	<5.0	<5.0
Max	9.1	11.3	10.3	10.3	3.6	21.0	14.0
Mean	6.6	7.8	7.7	8.3	2.0	10.6	7.3
Median	6.4	7.9	7.6	8.1	1.9	10.0	7.0

Mean and median statistics derived from annual mean values of typically two or three samples collected in July, August, and/or September.
TP= Total Phosphorus; Epi = epilimnion; Meta = metalimnion; Hypo = hypolimnion; SDT= Secchi Disk Transparency, Chl *a*= Chlorophyll a

Lake Winnisquam has numerous tributaries and direct stormwater inputs (Figure 1-2). A summary of the water quality data from Black Brook and the Winnipesaukee River is presented in Table 1-2. Water quality entering the lake from the Winnipesukee River provides most of the flow to Lake Winnisquam and fortunately has very good quality most of the time. There are times when the water quality of the Winnipesaukee River could be improved. It is likely that stormwater inputs to the river from Laconia and other developed areas along the river contribute to the elevated TP concentrations in the river. TP is elevated in Black Brook at times. We suggest a number of best management practices (both structural and non-structural to lower loads of phosphorus from the Black Brook watershed to Lake Winnisquam.

These data, together with suggested management recommendations, provide a basis for the development of a Watershed Management Plan for the Black Brook watershed. Outreach and education will be an important aspect of this project. A Site Specific Project Plan (SSPP) detailing the steps to be undertaken in development of the plan was presented to NHDES in the fall of 2010 and approved.

The purpose of the Black Brook watershed plan is to establish TP loading targets, a plan to meet those targets and a means for measuring progress. This watershed plan is the first step in a multi phased project to protect the high quality of Lake Winnisquam. Water quality that is consistent with state standards is, a priori, expected to protect designated uses. This plan recognizes the unique nature of Lake Winnisquam as a high quality water and sets targets and goals considered to be more protective of water quality than the minimum requirements to protect the lake's designated uses. AECOM prepared this watershed plan according to the United States Environmental Protection Agency's (US EPA) guidance (US EPA, 2008). The main objectives of this watershed plan include the following 9 elements from the EPA guidance:

1. Identification of causes of impairment and pollutant sources or groups of similar sources that need to be controlled to achieve needed load reductions, and any other goals identified in the watershed plan. Sources that need to be controlled should be identified at the significant

subcategory level along with estimates of the extent to which they are present in the watershed (e.g., X number of dairy cattle feedlots needing upgrading, including a rough estimate of the number of cattle per facility; Y acres of row crops needing improved nutrient management or sediment control; or Z linear miles of eroded streambank needing remediation).

2. An estimate of the load reductions expected from management measures.
3. A description of the nonpoint source management measures that will need to be implemented to achieve load reductions in paragraph 2, and a description of the critical areas in which those measures will be needed to implement this plan.
4. Estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon to implement this plan.
5. An information and education component used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the nonpoint source management measures that will be implemented.
6. Schedule for implementing the nonpoint source management measures identified in this plan that is reasonably expeditious.
7. A description of interim measurable milestones for determining whether nonpoint source management measures or other control actions are being implemented.
8. A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made toward attaining water quality standards.
9. A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under item 8 immediately above.

This watershed management plan is expected to fulfill the nine requirements for a watershed management plan required to qualify a project for Section 319 restoration funding.

2.0 Phosphorus Target

2.1 Numeric Water Quality Target

To develop a watershed management plan, it is necessary to derive a numeric TP target values (e.g., in-lake concentration) for determining acceptable nutrient loads. The suggested TP values are described in the following paragraphs.

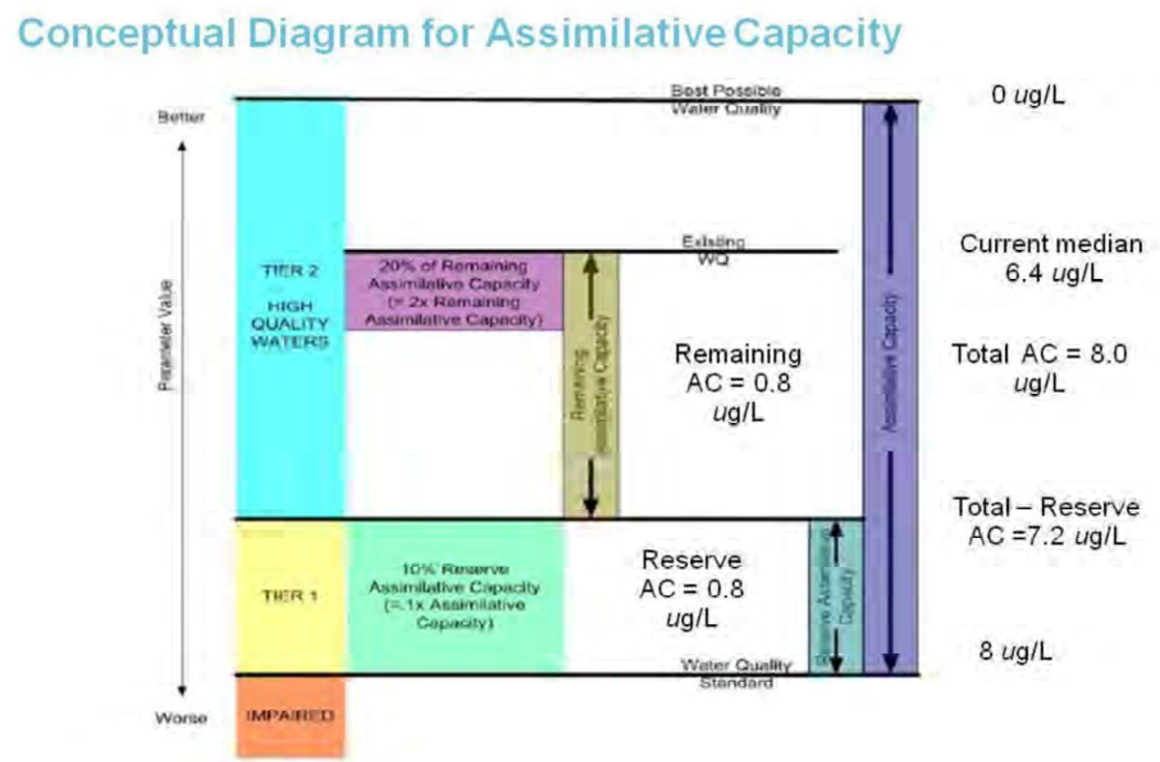


Figure 2-1: Lake Winnisquam Water Quality Target

Determining the nutrient load that a lake can assimilate without degrading or exceeding water quality standards is challenging and complex. First, many lakes receive a high proportion of their nutrient loading from non-point sources, which are highly variable and are difficult to quantify. Secondly, lakes demonstrate nutrient loading on a seasonal scale, not a daily basis. Loading during the winter months may have little effect on summer algal densities. Finally, variability in loading may be very high in response to weather patterns, and the forms in which nutrients enter lakes may cause increased variability in response. Therefore, it is usually considered most appropriate to quantify a lake nutrient budget as an annual load and evaluate the results of that annual load on mid-summer conditions that are most critical to supporting recreational and aquatic life uses. Accordingly, the nutrient loading capacity of lakes is typically determined through water quality modeling, which is usually expressed on an annual basis. Thus, while a single value may be chosen as the target load for each nutrient, it represents a range of loads with a probability distribution for associated water quality problems (such as algal blooms). Uncertainty is likely to be very high, and the resulting target load should be viewed as a nutrient-loading goal that helps set the direction and magnitude of management, not as a rigid standard that must be achieved to protect against eutrophication. While data from individual sampling dates and seasons are important to understanding the nutrient loading dynamics of Lake Winnisquam, the annual mean load should be given primacy when developing and evaluating the effectiveness of nutrient loading reduction strategies.

Numerical water quality criteria for TP in oligotrophic lakes were recently developed by the State of New Hampshire. For Lake Winnisquam, an oligotrophic lake, the criteria is set at < 8 µg/L. This criterion is over 20% higher than the current median concentration of TP (6.4 µg/L). Best professional judgment of AECOM, NH DES, and the Town of Sanbornton was employed to select a quantitative target in-lake TP concentration that will protect water quality. Review of existing data and modeling of current conditions suggested that the current phosphorus concentrations in the lake would result in acceptable water quality going forward. This point is bolstered by the fact that water quality as measured by chl *a* and TP has not changed appreciably in recent years. However, it was acknowledged that short-term phenomenon had the potential to cause periodic water quality problems like the bloom experienced in 2008 and the anecdotal evidence that nearshore water quality may be declining. It was further recognized that there would be future development in the greater Lake Winnisquam watershed as well as the Black Brook watershed.

Target options were discussed at a meeting held on April 21, 2011 with NHDES, AECOM and the Town of Sanbornton. A memorandum was then prepared by AECOM to present target options and recommend an acceptable target for Lake Winnisquam (Appendix A). Using the conceptual assimilative capacity approach and a criteria of 8 ug/L as the cutoff point between oligotropic and mesotrophic lakes, the target for Lake Winnisquam could be set at 0.2 ug/L higher than existing conditions allowing for a 10% reserve and using 20% of the remaining assimilative capacity. It was agreed that this target was too high for Lake Winnisquam given that periodic water quality problems had been experienced at current levels of phosphorus despite the fact that the annual average TP and chlor a concentration has been steady in recent years. Meeting attendees generally agreed that the water quality target should be set at current conditions (mean summer in-lake total phosphorus concentration= 6.6 *u*g/L and median = 6.4 *u*g/L based on the last 10 years of water quality data). A short term median summer in-lake total phosphorus goal of 6.1 *u*g/l (5% reduction from current) is proposed recognizing that current land development practices with minimal stormwater treatment may continue for some time into the future. Meeting this short term goal through watershed phosphorus load reductions with Best Management Practices (BMPs) will provide a buffer to this future development. This load reduction that results in a 5% in-lake reduction will be allocated across the watershed of the Pot Island basin of Winnisquam (including a value for the Black Brook watershed) as well as the direct sources of phosphorus to the Pot Island Basin provided by the Winnipesaukee River and the 3 Island Basin. Load reduction through BMP's is discussed further in Section 9 of the report.

The numeric (in-lake) water quality target for TP for Lake Winnisquam is 6.4 µg/L for a summer epilimnetic median concentration which is equivalent to the spring overturn TP concentration. Mean annual TP concentrations are usually higher than summer epilimnetic concentrations (Nurnberg 1996, 1998) however recent data from Lake Winnisquam in the spring suggests that spring overturn concentrations are very similar to summer epilimnetic concentrations probably due to the influence of the large volume of inflow water from the Winnipesaukee River. The target number is supported by evaluation of the Trophic State Indices (TSI) developed by Carlson (1977) and a probabilistic assessment of the likelihood of blooms (Walker 1984, 2000) discussed below in the modeling sections. The “weight of evidence” suggests that 6.4 μg/L is an appropriate target that will allow Lake Winnisquam to remain in its current high quality state. Possible reductions to move Lake Winnisquam below this target to a short term goal in lake summer median concentration of 6.1 μg/L to allow for future increases in TP are discussed in Section 7 below. The target concentration corresponds to non-bloom conditions, as reflected in suitable measures of both SDT and chl *a*.

3.0 LLRM Model of Current Conditions

Current TP loading was assessed using the Lake Loading Response Model (LLRM) methodology, which is a land use export coefficient model developed by AECOM for use in New England and modified for New Hampshire lakes by incorporating New Hampshire land use TP export coefficients when available and adding septic system loading into the model (CT DEP and ENSR, 2004). AECOM has recently incorporated the BMP effectiveness tables into LLRM to better evaluate proposed phosphorus reduction scenarios.

The major direct and indirect nonpoint sources of TP to Lake Winnisquam include:

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

Although the lake stratifies in the summer, the mean summer epilimnion and hypolimnion TP are similar so, internal loading is not expected be a major TP source to Lake Winnisquam. Internal loading therefore was not calculated in the current conditions model.

There are no permitted point source discharges of nutrients in the Black Brook watershed. However, construction activities in the watershed that disturb greater than one acre of land and convey stormwater through pipes, ditches, swales, roads or channels to surface water require a federal General Permit for Stormwater Discharge from Construction Activities. However, construction discharges are not incorporated in the model due to their variability and short-term impacts.

The Black Brook watershed contains one major tributary and two major branches draining most of the watershed as well as a number of smaller tributary streams (Figure 1-1). TP loads were estimated based on runoff and groundwater land use export coefficients. The TP loads were then attenuated as necessary to match tributary monitoring data, if available. Where no tributary data were available or current, then the attenuation factor was based on the slope, soils, and wetland attenuation.

Lake Winnisquam functions as three separate but linked lakes in series. The Black Brook watershed drains into the middle basin called the Pot Island Basin. Upstream (north) of the Pot Island Basin is the Three Island Basin. Downstream (southwest) of the Pot Island Basin is the Mohawk Basin. The Winnipesaukee River empties into the Pot Island Basin and is by far the largest tributary to Lake Winnisquam. Because the focus of this project was on the Black Brook watershed, the Three Island Basin and the Winnipesaukee River were considered as point sources to the basin and assigned loads based on monitoring data and either standard water yields in the case of Three Island Basin or measured flow at the Lakeport Dam at the outlet of Lake Winnipesaukee coupled with a standard water yield for contributing land below the Lakeport Dam in the case of the Winnipesaukee River. Chapman Brook was included as a separate subwatershed in the analysis at the request of the project steering committee. Pot Island Basin was modeled assuming that much of the input from Chapman Brook (90%) may be short circuited out of the Pot Island Basin to the Mohawk Basin due to its proximity of the outlet of the Pot Island Basin at the Route 3 Bridge. The Mohawk Basin was not considered in the analysis as it is downgradient of the Pot Island Basin. A conceptual diagram of the lake model is presented in Figure 3-1.

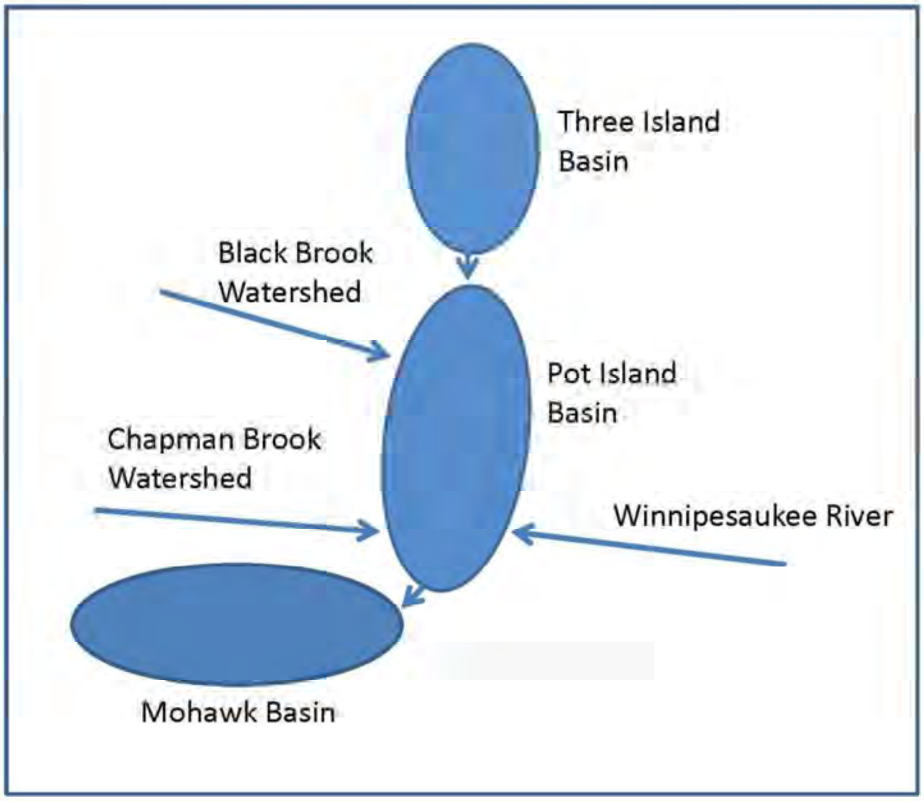


Figure 3-1: Conceptual model of Lake Winnisquam for LLRM model assessment of Black Brook

Loads from the watershed (Figure 3-2) as well as direct sources were then used to predict in-lake concentrations of TP, chl *a*, SDT, and algal bloom probability. The estimated load and in-lake predictions were then compared to in-lake concentrations. Because the inflow to the Pot Island Basin is so heavily influenced by the flow from the Winnipesaukee River, it is believed that the average summer concentrations are likely representative of annual average or average at spring overturn values. Spring data from 2011 support this assumption. The year round influence of inflow from the Winnipesaukee River dampens the “typical” summer epilimnetic phosphorus dynamics. In many lakes, the summer epilimnetic phosphorus concentrations are lower than annual average concentrations (spring overturn) due to reduced loading and settling of algal cells and other particles. Because there is a continuous load of phosphorus and water from the Winnipesaukee River to the epilimnion throughout the summer, we don’t observe that phenomenon in Lake Winnisquam. As a result concentrations of phosphorus are relatively stable throughout the year.

The attenuation factors were used as calibration tools to achieve a close agreement between predicted in-lake TP and observed mean/median TP. However, perfect agreement between modeled concentrations and monitoring data were not expected as monitoring data are limited for some locations and are biased towards summer conditions when TP concentrations are expected to be lower than the annual mean predicted by the loading model.

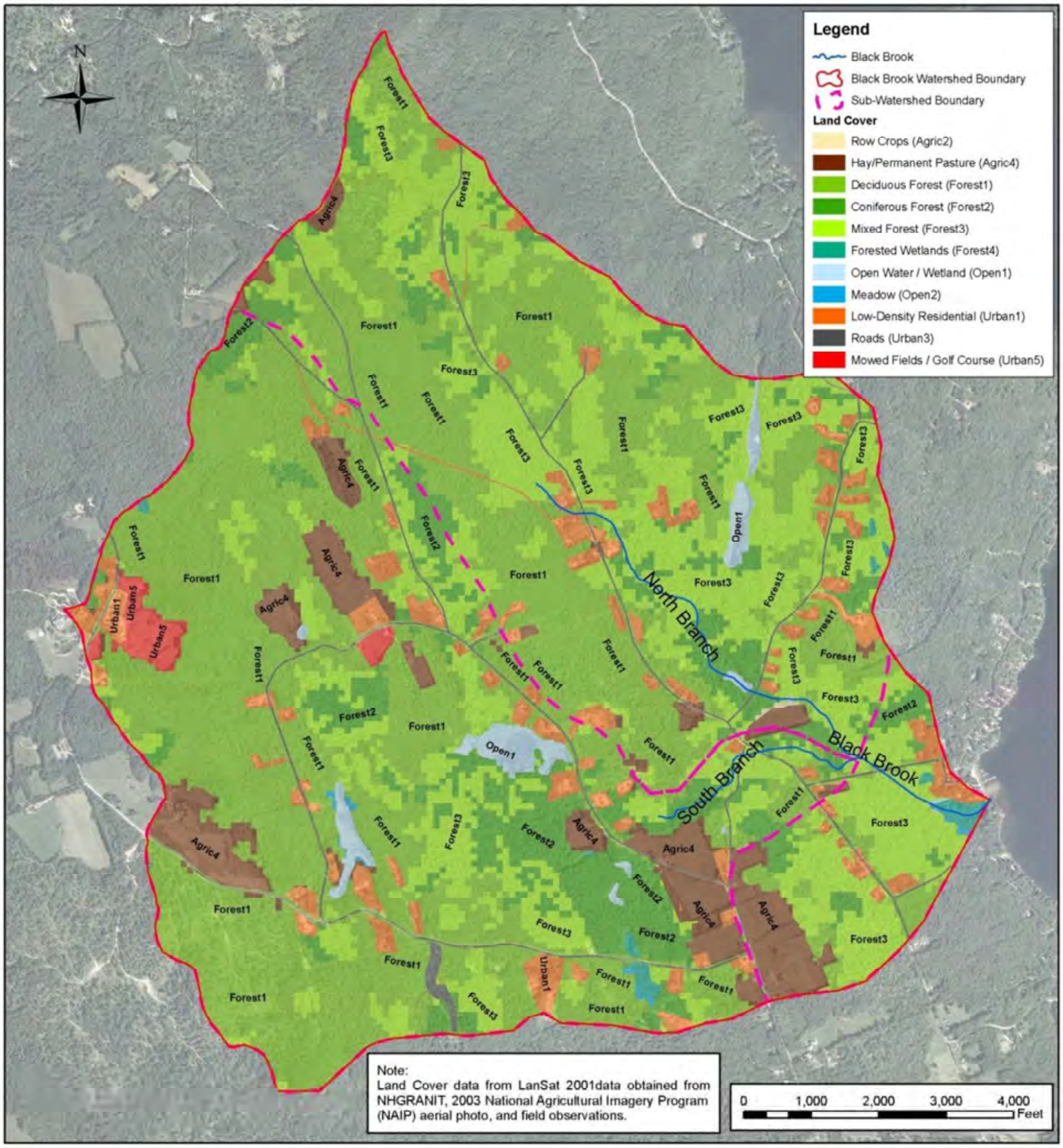


Figure 3-2: Black Brook Watershed Land Use

3.1 Hydrologic Inputs and Water Loading

Calculating TP loads to the Pot Island Basin of Lake Winnisquam requires estimation of the sources of water to this basin. The four primary sources of water are: 1) atmospheric direct precipitation; 2) runoff, which includes all overland flow to the tributaries and direct drainage to the lake; 3) baseflow, which includes all precipitation that infiltrates and is then subsequently released to surface water in the tributaries or directly to the lake (i.e., groundwater) and; 4) point sources including upstream basins and the Winnipesaukee River. Baseflow is roughly analogous to dry weather flows in streams and direct groundwater discharge to the lake. The water budget is broken down into its components in Table 3-1.

- Precipitation - Mean annual precipitation was assumed to be representative of a typical hydrologic period for the watershed. The annual precipitation value was derived from the USGS publication: Open File Report 96-395, "Mean Annual Precipitation and Evaporation - Plate 2", (USGS 1996) and confirmed with precipitation data from weather station in Concord. For the Black Brook watershed, 1.20 m (47.14 in) of annual precipitation was used.
- Runoff - For each land use category, annual runoff was calculated by multiplying mean annual precipitation by basin area and a land use specific runoff fraction. The runoff fraction represents the portion of rainfall converted to overland flow. This was compared to the standard water yield for this area.
- Baseflow - The baseflow calculation was calculated in a manner similar to runoff. However, a baseflow fraction was used in place of a runoff fraction for each land use. The baseflow fraction represents the portion of rainfall converted to baseflow.
- Point Source – This includes loads from the Three Island Basin and the Winnipesaukee River.

Runoff and baseflow fractions from Dunn and Leopold (1978) were altered slightly to be representative for the generally steeper slopes in the Black Brook watershed (i.e. less infiltration to baseflow and more runoff). The fractions are listed in Appendix B. The hydrologic budget was calibrated to a representative standard water yield for New England (Sopper and Lull, 1970; Higgins and Colonell 1971, verified by assessment of yield from various New England USGS flow gauging stations).

Table 3-1: Pot Island Basin and Black Brook Water Budget

WATER BUDGET	M^3/YR
Atmospheric	14,727,658
Septic System	45,625
BB-South Branch[1]	4,116,813
BB-North Branch[1]	3,173,386
BB-Main Stem	7,511,531
Pot Island Basin	14,816,419
Chapman Brook	1,048,555
3 Island Basin[2]	28,650,767
Winnipesaukee River[2]	484,010,528
Total	**550,811,083**

[1]Note the Black Brook North and South Branch totals are not used directly to calculate Pot Island Basin total since they are included in the total for the Black Brook Main Stem.
[2]Input from these two basins are modeled as point sources of water to the Pot Island Basin

3.2 Nutrient Inputs

Land Use Export

The Black Brook watershed boundary was delineated using NRCS and NH DES HUC8 delineations and the Winnisquam Lake USGS topographic quadrangle map, 1987. Land uses within the watershed were determined using several sources of information including: (1) Geographic Information System (GIS) data, (2) analysis of aerial photographs and (3) drive-by observations.

The TP load for the watershed was calculated using export coefficients for each land use type. The watershed loading was adjusted based upon proximity to the lake, soil type, presence of wetlands, and attenuation provided by Best Management Practices (BMPs) for water or nutrient export mitigation. The watershed load (baseflow and runoff) was combined with direct loads (atmospheric, septic system, and waterfowl) to calculate TP loading. The generated load to the lake was then input into a series of empirical models that provided predictions of in-lake TP concentrations, chl *a* concentrations, algal bloom frequency and water clarity. Details on model input parameters and major assumptions used to estimate the baseline loading (i.e., existing conditions) for Lake Winnisquam are described below.

- Areal land use estimates were generated from land cover GIS data layers from NH GRANIT. For Lake Winnisquam, data sources are: 2001 NH Land Cover Assessment data (Complex Systems Research Center (CSRC), Durham, New Hampshire), New Hampshire Roads (NH Department of Transportation), National Wetlands Inventory (NRCS)and New Hampshire Hydrography Dataset (CSRC, USGS, US EPA, NH DES)). Land use categories were matched with the LLRM land use categories and their respective TP export coefficients. Table 3-2 lists LLRM land use categories in which the GRANIT categories were matched. Land cover data and aerial photographs were used to determine certain land use classifications, such as agriculture and forest types. Selected land uses were confirmed on the ground during a watershed survey and through consultation with the town planner. Watershed land use is presented spatially in Figure 3-2 and summarized in Table 3-2.

- TP export coefficient ranges were derived from values summarized by Reckhow et al. (1980), Dudley et al. (1997) as cited in ME DEP (2003) and Schloss and Connor (2000). Appendix Table B-1 provides ranges for export coefficients and Appendix Table B-2 provides the runoff and baseflow export coefficient for each land use category in the Black Brook watershed and the sources for each export coefficient. Residential areas were designated as Urban 1 (Low Density Residential). The export coefficient for Urban 1 was set at 0.9 kg/ha/yr. A University of New Hampshire study also found a TP runoff export coefficient of 0.35 kg/ha/yr to be at the lower end of the range and 0.9 kg/ha/yr to be a moderate export coefficient for urban land use in the Flints Pond watershed (Schloss and Connor, 2000). The land use distribution in the Flints Pond watershed of denser residential along the shoreline and low density non-shoreline residential found is also found in the Pot Island Basin watershed (AECOM, 2009).
- Areal loading estimates were attenuated within the model based on natural features such as porous soils and wetlands that would decrease loading. The Black Brook watershed has relatively steep, shallow, moderate- to poorly-drained soils. The watershed also has some wetland complexes in the watershed which are expected to reduce the rate of runoff flow and encourage water infiltration, settling and adsorption of TP. A TP attenuation factor of 10% was applied to the Pot Island Basin and North and South Branches of Black Brook, meaning that 90% of the generated TP load from these areas is actually delivered to the lake. An additional 5% of attenuation was assumed in the confluence reach of Black Brook. Chapman Brook was assigned an attenuation factor of 90% due to its proximity to the outlet of the Pot Island Basin. It was assumed that the majority of the water and phosphorus associated with Chapman Brook exits the Pot Island Basin without entering the main basin.
- Annual areal loading of TP from the Black Brook watershed is estimated to be 224 kg/yr, which represents 4.3% of the total load to the Pot Island Basin. The total phosphorus load to the Pot Island Basin is 5182 kg/yr. The distribution of the load among sources is presented in Table 3-3.

Table 3-2: Land Use Categories by Subwatershed (Existing Conditions)

	Subwatershed Area (Hectares (Acres))				
Land Use	**Black Brook South Branch**	**Black Brook North Branch**	**Black Brook Main Stem**	**Pot Island Basin**	**Chapman Brook**
Urban 1 (Low Density Residential)	37.5 (93)	26.4 (65)	7.0 (17)	200.0 (494)	5.7 (14)
Urban 2 (Mid Density Residential/Commercial)	--	--	--	41.5 (103)	--
Urban 3 (Roads)	11.2 (28)	5.6 (14)	1.9 (5)	241.6 (597)	37.8 (93)
Urban 4 (Industrial)	--	--	--	--	--
Urban 5 (Mowed Fields)	10.2 (25)	--	--	--	--
Agric 1 (Cvr Crop)	--	--	--	--	--
Agric 2 (Row Crop)	--	0.4 (1)	--	0.9 (2)	7.6 (19)
Agric 3 (Grazing)	--	--	--	--	--
Agric 4 (Hayfield)	53.9 (133)	8.2 (20)	15.3 (38)	204.7 (506)	174.0 (430)
Forest 1 (Deciduous)	323.1 (798)	206.1 (509)	12.3 (30)	563.3 (1392)	477.8 (1181)
Forest 2 (NonDeciduous)	83.6 (207)	44.2 (109)	7.9 (19)	323.0 (798)	293.2 (725)
Forest 3 (Mixed)	88.2 (218)	173.3 (428)	43.6 (108)	570.4 (1409)	447.6 (1106)
Forest 4 (Wetland)	2.2 (5)	0.6 (2)	2.3 (6)	--	1.1 (3)
Open 1 (Wetland/Lake)	11.3 (28)	5.5 (14)	0.2 (0.4)	63.8 (158)	15.5 (38)
Open 2 (Meadow)	1.1 (3)	--	0.3 (1)	7.5 (19)	13.6 (34)
Open 3 (Excavation)	--	--	--	9.6 (24)	20.4 (50)
TOTAL	622.2 (1538)	470.3 (1162)	90.7 (224)	2226.3 (5501)	1494.3 (3692)

Atmospheric Deposition

Nutrient inputs from atmospheric deposition were estimated based on a TP coefficient for direct precipitation. The atmospheric load of 0.25 kg/ha/yr includes both the mass of TP in rainfall and the mass in dryfall (Wetzel, 2001). The sum of these masses is carried by rainfall. The concentration calculated for use in the loading estimate 24 μg/L is roughly equivalent to the mean concentration (25 μg/L) observed in rainfall in Concord, NH (NH DES, 2008 Unpublished Data). The coefficient was then multiplied by the lake area (ha) in order to obtain an annual atmospheric deposition TP load. The contribution of atmospheric deposition to the annual TP load to the Pot Island Basin was estimated to be 308 kg/yr or 5.9% of the total load.

Septic systems

TP export loading from residential septic systems was estimated within the 125 ft shoreline zone. The 125 ft zone is the minimum distance from lakes that new septic systems are allowed in New Hampshire with rapid groundwater movement through gravel soils. The TP load was calculated by multiplying a TP export coefficient (based on literature values for wastewater TP concentrations and expected water use), the number of dwellings, the mean number of people per dwelling, the number of days occupied per year, and an attenuation coefficient of 90% for systems meaning that 10% of the phosphorus load from these systems reaches the lake. In the Pot Island watershed, the TP loading from shoreline septic systems was estimated to be 36.5 kg/yr, which is 0.7% of the TP load to the Pot Island Basin. A more detailed septic survey as more subwatersheds around Lake Winnisquam are investigated may yield more precise estimates of septic loading. The following assumptions were used in estimating the TP load from septic systems.

- It was estimated that 200 year round residences are within 125 feet of the Pot Island Basin.
- Two and a half people were estimated to reside in each dwelling. It was estimated that each resident uses 65 gallons per day for 365 days per year
- The TP coefficients were calculated based on mean TP concentration in domestic wastewater of 8 mg/L and mean household water uses (Metcalf & Eddy, 1991).
- All septic loads to Lake Winnisquam from septic systems were attenuated 90% (Dudley and Stephenson, 1973; Brown and Associates, 1980) to account for TP uptake in the soil between the septic systems and the lake (10% of TP gets to the lake).

Direct Inputs from the Three Island Basin and the Winnipesaukee River.

The LLRM model was configured to consider the Three Island Basin and the Winnipesaukee River as point sources. Average annual water yield/flow was multiplied by average annual phosphorus concentrations from these sources to derive an estimated annual load to the Pot Island Basin of Lake Winnisquam. The total annual phosphorus load from the Three Island Basin was estimated to be 183.4 kg/yr while the load from the Winnipesaukee River was estimated to be 3533.3 kg/yr. It was assumed that 95% of the phosphorus load that enters the lake through the Winnipesaukee River mixes in the Pot Island Basin and the remaining 5% leaves through the basin outlet to the Mohawk Basin without mixing (Conner personal communication 2011).

3.3 Phosphorus Loading Assessment Summary

The current TP load to the Pot Island Basin of Lake Winnisquam was estimated to be 5182.2 kg/yr from all sources. The TP load according to source is presented in Table 3-3.

Loading from the watershed was overwhelmingly the largest source at 4838.2 kg/yr (93%) of the TP load to the Pot island Basin. Direct precipitation provides approximately 6% of the annual TP load or 307.5 kg/yr. The Winnipesaukee River is responsible for 68% of the phosphorus load to the Pot Island Basin. Septic systems contribute 36.5 kg/yr or 1% of the annual TP budget for the Pot island Basin.

Table 3-3: Pot Island Basin of Lake Winnisquam Phosphorus Loading Summary

TP INPUTS	Modeled Current TP Loading (kg/yr)	% of Total Load
Atmospheric	307.5	6
Internal	0.0	0
Waterfowl	0.0	0
Septic Systems	36.5	1
BB-South Branch[1]	134.1	3
BB-North Branch[1]	75.0	1
BB-Main Stem	223.7	4
Pot Island Basin	863.4	17
Chapman Brk	34.5	1
Winnipesaukee River[2]	3533.3	68
Three Island Basin[2]	183.4	4
Watershed Total	4838.2	93
Total	**5182.2**	**100**

[1]Note the Black Brook North and South Branch totals are not used directly to calculate Pot Island Basin total since they are included in the total for the Black Brook Main Stem.

[2]Input from these two basins are modeled as point sources of phosphorus to the Pot Island Basin

3.4 Phosphorus Loading Assessment Limitations

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

- Precipitation varies among years and hence hydrologic loading will vary. This may greatly influence TP loads in any given year, given the importance of runoff to loading.
- Spatial analysis has innate limitations related to the resolution and timeliness of the underlying data. In places, local knowledge was used to ensure the land use distribution in the LLRM model was reasonably accurate, but data layers were not 100% verified on the ground. In addition, land uses were aggregated into classes which were then assigned export coefficients; variability in export within classes was not evaluated or expressed.

- TP export coefficients as well as runoff/baseflow exports were representative but also had limitations as they were not calculated for the study water body, but rather are regional estimates.
- The TP loading estimate from septic systems was limited by the assumptions associated with this calculation described above in the “Septic Systems” subsection.
- Water quality data for Black Brook and other sources to Lake Winnisquam are limited, restricting calibration of the model.

3.5 Lake Response to Current Phosphorus Loads

TP load outputs from the LLRM Methodology were used to predict in-lake TP concentrations using five empirical models. The models include: Kirchner-Dillon (1975), Vollenweider (1975), Reckhow (1977), Larsen-Mercier (1976), Jones-Bachmann (1976), and Nurnberg (1998). These empirical models estimate TP from system features, such as depth and detention time of the waterbody. The load generated from the export portion of LLRM was used in these equations to predict in-lake TP. The mean predicted TP concentration from these models was compared to measured (observed) values. Input factors in the export portion of the model, such as export coefficients and attenuation, were adjusted to yield an acceptable agreement between measured and average predicted TP. Because these empirical models account for a degree of TP loss to the lake sediments, the in-lake concentrations predicted by the empirical models are lower than those predicted by a straight mass-balance for the Pot Island Basin (9 µg/L) where the mass of TP entering the lake is equal to the mass exiting the lake without any retention. Also, the empirical models are based on relationships derived from many other lakes. As such, they may not apply accurately to any one lake, but provide an approximation of predicted in-lake TP concentrations and a reasonable estimate of the direction and magnitude of change that might be expected if loading is altered. These empirical modeling results are presented in Table 3-4.

The TP load estimated using LLRM methodology translates to predicted mean in-lake concentrations ranging from 5.7 to 7.3 µg/L. The mean in-lake TP concentration of the five empirical models was 6.6 µg/L. The mean and median epilimnetic TP concentration from observed in-lake data from 2001 to 2010 were 6.6 and 6.4 µg/L, respectively.

Table 3-4: Predicted In-Lake Total Phosphorous Concentration for Pot Island Basin under Current Conditions using Empirical Models

Empirical Equation	Equation	Predicted TP (*ug*/L)
Mass Balance	TP=L/(Z(F))*1000	9.4
Kirchner-Dillon 1975	TP=L(1-Rp)/(Z(F))*1000	7.3
Vollenweider 1975	TP=L/(Z(S+F))*1000	7.2
Larsen-Mercier 1976	TP=L(1-Rlm)/(Z(F))*1000	5.7
Jones-Bachmann 1976	TP=0.84(L)/(Z(0.65+F))*1000	6.1
Reckhow General 1977	TP=L/(11.6+1.2(Z(F)))*1000	6.4
Nurnberg (1998)	TP=(L/Z(F))(1-(15/(18+Z(F)))) * 1000	7.2
Average of Above 6 Model Values		***6.6***
Observed Summer Epilimnion Mean		***6.6***
Observed Summer Epilimnion Median		***6.4***

Variable	Description	Units	Equation
L	Phosphorus Load to Lake	g P/m2/yr	
Z	Mean Depth	m	Volume/area
F	Flushing Rate	flushings/yr	Inflow/volume
S	Suspended Fraction	no units	Effluent TP/Influent TP
Qs	Areal Water Load	m/yr	Z(F)
Vs	Settling Velocity	m	Z(S)
Rp	Retention Coefficient (settling rate)	no units	((Vs+13.2)/2)/(((Vs+13.2)/2)+Qs)
Rlm	Retention Coefficient (flushing rate)	no units	1/(1+F^0.5)

Once TP estimates were derived, annual mean chl *a* and SDT can be predicted based on another set of empirical equations: Carlson (1977), Dillon and Rigler (1974), Jones and Bachman (1976), Oglesby and Schaffner (1978), Vollenweider (1982), and Jones, Rast and Lee (1979). Bloom frequency was also calculated based on equations developed by Walker (1984, 2000) using a natural log mean chl *a* standard deviation of 0.5. These predictions are presented in Table 3-5. Predicted mean chl *a* concentrations (Table 3-5) are similar to those observed in the monitoring data. Predicted Secchi transparencies are substantially lower than observed which may be a reflection of the minimal amount of dissolved color in Lake Winnisquam and a general lack of non-algal turbidity.

Table 3-5: Predicted In-Lake Chlorophyll a and Secchi Disk Transparency Predictions based on an Annual Average In-Lake Phosphorous Concentration of 6.6 μg/L

Empirical Equation	Equation	Predicted Value
Mean Chlorophyll		***ug*/L**
Carlson 1977	Chl=0.087*(Pred TP)^1.45	1.4
Dillon and Rigler 1974	Chl=10^(1.449*LOG(Pred TP)-1.136)	1.1
Jones and Bachmann 1976	Chl=10^(1.46*LOG(Pred TP)-1.09)	1.3
Oglesby and Schaffner 1978	Chl=0.574*(Pred TP)-2.9	0.9
Modified Vollenweider 1982	Chl=2*0.28*(Pred TP)^0.96	3.5
Average of Model Values		**1.6**
Observed Summer Mean		***2.0***
Peak Chlorophyll		***ug*/L**
Modified Vollenweider (TP) 1982	Chl=2*0.64*(Pred TP)^1.05	9.4
Vollenweider (CHL) 1982	Chl=2.6*(AVERAGE(Pred Chl))^1.06	4.4
Modified Jones, Rast and Lee 1979	Chl=2*1.7*(AVERAGE(Pred Chl))+0.2	5.7
Average of Model Values		**6.5**
Observed Summer Maximum		***3.6***
Bloom Probability		***% of Summer***
Probability of Chl >15 *u*g/L	See Walker 1984 & 2000	0.00%
Secchi Transparency		***m***
Mean: Oglesby and Schaffner 1978	SDT=10^(1.36-0.764*LOG(Pred TP))	5.4
Max: Modified Vollenweider 1982	SDT=9.77*Pred TP^-0.28	5.7
Observed Summer Mean		***8.3***
Observed Summer Maximum		***10.3***

Variable	Description	Units
"Pred TP"	The average TP calculated from the 5 predictive equation models in Table 3-5	*u*g/L
"Pred Chl"	The average of the 3 predictive equations calculating mean chlorophyll	*u*g/L

*The observed summer maximum is based on n=26 and is not necessarily the peak chlorophyll

3.6 Critical Conditions

Critical conditions in Lake Winnisquam typically occur during the summertime, when the potential (both occurrence and frequency) for nuisance algal blooms are greatest. The loading capacity for TP was set to achieve desired water quality targets during this critical time period and also provide adequate protection for designated uses throughout the year. This was accomplished by using a target concentration based generally on summer epilimnetic data and applying it as a mean annual concentration in the predictive models used to establish the mean annual maximum load. Summer epilimnetic concentrations of phosphorus are typically lower than annual average concentrations (Nurnberg 1998).

3.7 Seasonal Variation

As explained in Section 3.5, the Lake Winnisquam model takes into account seasonal variations because the target annual load is developed to be protective of the most sensitive (i.e., biologically responsive) time of year (summer), when conditions most favor the growth of algae.

3.8 Loading Model Development Summary

The relationship between TP and algal biomass is well documented in scientific literature. This assessment was developed for TP and is designed to protect Lake Winnisquam and its designated uses impacted by excessive chl *a* concentrations.

In conclusion, water quality was linked to TP loading by:

- Choosing a preliminary target in-lake TP level, based on historic state-wide and in-lake water quality data, best professional judgment, and through consultation with NH DES and Sanbornton, sufficient to attain water quality standards and support designated uses. The preliminary in-lake TP concentration target is a mean of 6.6 μg/L (median 6.4 μg/L).
- Recognizing that future development may increase future loading a short term goal of an in-lake mean concentration of 6.3 μg/L (median 6.1 μg/L) was set.
- Using the mean of five empirical models that link in-lake TP concentration and load, calibrated to lake-specific conditions, to estimate the load responsible for observed in-lake TP concentrations.
- Determining the overall mean annual in-lake TP concentration from those models, given that the observed in-lake concentrations may represent only a portion of the year or a specific location within the lake.
- Using the predicted mean annual in-lake TP concentration to predict Secchi disk transparency, chl *a* concentration and algal bloom frequency.
- Using the aforementioned empirical models to determine the TP load reduction needed to meet the numeric concentration target.
- Using a GIS-based spreadsheet model to provide a relative estimate of loads from watershed land areas and uses under current and various projected scenarios to assist stakeholders in developing TP reduction strategies.

4.0 Evaluation of Alternative Loading Scenarios

The LLRM model was used to evaluate a number of alternative loading scenarios and the probable lake response to these loadings. These scenarios included:

- Current Loading
- Natural Environmental Background Loading
- Build-out of Watershed
- Reduction of Watershed Loads to Meet Mean 6.3 μg/L Short Term Goal

The current loading scenario is discussed above in Section 3.0. Each scenario described below represents a change from the current loading scenario. The discussion of each scenario includes only the portions of the current loading scenario that were altered for the specific simulation. A comparison of the results of each of the alternative scenarios is presented in Tables 4-1 and 4 -2.

Table 4-1: Comparison of Phosphorous Loading Scenarios for the Pot Island Basin, Lake Winnisquam

Inputs	**Current Load (kg/yr)**	**Natural Environmental Background (kg/yr)[1]**	**Build Out Analysis (kg/yr)[1]**	**Short-Term Goal to Obtain 6.3 *u*g/L Mean In-lake Concentration (kg/yr)**
Atmospheric	307.5	307.5	307.5	307.5
Waterfowl	0	0	0	0
Septic System	36.5	0.0	73.0	34.7
Watershed Load	4,838	1,352	11,597	4,597
Total Load	**5,182**	**1,660**	**11,977**	**4,939**
Change from Current Total Load (kg/yr)	-	-3,522	6,795	-243
Percent Change from Current Total Load (%)	-	-68%	131%	-5%
Black Brook Load (kg/yr)	224	102	791	213
Percent Change from Current Black Brook Load (%)	-	-45%	253%	-5%

[1]Note that natural environmental background and buildout analyses were only conducted for the Pot Island Basin. Other areas of the watershed such as Lake Winnipesaukee and the Three Island Basin were estimated (see section 4.2)

Table 4-2: Lake Water Quality Response to Different Loading Scenarios for the Pot Island Basin, Lake Winnisquam

Parameters	Current Load	Natural Environmental Background[1]	Build Out Analysis[1]	Short-Term Goal to Obtain 6.3 *u*g/L Mean In-lake Concentration
TP Load (kg/yr)	5,182	1,660	11,977	4,939
Mean Annual TP (*u*g/L)	6.6	1.9	16.0	6.3
Mean Secchi Disk Transparency (m)	5.4	13.9	2.8	5.6
Mean Chlorophyll *a* (*u*g/L)	1.6	0.4	5.6	1.5
Peak Chlorophyll *a* (*u*g/L)	6.5	1.2	19.6	6.1
Probability of Summer Bloom (Chl *a* > 15 *u*g/L)	0.0%	0.0%	1.3%	0.0%

[1]Note that natural environmental background and buildout analyses were only conducted for the Pot Island Basin. Other areas of the watershed such as Lake Winnipesaukee and the 3 Island Basin were estimated (see section 4.2)

4.1 Natural Environmental Background Phosphorus Loading

Natural environmental background levels of TP in the lake were evaluated using the LLRM model. Natural background was defined as background TP loading from non-anthropogenic sources. Hence, land uses in the Pot Island watershed were set to its assumed “natural” state of forests and wetlands. Loading was then calculated using the LLRM model as described above. This estimate is useful as it sets a realistic lower bound of TP loading and in-lake concentrations possible for Lake Winnisquam. Loadings and target concentrations below these levels are very unlikely to be achieved.

The septic loads were removed and all developed land was converted to forests. The developed land was split into mixed, deciduous, and coniferous forest categories in the same percentages as the current watershed forest composition. Wetland areas were not changed because it was assumed no wetland had been lost due to development. The estimated percent difference in loading from the Pot Island Basin between current conditions and natural environmental conditions was then applied to the loads from the Three Island Basin and the Winnipesaukee River. A detailed land use analysis was not conducted for this portion of the watershed so absolute numbers from this analysis should be interpreted with caution.

Background TP loads under this scenario were 1,660 kg/yr total with a watershed load of 1,352 kg/yr. Table 4-1 compares loads for possible scenarios. The calculated background loading of TP to Lake Winnisquam would result in mean in-lake TP concentration of 1.9 µg/L, a mean Secchi Disk transparency of 13.9 m, and a bloom probability of chl *a* > 15 µg/L of 0.0%. Estimated TP loading to the lake under this scenario is 68% lower than current loads to the lake for the entire watershed and 45% lower than current loads for the Black Brook watershed (Table 4-1). The lake would support designated uses and be viewed as pristine under this scenario as in-lake predicted mean TP concentration (1.9 μg/L) is well below the target value (6.6 μg/L) and the short-term goal (6.3 μg/L). This scenario provides the lower limit of phosphorus concentrations for Lake Winnisquam.

4.2 Build Out Analysis

Since the human population within a watershed may continue to grow and contribute additional TP to the impaired lakes, watershed plans should allow for growth and associated future TP loading. For example, in Maine, target TP loading from anticipated future development is set to allow a 1.0 μg/L change in in-lake TP concentration (Dennis et al., 1992). It should be recognized that the NH DES has no mechanism for regulation/enforcement of TP export from future developments of single house lots that do not require a Section 401 Water Quality Certification or fall under the thresholds for alteration of terrain permits (100,000 square feet of disturbance or 50,000 square feet within 250 feet of a lake). Municipalities can, however, regulate such development by revising their land use ordinances/regulations to require no additional loading of TP from new development. Increases in future loads were anticipated in this plan by incorporating a short term goal of reduction of loading and in-lake concentrations below the target. A build out scenario was developed to form the upper bound for development potential and is presented below.

The build out scenario was developed to assess the impact of complete development of the watershed. This scenario involved converting all existing forested and agricultural land not currently in conservation to low density residential land within the Pot Island watershed. This did not include wetland areas or conservation areas but did include areas with insufficient road frontage under the current conditions assuming that more roads could be built to serve these areas. It was assumed that all future building would retain similar characteristics as current building in the watershed and similar levels of best management practices. This was designed as a worst case scenario. In reality, some level of best management practices could be expected for future development so the actual increases in loading might be lower than those projected. It should also be noted that development could include more intensive uses which would tend to increase the loading estimates. The estimated percent difference in loading from the Pot Island Basin between current conditions and build out condition was then applied to the loads from the Three Island Basin and the Winnipesaukee River. A detailed land use analysis was not conducted for this portion of the watershed so absolute numbers from this analysis should be interpreted with caution.

Under this scenario, loading to the Pot Island Basin from all sources would be expected to increase 131% over current levels to a total of 11,977 kg/yr (Table 4-1). This would result in an in-lake average TP concentration of 16.0 μg/L, a mean transparency of 2.8 m which is roughly half of the current transparency and a probability of a bloom greater than 15 μg/L of 1.3% translating to 5 days per year (Table 4-2). Under this scenario, loads from the Black Brook watershed to the Pot Island Basin would roughly triple. Clearly, this is a scenario that would produce unacceptable water quality in Lake Winnisquam. Tables 4-4 and 4-5 summarize estimated changes in phosphorus loading and land use under the future buildout scenario.

4.3 Reduction of Loads to Meet In-lake Short-Term TP Goal of 6.3 µg/L Mean In-Lake Concentration

This scenario involves the focus of resources on the largest source of TP to Lake Winnisquam, the watershed load as well as one of the smaller loads (septic systems). Under this scenario, watershed TP loads were iteratively reduced until predicted in-lake concentrations met the 6.3 µg/L short-term goal for an annual mean concentration (equivalent to a median value of 6.1 µg/L). In order to achieve an average in-lake concentration of 6.3 µg/L (median of 6.1, the short term goal), phosphorus loading from the watershed (including septic systems) must be reduced from the current level of 4,838 kg/yr to 4,597 kg/yr for a reduction of 243 kg/yr or 5% of all sources (Table 4-1). This includes sources in the Three Island Basin and the Winnipesaukee River Watershed as well as all sources to the Pot Island basin with the exception of atmospheric contributions. The watershed reduction required from the Black Brook watershed to meet this goal is 10.7 kg from a current total load of 223.7 kg/yr to yield a short term goal of 213.0 kg/yr.

As some sources are less controllable than others, the actual reduction to be applied to achieve this goal will vary by source (see Sections 6 and 7). A 5% reduction from manageable watershed sources (Table 3-5) would be required to achieve the 6.3 ug/l annual average short-term goal TP concentration. Loading reduction strategies are discussed further in Section 7 below.

There are other combinations of alternatives that could also meet the short-term goal. Water quality under this scenario would be improved over current conditions but it should be recognized that current conditions are the target and this scenario allows some level of future development to be accommodated. Options for meeting this short-term goal are presented in the management section of this document (Section 7).

4.4 Distribution of Load in Black Brook Watershed

Tables 4-3 and 4-4 present the distribution of the phosphorus load to Lake Winnisquam from the Black Brook watershed under the current condition and under the future build-out scenario as predicted by the LLRM model. Reductions associated with the short-term goal scenario are not presented as there are numerous combinations of BMP's that could meet this target. The potential BMP's and associated reductions are discussed further below in Sections 5 and 6.

Phosphorus loading by land use category and subwatershed to Lake Winnisquam from the Black Brook watershed under current conditions are presented in Table 4-3. Note the Main Stem subwatershed includes only direct drainage to Black Brook from the confluence of the North and South Branches to the mouth of Black Brook.

Table 4-3: Phosphorus Loading to Black Brook by Land Use (Current Conditions)

LAND USE	BB-South Branch (kg/yr)	BB-North Branch (kg/yr)	BB Main Stem (kg/yr)	Black Brook Total (kg/yr)
Urban 1 (Low Density Residential)	30.7	21.6	6.4	55.8
Urban 2 (Mid Density Residential/Commercial)	0.0	0.0	0.0	0.0
Urban 3 (Roads)	18.2	9.1	3.5	29.2
Urban 4 (Industrial)	0.0	0.0	0.0	0.0
Urban 5 (Mowed Fields)	7.4	0.0	0.0	7.0
Agric 1 (Cvr Crop)	0.0	0.0	0.0	0.0
Agric 2 (Row Crop)	0.0	0.8	0.0	0.8
Agric 3 (Grazing)	0.0	0.0	0.0	0.0
Agric 4 (Hayfield)	31.5	4.8	9.9	44.0
Forest 1 (Deciduous)	30.2	19.3	1.3	48.3
Forest 2 (NonDeciduous)	7.3	3.9	0.8	11.3
Forest 3 (Mixed)	7.7	15.1	4.2	25.7
Forest 4 (Wetland)	0.2	0.0	0.2	0.4
Open 1 (Wetland/Lake)	0.7	0.3	0.0	1.0
Open 2 (Meadow)	0.2	0.0	0.1	0.2
Open 3 (Excavation)	0.0	0.0	0.0	0.0
Total Black Brook Load	**134.1**	**75.0**	**26.3**	**223.7**

Phosphorus loading by land use category and subwatershed to Lake Winnisquam from the Black Brook watershed under future buildout conditions are presented in Table 4-4. Note the Main Stem subwatershed includes only direct drainage to Black Brook from the confluence of the North and South Branches to the mouth of Black Brook.

Table 4-4: Phosphorus Loading to Black Brook by Land Use (Buildout Conditions)

LAND USE	BB-South Branch (kg/yr)	BB-North Branch (kg/yr)	BB Main Stem (kg/yr)	Black Brook Total (kg/yr)
Urban 1 (Low Density Residential)	297.4	232.1	41.6	542.5
Urban 2 (Mid Density Residential/Commercial)	0.0	0.0	0.0	0.0
Urban 3 (Roads)	111.8	82.9	15.8	200.0
Urban 4 (Industrial)	0.0	0.0	0.0	0.0
Urban 5 (Mowed Fields)	7.4	0.0	0.0	7.1
Agric 1 (Cvr Crop)	0.0	0.0	0.0	0.0
Agric 2 (Row Crop)	0.0	0.2	0.0	0.2
Agric 3 (Grazing)	0.0	0.0	0.0	0.0
Agric 4 (Hayfield)	9.5	1.4	3.0	13.2
Forest 1 (Deciduous)	9.1	5.8	0.5	14.6
Forest 2 (NonDeciduous)	2.2	1.2	0.3	3.5
Forest 3 (Mixed)	2.3	4.6	2.1	8.6
Forest 4 (Wetland)	0.2	0.0	0.2	0.4
Open 1 (Wetland/Lake)	0.7	0.3	0.0	1.0
Open 2 (Meadow)	0.2	0.0	0.1	0.2
Open 3 (Excavation)	0.0	0.0	0.0	0.0
Total Black Brook Load	**440.8**	**328.6**	**63.5**	**791.2**

Table 4-5: Land Use Categories by Subwatershed (Buildout Conditions)

	Subwatershed Area (Hectares (acres))				
Land Use	**BB-South Branch**	**BB-North Branch**	**BB-Main Stem**	**Pot Island Basin**	**Chapman Brk**
Urban 1 (Low Density Residential)	363.1 (897.3)	283.4 (700.3)	45.7 (112.9)	1271.7 (3142.4)	885.1 (2187.1)
Urban 2 (Mid Density Residential/Commercial)	-	-	-	41.5 (102.5)	-
Urban 3 (Roads)	68.6 (169.6)	50.9 (125.8)	8.7 (21.6)	394.6 (975.1)	193 (476.9)
Urban 4 (Industrial)	-	-	-	-	-
Urban 5 (Mowed Fields)	10.2 (25.2)	-	-	-	-
Agric 1 (Cvr Crop)	-	-	-	-	-
Agric 2 (Row Crop)	-	0.1 (0.3)	-	0.6 (1.5)	-
Agric 3 (Grazing)	-	-	-	-	-
Agric 4 (Hayfield)	16.2 (40.0)	2.5 (6.1)	4.6 (11.3)	-	-
Forest 1 (Deciduous)	97.1 (240.0)	61.8 (152.8)	4.4 (10.9)	169.0 (417.6)	143.3 (354.1)
Forest 2 (NonDeciduous)	25.6 (63.3)	13.3 (32.9)	2.7 (6.6)	96.9 (439.4)	88.0 (217.5)
Forest 3 (Mixed)	26.9 (66.4)	52.1 (128.8)	21.9 (54.1)	171.1 (422.8)	134.3 (331.9)
Forest 4 (Wetland)	2.2 (5.3)	0.6 (1.6)	2.3 (5.7)		1.1 (2.7)
Open 1 (Wetland/Lake)	11.3 (27.9)	5.5 (13.5)	0.2 (0.4)	63.8 (157.7)	15.5 (38.3)
Open 2 (Meadow)	1.1 (2.8)	-	0.3 (0.7)	7.5 (18.5)	13.6 (33.6)
Open 3 (Excavation)	-	-	-	9.6 (23.5)	20.4 (50.4)
TOTAL	622.3 (1537.7)	470.3 (1162.1)	90.7 (224.1)	2226.3 (5501.3)	1494.3 (3692.5)

5.0 Options for Managing Phosphorus Loading to Lake Winnisquam from the Black Brook Watershed.

This section describes non-point sources of phosphorus within the Black Brook watershed and outlines methods that could be employed to control their transport into Lake Winnisquam. These management practices could provide reductions in current loading rates and should be considered along with other management options as the Black Brook watershed becomes more developed and the need to manage loads becomes more critical to the preservation of Lake Winnisquam water quality.

Of the various sources of TP identified by land use in Section 4.4, the largest contributors of TP per land area are most appropriate sources to target for reductions. In the Black Brook watershed these consist of developed land (Urban 1), roads (Urban 3), hayfields (Agric4) and mowed fields (Urban5). These sources can be managed by employing BMPs and establishing regulations that support measures that protect the water quality of Black Brook and Lake Winnisquam.

Experience suggests that aggressive implementation of watershed BMPs may result in a maximum practical TP loading reduction of 60-70% in some watersheds. Greater reductions are possible, but consideration of costs, space requirements, and legal ramifications (e.g., land acquisitions, jurisdictional issues), limit attainment of such reductions. Most techniques applied in a practical manner do not yield >60% reductions in TP loads (Center of Watershed Protection, 2000). Better results may be possible with widespread application of low impact development techniques, as these reduce post-development volume of runoff as well as improve its quality, but there is not enough of a track record yet to generalize attainable results on a watershed basis.

The actual reduction in watershed loading from the Black Brook watershed necessary to meet the 6.3 μg/L short-term goal is 5%, and it is assumed that this reduction would be obtained mainly from the runoff portion of the load. This level of reduction is well within the practical maximum suggested by Center of Watershed Protection (2000), and should be achievable. Implementation will be phased in over a period of several years, with monitoring and adjustment as necessary.

There are a number of BMPs that could potentially be implemented in the Black Brook watershed (Table 5-1). BMPs fall into three main functional groups: 1) Recharge / Infiltration Practices, 2) Low Impact Development Practices, and 3) Extended Detention Practices. The table lists the practices, the pollutants typically removed and the degree of effectiveness for each type of BMP. Specific information on the BMPs is well summarized by the Center for Watershed Protection (2000).

Some of these practices may be directly applicable to the Black Brook watershed. Natural wetlands function to slow runoff water thereby encouraging infiltration of water and removal of TP through settling, soil adsorption and plant uptake. These functions should be preserved throughout the watershed. Maintaining buffers between lawn and other disturbed areas and Black Brook as well as encouraging minimal or no use of fertilizers is recommended. If fertilizer must be used, low or no TP fertilizer is recommended for lake protection.

Detention and infiltration practices can improve the quality of storm water originating from the roads and developments in the Black Brook watershed. Designing and installing BMPs that encourage infiltration or stormwater detention would reduce channel erosion and reduce TP concentrations by settling and contact with the soil prior to entry to the lake.

Key
- Adverse Impact
- Moderate Mitigation
- Good Mitigation
- Minimal Mitigation
- Moderately Suited
- Well Suited
- Not Applicable

Table 5-1: Best Management Practices Selection Matrix

Management Practice	Ability to Mitigate																Applicability							Notes
	Runoff Volume (↑)	Peak Flow Rates (↑)	Bankfull Flow (↑)	Baseflow (↓)	Mod. Sed. Transport	Channel Morph. Changes [1]	In-Stream Temp. (↑)	Sediment conc. (↑)	Nutrient conc. (↑)	Metal Conc. (↑)	Hydrocarbon Conc. (↑)	Bacteria/Pathogens (↑)	Organic carbon Conc. (↑)	MTBE Conc. (↑)	Pesticide conc. (↑)	Deicer conc. (↑)	New Development	Retrofit	Urban	Sub-Urban	Residential Sub-Division	Commercial	Industrial	
Recharge / Infiltration Practices[2]																								
Infiltration Swale																								Permeable site soils required. Pre-treatment recommended.
Infiltration Trench/Galley																								Permeable site soils required. Pre-treatment recommended.
Retention/Infiltration Basin																								Permeable site soils required. Pre-treatment recommended.
Low Impact Development Practices																								
Bioretention																								
Disconnecting Impervious Area																								
Flow Path Practices																								Includes increasing roughness, sheet flow, flow path length, and flattening slopes.
Green Roof																								
Minimize Disturbance Area																								Used as a component of LID site design.
Minimize Site Imperviousness																								Includes imiting use of sidewalks, and reducing road/driveway length/width.
Porous Pavement																								
Preserve Infiltratable Soils																								Used as a component of LID site design.
Preserve Natural Depression Areas																								Used as a component of LID site design.
Rain Barrels/Cisterns																								
Rain Garden																								
Soil Amendment																								Used as a component of LID site design.
Vegetated Filter Strip																								
Vegetation Preservation																								Used as a component of LID site design.
Extended Detention Practices																								
Created Wetland/Biofilter Detention																								
Extended Detention Pond																								
Wet Detention																								
Other Best Management Practices																								
Deep Sump Catch Basins																								Pre-treatment prior to infiltration BMPs
Sand/Organic Filter																								
Swale																								Dry swale with some infiltration.
Water Quality Inlet																								Includes proprietary hydrodynamic devices. Pre-treatment prior to exfiltration BMPs.

[1] Impacts include channel enlargement/incision/embededness, changes in pool/riffle structure, and reduced channel sinousity.

[2] Recharge and infiltration measures require permeable soils and pre-treatment is recommended. See specific BMP descriptions for more information.

5.1 Land Development

As natural undisturbed land is developed, impervious areas and the potential for phosphorus export are typically increased. Increased volume and rates of runoff from impervious roofs, driveways, and compacted soils causes greater potential for the transport of phosphorus to surface water. If not properly managed, these increased flows can cause substantial erosion of land that previously had not conveyed water as well as along existing drainage channels. The sediment load from such erosion can be a major source of phosphorus as the available phosphorus is transported by stormwater to surface waters.

Specific sources of phosphorus introduced with development include lawn and garden fertilizers, septic systems, and pet and livestock/fowl waste. Without proper erosion controls, a considerable amount of phosphorus and sediment can also be transported during construction activities.

Based on the land use data used in this study, there are currently 89.6 hectares (222 acres) of developed residential land and roads in the Black Brook watershed. This is 7.6 percent of the total Black Brook watershed area. Existing development within the Black Brook watershed is dispersed throughout the watershed and no densely populated areas currently exist. Future increases in TP loading from stormwater runoff associated with new development are a particular concern in the Black Brook watershed due to the presence of steep slopes and the potential for new driveway and road cuts to cause runoff from the development to contribute to the existing roadway swales which in many cases are not suitable for high-flow conveyance or stormwater treatment.

5.1.1 Existing Land Development Protection

Development regulations pertaining to the Black Brook watershed are under the jurisdiction of the federal government, the State of New Hampshire and the Towns of Sanbornton and Meredith. While this is not intended to be an exhaustive review of those regulations, it highlights important provisions of each of the jurisdictions regulations that have relevance to water quality in the Black Brook watershed. Any specific development project should do a complete review of requirements prior to any action.

Federal Requirements

- Dredge and fill permit. – Under section 404 of the Clean Water Act dredging and filling of waters of the United States is regulated. A permit is required for dredging or filling water. This included many activities on the waterfront, along streams or in wetlands including construction of beaches, break walls and boat houses.
- Stormwater Permit – A federal stormwater permit (NPDES – Phase II Construction Permit) is required for any land disturbance of greater than 1 acre.

State Requirements

- Site Specific Permit – A Site Specific Permit is required when disturbing more than 100,000 square feet of land or more than 50,000 square feet of land in the Shoreland zone (within 250 feet of a lake or tributary).
- State Septic Permit – A permit for on-site wastewater disposal is required for new construction or expansion of current use of a structure to include additional bedrooms.

- Shoreland Protection Act – Requires a permit for many activities in the 250 foot zone from a lake or tributary

Sanbornton Requirements

- Subdivision Regulations (adopted by voters March 12, 1957)
  - Expressed purpose " To prevent pollution of air, land, watercourses and waterbodies….."
  - The planning board "shall consider the impact of the proposed subdivision on the environment including, but not limited to, water and air pollution….."
  - " The subdivision plan shall be designed, in so far as possible, to preserve such natural features as wetlands, water courses, waterbodies, floodplains, steep slopes, aquifer recharge areas",
  - Lots shall be graded to the ditchline or shall have a stormwater system, no discussion of water quality or infiltration of water..
  - Stormwater management or drainage plans may be required by planning board for construction, no standards for runoff quality after development are included.
- Zoning Ordinance (2010 edition)
  - 50 foot setback from water bodies for buildings (note wetlands sections specifies 75 feet)
  - 2 acre zoning for new construction in the General Residential District
  - 6 acre zoning in the Forest Conservation District
  - 3 acre zoning in the General Agriculture District
  - 1.5 acre zoning in the Recreational District
  - Soil and erosion control plan is required for site plans and subdivisions
  - 6 acre zoning and impervious cover limit of 10% in Aquifer Conservation District
  - Cluster development allowed with planning board approval per Article 4 section T.

Meredith Requirements

- Zoning Regulations (adopted August 27, 1971, amended March 9, 2010)
  - In the Forestry and Conservation, Forestry and Rural, the minimum setback from the shoreline shall be sixty-five (65) feet
  - Most restrictive lot size prevails on a particular parcel
  - Minimum lots size based on soils and slopes and varies from approximately 1-4 acres.
  - Minimum lot size based on the Forestry and Conservation zone in the Black Brook watershed is 10 acres which would have primacy over soil based lot size requirements.
  - Minimum lot size based on the Forestry and Rural zone in the Black Brook watershed is 3 acres which may have primacy over soil based lot size requirements
  - Contains both a Conservation Subdivision and an Erosion and Sediment Control Ordinance
- Land Subdivision Regulations (March 13, 1968, amended July 8, 2008)
  - "Regard shall be shown for all natural features such as large trees, watercourses…"

  - Drainage portion of ordinance deals with water quantity and not water quality
- Site Plan Review Regulations (March 15, 1975, amended July 8, 2008)
  - Water quality is not specifically addressed but reference to zoning ordinance is made which includes the Erosion and Sediment Control Ordinance

Towns in New Hampshire have the authority to develop and enforce ordinances to protect designated resources of the town such as Lake Winnisquam. The statute authority is granted under RSA 674:35 and 674:43 to regulate subdivisions, and nonresidential and multi-family residential site development, respectively. The requirements associated with the development of a town master plan are stated in RSA 674:1-4. Authority for developing and enforcing zoning ordinances are specified in 674:17-20, and the application of innovative land use controls are described in RSA 674:21.

5.1.2 Considerations for Management of Land Development

Water quality impacts associated with development activities can be mitigated through zoning and planning ordinances and measures including:

- Removing the potential for development: If a land owner is willing, a conservation organization or the town can either remove the development rights from a property through a conservation easement, or through deeded ownership of the land. Land owners may donate conservation easements in exchange for tax deductions, or request financial compensation. Approximately 1.0% of the Black Brook watershed is currently under conservation protection. These conservation lands consist of two lots totaling 29.6 acres along Black Brook Road. Additional land conservation has the potential to considerably reduce the future increases in TP export to Lake Winnisquam from the Black Brook watershed. As presented in the discussion of buildout (Section 4.2), development of all land that could currently be developed in the Black Brook watershed would result in an increase in phosphorus loading to Lake Winnisquam of 253% from the Black Brook watershed. Additional protection of lands from development would result in a direct decrease in the maximum potential increase in TP loading related to future development. A search of October 2011 real estate listings suggest that larger parcels of land without water access and without current conservation easements in Sanbornton can be purchased for approximately $5,000 – $25,000 per acre. Purchasing conservation easements on property would be less expensive than deeded ownership. Based on the analysis conducted in Section 4, the removal of the development potential from currently undeveloped forested land to low density residential land in the Black Brook watershed will eliminate potential future increases in loads of 0.8 kg TP per hectare (0.7 lb/acre) of land protected.
- General Ordinances
  - Local or regional bans on phosphorus in lawn fertilizer
- New Development / Construction Ordinances
  - Incorporate low impact development (LID) requirements
    - Dry wells
    - Infiltration trenches
    - Bioretention Systems (“rain gardens”)
    - Rain Barrels
  - Minimize disturbed areas

- Maintain natural buffers
- Maximize setbacks from lakes and tributaries
- Minimize impervious cover
- Minimize construction footprint
- Pervious pavers / pavement
- Minimize soil compaction during construction
- Provide drainage management for impervious areas (gravel & paved driveways, and roofs)inclusion of no net increase in phosphorus export provisions for development.
- Prohibit stormwater discharges from new driveways and new roads into an existing road or existing road drainage system unless potential impacts (i.e., TP and sediment loading) can be deemed negligible by a qualified professional engineer.

- Enforcement of Ordinances

Any of the above provisions could be codified in the Sanbornton or Meredith Planning or Zoning regulations. Examples of ordinances are presented in Appendix C.

The Subdivision Regulations in the Town of Sanbornton currently addresses drainage in terms of providing "adequate facilities (culvert and ditches) to allow for the removal of stormwater runoff and to maintain natural drainage patterns". The Subdivision Regulations should be amended to include requirements for low-impact development practices and stormwater management techniques in order to protect the water quality of Black Brook and Lake Winnisquam.

5.2 Septic Systems

Phosphorus loads from septic systems are typically included in Watershed Management Plans because they can be a significant source in some watershed, especially where old camps with poorly designed septic systems and/or direct sanitary discharges exist.

Septic systems and their potential for phosphorus loading will be an important consideration in the Watershed Management Plan for Lake Winnisquam; however, there is no evidence that nutrient loading from septic systems on Black Brook is a source that needs to be addressed by this Plan.

5.3 Roads and Stormwater Management

There are approximately 12.2 miles of road within the Black Brook watershed. Of these, 6.1 miles (50.6%) are gravel roads and 6.0 miles (49.4%) are paved. The paved roads include approximately 0.40 miles of Black Brook Road, 0.52 miles of Lower Bay Road, 2.03 miles of Steele Hill Road, and 2.40 miles of Woodman Road. The gravel roads include approximately 1.01 miles of Kaulback Road, 1.14 miles of Oak Hill Road, 0.43 miles of Huse Road, and 1.99 miles of Roxbury Rd.

Roads, especially gravel roads, are a large source of TP and solids in Black Brook, which can be managed with appropriate BMPs. Section 5.6 identifies specific road drainage areas near Black Brook where runoff from roads is directly conveyed into Black Brook and BMPs are recommended. The southern branch of Black Brook is influenced by direct drainage from portions of Woodman Road and Huse Road. The main stem and northern branch of Black Brook are influenced by direct drainage from portions of Black Brook Road, and Kaulback Road. A combination of general road maintenance BMPs and the installation of structural means that promote the infiltration of stormwater from roads are recommended as described in the following sections.

5.3.1 Road Maintenance

To minimize sediment and phosphorus transport from roadways into Lake Winnisquam and its tributaries, stormwater control and treatment practices should be employed and routine maintenance of the roads and drainage systems should be performed.

A primary mechanism for the transport of phosphorus from paved roads is sheet flow washing of sediments. Sand that is applied in winter to paved roads is a major source of sediment load to down gradient streams and lakes. Best management practices for minimizing the sediment and phosphorus load from paved roads include:

- Minimize use of sand and salt during the winter;
- Remove sand from the streets prior to spring rain and ground thaw;
- Routine monitoring of and removal of sediments in stormwater catch basins.

Gravel roads are essentially impervious so precipitation quickly pools and flows to the edge of the road where it either infiltrates into surrounding soils or becomes channelized and flows along a roadside drainage ditch to the nearest surface water or topographic low point. The slope of the road and abutting land, the infiltration capacity and ground cover of the surrounding soil, and the intensity of the storm event are factors that determine the amount of sediment that is transported from gravel roads. Unfortunately these factors are generally established by the location and layout of the road. Through proper road maintenance and the incorporation of a system for treating the drainage, sediment loads associated with runoff from gravel roads can be managed.

As is the case for most potential pollution sources, control at the source is typically the easiest and most cost effective. The following best management practices address gravel roads as the source of sediment loads through on-going maintenance:

- Evaluate and maintain the best cross-road pitch as is appropriate for the drainage conditions. It is important to pitch gravel roads to minimize runoff flow velocity and contact time, ponding, and erosion. A road center crown is appropriate when surrounding topography is flat enough to infiltrate sheet flow or roadside drainage ditches/swales exist that are adequate for the expected flow. Where possible, it is ideal to maintain a road grade and pitch that causes sheet flow to the area abutting the road where it can infiltrate in undisturbed soils. Pitching the road toward the upslope edge should be considered where downslope erosion is a concern. The ditch/swale along the upslope roadside must be adequately sized and reinforced to manage the concentrated channelized flow and the discharge at the low topographic point must be capable of handling and treating the expected flow.
- Re-surface gravel roads as is needed to maintain the cross-road pitch, remove pot-holes, and maintain the road elevation as is needed for proper drainage. Crushed bank-run gravel or similar angular-grained material should be used for re-surfacing.
- When plowing, care must be taken to ensure the gravel is not disturbed.
- The edge of gravel roads must be graded such that water can freely flow to the abutting ditch/swale or ground surface. Improper grading along road shoulders can cause stormwater to channelize, erode abutting materials, and transport sediment from the road directly to a waterbody. Gravel that falls into drainage ditches and swales must be removed.
- Schedule maintenance to minimize potential erosion. Top coating should be performed after spring thaw and at a time when no or very little rain is predicted.

As runoff is channelized along roadside ditches, its potential to cause erosion and suspend sediment greatly increases. In order to minimize the sediment loads associated with drainage conveyance, it is important to understand the size and characteristics of the area draining to channel and properly engineer the channel and treatment practice for predicted storm volumes and peak rates. Refer to *Gravel Road Maintenance Manual, A Guide for Landowners on Camp and Other Gravel Roads*, MEDEP & Kennebec County Soil and Water Conservation District, April 2010, for information on proper gravel road construction and maintenance.

Routine inspections of the drainage along gravel roads are important for the identification of potential problems. Some problems with simple solutions such as a clogged culvert can cause major damage to a gravel road.

5.3.2 Culvert Cleaning/Maintenance

There has been historic overtopping of Black Brook and Woodman Road as a result of clogged or undersized culverts. During site visits in 2010 and 2011, AECOM noted the culverts at Black Brook Road and Kaulback Road were partially blocked with woody debris. Culvert blockage can cause water to pond on the upstream side of roads and potentially overtop the road during high flow events. In 2010, Woodman Road washed out at the Black Brook crossing which resulted in large amount of roadway fill material washing into the brook. The sediment and TP load from this type of event can be considerable, as well as its long-term impact to the stream morphology and associated aquatic habitat. Culverts should be inspected and cleaned at least seasonally, with more frequent cleaning prior to spring flow and during autumn leaf fall. The two 48-inch culverts and one 36-inch culvert at Black Brook Road, and the four 36-inch culverts at Kaulback Road are particularly important to inspect and clean because of their high-flow potential and natural tendency to accumulate woody debris.

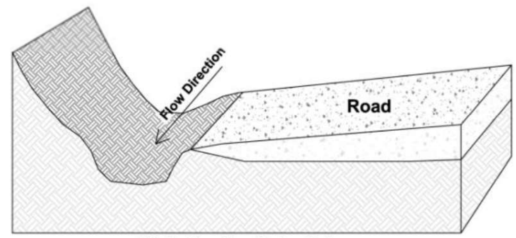
The adequacy of the sizes of culverts on Black Brook Road, Kaulback Road, and Woodman Road should be evaluated by a qualified professional engineer. Hydraulic conditions under 25-, 50- and 100-year, 24 hour, storm events should be evaluated, and culvert design modifications should be implemented if needed. The flow capacity of the culverts under Black Brook Road and Kaulback Road are dependent upon backwater conditions in the streams, thus they cannot be estimated without further study of the physical characteristics of the streams.

5.3.3 Stormwater Management Practices

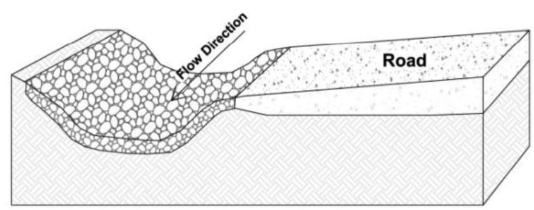
Paved and gravel roads are essentially impervious so during rain events water rapidly collects and flows to the nearest water conveyance channel or area where it can infiltrate to the ground. Road-side ditches have historically been built or were naturally created to rapidly drain stormwater to the nearest waterbody, but due to increased flooding, erosion, and contaminant transport associated with this practice, alternative techniques for managing road runoff are recommended. Minimizing the accumulation of channelized flow is the initial step toward controlling stormwater. This is accomplished by directing runoff to areas near the point of generation that are capable of natural infiltration. As greater amounts of runoff accumulates, the complexity of capturing, slowing, and treating the stormwater increases along with the costs. The New Hampshire Stormwater Manual (NHDES, 2008) is a comprehensive resource for stormwater best management practices. As residential development, and road and driveway construction takes place in the Black Brook watershed, it will be important that stormwater controls are implemented in accordance with this guidance document.

The following stormwater management practices are presented as examples of measures that could be employed in the Black Brook watershed. These measures, as well as others that are listed in Table 5-1 and described in the NH Stormwater Manual should be considered for existing sites and those that are discovered or developed in the future.

Swales



High Erosion Potential
Narrow Roadside Ditch with Steep Side-Slope



Low Erosion Potential
Riprap Reinforced Swale
Widened with Lowered Side-Slopes

Swales convey stormwater along roadsides to prevent water from ponding on, or flowing over the road. In many cases, road-side swales are ditches that have been created by channelized stormwater eroding a path of least resistance. The sediment and nutrient load associated with this type of drainage is considerable, as is the potential damage to the road integrity and abutting property. Properly designed swales provide a channel that is capable of conveying expected storm flow rates without erosion. Factors that need to be considered in the design of a road-side swale include topographic slope, drainage area, expected storm flow, swale dimensions, outlet control, base material and vegetation.

The performance of swales can be improved and their potential contribution to sediment and nutrient loading reduced by increasing their depth and width, reinforcing with appropriately sized riprap, installing check dams (riprap) and step pools, and reducing their slope (cross-section and profile). Where feasible, infiltration trenches should be considered in place of conveyance swales. Opportunities for swales to turn-out into areas with excess infiltration capacity should be assessed and utilized to convert channelized swale flow to sheet flow and infiltration.

Culvert Inlet and Outlet Scour Protection

To reduce sediment and nutrient loading associated with erosion at culvert inlets and outlets, loose sediments should be routinely removed, the inlet and outlet pools should be reinforced with appropriately sized riprap, and headwalls should be installed. Inlet and outlet culvert areas are subject to concentrated flow velocities so the potential for erosion at these locations is considerable. By installing an energy-dissipation/sediment traps at locations where scour is likely due to high flow velocities, erosion can be mitigated. These pools are intended for use at the low point of swales and intermittent streams and stormwater drainage culverts, not perennial streams. The size of this type of pool is dependent upon the expected flow rates and the site conditions.

Ditch Turnout Buffer

Ditch turn-out buffers are recommended to minimize erosion along roadside ditches where due to the grade of the road or the limitation of other stormwater control options, channelized flow is likely to cause erosion of the edge of the road or roadside ditch. Ditch turn-out buffers are designed to convert channelized flow into sheet flow by diverting ditch drainage into areas that slow the flow rates using check dams along a level channel and disperses the stormwater over a vegetated or forested area with a level spreader to allow for natural infiltration and plant update. For applications along gravel roads a sediment trap should be incorporated to ease maintenance operations. See Appendix

Vegetated Buffer

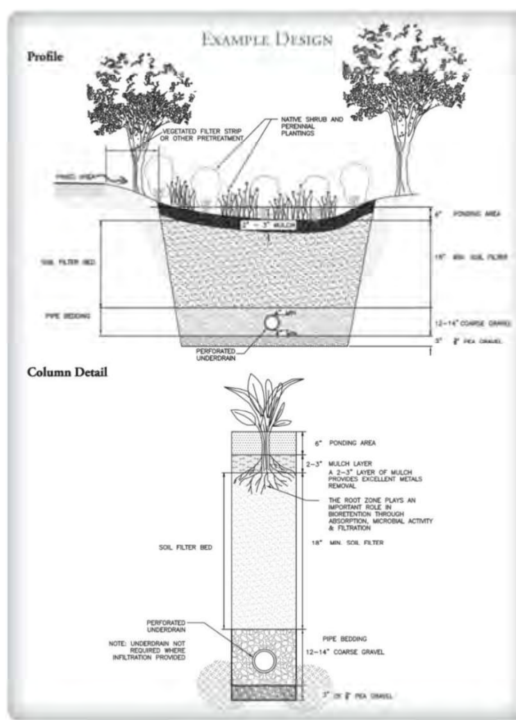
Vegetated buffers provide treatment for the ditch turnouts and are an effective BMP for areas where sheet flow can be maintained such as along roadway shoulders, parking lots, or at the edge of fields. Vegetated buffers are either natural undisturbed forested areas or areas where vegetation and uncompacted soil allow for plant uptake of nutrients and sheet flow infiltration. A sufficient flow path length across the buffer is necessary to ensure treatment is provided by the BMP. Design criteria are specified in the NH Stormwater Manual, Vol. 2, 4-3 (6).

Pervious Pavement / Pavers

Properly designed and constructed pervious asphalt pavement and pervious concrete pavers result in no direct runoff from these areas. The installation of pervious pavement/pavers is ideal where land area for runoff treatment is insufficient and the ability to infiltrate runoff before it channelizes is limited. Factors that control the feasibility of this stormwater control option include the depth to groundwater, depth to bedrock, native soil permeability, topographic limitations, and expected traffic load. For optimal performance it is essential that pervious pavement / pavers are constructed in accordance with current design standards (http://www.unh.edu/unhsc/sites/unh.edu.unhsc/files/pubs_specs_info/unhsc_pa_spec_10_09.pdf).

Bioretention System

Bioretention systems are shallow basins designed to infiltrate runoff thorough an engineered permeable soil material with sufficient vegetation to provide water treatment and plant uptake. Water treated with a bioretention system either infiltrates to the groundwater ("rain garden") or discharges via an underdrain system. Bioretention systems are vegetated to assist with the uptake of pollutants and to blend in with landscape aesthetics. Typically these systems are designed with a treatment capacity of the 10-year 24-hour storm. Pretreatment to remove settleable solids is required, as is a means to bypass flows greater than the design storm. Design criteria are specified in the NH Stormwater Manual, 2008, Volume 2 (http://des.nh.gov/organization/commissioner/pip/publications/wd/documents/wd-08-20b.pdf). Example design shown here is from the NH Stormwater Manual.



Total suspended solids and total phosphorus removal from properly designed and installed bioretention systems is reported to be approximately 90% and 65%, respectively (NH Stormwater Manual). Installed costs for bioretention systems vary widely based on their size and site complexity. Systems could cost from $3,000 for very small simple systems, to over $35,000 for large systems.

5.4 Timber Harvesting

Timber harvesting operations have considerable potential to cause soil erosion, runoff, and sediment and nutrient loading. The document, Best Management Practices for Erosion Control on Timber Harvesting Operations, 2004, published by the New Hampshire Department of Resources and Economic Development, Division of Forests and Lands is available on-line at: http://www.nhdfl.org/library/pdf/Forest%20Protection/2004%20BMPs%20for%20Erosion%20Control.pdf

Loggers should be made aware by town officials that erosion control BMPs shall be followed during timber harvesting operations. Inspections by town officials or commission members should be performed to ensure BMPs are practiced and disturbance of soils, wetlands, and waterways are properly minimized. Hiring a forester or environmental consultant with a working knowledge of forestry BMPs to conduct routine inspections during logging operations is an effective approach to control soil erosion, storm water runoff, and wetland disturbances.

5.5 Agriculture / Field Management

Based on the land use delineation used to develop the TP loading model for this plan, approximately 192 acres within the Black Brook watershed are used for agricultural purposes. Most of this area appears to be used for hay or crop production. There are some agricultural fields on Woodman Road that have direct drainage paths to Black Brook. Nutrient loading from agricultural land can be managed through many methods including runoff controls and treatment, grazing area restrictions and setbacks, and manure application timing and buffers. Considerable information is available to assist with the management of nutrient loads from agricultural lands. The US Environmental Protection Agency has published a series of Nonpoint Source Management Fact Sheets (http://www.epa.gov/owow/nps/pubs.html#ag).

Fields that are maintained for uses such as sporting fields, golf courses, cemeteries, and parks typically have higher TP export due to fertilizer, grass clippings, animal/bird feces, and higher runoff rates due to soil compaction. Maintaining natural buffers around fields and providing treatment measures for channelized drainage from fields are critical in reducing the potential loading from fields. Treatment measures that are applicable to stormwater management from fields include infiltration techniques, treatment ponds and wetlands, and natural vegetated buffers.

5.6 Black Brook - Site-Specific, Non-Point Source Management Measures

This section identifies specific areas in the Black Brook watershed that are probable sources of sediment and nutrient load to Black Brook currently and proposes Best Management Practices (BMPs) that could be employed to reduce the loading from these areas.

Locations of the proposed BMPs are presented on Figure 5-1. The predicted reductions from the management practices are estimates based upon literature values and best professional judgment. Removal efficiencies and associated construction costs are provided in Tables 5-1 and 5-2.

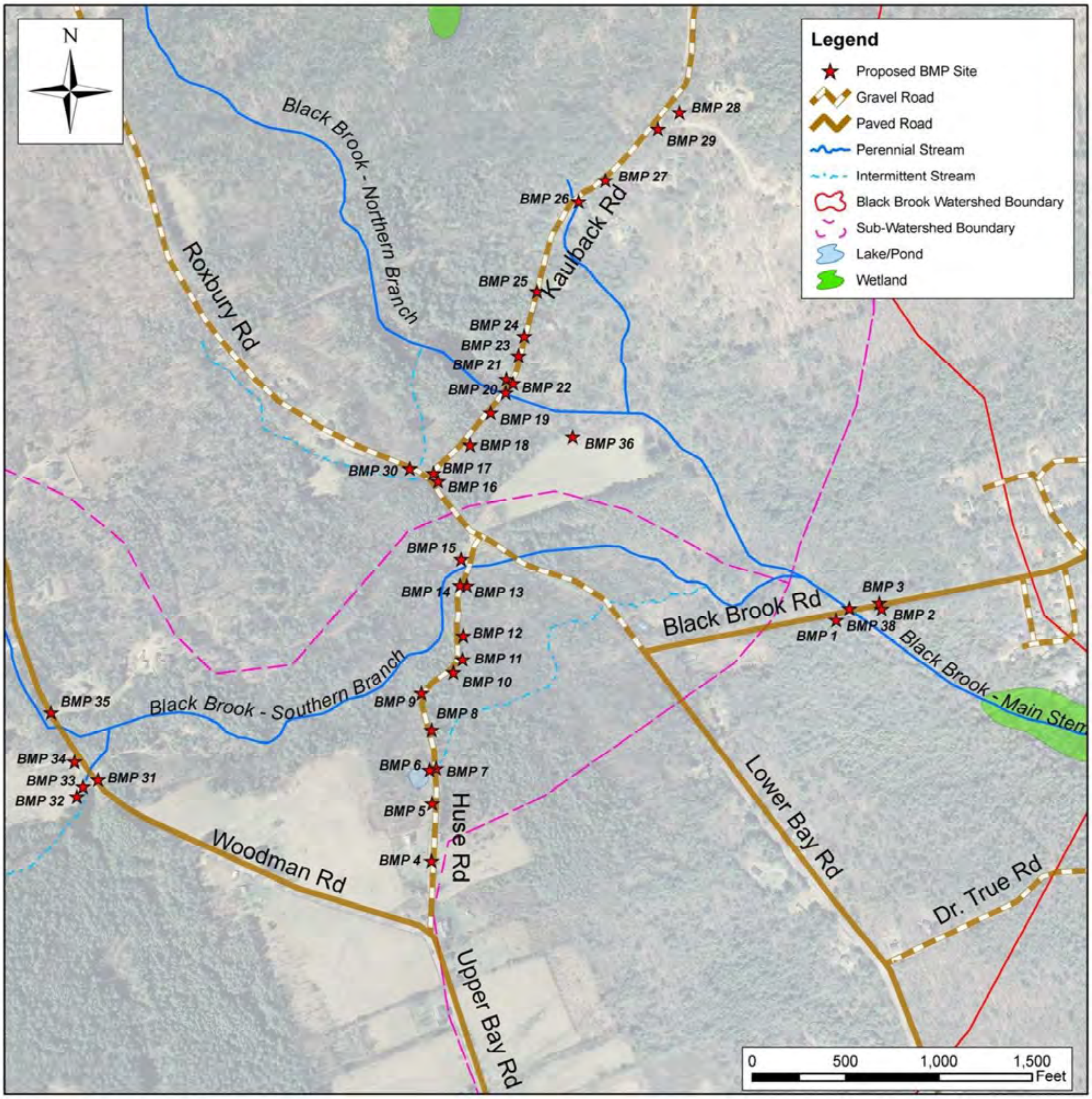


Figure 5-1: Sites for Best Management Practice Implementation

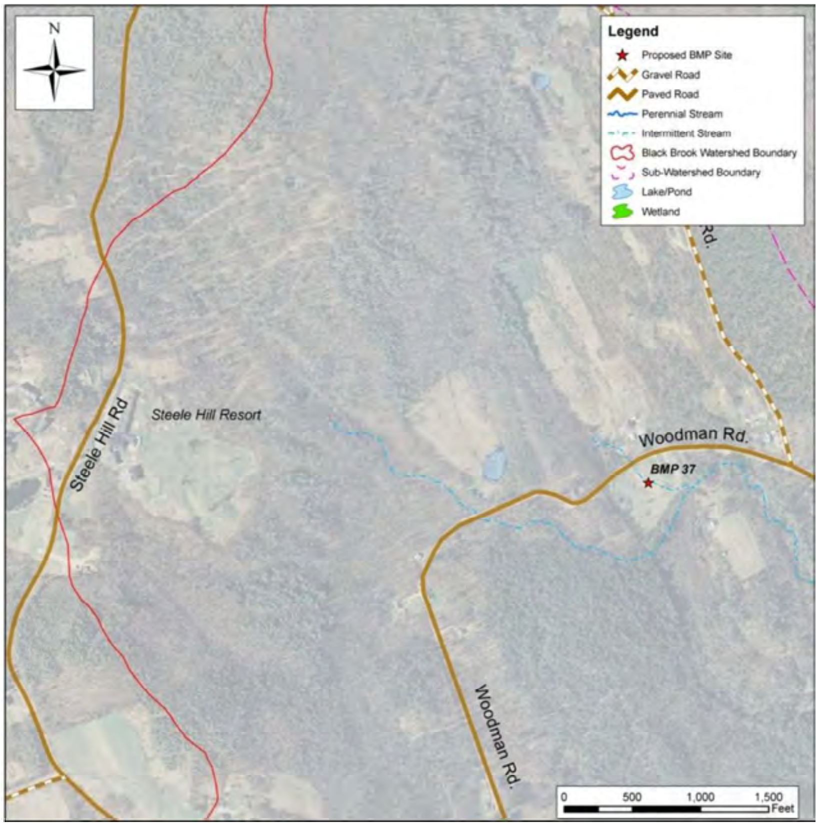


Figure 5-2: Sites for Best Management Practice Implementation - Western Headwaters

5.6.1 Road Drainage BMP's

Managing stormwater and erosion from roads in the Black Brook watershed is the most critical and accessible means of reducing TP loading to Black Brook. Recommended management practices include drainage diversion, stormwater infiltration, bioretention, source minimization, and routine maintenance. The following locations within the Black Brook watershed have the potential for specific BMP applications. Estimated TP load removal and installation costs are complied in Tables 6-1 and 6-2.

According to John Thayer, Sanbornton Public Works Director, approximately three to five inches of gravel is added to resurface gravel roads every two to three years. This equates to a total of approximately 1900 yd^3 that is lost from gravel roads each year, assuming minimal 3-inches used on all 6.1 miles of road every two-and-a-half years. Approximately 23 yd^3 is also added for traction during winter conditions based on the application rate of 250 lbs per lane mile and assuming 35 applications per year. Management practices are proposed to reduce the loss of gravel by minimizing erosion through stormwater diversions and road maintenance, and capture gravel in sediment traps.

5.6.1.1 Black Brook Road

Black Brook Road is a paved road that crosses the main stem portion of Black Brook (Figure 5-1). Black Brook Road has a slight (<2%) grade toward the Brook and is slightly higher in elevation than the abutting natural topography. As noted by AECOM during site visits in 2010 and 2011, the shoulder of the road near the crossing was not properly graded and stormwater flow and sediment transport along the edge of the road was evident. East of the crossing, evidence of direct discharge of stormwater from the edge of the road and shoulder into Black Brook existed. On the southwest side of the crossing, the shoulder is graded to divert stormwater directly into the Brook and into a low-lying floodplain area.

Photo 1: Black Brook Road, Shoulder Grading, Looking West (BMP 3)

Photo 2: Black Brook Road, Proposed Sediment Trap (BMP 1)

TP and sediment loading from the northern side of this road can be reduced by re-grading the shoulders so stormwater from the road directly runs off as sheet flow into the adjacent forested/vegetated areas (BMP 3). Efforts should be made during this re-grading work to prevent the channeling of stormwater runoff. The Black Brook Road pavement was is very poor condition at the time of the site visits. When this road is repaved, it will be important to pitch the road toward the shoulder and re-grade the shoulder with a stable material that will assist with the distribution of runoff over the adjacent undisturbed area. The runoff from the south side of Black Brook Road, east of the crossing should be directed to the adjacent forested area to prevent channelized runoff along the edge of the road from discharging directly into Black Brook (BMP 2).

On the southwestern side of the crossing the road shoulder should be graded in a manner that directs stormwater runoff to the low-lying floodplain area (BMP 1). The stormwater treatment potential in this area can be improved by installing an outlet control in the floodplain area to promote sediment capture and infiltration. Currently stormwater passes through this area and flows to Black Brook via a small tributary channel. By installing an outlet control such as rip-rap, stormwater would be retained in this area and through the settling of sediments and infiltration processes some removal of TP is possible.

Black Brook Road has historically flooded during large storm events apparently as a result of undersized culverts. These events have caused considerable erosion of the shoulder of Black Brook Road and deposition of the road-side sand and gravel into Black Brook. There are two 48-inch and one 36-inch culvert under Black Brook Road. The adequacy of the culvert sizes should be evaluated with respect to anticipated flow rates during 25-year, 50-year, and 100-year, 24-hour storm frequencies, and if needed, they should be replaced with a culvert or bridge that provides adequate passage in accordance with NH Env-Wt 904 (Design and Construction of Stream Crossings). Associated road reconstruction designs should incorporate storm water control measures that minimize TP and sediment loading to Black Brook to the maximum extent practicable. The replacement of the Black Brook Road culvert is listed on Tables 6-1 and 6-2 as BMP 38. Since this BMP is intended to prevent the wash-out events that occur during large storm discharges, the TP reduction associated with this BMP cannot be quantified on an annual basis. Under the reasonable assumption that approximately 6 yd^3 of soil are eroded from the road shoulders and stream bank during a major flooding event across Black Brook Road, approximately 1 kg of total phosphorus bound to the soil would be transferred into Black Brook, assuming 100% release of the assumed 100 mg TP/kg soil are released over time.

5.6.1.2 Huse Road

Huse Road is a gravel road located along a very steep bank adjacent to the southern branch of Black Brook (Figure 5-1). The steep portions of this road have slopes between 10%-15%. Runoff from the western side of this road channelizes and flows over the edge of a steep bank into Black Brook. The bank is eroded in many locations as a result of stormwater runoff. The eastern side of Huse Road drains along the edge of the road. Some rudimentary ditch turn-outs allow runoff from this side of the road to discharge in adjacent forested areas. These turnouts appear to routinely fill with sediments, minimizing their effectiveness. Based on gravel amounts used for resurfacing provided by the Sanbornton Public Works Director, Huse Road requires the equivalent of 135 yd^3 per year.

Minimizing sediment and TP loading from Huse Road is a challenge because of the minimal area available for stormwater controls and BMP's adjacent to the road, and the natural effect of gravel eroding from steep slopes. The following options should be considered as potential means of reducing the sediment and TP load from Huse Road.

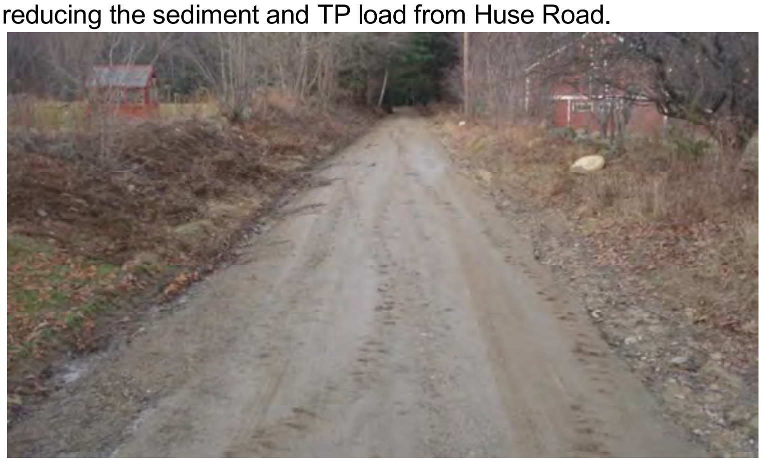


Photo 3: Huse Road, Southern Portion (BMP 4)

Much of Huse Road is lower than its adjacent native ground surface and stormwater that runs off the road surface channelizes and flows along the edge of the road. In order to reduce the erosion of the edge of the road, the proper design and construction of swales should be considered, where feasible.

In some areas this will require significant removal of adjacent soil and trees. Available right-of-way widths and granting of drainage easements may be limiting factors along with the adjacent road materials, (i.e., bedrock). BMP 4 is identified in Table 6-1 and Figure 5-1 and represents the swale construction along Huse Road. The identification of suitable swale locations is not reasonable until a comprehensive plan for addressing Huse Road is developed.

Approximately 660 feet of the western side of Huse Road is drained through a ditch turn-out into a field and a small (0.2 acre) pond that discharges into a Black Brook tributary. Improvements to this turn-out (BMP 5) include the installation of a ditch turn-out with a sediment trap and gravel trench level spreader in the adjacent field. If access to this private property is not allowed, replacement of the mounded treeline along the road with a reinforced swale with check dams should be considered as a means to capture sediment (Photo 4). At the low point of this drainage (BMP 6), the installation of a sediment trap may be a feasible BMP to provide additional removal of TP and sediment.

Photo 4: Huse Road Proposed Ditch Turn-Out with Sediment Trap (BMP 5)

The eastern side of Huse Road, approximately 850 feet from its intersection with Woodman Road, drains through a ditch turn-out into a low-lying area and is hydraulically connected to the same tributary. The existing turn-out does not appear to be functioning due to the accumulation of sediment at the inlet. This BMP (BMP 7) could be improved by installing a properly designed sediment trap and level spreader approximately 30 feet upslope from the existing locations. The discharge from the level spreader should be directed to the adjacent low-lying area. The BMP locations and details are presented in Figure 5-1 and Tables 6-1 and 6-2.

Photo 5: Huse Road, Existing Turn-Out, Proposed Sediment Trap with Forested Buffer (BMP 7)

At the locations of BMP 8 through BMP 12, ditch turn-outs exist; however there are no sediment traps or structures to diffuse runoff. At each of these locations a ditch turn-out with forested buffer may be feasible for the reduction of sediments and TP from portions of Huse Road. Much of the western side of Huse Road currently drains over the bank directly to Black Brook. Approximately 80 feet upslope from the BMP 9 location significant erosion over the bank has undermined tree roots. A stone berm should be constructed at this location to divert runoff along the western edge of the road to BMP 9. BMP 9 is a sediment trap and a level spreader. The removal of trees should be minimized in this area, while constructing a level spreader that is designed to diffuse the road runoff over a large enough area that the steep hillside will not be eroded. At other locations along the western side of Huse Road, road grading toward the inside of the slope (eastern side) is advised to minimize the erosion along the western bank. Where possible, a properly designed and constructed swale along the inside (eastern side) of the road would reduce the erosion of the road and hillside.

Photo 6: Huse Road, Existing Turn-Out, Proposed Sediment Trap (BMP 8)

Photo 7: Huse Road, Existing Turn-Out, Proposed Sediment Trap with Forested Buffer (BMP 9)

Photo 8: Huse Road, Existing Turn-Out, Proposed Sediment Trap (BMP 10)

Photo 9: Huse Road, Existing Turn-Out, Proposed Sediment Trap (BMP 11)

Photo 10: Huse Road, Existing Turn-Out, Proposed Turn-Out with Forested Buffer (BMP 12)

Runoff from the lower portion of Huse Road currently flows directly into Black Brook. There are sufficient relatively flat land areas on both sides of Huse Road immediately south of the Black Brook crossing where ditch turn-outs with sediment traps and forest buffer level spreaders could be feasible (BMP 13 and BMP 14).

Photo 11: Huse Road, Proposed Ditch Turn-Out with Forested Buffer (BMP 13)

Photo 12: Huse Road, Proposed Ditch Turn-Out with Forested Buffer (BMP 14)

Because of the steep slope of Huse Road, the loss of gravel due to erosion will be a routine occurrence and maintenance costs for re-surfacing, re-grading and sediment trap cleaning must be considered when developing a long-term plan for this road. In consideration of the long-term maintenance costs for Huse Road, the feasibility of paving Huse Road should be considered. This would require considerable capital expense since the design may require replacing a portion of the roadbed materials, hard-piping some portions of the drainage to properly design stormwater control structures, and road widening to accommodate adequately sized swales. The cost of paving Huse Road may range from approximately $200,000 to $500,000 depending upon existing conditions, and drainage and right-of-way limitations. This option was not considered with the cost estimates because the engineering involved in this type of effort exceeds the scope of this watershed management plan.

However, if properly designed, paving the steep portion of Huse Road could substantially reduce sediment and nutrient loading to Black Brook.

Another option for minimizing TP and sediment loading from Huse Road is to close the road to traffic, and stabilize the road by replacing the roadbed with loam / topsoil and seeding with native grass, bushes, and trees. This can be considered an alternative BMP in place of BMPs 4 through 14.

BMP 15 is proposed to treat runoff from the area near the intersection of Huse Road and Roxbury Road (Figure 5-1). Currently runoff from Huse Road and the private property located at this intersection flows overland directly into Black Brook. A properly designed gravel trench constructed across this area would provide some potential for infiltration and evenly distribute runoff over a buffer area prior to discharging into Black Brook. The buffer area should be an area that provides at least a 20 foot flow path from the gravel trench to the Brook, and should be created by loosening hard-packed soil and planting native grasses and shrubs that will promote infiltration. This BMP location is on private property, so land owner cooperation will be required.

Photo 13: Huse Rd/Roxbury Rd., Proposed Gravel Trench and Vegetated Buffer (BMP 15)

5.6.1.3 Kaulback Road

Kaulback Road is a gravel road that crosses the northern branch of Black Brook (Figure 5-1). Stormwater drains from the eastern side of the southern portion of Kaulback Road along the edge of the road in the roadside ditch and discharges directly to Black Brook. This ditch also receives runoff from a portion of Roxbury Road and approximately three acres of forested area south of Roxbury Road. During 2010 and 2011 site visits, this ditch was lined with sediment and leaf debris and erosion of the edge of the road was evident. This portion of Kaulback Road is bordered by steeply rising bank with a stone wall on top. Telephone poles are also installed along the road border. The primary cause of erosion along the edge of this section of Kaulback Road is the runoff and groundwater seepage from the upland forested area south of Roxbury Road. BMP 17 is the installation of a culvert under Kaulback Road that is designed to divert this runoff and groundwater seepage from the eastern side of Kaulback Road directly to the Black Brook tributary that is located immediately west of Kaulback Road. Proper culvert sizing and measures for diverting higher than design flows must be considered in the design. Also erosion controls must be incorporated in the new outlet and swale to the Black Brook tributary.

BMP 18 consists of armoring the ditch along the eastern side of Kaulback Road with riprap to minimize erosion. Where possible the ditch should be widened and deepened to improve the stability of the channel. This channel discharges directly into Black Brook. In order to treat the runoff from this section of Kaulback Road BMP 19, a sediment trap and infiltration basin is proposed for construction in the low-lying area adjacent to Black Brook (Figure 5-1).

Photo 14: Kaulback Road, Looking North Toward Black Brook – Swale Improvement (BMP 18)

Photo 15: Kaulback Road, Sediment Trap/Infiltration Basin BMP Location (BMP 19)

Photo 16: Kaulback Road, Proposed Vegetated Shoulder (BMP 20)

Kaulback Road is flat where it crosses Black Brook; however runoff from this gravel area flows directly into Black Brook. The road width in this area is approximately 30 feet. The construction of a vegetated shoulder approximately four feet wide on both side of this section of Kaulback Road would reduce the potential for the gravel road in this area to erode into the brook (BMP 20). The road shoulder would need substantial organic/top soil amendments to provide an adequate growing medium, so measures must be in place to prevent the loss of this material during construction.

Paving sections of Kaulback Road near Black Brook is an option that could be considered to reduce the road maintenance costs and the sediment and TP loading of Black Brook associated the gravel road. If it were paved, additional stormwater control measures would need to be employed to reduce the flow rate and treat the runoff appropriately.

Stormwater that drains along the lower portion of Kaulback Road currently flows directly into Black Brook. Areas for the installation of a BMP in these locations are limited, but simple sediment traps are recommended to capture some of the sediment that erodes from this portion of the road and shoulder (BMP 21 and 22). Reinforcement of the swales with riprap could also reduce erosion along these areas.

Photo 17: Kaulback Road, Proposed Sediment Trap Location (BMP 22)

Kaulback Road slopes uphill to the north from Black Brook between approximately 4% and 6%, on average. Stormwater channelizes along the edge of this road, primarily on the western side, and flows directly into Black Brook. Erosion of the road and the western roadside ditch was evident during visits in 2010 and 2011. Erosion from this ditch could be reduced by constructing a properly designed swale that is reinforced with riprap. There are two areas along the lower portion of this section of Kaulback Road where ditch turn-outs, sediment traps and level spreaders with forest buffers may be feasible BMPs for the reduction of sediment load and TP (BMP 23 and 24).

Photo 18: Kaulback Road, Looking South, Proposed Turn-Out Location (BMP 23)

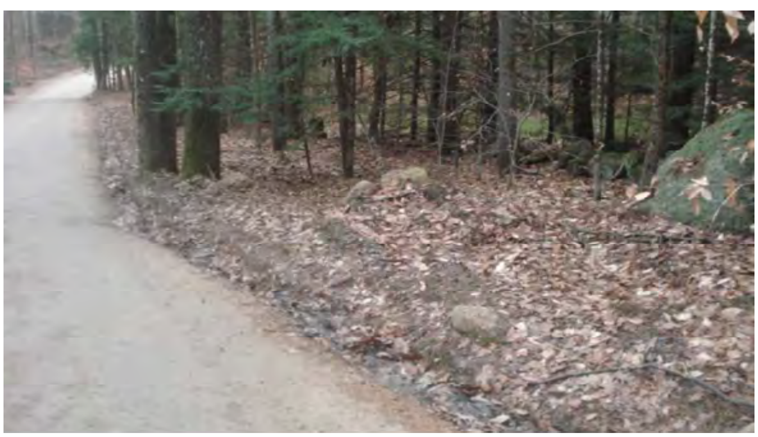


Photo 19: Kaulback Road, Looking South, Proposed Turn-Out Location (BMP 24)

The installation of a culvert at the location of BMP 25 on Kaulback Road is recommended to divert storm water runoff from the up-gradient roadway and reduce the potential for the runoff from the up-gradient wetlands to overtop the road in this area. This BMP is located across a slight dip in Kaulback Road. Runoff that isn't diverted at this location can contribute to roadside erosion down-slope toward Black Brook. An eight-inch culvert will likely be adequate; however, the appropriate size should be confirmed using standard hydrological peak-flow calculations.

BMP 26 is the site of a proposed wetland restoration. A wetland area approximately 0.25 acres in size has been filled in by historic gravel road washout events. The small stream that passes through this area has caused erosion in the gravel fill, exposing between 1.5 and 2.0 feet of gravel material that will continue to be eroded if restoration does not occur. A preliminary survey to delineate the extent of the fill and identify appropriate methods of restoration would need to be conducted and a work plan for the restoration would need to be prepared for approval and permitting.

Photo 20: Gravel Road Fill, Proposed Wetland Restoration (BMP 26)

BMP 27 is the improvement of an existing relatively steep roadside swale that has been eroded. This swale should be widened and deepened, armored with riprap and, where feasible, a ditch turn-out with a sediment trap and a level spreader constructed. The installation of a sediment trap and level spreader may require a drainage easement since the right-of-way in the area will likely not provide sufficient area.

Photo 21: Proposed Swale Improvement, Ditch Turn-Out with Sediment Trap (BMP 27)

5.6.1.4 Roxbury Road

Stormwater is channeled down a steep section of Roxbury Road near its intersection with Kaulback Road (Figure 5-1). The road in the section is bordered by steep banks that rise to the natural forested topography. The edge of this section of Roxbury Road is eroded and ditch turn-outs at the low end of this road section discharge directly into a tributary to Black Brook. To reduce erosion along the edge of this road, the shoulder could be widened by cutting back the road bank where feasible and constructing a properly designed swale that is reinforced with riprap. Drainage from the southern side of the road should be directed through a culvert to the northern side of the road to avoid the direct discharge to the brook. At the low end of this section of Roxbury Road, a sediment trap and level spreader is recommended as a BMP (BMP 30) to reduce sediment and TP load from this road.

Paving the steep section of Roxbury Road may be an option that could be considered to reduce the maintenance costs and the sediment and TP loading of Black Brook associated with the gravel road. If it were paved, additional stormwater control measures would need to be employed to reduce the flow rate and treat the runoff appropriately.

Photo 22: Roxbury Road, Looking West

Photo 23: Roxbury Road, Proposed Sediment Trap and Level Spreader Location (BMP 30)

BMP 16 is proposed to treat the runoff from the section of Roxbury Road immediately east of its intersection with Kaulback Road. This BMP consists of the installation of a culvert under Roxbury Road to convey stormwater from the southern side of Roxbury Road to the northern side where an infiltration basin could potentially be constructed. The location of the proposed infiltration basin is on private property, so a drainage easement may be required.

Photo 24: Proposed Culvert to Sediment Trap/Infiltration Basin (BMP 16)

5.6.1.5 Woodman Road

Woodman Road is a paved road that crosses the southern branch of Black Brook and tributaries to Black Brook (Figure 5-1). Stormwater from approximately 7,000 square feet of the northern section of Woodman Road drains to a driveway and into a culvert that discharges to a tributary of Black Brook. The culvert appeared to be clogged during a site visit in 2011 and stormwater had caused some erosion of the gravel driveway and shoulder. The installation of a bioretention basin may be feasible in this location (BMP 31). An underdrain and a high level drain should be installed to direct the treated water or bypassed water through a new culvert to the downslope side of the driveway where the existing culvert outlet exists. The location of the proposed BMP may be on private property, so access may be a limiting factor in the feasibility of this option.

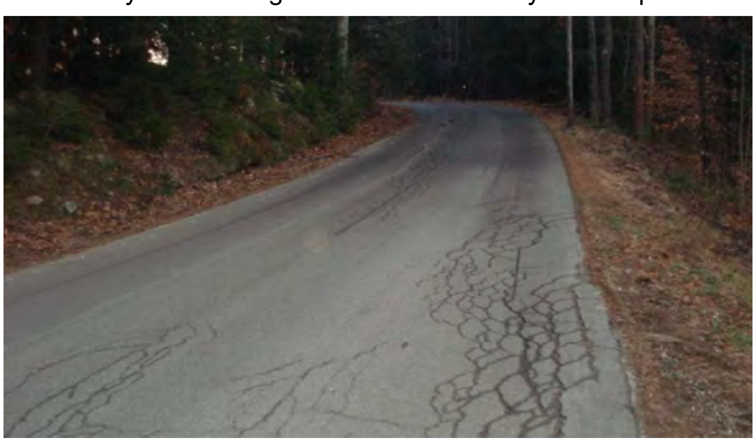


Photo 25: Woodman Road, Drainage to Proposed BMP 31

Photo 26: Woodman Road, Proposed Bioretention Basin Location (BMP 31)

BMP 34 is the deepening and widening of the swale along Woodman Road immediately down-slope of 86 Woodman Road. Runoff from the adjacent driveway currently flows into and potentially across Woodman Road. By creating a vegetated swale (50'L x 10'W x 1.5'D approximately) along the Woodman Road right-of-way in front of the Woodman Cemetery, the runoff and associated sediment from the driveway could be retained in this basin. Overflow could be directed across the existing vegetated area to the culvert under the cemetery access road.

Photo 27: Woodman Road, Proposed Swale Improvement (BMP 34)

5.6.2 Driveway Runoff

There are many locations in the Black Brook watershed where gravel driveways slope down from higher topographical areas to the adjoining road. Stormwater from these driveways is typically directed into the roadside ditch that in most areas do not meet the town standards for swales, such as those detailed in the Town of Sanbornton Subdivision Control Regulations (Section 8(c)(10)). Three locations of driveway runoff that discharges to Black Brook are noted in this plan as examples, BMP 28, 29, and 35 (Figure 5-1). At the location of BMP 35, approximately 7,100 square feet of gravel driveway drains down a steep driveway to a culvert on the west side and directly into Black Brook on the east side. There are no stormwater controls in-place, so sediment and TP are not currently reduced prior to discharge. The slope at this site is very limiting, but with considerable earth moving the construction of a sediment trap and a filtering or infiltration device such as a bioretention basin or infiltration trench may be possible. The feasibility of installing a BMP for this runoff source is dependent, in part, upon the property boundary location and property owner's cooperation.

Photo 28: Driveway Runoff, Proposed Infiltration Trench (BMP 35)

A similar driveway scenario exists on Kaulback Road, BMPs 28 and 29 (Figure 5-1). At BMP 29, approximately 8,600 square feet of gravel driveway drains down a steep driveway into a roadside swale. This swale has some cobble reinforcement so erosion along the flow path does appear to be occurring. Sediment and TP from the driveway are not attenuated along this drainage path which discharges to Black Brook after meandering through a wetland area near Kaulback Road. The placement of large logs at the edge of the driveway helps retain some sediment from the driveway, but additional measures could be put in-place, such as re-grading the area and installing berms or sediment traps in a manner that promotes on-site infiltration of stormwater. This BMP is entirely associated with the management of private property, so the Town has no authority under current regulations to restrict sediment and TP loading from either of these properties.

Photo 29: Driveway Runoff, Proposed Regrading, Berm, with Sediment Trench (BMP 29)

A revision to town ordinances associated with permitting new driveways could reduce or prevent un-treated stormwater runoff from entering town owned and maintained roads and stormwater conveyances. See Appendix C for an example of an ordinance that contains requirements for new driveways. The incorporation of low-impact development (LID) methods for stormwater control from roads and driveways in town subdivision regulations could also minimize or eliminate new sources of sediment and TP loads associated with development.

5.6.3 Field Management (Agriculture /Golf Course/Cemetery)

The TP load from agricultural and mowed fields within the Black Brook watershed contributes approximately 51 Kg/yr of the total 223.7 Kg/ yr load based on the loading model used for this plan. Loading is typically higher from fields than natural forested areas as a result of fertilizer application, manure spreading, grass cuttings, and soil compaction or disturbance. Site-specific TP load and stormwater runoff controls for all agricultural land in the Black Brook watershed could not be specified in this plan because of access limitations. However, two mowed field areas that appear to have direct runoff into Black Brook or a tributary to Black Brook were identified using aerial photographs. In the location of BMP 36, an approximately 5.7 acre field off of Roxbury Road appears to have a surface water feature within the mowed area that discharges to Black Brook via a small tributary. BMP 36 is the creation of at least a 40-foot buffer around this surface water feature where native shrubs and wetland vegetation are allowed to grow and are not cut during mowing operations. This natural plant growth will enhance infiltration of runoff and nutrient removal through plant uptake.

At the location of BMP 37 on Woodman Road (Figure 5-2), a tributary to Black Brook is apparently exposed to direct runoff from neighboring lawns. This could be a considerably high TP loading area if phosphorus fertilizer is used on these lawns. BMP 37 is the establishment of at least a 40-foot vegetated buffer along the brook. The buffer should consist of native shrubs, grasses, and wetland plants that are allowed to remain in their natural condition. The use of phosphorus fertilizers should be discussed with the abutting property owners and discouraged, and if the Town imposes a ban on phosphorus fertilizer use, these property owners should be specifically notified.

Golf courses and other fields that are typically fertilized and maintained for turf quality are sources of potentially high TP loading. Typical fertilizer application rates are 15 pounds/acre/year, of which approximately 75% is assumed to either runoff or infiltrate to groundwater (NHDES, 2010). The elimination of phosphorus fertilizer can drastically reduce the TP load to surface water. Town ordinances banning phosphorus fertilizer use have the potential to reduce this load. Steele Hill Resort, located along Steele Hill Road in the upper watershed of the southern branch of Black Brook, has approximately 16 acres of managed turf based on aerial photos (Figure 5-2). The use of phosphorus fertilizer should be discussed with the owners of this resort and discouraged, and if the Town imposes a ban on phosphorus fertilizer use, this property owner should be specifically notified.

The cemetery located on Woodman Road has approximately 2.6 acres of turf and gravel access roads (Figure 5-1) (BMP 32). The southeastern portion of the cemetery is sloped toward a beaver dam impoundment in the tributary to Black Brook. The creation of a vegetated buffer along the shore of the tributary and southeastern field would reduce the amount of runoff and TP that is discharging from this area which is currently a mowed field. The beaver dam in this pond has been breached at its southern edge. This has caused a portion of the downstream bank that is approximately 15 feet wide and 4 feet high to erode. Small trees have been uprooted by this erosion. BMP 33 is the restoration of this stream bank by re-grading and re-vegetating the bank and reinforcing the edge of the dam with riprap as needed. This restoration will reduce the continued sediment and TP load that is occurring from this unstable bank condition.

Photo 30: Woodman Cemetery, Proposed Vegetated Buffer (BMP 32)

Photo 31: Woodman Cemetery, Proposed Stream Bank Restoration (BMP 33)

6.0 Implementation Plan

The following phosphorus control implementation plan summarizes and prioritizes the recommendations for BMPs for water quality improvements including cost estimates, and provides a schedule for meeting the phosphorus load reduction required to meet the short-term goal established in this plan. The recommendations are intended to provide options of potential watershed management strategies that can improve water quality to meet target loads. Note that providing a comprehensive diagnostic/feasibility study is beyond the scope of this report, but we have attempted to narrow the range of management options in accordance with known loading issues and desired loading reductions.

The successful implementation of this watershed plan will be based on maintaining the TP target and attaining the short-term goal for reductions in TP loading to Lake Winnisquam from Black Brook. It is anticipated that TP reductions associated with this plan will be conducted in phases.

As discussed in Section 3, watershed TP loading is the predominant source (93%) of TP to Lake Winnisquam. Septic systems also contribute to the total load, but if this source were removed completely which is impractical, the annual TP load would be reduced only by 0.7% (Section 4). In the Black Brook watershed, erosion from gravel roads associated ditches as well as ditches along paved roads has been identified as a key contributor to phosphorus and sediment loading to Black Brook.

The recommended strategy to reduce TP loading into Lake Winnisquam includes the implementation of BMPs to reduce TP loading from roads and development, the establishment of stormwater treatment standards for new development, and public education and outreach. The purpose of this strategy is to attain an in-lake mean TP concentration of 6.3 µg/L, which represents the short-term goal for Lake Winnisquam as well as provide the framework necessary to prevent long-term increases in TP from exceeding the long-term goal of 6.6 µg/L (mean) (6.4 µg/L median).

Retrofitting developed land with low impact designs is a highly desirable option, especially near the brook. Educational programs can help raise the awareness of homeowners and inform them how they can alter drainage on their property to reduce nutrients entering the lake via the brook. Another option to engage the community is through technical assistance programs, such as BMP training for municipal officials and septic system inspection programs. Guidelines for evaluating TP export to lakes are found in “Phosphorus Control in Lake Watersheds: A Technical Guide to Evaluating New Development” (Dennis et al., 1992). Guidance for low impact living on the shoreline, “Landscaping at the Water’s Edge: An Ecological Approach”, has been developed by UNH Cooperative Extension (2007).

Section 319 of the Clean Water Act was established to assist states in nonpoint source control efforts. Under Section 319, grant money can be used for technical assistance, financial assistance, education training, technology transfer, load reduction projects and monitoring to assess the success of specific nonpoint source implementation projects,

This watershed plan was written to meet the criteria of the nine elements required by EPA to be a part of watershed plans (Section 1). Application materials and instructions for 319 funding can be obtained through:

Nonpoint Coordinator
New Hampshire Department of Environmental Services
29 Hazen Drive
P.O. Box 95
Concord, NH 03302
http://des.nh.gov/organization/divisions/water/wmb/was/categories/grants.htm

Proactive planning can preserve lake water quality. However, past resistance to zoning regulations creates difficulties for proactive planning. The watershed planning process is intended to give a direction and goal for planning and watershed management. As the lake improves towards the short-term goal, the implementation strategy should be re-evaluated using current data and modeling, and the plan for further load reduction adapted accordingly.

6.1 Phosphorus Management Summary

The measures recommended for the management of phosphorus loading in the Black Brook watershed as described in Section 5.0, are prioritized with cost estimates and predicted phosphorus removal in Tables 6-1 and 6-2. The BMP Sites referenced in this table refer to locations on Figure 5-1. Recommended measures are also summarized in Table 6-3 with a proposed implementation schedule.

The cost estimates are rough approximations based on best professional judgment and available cost information. Some of the recommended measures will require technical assistance with preliminary investigations and engineering designs to develop more accurate cost estimates. The measures are prioritized with respect to their associated load and potential for overall load reduction. Table 6-3 is presented as a general guide to help direct watershed management efforts in a manner that is most cost effective with respect to the goal of reducing current and minimizing future phosphorus loading.

6.1.1 Road Maintenance and Storm Water Drainage Improvements

The BMP's for reducing phosphorus loading from storm-water runoff are prioritized in Tables 6-1 and 6-2 by their estimated removal potential. These BMP's are grouped by their general location and associated road and drainage area. Most of the BMP's result in minor reductions individually, so their potential for load reductions should be considered in terms of an overall road maintenance and storm water control program. The estimated costs and suggested implementation schedule by Project Group are summarized in Table 6-3.

Some of the BMP's may not be feasible due to property ownership issues, thus efforts to implement these BMP's may need to adjust accordingly. The effort associated with the implementation these BMP's was not considered in this ranking, so for example, performing all of the riprap and settling/energy dissipation pool installations may be more cost effective if they are done at the same time even though they are not all prioritized equally in terms of their removal potential.

Road maintenance and storm-water drainage improvements are costly given the predicted phosphorus removal from these BMPs; however, they are specific sources that can be addressed with structural measures. This is unlike the more abstract removal potentials predicted from watershed-based ordinances and education programs.

Table 6-1: Recommended Measures to Manage Phosphorous Loading to Lake Winnisquam – Load Reduction Estimates for Road Drainage Improvements

BMP Site ID	Site Location	Map & Lot# (If BMP on private property or easement may be required)	Source	Basin	Estimated Contributing Drainage Area (acres)	Estimated Contributing Drainage Area (square feet)	Estimated Annual Phosphorus Load (kg/yr)[1]	BMP Description	Removal Efficiency[2]	Estimated Load Reduction (kg/yr)
BMP 1	Black Brook Road	Map 10, Lot 77	Road Runoff	Main Stem	0.05	2,100	0.1	Settling Basin	45%	0.1
BMP 2	Black Brook Road	ROW	Road Runoff	Main Stem	0.09	4,000	0.2	Forested Buffer (Shoulder Grading)	50%	0.1
BMP 3	Black Brook Road	ROW	Road Runoff	Main Stem	0.09	4,000	0.2	Forested Buffer (Shoulder Grading)	50%	0.1
BMP 1-2-3 Alternative (See BMP38)	Black Brook Road	design dependent	Road Runoff	Main Stem	0.78	34,000	1.8	Treatment/ Infiltration Swale incorporated with new road construction	45%	0.8
BMP 4	Huse Road	site dependent	Road Ditch Erosion	Southern Branch	0.14	6,000	0.9	Swale Widening and RipRap Armoring (Erosion Control Measure)	50%	0.5
BMP 5	Huse Road	Map10, Lot 62	Road Runoff	Southern Branch	0.22	9,400	1.5	Ditch Turn-Out with Sediment Trap and Gravel Trench Level Spreader	50%	0.7
BMP 6	Huse Road	Map 10, Lot 62	Road Runoff	Southern Branch	0.05	2,300	0.4	Sediment Trap	25%	0.1
BMP 7	Huse Road	Map 10, Lot 136-2	Road Runoff	Southern Branch	0.28	12,200	1.9	Ditch Turn-Out with Sediment Trap and Level Spreader to Forested Buffer	45%	0.9
BMP 8	Huse Road	Map 10, Lot 136-3	Road Runoff	Southern Branch	0.04	1,900	0.3	Ditch Turn-Out with Sediment Trap	45%	0.1
BMP 9	Huse Road	Map 10, Lot 48	Road Runoff	Southern Branch	0.07	3,200	0.5	Ditch Turn-Out with Sediment Trap and Level Spreader to Forested Buffer	45%	0.2
BMP 10	Huse Road	Map 10, Lot 136-3	Road Runoff	Southern Branch	0.13	5,800	0.9	Ditch Turn-Out with Sediment Trap	45%	0.4
BMP 11	Huse Road	Map 10, Lot 49	Road Runoff	Southern Branch	0.03	1,100	0.2	Ditch Turn-Out with Sediment Trap	45%	0.1
BMP 12	Huse Road	Map 10, Lot 49	Road Runoff	Southern Branch	0.04	1,800	0.3	Ditch Turn-Out with Sediment Trap and Level Spreader to Forested Buffer	45%	0.1
BMP 13	Huse Road	Map 10, Lot 49	Road Runoff	Southern Branch	0.09	3,800	0.6	Ditch Turn-Out with Sediment Trap and Level Spreader to Forested Buffer	45%	0.3
BMP 14	Huse Road	Map 10, Lot 48	Road Runoff	Southern Branch	0.08	3,300	0.5	Ditch Turn-Out with Sediment Trap and Level Spreader to Forested Buffer	45%	0.2
BMP 15	Huse Road	Map 10, Lot 48	Road and Yard Runoff	Southern Branch	0.09	4,100	0.4	Gravel Trench - Infiltration and Vegetated Filter Strip	65%	0.3
BMP 16	Roxbury Road	Map 10, Lot 50	Road Runoff	Northern Branch	0.13	5,700	0.9	Culvert to North Side of Road, Infiltration Basin	65%	0.6
BMP 17	Kaulback Road	Map 10, Lot 33	Road Ditch Erosion	Northern Branch	2.96	129,100	0.4	Culvert under Kaulback to divert runoff from forested area to trib of Black Brook	100%	0.4
BMP 18	Kaulback Road		Road Ditch Erosion	Northern Branch	0.02	900	0.1	Swale Widening and RipRap Armoring (Erosion Control Measure)	30%	0.0
BMP 19	Kaulback Road	Map 10, Lot 50	Road Runoff	Northern Branch	0.08	3,400	0.5	Sediment Trap/Infiltration Basin	65%	0.4
BMP 20	Kaulback Road	ROW	Road Runoff	Northern Branch	0.03	1,400	0.2	Vegetated Buffer	30%	0.1
BMP 21	Kaulback Road	Map 10, Lot 33	Road Runoff	Northern Branch	0.02	1,100	0.2	Sediment Trap	35%	0.1
BMP 22	Kaulback Road	Map 10, Lot 35	Road Runoff	Northern Branch	0.02	1,100	0.2	Sediment Trap	35%	0.1
BMP 23	Kaulback Road	Map 10, Lot 33	Road Runoff	Northern Branch	0.03	1,500	0.2	Ditch Turn-Out with Sediment Trap and Level Spreader to Forested Buffer	45%	0.1
BMP 24	Kaulback Road	Map 10, Lot 33	Road Runoff	Northern Branch	0.05	2,200	0.3	Ditch Turn-Out with Sediment Trap and Level Spreader to Forested Buffer	45%	0.2

[1] Total Phosphorus loads were calculated using the Simple Method and Event Mean Concentrations (NHDES, 2008)

[2] BMP load reductions are based on published removal efficiency values and professional judgement with respect to erosion control potential and BMP location.

Table 6-1 (Continued): Recommended Measures to Manage Phosphorous Loading to Lake Winnisquam – Load Reduction Estimates for Road Drainage Improvements

BMP Site ID	Site Location	Map & Lot# (If BMP on private property or easement may be required)	Source	Basin	Estimated Contributing Drainage Area (acres)	Estimated Contributing Drainage Area (square feet)	Estimated Annual Phosphorus Load (kg/yr)[1]	BMP Description	Removal Efficiency[2]	Estimated Load Reduction (kg/yr)
BMP 25	Kaulback Road	ROW	Road Runoff	Northern Branch	0.04	1,900	0.2	Culvert to convey road drainage and wetlands from west to eastern natural wetland area	44%	0.1
BMP 26	Kaulback Road	Map 5, Lot 17	Historic Wetland Fill from Road Washout	Northern Branch	n/a	n/a	n/a	Wetland restoration (remove gravel fill and restore wetland vegetation)		
BMP 27	Kaulback Road	Map 5, Lot 16	Road Runoff	Northern Branch	0.07	3,100	0.5	Swale Widening and RipRap Armoring / Ditch Turn-Out to Sediment Trap	30%	0.1
BMP 28	Driveway on Kaulback Road	Map 5, Lot 42	Gravel Driveway	Northern Branch	0.13	5,800	0.9	Water bar diversion to Sediment Trap and Level Spreader to Forested Buffer	45%	0.4
BMP 29	Driveway on Kaulback Road	Map 5, Lot 18	Gravel Driveway	Northern Branch	0.20	8,600	1.4	Permanent diversion berm, regrading, and gravel trench spreader to forested buffer	60%	0.8
BMP 30	Roxbury Road	Map 10, Lot 33	Road Runoff and Ditch Erosion	Northern Branch	0.19	8,300	1.3	Culvert to north side of road into Sediment Trap and Level Spreader to Forested Buffer	30%	0.4
BMP 31	Woodman Road	Map 10, Lot 46-2	Road & Ag Field Runoff	Southern Branch	1.25	54,300	0.9	Bioretention Basin at driveway	65%	0.6
BMP 32	Woodman Cemetery	Map 10, Cemetery	Field Runoff	Southern Branch	0.47	20,400	0.2	Natural vegetated buffer (30-foot vegetated buffer)	65%	0.2
BMP 33	Woodman Cemetery	Map 10, Cemetery	Stream Bank Erosion	Southern Branch	n/a	n/a	n/a	Stream bank restoration 15 ft long x 4 ft deep area washed out at corner of beaver dam.		
BMP 34	Woodman Road	ROW	Driveway Runoff	Southern Branch	0.13	5,500	0.9	Swale improvement / sediment trap	45%	0.4
BMP 35	Woodman Road	Map 10, Lot 46-3	Driveway Runoff	Southern Branch	0.16	7,100	1.1	Infiltration Trench	60%	0.7
BMP 36	Ag. Field off Roxbury Rd	Map 10, Lot 50	Agricultural Field	Northern Branch	0.74	32,100	0.6	Approx. 40 foot natural vegetated buffer between mowed field and stream	30%	0.2
BMP 37	Mowed Field off Woodman Rd	Map 4, Lot 58 & Map 10, Lot 24	Mowed Field	Southern Branch	3.43	149,400	2.8	Approx. 40 foot natural vegetated buffer between mowed field and stream	35%	1.0
BMP 38	Black Brook Road	ROW	Large Storm Event Erosion / Road Washout	Main Stem	2720	---	---	Replace existing culverts with structure designed for 100-year storm. TP removal not calculated because contribution cannot be quantified on an annual basis. Loading is event based and highly dependent upon hydrological conditions.		
								ESTIMATED TOTAL PHOSPHORUS REDUCTION (KG/YR):		**10.8**

[1] Total Phosphorus loads were calculated using the Simple Method and Event Mean Concentrations (NHDES, 2008)

[2] BMP load reductions are based on published removal efficiency values and professional judgement with respect to erosion control potential and BMP location.

Table 6-2: Recommended Measures to Manage Phosphorus Loading to Lake Winnisquam – Cost Estimates for Road Drainage Improvements

BMP Site ID	Drainage swale improvement length (feet)	Drainage swale improvement base width (feet) (assume 2:1 ss, 18" depth)	Level spreader length (ft)	Surface Area (top of basin)(sqft) w/ 1:1 side slopes (see Appendix D)	Sediment Trap / Basin Depth (ft) =Dfull (See Appendix D)	Riprap/berm stone estimate (tons)	Riprap/berm stone (cuyds)	Filter fabric area (ft^2)	Bioretention Soil / Loam (cuyds)	Inlet Headwall / Culvert ($)	Wetland/ Buffer Plants ($)	Materials Cost Estimate ($)	Labor & Equipment Cost Estimate ($)	Technical Services Cost Estimate ($) (Engineering, Permitting, etc...)	Total Cost Estimate[1]	Low Cost Estimate (-20%)[1]	High Cost Estimate (+50%)[1]	Total Estimated Cost/gram P-Reduction	Priority (Based on TP-Removal Estimates)	Project Group[2]	Assumptions
BMP 1					1	4.0	2.2					$88	$477		$600	$500	$900	$12	Low	1	Berm stone placement at low point of natural basin area
BMP 2													$733		$800	$700	$1,200	$8	Medium	1	Shoulder grading
BMP 3													$733		$800	$700	$1,200	$8	Medium	1	Shoulder grading
BMP 4	2000	2				533	296	19200				$14,901	$185,778	$30,102	$230,800	$184,700	$346,200	$487	High	4	2,000 feet of swale widening and armoring along various sections of Huse Road
BMP 5				150	2	28.0	16	560				$708	$4,064	$716	$5,500	$4,400	$8,300	$7	High	4	Ditch Turnout with sediment trap and 20 ft long x 3 ft deep gravel trench level spreader
BMP 6	20	1		80	2	18.9	11	290				$464	$3,298	$564	$4,400	$3,600	$6,600	$48	Low	4	Swale armoring and approx. 7ft dia. sediment trap
BMP 7	15	1	20	170	2	31.4	17	570				$785	$4,642	$814	$6,300	$5,100	$9,500	$7	High	4	Ditch turn-out with sediment trap and 20 foot level spreader
BMP 8	20	1		80	2	13.6	8	240		$6,270		$7,236	$6,945	$2,127	$16,400	$13,200	$24,600	$124	Medium	4	Culvert and sediment trap
BMP 9	10	1	20	90	2	19.5	11	350				$486	$6,324	$1,021	$7,900	$6,400	$11,900	$35	Medium	4	Ditch turn-out with sediment trap and 20 foot level spreader / berm across up-slope turnout
BMP 10	10	1		120	2	19.1	11	340				$476	$2,796	$491	$3,800	$3,100	$5,700	$9	Medium	4	Ditch turn-out with sediment trap
BMP 11	10	1		70	2	13.1	7	240				$327	$1,916	$337	$2,600	$2,100	$3,900	$32	Low	4	Ditch turn-out with sediment trap
BMP 12	10	1	20	80	2	16.3	9	290				$406	$2,477	$432	$3,400	$2,800	$5,100	$27	Medium	4	Ditch turn-out with sediment trap and 20 foot level spreader
BMP 13	10	1	20	100	2	18.7	10	340				$467	$2,829	$494	$3,800	$3,100	$5,700	$14	Medium	4	Ditch turn-out with sediment trap and 20 foot level spreader
BMP 14	10	1	20	90	2	17.5	10	310				$435	$2,653	$463	$3,600	$2,900	$5,400	$15	Medium	4	Ditch turn-out with sediment trap and 20 foot level spreader
BMP 15			20			12.0	7	170	6		$400	$915	$12,540	$2,018	$15,500	$12,400	$23,300	$58	Medium	4	Gravel interceptor trench (approx 20x3x3), 15 foot vegetated strip
BMP 16	20	1		491		12.0	7	220		$6,330		$7,263	$17,513	$3,716	$28,500	$22,800	$42,800	$49	High	2	Culvert from south side to north side of Roxbury Rd / Sediment forebay to infiltration basin
BMP 17						5.3	3	100		$6,440		$7,218	$7,969	$2,278	$17,500	$14,000	$26,300	$44	Medium	2	Culvert from east side to west side of Kaulback Road with channel protection to Black Brook tributary
BMP 18	450	1				60.0	33	2160				$1,676	$20,900	$3,386	$26,000	$20,800	$39,000	$609	Low	2	Swale armoring approximately 450' long on eastern side
BMP 19				90	2	10.8	6	190				$269	$1,584	$278	$2,200	$1,800	$3,300	$6	Medium	2	Sediment Trap (approx. 12' dia)
BMP 20									67		$800	$3,630	$11,733	$2,305	$15,400	$12,400	$23,100	$225	Low	3	Replace 4-feet of shoulder with top soil and seed with native hardy-drought tolerant grasses&shrubs / runoff diversion to sediment traps
BMP 21	40	2		70	2	21.7	12	390				$542	$3,188	$560	$4,300	$3,500	$6,500	$72	Low	3	Sediment trap at low point adjacent to brook
BMP 22	40	2		70	2	21.7	12	390				$542	$3,188	$560	$4,300	$3,500	$6,500	$72	Low	3	Sediment trap at low point adjacent to brook

Table 6-2 (Continued): Recommended Measures to Manage Phosphorus Loading to Lake Winnisquam – Cost Estimates for Road Drainage Improvements

BMP Site ID	Drainage swale improvement length (feet)	Drainage swale improvement base width (feet) (assume 2:1 ss, 18" depth)	Level Spreader length (ft)	Surface Area (top of basin)(sqft) w/ 1:1 side slopes (see Appendix D)	Sediment Trap / Basin Depth (ft) =Dfull (See Appendix D)	Riprap/berm stone estimate (tons)	Riprap/berm stone (cuyds)	Filter fabric area (ft^2)	Bioretention Soil / Loam (cuyds)	Inlet Headwall / Culvert ($)	Wetland/ Buffer Plants ($)	Materials Cost Estimate ($)	Labor & Equipment Cost Estimate ($)	Technical Services Cost Estimate ($) (Engineering, Permitting, etc…)	Total Cost Estimate[1]	Low Cost Estimate (-20%)[1]	High Cost Estimate (+50%)[1]	Total Estimated Cost/gram P-Reduction	Priority (Based on TP-Removal Estimates)	Project Group[2]	Assumptions
BMP 23	50	1	20	70	2	25.7	14	460				$642	$3,538	$627	$4,900	$4,000	$7,400	$45	Medium	3	Ditch turn-out with sediment trap and 20 foot level spreader
BMP 24	50	1	20	80	2	26.9	15	480				$672	$3,703	$656	$5,100	$4,100	$7,700	$33	Medium	3	Ditch turn-out with sediment trap and 20 foot level spreader
BMP 25	60	2				25.3	14	460		$6,270		$8,322	$4,676	$1,950	$15,000	$12,000	$22,500	$200	Low	3	Assume 24'x 10" culvert with head walls, riprap inlet/outlet, 60' of swale improvement.
BMP 26														$20,020	$20,100	$16,100	$30,200		Medium	7	Cost for preliminary survey and development of restoration work plan. Total cost is dependent upon preliminary investigation.
BMP 27	200	2		140	3	83.5	46	1500				$2,084	$14,537	$2,493	$19,200	$15,400	$28,800	$132	Medium	3	Widen and armor swale, construct turn-out to sediment trap and forested level spreader
BMP 28	20	2		120	2	21.1	12	380				$526	$3,037	$534	$4,100	$3,300	$6,200	$10	Medium	6	Water bar across driveway to sediment trap and forested buffer
BMP 29									17		$20	$645	$4,730	$806	$6,200	$5,000	$9,300	$8	High	6	Install permanent berm, vegetate elevated 6-ft buffer strip along low-point, regrade to direct runoff into adjacent forested area
BMP 30	400	2		140	2	61.7	34	2220		$6,393		$8,757	$21,834	$4,589	$35,200	$28,200	$52,800	$90	Medium	2	Armor swale with riprap trench, add drop inlet and culvert at low point to convey south side to north, install 15 foot wide sed trap/infiltration basin, ensure diffuse outlet to forested area.
BMP 31	200	2				45.8	25	1650	14	$6,222	$500	$9,438	$27,049	$5,473	$42,000	$33,600	$63,000	$76	High	5	Bioretention basin (10x15x2) along bank, underdrain to existing culvert location (replace culvert)
BMP 32											$1,000	$1,100	$18,333	$2,915	$22,400	$18,000	$33,600	$143	Medium	6	Establish approximately 30-foot natural buffer around surface water feature using native shrubs, grasses and wetland plants.
BMP 33						20.0	11	360			$300	$3,029	$11,183	$8,528	$22,800	$18,300	$34,200		High	7	Bank erosion (approx. 12x4 area) can be stabilized by re-sloping bank, reinforcing pond side with riprap, and revegetating bank.
BMP 34	25	4											$1,467	$220	$1,700	$1,400	$2,600	$4	Medium	5	Deepen swale along Woodman Road along Woodman Cemetery to capture runoff from adjacent driveway.
BMP 35	100	2				49.3	27	890		$3,120		$4,664	$12,296	$2,544	$19,600	$15,700	$29,400	$29	High	6	Armor swale with riprap, regrade and construct sediment trap and infiltration trench (4x20x3) with outlet to existing culvert.
BMP 36											1,000	$1,100	$12,222	$1,998	$15,400	$12,400	$23,100	$87	Medium	6	Establish approximately 40-foot natural buffer around surface water feature using native shrubs, grasses and wetland plants.
BMP 37											1,000	$1,100	$24,444	$3,832	$29,400	$23,600	$44,100	$30	High	6	Establish approximately 40-foot natural buffer around surface water feature using native shrubs, grasses and wetland plants.
BMP 38												$80,000	$140,000	$25,000	$245,000	$196,000	$367,500		Medium	1	Cost estimate for Black Brook Road culvert replacement dependent upon findings of hydrologic/hydraulic study and site conditions.
														TOTAL COST ESTIMATES:	$912,500	$731,600	$1,369,400				

[1] Cost estimates are approximations based on estimated labor, materials, consulting costs, and best professional judgement. Costs are intended for general prioritization of measure implementation. More accurate cost estimates will require additional designs, assessments of site condition, and feasibility evaluations. Cost estimates do not consider construction oversight or as-built record drawings. Technical services estimates based on 15% of total construction cost estimate.

[2] Projects are grouped based on location and BMP type to assist with scheduling and budgetting. Estimated technical services costs are divided within groups to gain efficiency of design and survey tasks.

6.2 Implementation Schedule

Table 6-3: Implementation Schedule

Management Practice		Estimated Total Load Reduction (kg/yr)	Estimated Cost[a] ($)	Implementation Schedule
Road Drainage Improvement				
	Project Group			
	1	0.3	$247,200	Year 1
	2[b]	1.8	$109,400	Year 1
	3[b]	0.7	$68,200	Year 2
	4[b]	3.9	$304,000	Year 3
	5	0.9	$43,700	Year 2
	6	3.2	$97,100	Year 1 - Year 5[c]
	7	not quantified	$42,900	Year 1 - Year 5[c]
Road & Culvert Maintenance				
Engineering Evaluation of Culvert Adequacy		not quantified	$12,000	Year 1
Routine Culvert Cleaning		not quantified	not estimated	On-going
Maintenance of Road Drainage Structures and BMPs		not quantified	not estimated	On-going
Ordinance and Subdivision Amendments				
Driveway Permit Requirements		not quantified	N/A	Year 1
Natural Buffer Zones		not quantified	N/A	Year 1
Phosphorus-Fertilizer Ban		not quantified	N/A	Year 1

a. Cost estimates are preliminary approximations for planning purposes only.

b. Scope of work and associated costs dependent upon factors related to paving road versus simple BMP implementation with gravel road.

c. Implementation of driveway and agric/field BMPs is dependent upon land owner cooperation and feasibility factors.

7.0 Public Outreach and Education

The centerpiece of efforts to control phosphorus (and sediment) loading to Lake Winnisquam via Black Brook is public outreach and education. In addition to educating individual homeowners on the implications of their actions on phosphorus export to the lake and the impact of that phosphorus on lake water quality, the secondary purpose to education and outreach is to educate decision makers at the town level so that phosphorus management becomes part of the criteria evaluated as decisions are made on zoning, planning, public works, recreation and site development issues.

Conduct meetings to brief officials (i.e. selectmen or managers, administrators, planning boards, conservation commissioners, etc.) of cities and towns (including Sanbornton) that have Lake Winnisquam watersheds to discuss non point source pollution issues: identification, control, remedial action, short term and long term planning and zoning, etc. These discussions will be based on what has been learned in developing the current plan and will emphasize that the current plan only covers a small portion of the total watershed and that are wide area cooperation will be needed to meet Lake Winnisquam water purity goals as established in the WMP.

Send a general mailing to all Sanbornton (03269) mail boxes to provide awareness on topics like shore land protection, phosphorus fertilizers, road maintenance and septic system maintenance and citizen responsibilities in watershed, and non watershed, locations. The mailing will cite references where additional information is available.

The current public awareness and outreach program at Black Brook has several key elements. Below each element are suggestions of ways to enhance the program:

1) **Media Coverage**

   Prepare and circulate periodic press releases to media with local and Statewide coverage explaining non point source pollution issues and documenting progress in implementing the WMP. Post the same information on local websites and newsletters, if available

2) **Web site**

   Current Program - Sanbornton and Meredith have websites that are clearinghouses for town information.

   Suggested Enhancements

   a) Provide a list of documents that would be useful to lake and watershed residents. This watershed plan which incorporates many relevant activities and documents would be a good choice for one of the documents. Other potential documents include; planning and zoning documents, NHDES fact sheets, popular articles on water quality and watersheds, forms and permit applications, lists of native plants etc.

   b) Increase traffic to the web site. The web site is only useful if people visit it. The single most viewed feature of many lake and watershed association web sites is a live web-cam image. These can be installed and maintained fairly easily and provide a place for residents who are “away” to see their lake or Black Brook and, in the process, visit the web page. A related feature is the ability to post pictures in a variety of categories. An example of a web site with a web cam and picture forums maintained by volunteers can be found at www.lwa.org. Largely because of the web cam and forums, the Lake

Wentworth Association website receives 50-100 visits a day. An up-to-date posting of lake level or stream level and lake temperature can also be an attractor to a lake association web site.

c) Consider addition of a forum specifically for water quality and watershed questions.

3) Speakers Bureau

Make knowledgeable speakers available to local organizations to explain non point source pollution issues, remedies and current progress with Black Brook WMP.

Consider the inclusion of invited speakers or special outdoor sessions to address specific topics. Examples could include specific information from a vendor who presents information on specific BMPs or a seminar on Shoreland Protection and landscaping that could feature NHDES Shoreland Protection outreach specialists, UNH cooperative extension specialist, staff from the New Hampshire Lakes Association or a local nursery staff member to talk about local, low maintenance native plants for landscaping with no fertilizer requirements.

Consider a perpetual award to be given annually to the person or organization that shows outstanding stewardship of the watershed resources or implements a particularly unique and effective project.

4) Lake Host

Current Program **–** Lake Winnisquam currently participates in the NH Lakes Lake Host program. This program is also currently quite successful.

Suggested Enhancements **–** Consider provision of information to the Lake Host on watershed issues of at least inform the lake host on current initiatives on the lake so that information can be shared with users of the boat ramp.

5) Published and Posted Materials

Current Program: Signage and public education posters at the boat launch.

Suggested Enhancements **–** a) stencil or put signs near storm drains or culverts in the Black Brook watershed with a message that says: " Drains to Lake Winnisquam, do not dump" or equivalent." b) prepare and distribute flyers or information sheets on specific issues related to septic systems, phosphorus in fertilizer, shoreland protection and native plantings etc. c) Present materials at local schools to engage young people. d) Provide information related to successful BMP installation. This could range from a guided or self tour of completed BMP projects to a seminar on gravel road maintenance that features a road that has been retrofitted to reduce phosphorus and sediment export to the lake and is aesthetically pleasing. e) Provide information and/or sponsor training courses for loggers, developers or public works officials on BMPs for phosphorus and sediment reduction.

8.0 Monitoring Plan

The New Hampshire Department of Environmental Services (NH DES) conducted water quality monitoring in the Pot Island Basin of Lake Winnisquam in 1979, 1984, 1990, and 2001 for Lake Trophic Studies (NHDES 2009). Lake Winnisquam has participated in the Volunteer Lake Assessment Program (VLAP) since 1987 (NH DES 2009). Lake Winnisquam also participates in the Lake Host program (NHDES 2009) to educate boaters and examine boats and trailers for exotic plants entering or leaving lakes.

The deepest site in the center of each of the three basins of the lake is the primary sampling location in Lake Winnisquam (Figure 1-1). Water quality samples collected during summer stratification are tested for epilimnetic, metalimnetic and hypolimnetic TP. In addition, a composite sample of the water column to the depth of the thermocline is tested for chl *a*. A DO profile from top to bottom is conducted and a Secchi disk transparency measurement is taken. Data from the mouth of Black Brook has been collected periodically since 1980 with additional effort in recent years. This data collection should continue. Additional sampling should be conducted throughout the Black Brook watershed to attempt to bracket locations where the bulk of the TP and sediment is entering and to confirm the influence of mitigation measures on TP concentrations Stream samples should be collected during both wet and dry periods and multiple samples should be collected during long storm events. Flow measurements associated with the sample collection would allow direct calculation of loads rather than estimation through modeling. This can be accomplished by installing staff gages in the Black Brook at various locations and developing stage/discharge relationships for each gage to relate specific gage readings with specific flows. If specific locations show consistently high concentrations or flows, visual investigation and/or additional monitoring points upstream should be considered to isolate the cause. An ideal sampling scheme would include sampling at each road crossing of the Main Stem of Black Brook as well as the North and South Branches. Reaches with the highest TP load would be the target of initial efforts to reduce TP.

An ideal tributary sampling period might include a spring snowmelt/rain sampling event prior to leaf-out, 2 wet and 2 dry summer events and a fall rain event after leaf fall. A minimum of ½ inch of rain forecast over a six hour period provides a target for a wet weather event (with the exception of a snowmelt event). A dry event would be best represented by sampling after a minimum of 72 hours with no rainfall or runoff. These data should be evaluated as a time series that can be updated as additional data are collected in the future.

It is recommended that VLAP sampling be continued to document the in-lake response, trends, and compliance with water quality criteria following implementation of TP reduction measures. As discussed in the previous section, successful implementation of this watershed management plan will be based on attaining the target and short-term goal for TP in the Pot Island Basin of Lake Winnisquam. Data collected by VLAP which includes DO, conductivity, transparency, planktonic chl *a* and the reporting of cyanobacteria scums should continue. NH DES staff will continue to sample and document the extent and severity of any potential future reported cyanobacteria blooms through microscopic identification, cell counts and toxicity tests.

With respect to implementation of specific BMPs throughout the watershed, the existing tributary monitoring program should be augmented with site specific monitoring immediately below and above the sites of proposed BMP implementation. As with the routine monitoring, the sampling program should include a spring snowmelt/rain sampling event prior to leaf-out, 2 wet and 2 dry summer events and a fall rain event after leaf fall. A minimum of ½ inch of rain forecast over a six hour period provides a target for a wet weather event (with the exception of a snowmelt event). A dry event would be best represented by sampling after a minimum of 72 hours with no rainfall or runoff. Alternatively, a monthly program from April through November could be implemented. If BMP's are located in proximity to the routine sampling sites described above, data from the routine stations can be used for either the upstream or downstream BMP effectiveness station. Pre and post BMP data as well as upstream and downstream data can be compared graphically using box and whiskers plots or statistically using a Student's t-test ($p < 0.1$).

This BMP effectiveness monitoring should commence as soon as practicable prior to the installation of BMP's and continue through construction and after construction to document that estimated removal efficiencies are obtained. At a minimum, TP should be assessed but the addition of other parameters such as total suspended solids and flow should be considered. The addition of flow will allow the calculation of phosphorus loads directly. The evaluation of individual BMP's as well as routine data collection will allow progress towards the goal for Black Brook to be quantified.

In order to evaluate the effectiveness of the public outreach and education efforts to be conducted as a part of this plan, a survey that evaluates the current state of knowledge about fertilizer, shoreland protection, septic system maintenance and stormwater management. Use the results of the survey to target specific topics and individuals for educational efforts. After implementation of the public education components of the watershed plan, conduct a follow up survey to test the effectiveness of the program by repeating the initial survey. The increase in awareness will be used as a metric to measure the effectiveness of the program. If deficiencies are still noted in the knowledge of watershed residents, the public outreach and education program can be modified to provide the appropriate information.

9.0 Potential Sources of Funding

Improvements and management techniques described in Sections 5 and 6 will require funding to install and complete. There are several primary sources of funding for non point source projects in New Hampshire. These include, but are not limited to, Section 319 funding and NHDES Small Outreach and Education Grants and several other programs detailed below. Alternative funding may be in the form of donated labor from the Meredith and Sanbornton Department of Public Works as well as local volunteer groups and contractors from communities around the lake. Brief descriptions of potential funding sources are provided below:

Section 319 Grant Funding: Funds for NH DES Watershed Assistance and Restoration Grants are appropriated through the U.S. Environmental Protection Agency under Section 319 of the Clean Water Act (CWA). Two thirds of the annual funds are available for restoration projects that address impaired waters and implement watershed based plans designed to achieve water quality standards. A project eligible for funds must plan or implement measures that prevent, control, or abate no-point source (NPS) pollution. These projects should: (1) restore or maintain the chemical, physical, and biological integrity of New Hampshire's waters; (2) be directed at encouraging, requiring, or achieving implementation of BMPs to address water quality impacts from land-use; (3) be feasible, practical and cost effective; and (4) provide an informational, educational, and/or technical transfer component. The project must include an appropriate method for verifying project success with respect to the project performance targets, with an emphasis on demonstrated environmental improvement. Nonprofit organizations registered with the N.H. Secretary of State and governmental subdivisions including municipalities, regional planning commissions, non-profit organizations, county conservation districts, state agencies, watershed associations, and water suppliers are eligible to receive these grants. More information on the NH DES Watershed Assistance and Restoration Grants can be found at: http://des.nh.gov/organization/divisions/water/wmb/was/categories/grants.htm

Small Outreach and Education Grant: The NHDES provides funding to promote educational and outreach components of water quality improvement projects. This program provides small grants of $200 to $2,000 for outreach and education projects relating to NPS issues that target appropriate audiences with diverse NPS water quality related messages. These small grants are available year round on an ongoing basis, which allows applicants to move forward with outreach and education projects without having to wait for annual application deadlines. The NH DES Watershed Assistance Section administers the grant program using $20,000 each year from the U.S. EPA under Section 319 of the CWA. More information on the Small Outreach and Education Grant can be found at: http://des.nh.gov/organization/divisions/water/wmb/was/categories/grants.htm.

Conservation License Plate Program: To promote natural resource related programs throughout NH. Conservation Districts, Cooperative Extension, conservation commissions, schools, groups, and other non-profits can apply for funding. http://www.nh.gov/nhdhr/grants/moose/

Agricultural Nutrient Management Grant Program: The NH Department of Agriculture, Markets, and Food provides up to $2,500 grants to assist agricultural land and livestock owners with efforts to minimize adverse effects to waters of the state by better management of agricultural nutrients. Applications are accepted annually. More information can be found at: http://des.nh.gov/organization/divisions/water/wmb/was/categories/grants.htm

Land and Water Conservation Program: UNH Cooperative Extension helps New Hampshire communities and conservation groups with land and water conservation planning projects. Land & Water Conservation Program staff provide technical assistance, facilitation and guidance to communities interested in conserving their natural resources, prioritizing areas for protection, and working with local landowners to conserve land. Extension assistance is limited to project guidance and training, and does not include specific involvement in completing project tasks. http://extension.unh.edu/CommDev/CCAP.htm

Transportation Enhancement (TE) Program: The 1991 Intermodal Surface Transportation Efficiency Act (ISTEA) called for a ten percent designated share of all Surface Transportation Program funds to be used for Transportation Enhancement Activities. The intent of the program is to afford an opportunity to develop "livable communities" by selecting projects that preserve the historic culture of the transportation system and/or enhance the operation of the system for its users. The 1998 Transportation Equity Act for the 21st Century (TEA-21) continued the Transportation Enhancement Program and expanded the eligible use of funds. One of the categories of projects eligible for funding is "Environmental mitigation to address water pollution due to highway runoff or reduce vehicle-caused wildlife mortality while maintaining habitat connectivity." http://www.nh.gov/dot/org/projectdevelopment/planning/tecmaq/index.htm or http://www.enhancements.org/profile/new_profile_search.php

Wetlands Reserve Program: The Wetlands Reserve Program is a voluntary program offering landowners the opportunity to protect, restore, and enhance wetlands on their property. The USDA Natural Resources Conservation Service (NRCS) provides technical and financial support to help landowners with their wetland restoration efforts. The NRCS goal is to achieve the greatest wetland functions and values, along with optimum wildlife habitat, on every acre enrolled in the program. This program offers landowners an opportunity to establish long-term conservation and wildlife practices and protection. http://www.nrcs.usda.gov/Programs/wrp/

Forest Legacy Program: The Forest Legacy Program helps protect environmentally important private forestlands threatened with conversion to non-forest uses. The Secretary of Agriculture is responsible for the development and administration of the Forest Legacy Program. The US Forest Service in cooperation with States and other units of government is responsible for the implementation of the program. States have been granted the authority to establish criteria for their programs within the framework of the national program to help address specific needs and goals of their state.

To help maintain the integrity and traditional uses of private forest lands, the Forest Legacy Program promotes the use of conservation easements, legally binding agreements transferring a negotiated set of property rights from one party to another. Participation in the program is entirely voluntary. http://www.nhdfl.org/land-conservation/forest-legacy-program.aspx

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Appendix A

Black Brook/Lake Winnisquam Water Quality Target Memorandum August 25, 2011

Memorandum

To: Robert Ward: Town of Sanbornton, Don Fourdriat, Black Brook Steering Committee

From: Don Kretchmer, Al Pratt; AECOM

Cc: Andy Chapman; NHDES

Date 8/25/11

Subject: Lake Winnisquam Water Quality Target

Dear Bob and Don,

As you are aware, AECOM is preparing a watershed management plan for Black Brook in order to protect Lake Winnisquam water quality and improve conditions in the brook. Some of the issues that will be addressed in the watershed management plan include: road runoff and erosion, lawn fertilization, conservation of land, development, land use, septic systems, algal blooms and practical measures individuals and the Town of Sanbornton can do to improve and protect water quality. Lake Winnisquam is among the highest quality lakes in New Hampshire and a valuable asset to Sanbornton and the lakes region of NH. By planning and conducting careful management now, the efforts, led by Sanbornton, will be a model for other watersheds around Winnisquam to follow.

Recently, AECOM staff, Don Foudriat and NH DES scientists, met informally to discuss setting the water quality target. As part of the watershed management plan process, stakeholders must reach consensus on a water quality target. The water quality of Lake Winnisquam depends on the amounts of nutrients entering it. The most critical nutrient in freshwater is phosphorus. Therefore, setting an appropriate in-lake phosphorus concentration is essential to preserving water quality.

Lake Winnisquam qualifies as a Tier 2- High Quality Water which gives it a water quality standard of <8 *u*g/l total phosphorus. The attached figure summarizes the relevant water quality benchmarks and demonstrates that the target is well within the remaining assimilative capacity. Please note that the best possible water quality shown in the figure is not representative of background conditions for Lake Winnisquam. The best possible water quality for Lake Winnisquam is best approximated through modeling. A scenario wherein atmospheric deposition remains, all land use is returned to forest and septic loads are eliminated was evaluated with the water quality model. The LLRM model developed for Lake Winnisquam predicted a background concentration of 3.8 *u*g/L under this scenario.

Meeting attendees generally agreed that the water quality target should be set at current conditions (mean summer in-lake total phosphorus concentration= 6.6 *u*g/L and median = 6.4 *u*g/L based on the last 10 years of water quality data). A short term mean summer in-lake median total phosphorus goal of 6.1 *u*g/l (5% reduction from current) is proposed recognizing that future development will happen in the watershed. The total phosphorus numbers associated with this goal are summarized in Table 1.

Meeting this short term goal through watershed phosphorus load reductions with Best Management Practices (BMPs) will provide a buffer to this future development. Many of these BMPs will also function to reduce suspended solids loading to Black Brook and Lake Winnisquam. The load reduction that results in a 5% in-lake reduction will be allocated across the watershed of the Pot Island basin of Winnisquam (including a value for the Black Brook watershed) as well as the direct sources of phosphorus to the Pot Island Basin provided by the Winnipesaukee River and the 3 Island Basin.

Once agreement is reached on the target and short term goal, AECOM will model phosphorus loading reduction scenarios to determine a realistic phosphorus reduction in the Black Brook watershed to meet the short-term goal. The performance of proposed BMPs will be expressed in terms of the potential for total phosphorus load reduction as well as suspended solids load reduction to Black Brook. Since particulate P is attached to sediment, significant sources of Black Brook sediment pollution will be identified during the site-specific watershed evaluation to identify P load reduction sites. Additional detail on BMPs will be provided as a part of Objective 7. The short term goal of reducing the watershed phosphorus load will allow for future development loading while maintaining current water quality.

Please contact Don or Al to discuss either the water quality target or short term goal.

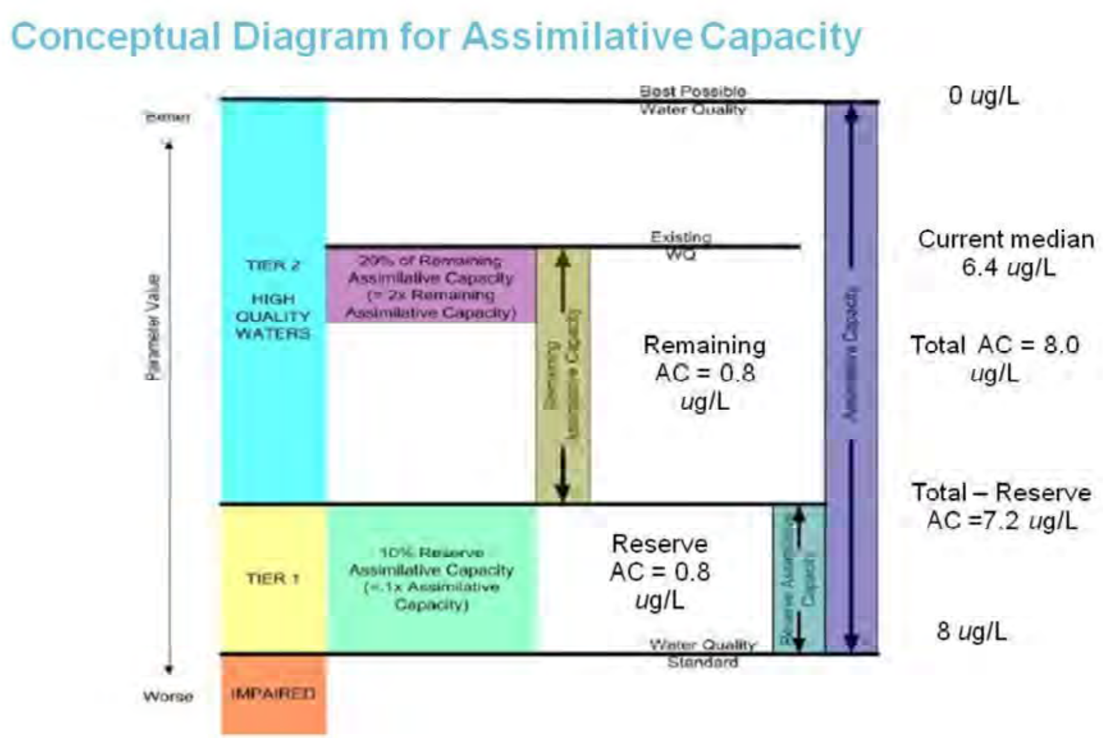


Figure 1: Conceptual Diagram for Assimilative Capacity

Table 1: Summary of reductions in total phosphorus loading associated with in-lake phosphorus target and in-lake short-term goal based on LLRM water quality model.

	Current Conditions	Proposed Target Conditions (same as current conditions)	Short-Term Goal (5% reduction in watershed and septic sources)
Median Lake Winnisquam Total Phosphorus concentration (Pot Island Basin)	6.4 *u*g/L	6.4 *u*g/L	6.1 *u*g/L
Phosphorus Load to Lake Winnisquam (Pot Island Basin)	5182 kg/yr 11,400 lb/yr	5182 kg/yr 11,400 lb/yr	4923 kg/yr 10,831 lb/yr
Phosphorus Load from Black Brook Watershed	224 kg/yr 493 lb/yr	224 kg/yr 493 lb/yr	212 kg/yr 466 lb/yr
Reduction Required in Black Brook	-	0 kg/yr 0 lb/yr	12 kg/yr 27 lb/yr

Appendix B

Model Parameter Tables

Table B-1. Land Use Categories and Export Coefficient Ranges used in the Pot Island Basin LLRM Model

LLRM Land Use	Runoff P export coefficient range	Runoff P export coefficient used	Source	Baseflow P export coefficient range	Baseflow P export coefficient used	Source
Urban 1 (Low Density Residential	0.19-6.23	0.90	Schloss and Connor 2000-Table 5	0.001-0.05	0.01	ENSR Unpublished Data; Mitchell et al. 1989
Urban 2 (Mid Density Residential/Commercial)	0.19-6.23	1.10	Reckhow et al. 1980	0.001-0.05	0.01	"
Urban 3 (Roads)	0.19-6.23	1.80	Dudley et al. 1997	0.001-0.05	0.01	"
Urban 4 (Industrial)	0.19-6.23	1.10	Reckhow et al. 1980	0.001-0.05	0.01	"
Urban 5 (Mowed Fields)	0.19-6.23	0.80	Reckhow et al. 1980	0.001-0.05	0.01	"
Agric 1 (Cvr Crop)	0.10-2.90	0.80	Reckhow et al. 1980	0.001-0.05	0.01	"
Agric 2 (Row Crop)	0.26-18.26	2.20	Reckhow et al. 1980	0.001-0.05	0.01	"
Agric 3 (Grazing)	0.14-4.90	0.80	Reckhow et al. 1980	0.001-0.05	0.01	"
Agric 4 (Hayfield)	0.35	0.64	Dennis and Sage 1981	0.001-0.05	0.01	"
Forest 1 (Deciduous)	0.29 - 0.973	0.10	Schloss and Connor 2000- Table 4	0.001-0.010	0.004	"
Forest 2 (NonDeciduous)	0.01 - 0.14	0.09	Schloss and Connor 2000- Table 4	0.001-0.010	0.004	"
Forest 3 (Mixed)	0.01-0.138	0.09	Schloss and Connor 2000- Table 4	0.001-0.010	0.004	"
Forest 4 (Wetland)	0.02 - 0.83	0.08	Schloss and Connor 2000-Table 4	0.001-0.010	0.004	"
Open 1 (Wetland/Lake)	0.02 - 0.83	0.07	Schloss and Connor 2000-Table 5	0.001-0.010	0.004	"
Open 2 (Meadow)	0.02 - 0.83	0.20	Reckhow et al. 1980	0.001-0.010	0.004	"
Open 3 (Excavation)	0.14- 4.90	0.80	Reckhow et al. 1980	0.001-0.010	0.004	"

Table B-2. Runoff and Baseflow Coefficients Used in the Pot Island Basin LLRM Model

	Low	Med	High
Baseflow fraction	0.10	0.40	0.95
Runoff fraction	0.01	0.20	0.40

Runoff and baseflow factions used in the model for Lake Winnisquam

Landuse Category	Runoff Fraction	Baseflow Fraction
Urban 1 (Low Density Residential)	0.30	0.25
Urban 2 (Mid Density Residential/Commercial)	0.50	0.15
Urban 3 (Roads)	0.60	0.05
Urban 4 (Industrial)	0.50	0.05
Urban 5 (Mowed Fields)	0.30	0.30
Agric 1 (Cvr Crop)	0.15	0.30
Agric 2 (Row Crop)	0.30	0.30
Agric 3 (Grazing)	0.30	0.30
Agric 4 (Hayfield)	0.15	0.30
Forest 1 (Deciduous)	0.20	0.40
Forest 2 (NonDeciduous)	0.20	0.40
Forest 3 (Mixed)	0.20	0.40
Forest 4 (Wetland)	0.05	0.40
Open 1 (Wetland/Lake)	0.05	0.40
Open 2 (Meadow)	0.30	0.30
Open 3 (Excavation)	0.60	0.30

Appendix C

Example Ordinances

Town of Windham – Cobbetts Pond

Excerpt from:

Town of Windham
Zoning Ordinances and Land Use Regulations
--- final amendment: March 13, 2012 ---

616: Cobbetts Pond and Canobie Lake Watershed Protection Ordinance

616.1 Authority and Statement of Intent

616.1.1 Pursuant to RSA 674: 21, the Town of Windham adopts a Watershed Protection Overlay District and accompanying regulations to ensure the protection and preservation of Cobbetts Pond and Canobie Lake and their watershed from the effects of point and non-point source pollution or sedimentation. The establishment of the Watershed Protection Overlay District and the adoption of these regulations are intended.

616.1.1.1 To protect public health,

616.1.1.2 To protect aquifers, which serve as existing or potential water supplies, and the aquifer recharge system,

616.1.1.3 To protect surface waters and wetlands contiguous to surface waters,

616.1.1.4 To protect the natural areas and wildlife habitats within the Watershed Protection Overlay Zone by maintaining ecological balances,

616.1.1.5 To prevent the degradation of water quality through the regulation of land uses and development within the Watershed Protection Overlay District, and

616.1.1.6 To assure proper use of natural resources and other public requirements.

616.1.2 In the event of a conflict between the requirements of this section and other requirements of the Windham Zoning Ordinance or state law, the more stringent requirements shall govern.

616.2 Applicability

616.2.1 The special provisions established in this Watershed Protection Ordinance shall apply to all development proposals and to potential contaminating activities within the Watershed Protection Overlay District. The boundaries of the Watershed Protection Overlay District have been delineated by the NH DES using current location data (see Cobbetts Pond Watershed Overlay District Parcel Map dated 1/27/10 and Canobie Lake Watershed Overlay District Parcel Map dated 11/15/11).

616.2.2 The boundaries of the Watershed Protection Overlay District are identified through drainage, groundwater and soils analyses and are considered to be essential to the protection of the watershed from the effects of point and non-point source pollution or sedimentation.

616.2.3 All development proposals occurring wholly or partly in an area within the Watershed Protection Overlay District shall be subject to the requirements of this Ordinance.

616.3 Administration

616.3.1 General: The Windham Planning Board shall have authority to create processes and procedures to administer the provisions of the Watershed Protection Ordinance.

616.3.2 Enforcement: The Code Enforcement Officer shall be responsible for enforcing the provisions and conditions of this Watershed Protection Ordinance, pursuant to the provisions of Section 1500 of Windham's Zoning Ordinance.

616.4 Definitions

Automobile Service or Repair Station: A retail establishment at which motor vehicles are refueled, serviced, and sometimes repaired.

Best Management Practices**:** As defined in the New Hampshire Stormwater Manual, Volume 1, Volume II, and Volume III, prepared by NH DES.

Buffer Zone: The undisturbed natural area sufficient in size to mitigate runoff effects harmful to water quality.

Commercial Agricultural Activities: The production of crops for sale, crops intended for widespread distribution to wholesalers or retail outlets. Commercial agriculture includes livestock production and livestock grazing. Commercial agriculture does not include crops grown for household consumption (e.g. backyard garden or from a vegetable garden or a few fruit trees).

Contamination: Sedimentation, point and non-point source pollution, septage, or the discharge of hazardous materials.

Development: Any activity resulting in a change in the physical character of any parcel of land, such as may be caused by, but not limited to: subdivisions, change in use, the construction or expansion of a building, deck, or shed; installation of a well or septic tank; land disturbing activity such as commercial agriculture or commercial forestry; paving of a previously permeable area; grading, and road building. Lot line adjustments are exempt.

Hazardous Materials: As defined in Superfund Amendment and Reauthorization Act of 1986 and Identification and Listing of Hazardous Wastes, 40 C.F.R. §261 (1987).

Hydrology: The study of the earth's waters, their distribution and the cycle involving precipitation, infiltration into the soil and evaporation.

Impervious Surface: Surface that is impenetrable by liquids, including, but not limited to, areas paved with conventional asphalt or concrete, sidewalks, patios, decks, and roofs which do not recharge water.

Infiltration Rate: The volume of surface water that filters into the soil per unit of time.

Low-Impact Development (LID): An approach to site development and design that provides increased opportunities for storm water infiltration and increased hydrologic function within a watershed as defined in NH DES Fact Sheet WD-WMB-17, "Low-Impact Development and Stormwater Management," 2010 or any updated versions thereof.

Non-point Source Pollution: Contaminants including, but not limited to pesticides, fertilizers, animal wastes, sediments, nutrients, and heavy metals that are deposited on the ground surface and flow into and pollute nearby surface waters.

Point and Non-point Source Pollution: Point pollution comes from a single source such as the discharge from a drainage pipe. Non-point pollution comes from multiple sources such as rain water run-off.

Potential Contaminating Activity: Activities that have the potential to create a new discharge of contaminants or to increase the discharge of contaminants to surface or ground-waters.

Public Water Body: All water bodies with a surface area of 10 acres or more.

Runoff Volume: The volume of surface water that runs off during a storm event.

Sedimentation: The deposition of sand, silt, soil or other matter into a watercourse or wetland, including that resulting from post-development surface runoff.

Storm Event: A period of sustained rainfall with a minimum total accumulation of 0.25 inches of precipitation over a 24 hour period.

Storm Water: Surface water run-off from a non point source caused by a storm event.

Tributary Stream: Any perennial or intermittent stream, flowing either directly or indirectly into a public water body. This shall include any tributary stream section contained within a pipe system.

Watershed: The area lying within the drainage basins of public water bodies.

616.5 Use Regulations

616.5.1 Allowed uses established by the underlying zoning district shall apply, except as modified below:

616.5.2 The following uses shall be specifically prohibited within the Watershed Protection Overlay District:

616.5.2.1 Storage or production of hazardous materials as defined in either or both of the following:

616.5.2.1.1 Superfund Amendment and Reauthorization Act of 1986.

616.5.2.1.2 Identification and Listing of Hazardous Wastes, 40 C.F.R. §261 (1987)

616.5.2.2 Disposal of hazardous materials or solid wastes.

616.5.2.3 Treatment of hazardous material, except rehabilitation programs authorized by a government agency to treat hazardous material present at a site prior to the adoption of this ordinance.

616.5.2.4 Any business that stores, uses or disposes of hazardous material, unless all facilities and equipment are designed and operated to prevent the release or discharge of hazardous materials and have undergone an inspection by the Town of Windham Building Inspector and Fire Inspector to certify they are in compliance with hazardous material regulations.

616.5.2.5 Disposal of septage or septic sludge, as defined by New Hampshire Solid Waste Rules Env-Wm101-300 & 2100 - 3700.

616.5.2.6 Automobile service and repair stations.
616.5.2.7 Junkyards and Salvage Yards as defined by RSA 236:112.

616.6 Review Requirements for Development in the Watershed Protection Overlay District

616.6.1 General. Applications for Subdivisions and Site Plans shall be accompanied by a hydrologic study as outlined in Section 616.7. The Hydrological study must document, in a manner acceptable to the Planning Board, that the proposed land development would provide the same or greater degree of water quality protection as existed on the site (s) at the time the application was made. Change of Use Applications that do not propose any new construction, paving, alterations to grading, or other alteration to the terrain are exempt from the requirements of the hydrological study.

616.6.2 Applications for new home construction and additions and reconstruction of existing homes need New Home Construction Applications and must include an erosion and sedimentation control plan prepared by an engineer licensed in the State of New Hampshire or a qualified professional familiar with erosion control measures and procedures and acceptable to the Town Engineer.

616.6.3 All development within the Watershed Protection Overlay District shall be evaluated to ensure that:

616.6.3.1 Non-point source pollution is prevented to the maximum extent possible, taking into account site conditions such as slope, soil type and erosivity and vegetative cover.

616.6.3.2 Best Management Practices (BMPs) are in place and are sufficient to remove or neutralize those pollutants that present a potential impact to the water body. The use or creation of detention ponds is not allowed for runoff control, except in those cases where an extended detention pond may be necessary to develop a site.

616.6.3.3 Grading and removal of vegetation at a development site is minimized and erosion and sedimentation control measures are in place and properly installed.

616.6.3.4 If two or more dwelling units share a common sewage treatment system a perpetual maintenance agreement from the building's owner is required.

616.6.3.5 Uses that may potentially cause contamination within the Watershed Protection Overlay District, must submit a spill prevention control and countermeasures plan for approval. This plan shall include the following elements:

616.6.3.5.1 Disclosure statements describing the types, quantities, and storage locations of all contaminants that will be part of the proposed project.

616.6.3.5.2 Contaminant handling and spill prevention techniques.

616.6.3.5.3 Spill reporting procedures, including a list of affected agencies to be contacted in the event of a spill.

616.6.3.5.4 Spill recovery plans, including a list of available equipment.

616.6.3.5.5 Spill cleanup and disposal plans.

616.7 Hydrologic Study and Plan

616.7.1 A hydrologic study shall be done by a professional engineer or hydrologist licensed in the State of New Hampshire and shall include the following information:

616.7.1.1 Description of the proposed project including location and extent of impervious surfaces; on-site processes or storage of materials; the anticipated use of the land and buildings; description of the site including topographic, hydrologic and vegetative features.

616.7.1.2 Characteristics of natural runoff on the site and projected runoff with the proposed project, including its rate and chemical and/or biological characteristics deemed necessary to make an adequate assessment of water quality.

616.7.1.3 Measures proposed to be employed to reduce the rate of runoff and pollutant loading of runoff from the project area, both during construction and after.

616.7.1.4 Proposed runoff control and watershed protection measures for the site. These measures shall be designed with the goal of ensuring that the rate of surface water runoff from the site does not exceed pre-development conditions and that the quality of such runoff will not be less than pre-development conditions. Special emphasis shall be placed on the impacts of proposed encroachments into the required buffer.

616.7.1.5 Where the developer of property subject to the terms of this Watershed Protection Ordinance seeks to utilize existing or planned off-site storm-water quality management facilities, the developer shall provide a written certification that the owner of the off-site facilities will accept the runoff and be responsible for its adequate treatment and that the arrangement will run with the land in a manner that will be acceptable to the Planning Board.

616.7.2 The study shall make use of existing Cobbett's Pond and Canobie Lake water quality historical data to the maximum extent possible. If new data is to be relied upon, the Town reserves the right to have the data reviewed by an independent expert at the expense of the developer, before the study is deemed complete and ready for review.

616.7.3 The study shall be submitted to the Planning Board for review and approval concurrently with the submission of applications for review as required by this Ordinance.

616.8 Buffer Requirements

616.8.1 A 100-foot wide buffer zone shall be maintained along the edge of any tributary stream discharging into Cobbett's Pond and Canobie Lake along the edge of any wetlands associated with those tributary streams. The required setback distance shall be measured from the centerline of such tributary stream and from the delineated edge of a wetland. Streams shall be delineated from their mean high water mark. The buffer zone shall be maintained in its natural state to the maximum extent possible.

616.8.2 Any reduction in the required buffer zone width may be granted by the Planning Board upon presentation of a hydrologic or other study that provides documentation and justification, acceptable to the Planning Board, that even with the reduction, the same or a greater degree of water quality protection would be afforded as would be with the full-width buffer zone. In granting such a reduction, the Planning Board may require certain conditions of approval which may include, but are not limited to, restrictions on use, type of construction, and erosion, runoff or sedimentation control measures as deemed necessary to protect water quality.

616.8.3 All development shall be located outside of the required buffer zone.

616.8.4 The following uses shall not be permitted within the buffer zone:

616.8.4.1 Septic tanks and drain-fields;

616.8.4.2 Feed lots or other livestock impoundments;

616.8.4.3 Trash containers and dumpsters which are not under roof or which are located so that leachate from the receptacle could escape unfiltered and untreated;

616.8.4.4 Fuel storage in excess of fifty (50) gallons [200L];

616.8.4.5 Sanitary landfills;

616.8.4.6 Activities involving the manufacture, bulk storage or any type of distribution of materials hazardous to Cobbett's Pond and Canobie Lake as defined in the Hazardous Materials Spills Emergency Handbook, American Waterworks Association, 1975, as revised, including specifically the following general classes of materials:

616.8.4.6.1 Oil and oil products,

616.8.4.6.2 Radioactive materials,

616.8.4.6.3 Any material transported in large commercial quantities that is a very soluble acid or base, highly biodegradable, or can create a severe oxygen demand,

616.8.4.6.4 Biologically accumulative poisons,

616.8.4.6.5 The active ingredients of poisons that are or were ever registered in accordance with the provisions of the Federal Insecticide, Fungicide, and Rodenticide Act, as amended (7 USC 135 et seq.),

616.8.4.6.6 Substances lethal to mammalian or aquatic life,

616.8.4.6.7 Road salt,

616.8.4.6.8 Lawn fertilizers.

616.9 Septic Systems

616.9.1 For any new construction, an Effluent Disposal System (EDS) shall be installed in accordance to NH DES regulations requiring a 75 foot setback from Hydric-A soils and a 50 foot setback from Hydric-B soils from any surface water or wetland area.

616.9.2 For any expansion of an existing structure, or the seasonal conversion of an existing structure, the owner shall conform to RSA 485-A: 38 and the associated Code of Administrative Rules for Subdivision and ISDS Design Rules, as amended.

616.9.3 For a new subdivision development for which EDS's are proposed, if the lots are less than 5 acres, then all plans and permit application shall conform to all relevant NH DES rules and regulations. For lots that are greater than 5 acres, all plans and permit applications shall show an area of 4000 sq. ft., within which the EDS may be located, with test pit and percolation test data to verify the site's suitability for a septic system.

616.9.4 If any septic assessment or an on-site inspection indicates that the existing system is in failure, a plan for a replacement system shall be submitted to NH DES within 30 days from the date of the onsite inspection.

616.10 Site Construction (Commercial / Industrial or Residential)

616.10.1 No new impervious driveways are allowed within 75 feet of any surface water or wetland area. Accessory structures are allowed when permitted by the NH DES.

616.10.2 The impervious area of any building lot is limited to 30%. Impervious area includes building area, gravel or asphalt driveway and parking area. For lots that currently exceed 30% impervious area, re-development must decrease the percent of impervious area.

616.10.3 For any use that will render impervious more than 20% or more than 2,500 square feet of any lot, whichever is greater, a storm water management and erosion control plan, consistent with Storm water Management and Erosion and Sediment Control Handbook for Urban and Developing Areas in New Hampshire, Rockingham County Conservation District, August 1992, as amended, shall be prepared and submitted to the Planning Board. No building Permit shall be issued until such time as the Planning Board has reviewed and approved said plan.

616.11 Commercial Agriculture Activities

616.11.1 Livestock are not allowed direct access to Cobbetts Pond and Canobie Lake or their tributaries.

616.11.2 Application of fertilizers or pesticides is not allowed within 200 feet from Cobbetts Pond and Canobie Lake or their tributaries or wetlands.

616.11.3 All livestock grazing and feeding areas shall be a minimum of 200 feet away from Cobbetts Pond and Canobie Lake or their tributaries.

616.11.4 All runoff from livestock feeding areas shall be directed away from Cobbetts Pond and Canobie Lake or their tributaries or wetland area.

616.11.5 The storage and use of all animal manure for fertilization purposes must be conducted in accordance with the Best Management Practices for the Handling of Compost, Fertilizer, and Manure in New Hampshire, NH Department of Agriculture, Markets and Food.

616.11.6 Unless stricter setbacks or operational requirements are outlined above, all agricultural operations shall be conducted in accordance with the Manual of Best Management Practices for Agriculture in New Hampshire, NH Dept. of Agriculture, June 1993, as amended, and in accordance with all appropriate sections of the Comprehensive Shore land Protection Act, NH RSA 483-B.

616.12 Commercial Forestry Activities

616.12.1 A minimum 75-foot undisturbed natural vegetated buffer shall be maintained adjacent to all surface waters or wetland areas.

616.12.2 Unless stricter setbacks or operational requirements are outlined above, all forestry operations shall be conducted in accordance with the Best Management Practices for Erosion Controls on Timber Harvesting Operations in New Hampshire, NH Division of Forests and Lands, February 2004, as amended, and in accordance with all appropriate sections of the Comprehensive Shore land Protection Act, as detailed in RSA 485-A: 17.

616.13 Emergency Exceptions

616.13.1 Emergency situations relating to public health, safety, and welfare will be temporarily relieved of the provisions of this ordinance in order to correct the emergency and restore the property to its previous condition as soon as possible.

616.13.2 The determination as to whether or not a situation is classified as an emergency shall be made by the Code Enforcement Officer and Building Inspector.

616.13.3 Within ten (10) business days of the determination being made as listed in Section 616.13.4, an application must be submitted as required by the provisions of this ordinance.

Watershed Protection Ordinance-preamble

Deering Lake, Deering, New Hampshire

Are you in favor of amending the Zoning Ordinance to add Section 12 Watershed Protection Ordinance as proposed by the Planning Board, to help protect Deering Lake from the effects of pollution and runoff caused by new development within its watershed?

Explanation:

- This Section will create an overlay to the Zoning Ordinance that applies minimal but essential requirements primarily to new development within the Deering Lake watershed that will protect the lake and its water quality from the increased sediment and nutrient run-off that enters the watershed when reasonable practices are not followed.

- Although there have been increases in sediment and nutrient loading caused by new development involving Lake properties, Deering Lake has been able to withstand these increases with little diminishment in water quality. Our lake has water quality that is among the best in NH.

- This will not remain the case as the rapid pace of development continues. A newly-commissioned study calculated the likely damage caused by new development scenarios. This ordinance reflects the findings of that study.

- Deteriorated water quality diminishes wildlife, scenic beauty, and recreational uses and destroys the values of Lake properties.

- Diminished property values affect the tax base of the town.

- This Overlay Ordinance would apply primarily to new development within the defined watershed of Deering lake and would require new subdivisions to demonstrate that they would "do no harm" to the lake and new home construction to include a soil erosion plan. Other development would be required to put in place "best practices" to protect the lake.

Deering Lake Watershed Protection Ordinance

10.1.1.1 SECTION 12: WATERSHED PROTECTION ORDINANCE

(Adopted March 9, 2005)

12.1 Authority and Statement of Intent

a. Pursuant to RSA 674: 21, the Town of Deering adopts a Watershed Protection Overlay Zone, and accompanying regulations to ensure the protection and preservation of Deering Reservoir, hereafter referred to as Deering Lake, the Deering Lake watershed and the water bodies within the Watershed Protection Overlay Zone from the effects of point and non-point source pollution or sedimentation . The establishment of the Watershed Protection Overlay Zone and the adoption of these regulations are intended:

(1) to protect public health,

(2) to protect aquifers, which serve as existing or potential water supplies, and the aquifer recharge system

(3) to protect surface waters and wetlands contiguous to surface waters,

(4) to protect the natural areas and wildlife habitats within the Watershed Protection Overlay Zone by maintaining ecological balances, and

(5) to prevent the degradation of the water quality through the regulation of land uses and development within the Watershed Protection Overlay Zone.

b. Within this district, and in the event of a conflict between the requirements of this section and other provisions of the Deering Zoning Ordinance or state law, the more stringent requirement shall govern.

12.2 Applicability

a. The special provisions established herein shall apply to all development proposals and to potential contaminating activities within the Watershed Protection Overlay Zone, and all such proposals and activities shall be subject to the review requirements set forth in Section 12.6. The boundaries of the Watershed Protection Overlay Zone have been delineated by the Planning Board using current location data. The Watershed Protection Overlay Zone is shown on the master zoning map kept on file in the Town Hall.

b. The boundaries of the Watershed Protection Overlay Zone may be identified through drainage, groundwater and soils analyses and are considered to be essential to the protection of the watershed from the effects of point and non-point source pollution or sedimentation. These boundaries may be modified as necessary by the Planning Board as new data becomes available.

12.3 Administration

a. General: The Deering Planning Board shall have sole and exclusive authority to administer the provisions of the Watershed Protection Ordinance. The Planning Board is further authorized to adopt amendments to the subdivision regulations in order to further administer the requirements of this section. All development proposals and other potential contaminating activity occurring wholly or partly in an area within the Watershed Protection Overlay Zone shall be subject to this Ordinance and to review and approval by the Planning Board as specified herein. Such review and approval shall be in addition to that required by statute, other provisions of the Deering Zoning Ordinance or Planning Board's rules or regulations. Such review, approval, and all conditions attached to the approval shall be properly documented before issuance of any building permit by the Town. Initial reviews and evaluations required by Section 12.6 c. shall be conducted by the Town of Deering Planning and Zoning Administrator on behalf of the Planning Board. If it is desired to have the full Planning Board consider an initial review or evaluation, a request for full Board consideration must be filed with the Planning and Zoning Administrator within 3 weeks of its issuance. If no such request is filed, the initial evaluation will become final.

b. Enforcement: The Board of Selectmen shall be responsible for the enforcement of the provisions and conditions of this Watershed Protection Ordinance, pursuant to the provisions of Section 7.

12.4 Definitions

a. Buffer Zone. The undisturbed natural area sufficient in size to mitigate runoff effects harmful to water quality.

b. Contamination. Sedimentation, point and non-point source pollution, septage, or the discharge of hazardous materials.

c. Development. Any construction, change in use, external repair, land disturbing activity, grading, road building, pipe laying, or other activity resulting in a change in the physical character of any parcel of land.

d. Hazardous Materials. As defined in Superfund Amendment and Reauthorization Act of 1986 and Identification and Listing of Hazardous Wastes, 40 C.F.R. §261 (1987).

e. Hydrology**.** The study of the earth's waters, their distribution and the cycle involving precipitation, infiltration into the soil and evaporation.

f. Impervious surface. An area whose water absorbing characteristics are greatly reduced as compared to the natural land and therefore less easily penetrated by moisture including, but not limited to, dirt and paved roads, driveways, parking lots, sidewalks, and roofs.

g. Infiltration rate. The amount and measure of time for surface water to filter into the soil.

h. Potential Contaminating Activity. Activities that have the potential to create a new discharge of contaminants or to increase the discharge of contaminants to surface or ground-waters.

i. Runoff Volume. The measure of surface water runoff during a storm event.

j. Sedimentation. The deposition of sand, silt, soil or other matter into a watercourse or wetland, including that resulting from post-development surface runoff.

k. Storm event. A period of sustained rainfall with a minimum total accumulation of 0.25 inches of precipitation over a 24 hour period.

l. Storm water. Surface water runoff from a non point source caused by a storm event.

m. Tributary stream. Any perennial or intermittent stream, flowing either directly or indirectly into Deering Lake.

n. Watershed. The area lying within the drainage basins of Deering Lake.

o. Non-point Source Pollution. Contaminants including, but not limited to; pesticides, fertilizers, animal wastes, sediments, nutrients, and heavy metals that are deposited on the ground surface and that may flow into and pollute nearby surface waters.

p. Best Management Practices. As defined in "Innovative Stormwater Treatment Technologies, Best Management Practices Manual-May 2002" and "Best Management Practices to Control NonPoint Source Pollution, A Guide for Citizens and Town Officials-January 2004" prepared by the New Hampshire Department of Environmental services and "Buffer for Wetlands and Surface Waters, a guidebook for New Hampshire Municipalities" May 1997 or any updated versions thereof.

12.5 Use regulations

a. Permitted uses, special exception uses, accessory uses, dimensional standards and special requirements established by the underlying zoning district shall apply, except as modified below:

b. The following uses shall be specifically prohibited within the Watershed Protection Overlay Zone:

(1) Storage or production of hazardous materials as defined in either or both of the following:

(a) Superfund Amendment and Reauthorization Act of 1986.

(b) Identification and Listing of Hazardous Wastes, 40 C.F.R. §261 (1987)

(2) Disposal of hazardous materials or solid wastes

(3) Treatment of hazardous material, except rehabilitation programs authorized by a government agency to treat hazardous material present at a site prior to the adoption of this ordinance.

(4) Dry-cleaning, dyeing, printing, photo processing and any other business that stores, uses, or disposes of hazardous material, unless all facilities and equipment are designed and operated to prevent the release or discharge of hazardous materials and have undergone an inspection by the Town of Deering Code Enforcement Officer to certify they are in compliance with hazardous material regulations.

(5) Disposal of septage or septic sludge, as defined by New Hampshire Solid Waste Rules Env-Wm101-300 & 2100 - 3700.

(6) Automobile service and repair stations

(7) Junkyards and Salvage Yards

12.6 Review requirements for Development in the Watershed Protection Overlay Zone

a. **General.** Applications for subdivision of land and for site plan review and approval are subject to all review requirements of this Section, including the requirement in 12.6 b. that they shall be accompanied by a hydrologic study. Applications for new home construction, and additions, modifications and repairs of existing homes, need not be accompanied by a hydrologic study, but must meet the other review requirements of this Section. New home construction applications must include a soil erosion plan as set forth in 12.6 c. This Watershed Protection Ordinance does not establish any pre-approval requirements for other land development proposals that do not involve potential contamination.

b. Any application for a land development proposal involving the subdivision of land or site review and approval, occurring wholly or partly in the Watershed Protection Overlay Zone, shall be submitted to the Planning Board for approval and shall be accompanied by a hydrologic study prepared in accordance with the requirements set forth in subsection 12.7 below. Said study must document, in a manner acceptable to the Planning Board, that the land development proposed would provide the same or a greater degree of water quality protection as existed on the site(s) in question at the time the application is made.

c. All development within the Watershed Protection Overlay Zone will be evaluated by the Planning Board to ensure that:

(1) Non-point source pollution is prevented to the maximum extent possible, taking into account site conditions such as slope, soil type and erosivity, and vegetative cover. The amount of lawn is limited to 10% of all dry land.

(2) Best Management Practices (BMPs) are in place sufficient to remove or neutralize those pollutants that present a potential impact to the water body. In the case of proposals for new home construction, the proposal shall include an erosion and sedimentation control plan prepared by a licensed engineer. The use or creation of holding-ponds is not allowed for runoff control.

(3) Grading and removal of vegetation at a development site is minimized and erosion and sedimentation control measures are in place and properly installed.

(4) All septic tanks will be pumped and inspected by a State of New Hampshire licensed septic services provider to ensure proper functioning and a copy of the pumping and inspection report shall be sent to the Town of Deering Planning and Zoning Administrator within 30 days of its occurrence. Such pumping and inspection shall occur at least every three years or at the interval recommended by the licensed septic service provider in writing at the time of last service. If two or more dwelling units share a common sewage treatment system, a perpetual maintenance agreement binding the dwelling owner is required.

(5) Activities involved in potential contamination within the Watershed Protection Overlay Zone, but which have received a special exception, must submit a spill prevention control and countermeasures plan (SPCC Plan) for approval. This plan shall include the following elements:

(a) Disclosure statements describing the types, quantities, and storage locations of all contaminants that will be part of the proposed project.

(b) Contaminant handling and spill prevention techniques

(c) Spill reporting procedures, including a list of affected agencies to be contacted in the event of a spill

(d) Spill recovery plans, including a list of available equipment

(e) Spill clean-up and disposal plans

d. Existing land uses located within the Watershed Protection Overlay Zone and identified as potential contaminating activities by the Planning Board shall comply with the requirements of Section 12.6, Subsection c.(5) listed above.

12.7 Hydrologic Study

a. A hydrologic study shall be performed by a registered professional engineer or hydrologist and it shall include, at a minimum, the following information:

(1) Description of the proposed project including location and extent of impervious surfaces; on-site processes or storage of materials; the anticipated use of the land and buildings; description of the site including topographic, hydrologic, and vegetative features.

(2) Characteristics of natural runoff on the site and projected runoff with the proposed project, including its rate and chemical characteristics deemed necessary to make an adequate assessment of water quality.

(3) Measures proposed to be employed to reduce the rate of runoff and pollutant loading of runoff from the project area, both during construction and after.

(4) Proposed runoff control and watershed protection measures for the site. These measures shall be designed with the goal of ensuring that the rate of surface water runoff from the site does not exceed pre-development conditions and that the quality of such runoff will not be less than pre-development conditions. Special emphasis shall be placed on the impacts of proposed encroachments into the required buffer.

(5) Where the developer of property subject to the terms of this Watershed Protection Ordinance seeks to utilize existing or planned off-site storm-water quality management facilities, the developer shall provide a written certification that the owner of the off-site facilities will accept the runoff and be responsible for its adequate treatment and that the arrangement will run with the land in a manner that will be acceptable to the Planning Board.

b. The study will make use of existing Deering Lake water quality historical data to the maximum extent possible. If new data is to be introduced, the Town reserves the right to have the data reviewed by an independent expert at the expense of the property developer.

c. The study shall be submitted to the Planning Board for review and approval concurrent with the submission of applications for review and approval of site or subdivision plans or applications for land disturbing or erosion and sediment control permits.

12.8 Buffer Requirements

a. A 75 foot wide buffer zone shall be maintained along the edge of any tributary stream discharging into Deering Lake and along the edge of any wetlands associated with those tributary streams. The required setback distance shall be measured from the centerline of such tributary stream and from the delineated edge of a wetland. Streams and wetlands shall be delineated from their mean high water mark. The buffer zone shall be maintained in its natural state to the maximum extent possible.

b. A reduction in the required buffer zone width down to an absolute minimum of fifty-feet (50') may be granted by the Planning Board upon presentation of a hydrologic or other study that provides documentation and justification, acceptable to the Planning Board, that even with the reduction, the same or a greater degree of water quality protection would be afforded as would be with the full-width buffer zone. In granting such a reduction, the Planning Board may require certain conditions of approval which may include, but are not necessarily limited to, restrictions on use or type of construction, and/or additional erosion, runoff or sedimentation control measures, as deemed necessary to protect water quality.

c. All development shall be located outside of the required buffer zone.

d. The following uses shall not be permitted within the buffer zone or within twenty-five feet (25') of any required buffer zone:

(1) septic tanks and drain-fields;

(2) feed lots or other livestock impoundments;

(3) trash containers and dumpsters which are not under roof or which are located so that leachate from the receptacle could escape unfiltered and untreated;

(4). fuel storage in excess of fifty (50) gallons [200L];

(5). sanitary landfills;

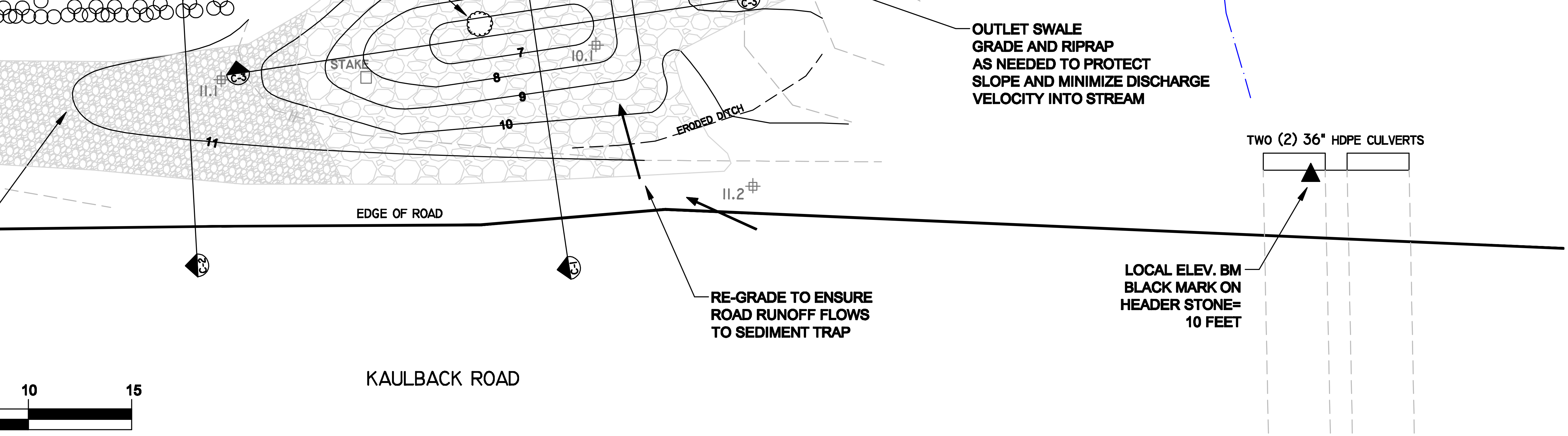
(6). activities involving the manufacture, bulk storage or any type of distribution of petroleum, chemical or asphalt products or any materials hazardous to Deering Lake (as defined in the Hazardous Materials Spills Emergency Handbook, American Waterworks Association, 1975, as revised) including specifically the following general classes of materials:

(a) oil and oil products
(b) radioactive materials
(c) any material transported in large commercial quantities that is a very soluble acid or base, highly biodegradable, or can create a severe oxygen demand
(d) biologically accumulative poisons
(e) the active ingredients of poisons that are or were ever registered in accordance with the provisions of the Federal Insecticide, Fungicide, and Rodenticide Act, as amended (7 USC 135 et seq.)
(f) substances lethal to mammalian or aquatic life.
(g) road salt
(h) lawns

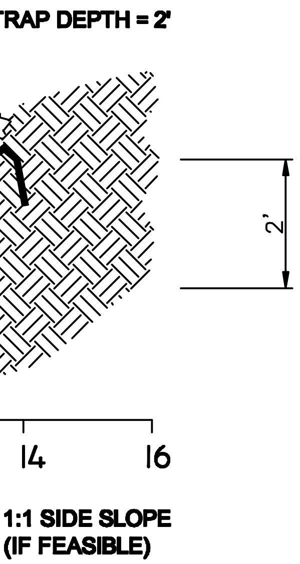
(7). No more than 50 % of basal area of timber may be cut over a twenty (20) year period

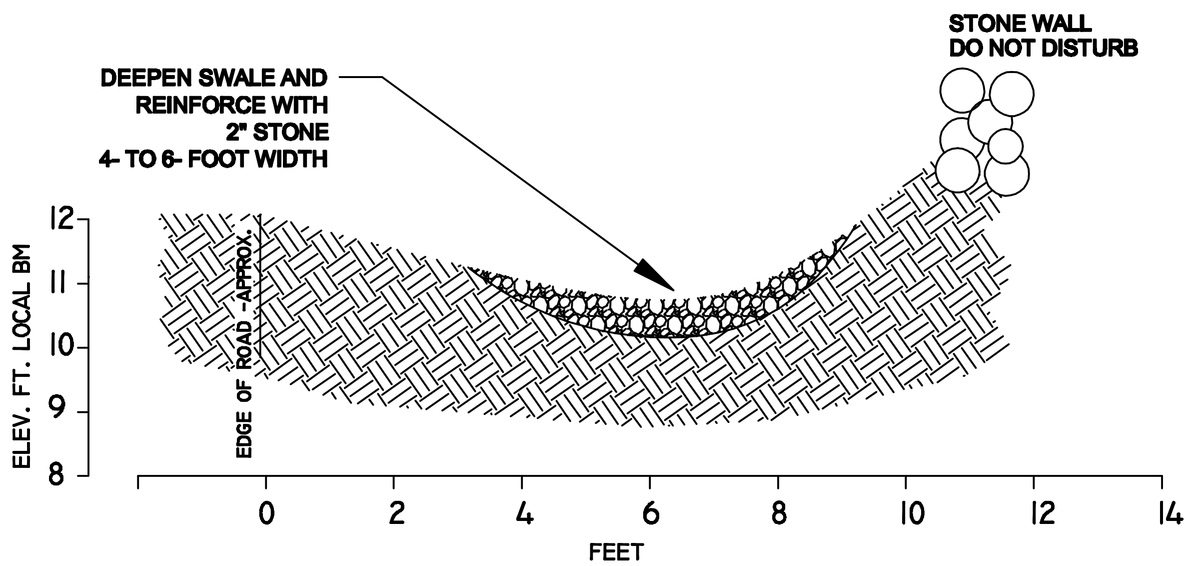
Appendix D

Selected BMP Designs

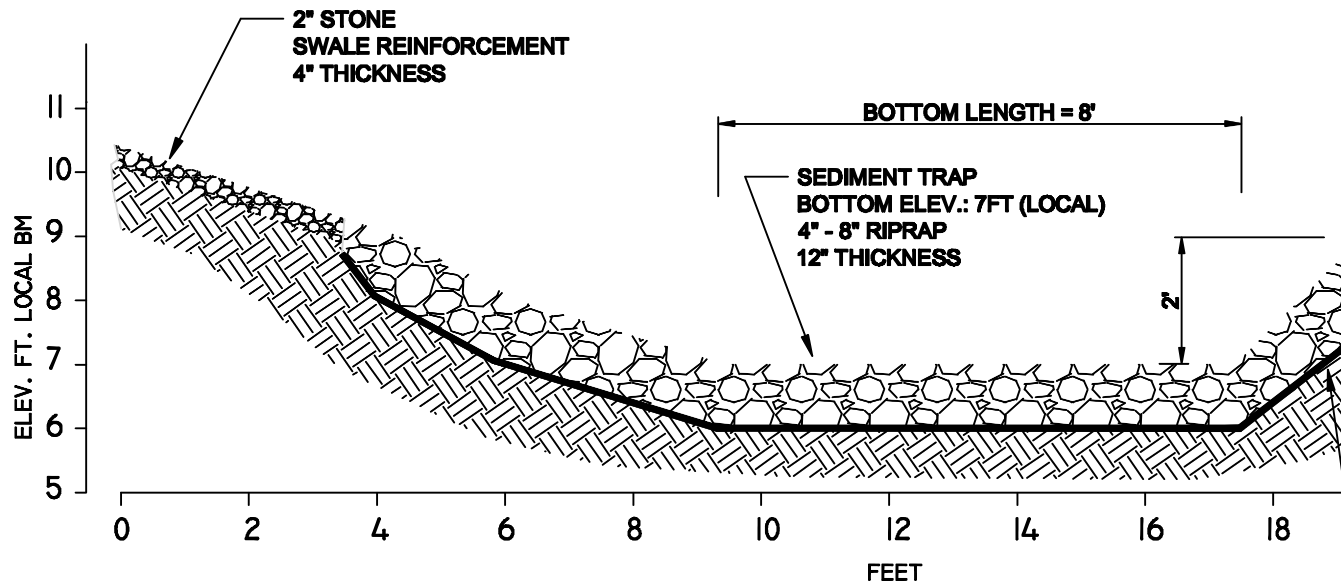


PLAN VIEW SKETCH





CROSS-SECTION C-2



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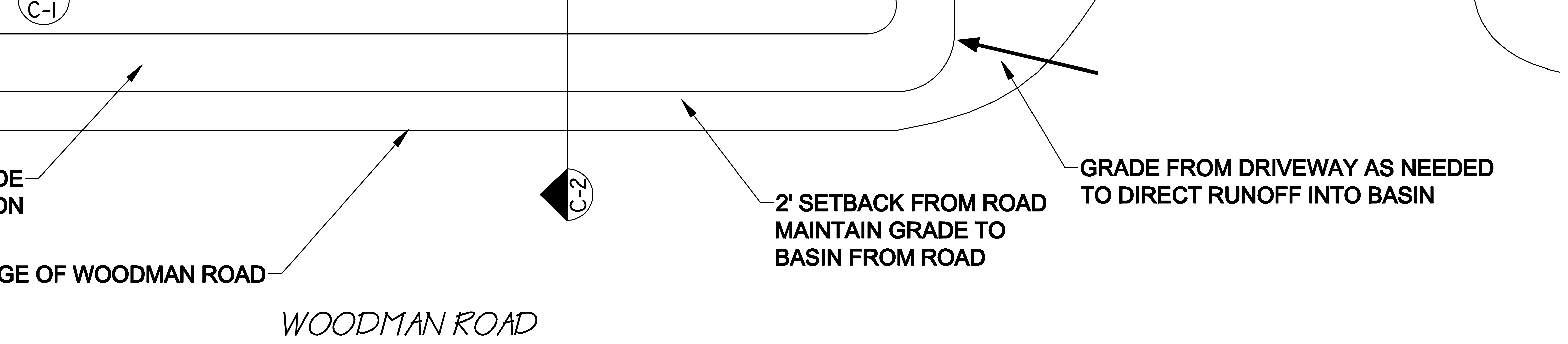

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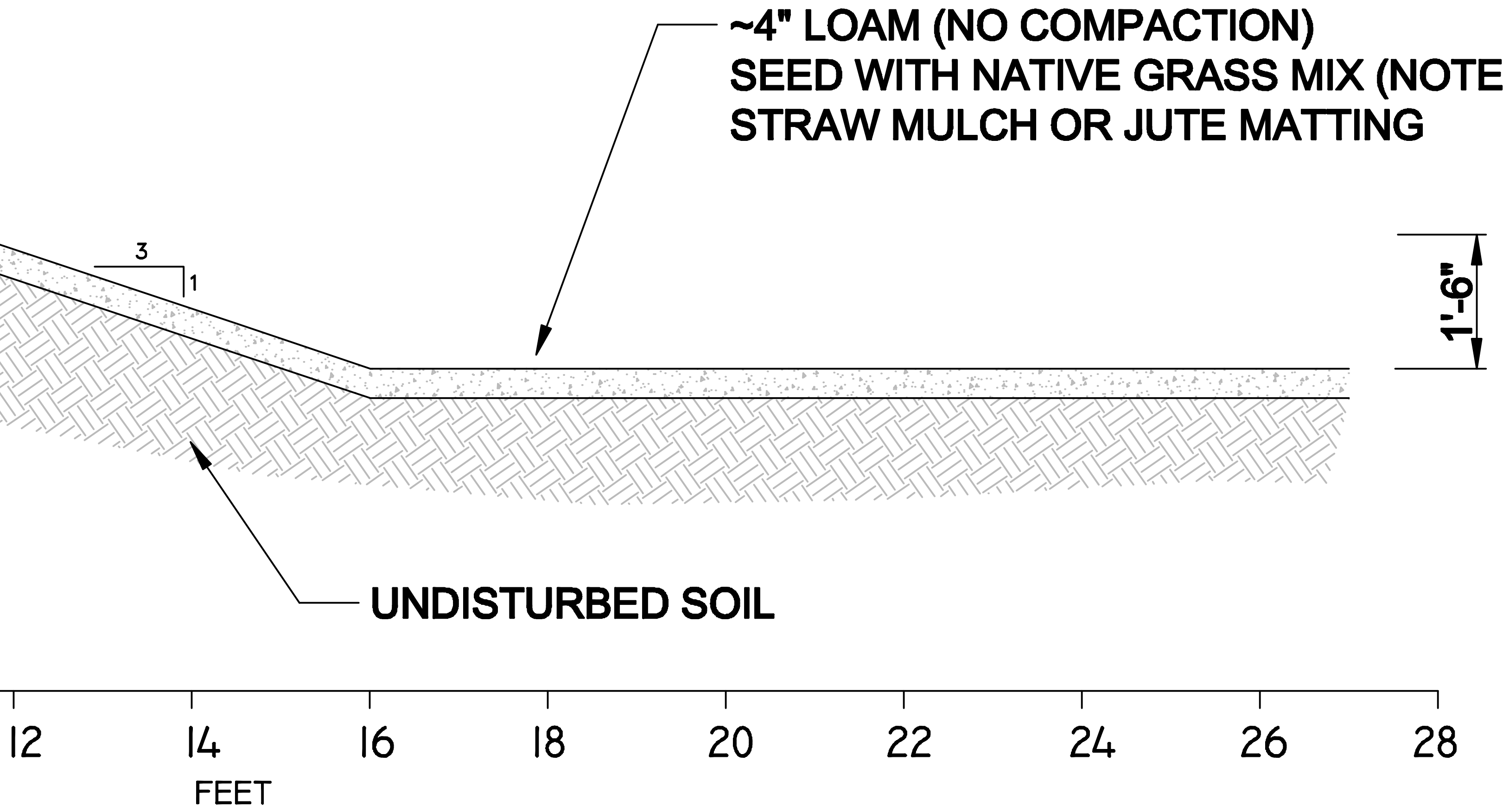

SS-SECTION C-1

CROSS-SECTION C-2

Appendix E

NHDES Watershed Management Fact Sheets

ENVIRONMENTAL Fact Sheet

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

29 Hazen Drive, Concord, New Hampshire 03301 • (603) 271-3503 • www.des.nh.gov

WD-WMB-19 2006

Why Watersheds Are Important to Protect

What is a Watershed?

A watershed can be defined as an area of land that drains down slope until it reaches a common point. "Watershed" is synonymous with other terms you may have heard such as "drainage basin" and "catchment area." Perhaps a simpler way of defining a watershed is by saying that it is an area of land where all of the water that falls in it ends up in the same place. All precipitation that falls within a watershed, but is not used by existing vegetation, will ultimately seek the lowest points. These low points are bodies of water such as rivers, lakes, and finally the ocean. This means that every stream, brook, tributary, and river that we see will eventually reach a larger body of water within its associated watershed. Even groundwater that we cannot see moves towards a common low point. One way to picture it is as a giant funnel that catches and directs all of the water that falls into it towards the bottom. On a topographical map, a watershed can be determined by connecting all of the points of highest elevation around a lake.

Who lives in watersheds?

Everyone lives in a watershed! No matter where we live we will always be part of a watershed. Major watersheds span across county, state and national boundaries. Therefore, a resident of New Hampshire can affect a lake in Massachusetts, Maine or Vermont and vice versa. It doesn't matter if the lake is in your front yard or miles away. Pollution anywhere within the watershed has the potential to affect all waterbodies located downstream from it.

How significant are watersheds?

Watersheds are *extremely* important. Watersheds provide many of us with our drinking water supply, plus recreational opportunities and aesthetic beauty. Unfortunately, the replacement of vegetation by impervious surfaces like roads, parking lots and rooftops has a negative impact on watersheds. This increases the velocity and amount of runoff flowing into surface waters and causes erosion, turbidity and degraded wildlife habitats. Not only that, but this runoff carries pollutants such as oil, bacteria, nutrients, sediment and metals into surface waters along with it. Forested areas play a very important role in the health of a watershed. The plant cover and leaf litter absorb moisture and help maintain soil structure, while root masses keep soil permeable and stable so moisture can move into it for storage. This is more desirable, because it allows water to be filtered and released slowly into the stream system rather than rapidly running overland.

Want help locating the watershed that you call home?

An easy way to locate your watershed is via the U.S. Environmental Protection Agency's website at cfpub.epa.gov/surf/locate/index.cfm, or at the U.S. Geological Survey website at water.usgs.gov/wsc.

ENVIRONMENTAL
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NEW HAMPSHIRE DEPARTMENT OF Environmental Services

29 Hazen Drive, Concord, New Hampshire 03301 • (603) 271-3503 • www.des.nh.gov

WMB-16 2005

Watershed Districts and Ordinances

What are Watershed Districts and Ordinances?

Watershed district and ordinances are methods of zoning that recognize watershed boundaries instead of political boundaries, as a means of regulating land uses that may affect surface water quality. A watershed district or ordinance may set rules or regulations that restrict certain activities within the watershed in order to protect surface water resources, such as lakes, ponds and rivers. Regulations could include setback requirements, buffer requirements, land use restrictions, implementation of best management practices (BMP) and implementation of low impact development (LID) techniques. Typically, a watershed district or ordinance is proposed by a town or city planning board and must be approved by the voters. Often, the ordinance or district modifies or amends zoning regulations already in place in the towns or cities involved. Watershed districts and ordinances may vary by town and can be tailored to suit the needs of the particular watershed.

How Can Watershed Districts and Ordinances Protect New Hampshire Lakes and Ponds?

This approach to watershed management is beneficial to New Hampshire's surface waters, especially those with expansive watersheds. Within a watershed district or ordinance, towns work together to protect their common water resource(s). A watershed district or ordinance may decrease sedimentation, and nutrient loading to surface waters by taking measures to reduce or eliminate stormwater runoff. In addition, reduction or elimination of the use of hazardous materials within the watershed may prevent dangerous substances from reaching lakes and ponds. In densely developed watersheds, this approach may help to improve water quality. In relatively undeveloped watersheds, this approach may help to protect water quality in the face of future development.

How To Form a Watershed District or Ordinance in Your Community

Forming a watershed district or ordinance involves bringing a lot of different groups together under a shared goal. Often, DES will work with the interested communities and provide as much assistance as possible throughout the process. The first step is to determine which towns are included in the lake or pond's watershed. Town planning boards and conservation commissions should be included in the planning process. Watershed districts and ordinances formed to protect lakes and ponds often involve local lake associations as well. These groups, as well as any other interested groups or individuals, determine what activities will be regulated. Regulated activities may include agriculture, forestry and construction, as well as standards for septic systems. Standards for wetlands and surface water protection may be included as well. Regulations or standards are set for the watershed district or ordinance, and put to a vote within each town. Once the voters of each town in the watershed accept the regulations and standards, the ordinance or district may go into effect.

For more information, or examples of watershed districts or ordinances that have been implemented in New Hampshire, contact Jody Connor, DES Limnology Center Director, at (603) 271-3414 or jconnor@des.state.nh.us.

ENVIRONMENTAL
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NEW HAMPSHIRE DEPARTMENT OF Environmental Services

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WD-WMB-17 2010

Low Impact Development and Stormwater Management

What is Stormwater
Stormwater is water from rain or melting snow that does not soak into the ground. In a forest, meadow, or other natural environment, stormwater usually soaks into the ground and is naturally filtered. When forests and meadows are developed, they are commonly replaced with residential neighborhoods, shopping centers, and other areas that introduce impervious surfaces such as houses, buildings, and roads and parking lots. Impervious surfaces prevent rain or melting snow from soaking into the ground and create excess stormwater runoff.

Excess stormwater runoff creates problems when stream channels have to accommodate more flow than nature designed them to. When this happens, flooding is more frequent, banks erode, and the groundwater table is lowered. Stormwater can also become polluted with trash and debris, vehicle fluids, pesticides and fertilizers, pet waste, sediment, and other pollutants when it flows over impervious surfaces, lawns, and other developed areas. These pollutants get picked up with the stormwater runoff and eventually flow untreated into nearby lakes, streams and other bodies of water.

Stormwater has been identified as a major source of water pollution in the United States. In New Hampshire, stormwater has been identified as contributing to over 80 percent of the surface water quality impairments in the state. All across New Hampshire, communities, businesses, and property owners are experiencing the challenge of managing stormwater to maintain transportation and storm drainage infrastructures, protect water quality, and to simply keep their driveways and landscaping from washing out each year.

Low impact development can be used to reduce the amount of stormwater that runs off impervious surfaces and protect nearby surface waters from stormwater pollution.

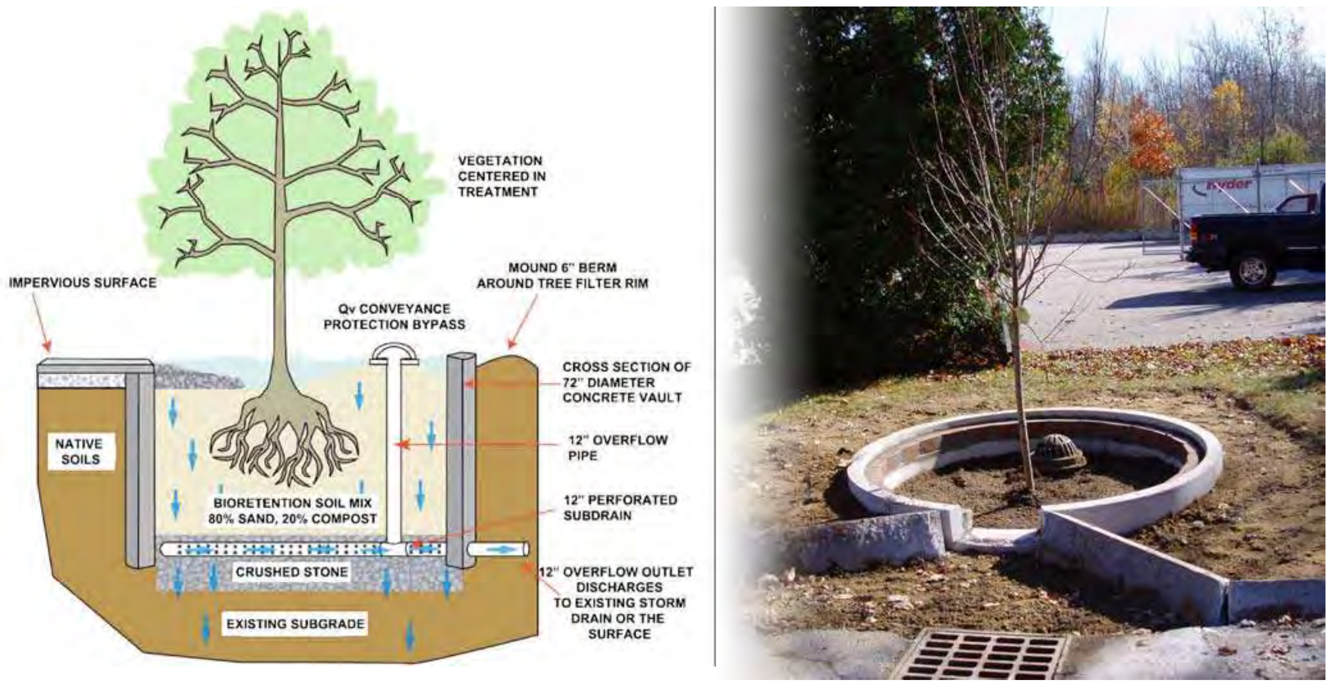
What is Low Impact Development?
Low impact development (LID) is a stormwater management approach. Unlike conventional stormwater management, which focuses on piping stormwater away from a site to large centralized stormwater treatment areas, LID focuses on controlling stormwater by using small, decentralized methods to treat stormwater close to the source. The primary goals of LID are accomplished through LID site planning and LID treatment practices and include:

- Lessening the impact of development, and the impact of stormwater resulting from that development, on the natural environment.
- Using the land more efficiently.
- Lowering capital and operating costs associated with development.

LID Site Planning
LID site planning reduces the amount of stormwater generated on a site through source control and protection of the site's existing hydrologic features, such as topography, vegetated buffers, wetlands, floodplains and high-permeability soils. More information on LID site planning can be found in Chapter 6 of the *New Hampshire Stormwater Manual: Volume 1 Stormwater and Antidegradation*.

Objectives of LID site planning include:

- Minimizing areas of disturbance
- Maintaining and restoring natural buffers
- Minimizing impervious cover
- Disconnecting impervious cover
- Minimizing soil compaction



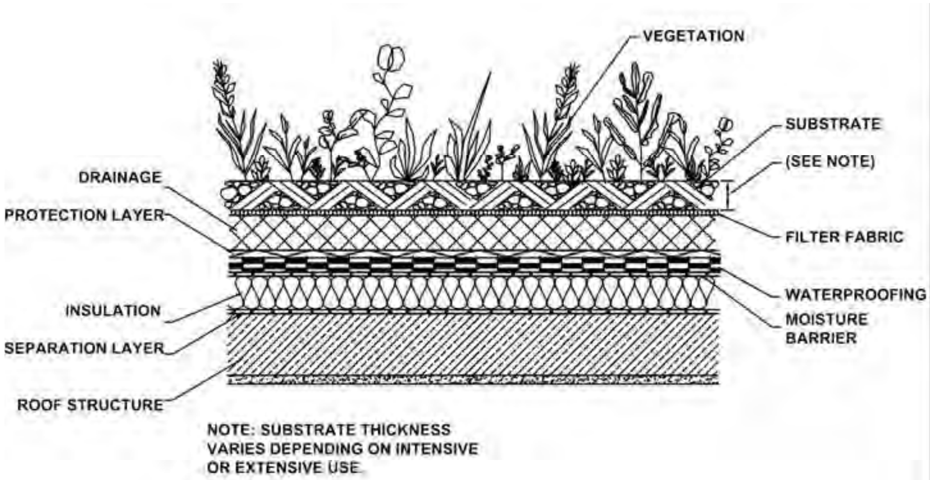
Example tree box filter design (UNH Stormwater Center 2007a) and installation in the Hodgson Brook Watershed in Portsmouth, NH.

LID Practices
Once LID site planning has been used to minimize the amount of stormwater generated on the site, site-level, decentralized LID treatment practices are used to treat any stormwater runoff that resulted from development. LID treatment practices are typically designed as open, vegetated systems that rely on plants and their root systems as well as permeable soils to slow the flow of water and encourage infiltration and filtration. This reduces both the velocity and volume of stormwater, as well as provides treatment of stormwater pollutants.

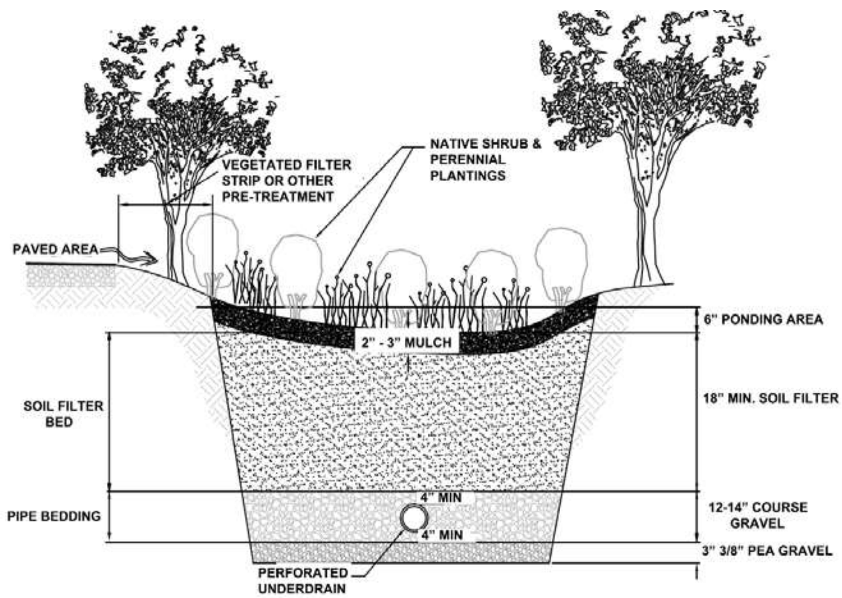
LID treatment practices can be used in existing development and can also be used in redevelopment projects to improve existing stormwater management. In redevelopment situations, LID focuses on minimizing and disconnecting existing impervious surfaces and implementing LID treatment practices for water quality, where feasible. More information on LID treatment practices can be found in Chapter 4 of the *New Hampshire Stormwater Manual: Volume 2 Post-Construction Best Management Practices Selection & Design*.

Examples of LID treatment practices include:

- Bioretention and Rain Gardens
- Dry Wells
- Rooftop Gardens and Green Roofs
- Vegetated Swales, Buffers, and Strips
- Soil Amendments
- Permeable Pavement
- Tree Box Filters
- Rain Barrels and Cisterns



Example green roof design (Maine DEP 2006, EPA 2006a) and installation at the Mount Washington Hotel, Bretton Woods, NH.



Rain garden and pervious pavement installation in downtown Peterborough, NH.

Barriers to LID

Although LID is not new, it is still considered innovative. Because of this, there are several potential barriers to implementing LID. For example:

- *Cost Concerns* – Many people are deterred from using LID practices because they believe they are more costly than conventional stormwater management practices, when in reality, LID practices can actually cost less than conventional stormwater management due to a reduced need for catch basins and piping. Also, with less infrastructure involved, LID can reduce the long-term cost of operation and maintenance.

- *Conflicting Local Ordinances* – Municipal ordinances and bylaws, such as minimum roadway widths, minimum parking requirements, and curb and gutter conveyance design, can conflict with LID principles. Local regulations can be modified or waivers or variances can be granted to allow for LID, or municipalities can adopt stormwater ordinances that require LID. More information on New Hampshire local ordinances can be found at: des.nh.gov/organization/divisions/water/wmb/repp/innovative_land_use.htm
- *Lack of Confidence* – Many people lack confidence in the performance of LID practices. LID has been used successfully in New England and across the country. Specifically, the University of New Hampshire Stormwater Center (UNHSC) has tested several LID practices and has data showing their efficiency in New Hampshire's climate. (www.unh.edu/erg/cstev/)
- *Site Constraints* – There are concerns that LID practices do not work in cold climates or on sites that have poorly draining soils, are close to groundwater, or other site constraints. The UNH Stormwater Center has shown that properly designed and installed LID practices perform well in New Hampshire.
- *Maintenance Concerns* – All best management practices need maintenance. The type of maintenance required for LID practices is often different than conventional systems. Because most LID practices are vegetated, maintenance focuses on maintaining healthy vegetation as well as removing sediment and other debris as necessary. LID practices tend to be smaller and usually do not require the use of heavy equipment to conduct maintenance.

For More Information

Additional information on Low Impact Development can be found in the following resources:

- DES Innovative Land Use Planning Techniques Handbook – http://des.nh.gov/organization/divisions/water/wmb/repp/innovative_land_use.htm
- The University of New Hampshire Stormwater Center – www.unh.edu/erg/cstev/
- EPA's National LID website – www.epa.gov/owow/nps/lid
- EPA New England Stormwater website – www.epa.gov/region1/topics/water/stormwater.html
- Center for Watershed Protection website – www.cwp.org
- Low Impact Development Center website – www.lowimpactdevelopment.org

ENVIRONMENTAL
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NEW HAMPSHIRE DEPARTMENT OF Environmental Services

29 Hazen Drive, Concord, New Hampshire 03301 • (603) 271-3503 • www.des.nh.gov

WD-WMB-10 2009

Potential Dangers of Cyanobacteria in New Hampshire Waters

What are Cyanobacteria?

Cyanobacteria are bacteria that photosynthesize. Many species of cyanobacteria grow in colonies to form surface water "blooms." Blooms are usually blue-green in color and consist of thousands of individual cells.

Cyanobacteria are some of the earliest inhabitants of our waters, and naturally occur in all of our lakes, often in relatively low numbers. However, research indicates that cyanobacteria abundance increases as lake nutrients increase. As part of the aquatic food web, they can be eaten by various grazers in the lake ecosystem, such as zooplankton and mussels.

Although most often seen when floating near the surface, many cyanobacteria species spend a portion of their life cycle on the lake bottom during the winter months. Increased water temperature and light in the spring promote the upward movement of cyanobacteria through the water column toward the surface where blooms or scums are formed. These scums are often observed in mid to late summer and sometimes well into the fall.

Why are Cyanobacteria a Concern?

Some cyanobacteria produce toxins that adversely affect livestock, domestic animals, and humans. According to the World Health Organization (WHO), toxic cyanobacteria are found worldwide in both inland and coastal waters. The first reports of toxic cyanobacteria in New Hampshire occurred in the 1960s and 1970s. During the summer of 1999, several dogs died after ingesting toxic cyanobacteria from a bloom in Lake Champlain. The WHO has documented acute impacts to humans from cyanobacteria from the US and around the world as far back as 1931. While most human health impacts have resulted from ingestion of contaminated drinking water, cases of illnesses have also been attributed to swimming in cyanobacteria infested waters.

The possible effects of cyanobacteria on the "health" of New Hampshire lakes and their natural inhabitants, such as fish and other aquatic life, are under study at this time. The Center for Freshwater Biology (CFB) at the University of New Hampshire is currently examining the potential impacts of these toxins upon the lake food web. The potential human health hazards via exposure through drinking water and/or during recreational water activities are also a concern to the CFB and the state.

Do Cyanobacteria Exist in New Hampshire Waters?
Yes, they occur in lakes world wide. Cyanobacteria have been found in a majority of lakes in New Hampshire, but most often cyanobacteria numbers present in our lakes are near the minimum level of detection. Four of the most common cyanobacteria found in New Hampshire are: Anabaena, Aphanizomenon, Oscillatoria, and Microcystis. Anabaena and Aphanizomenon produce neurotoxins (nerve toxins) that interfere with nerve function and have almost immediate effects when ingested. Microcystis and Oscillatoria are best known for producing hepatotoxins (liver toxins) known as microcystins. Oscillatoria and Lyngbya (another type of cyanobacteria) also produce dermatotoxins, which cause skin rashes.

Should You be Concerned about Swimming in or Drinking from a New Hampshire Lake?
Both DES and UNH have extensive lake monitoring programs. Generally, the water quality of New Hampshire's lakes is very good. However, the state strongly advises against using lake water for consumption, since neither in-home water treatment systems nor boiling the water will eliminate cyanobacteria toxins if present.

If you observe a well-established cyanobacteria bloom or scum in the water, please comply with the following:

- ✓ Do not wade or swim in the water!
- ✓ Do not drink the water or let children drink the water!
- ✓ Do not let pets or livestock into the water!

Exposure to toxic cyanobacteria scums may cause various symptoms, including nausea, vomiting, diarrhea, mild fever, skin rashes, eye and nose irritations, and general malaise. If anyone comes in contact with a cyanobacteria bloom or scum, they should rinse off with fresh water as soon as possible.

If you observe a cyanobacteria bloom or scum, please call DES at (603) 419-9229. DES will sample the scum and determine if it contains toxin-producing bacteria. An advisory will be posted on the immediate shoreline of a designated beach indicating that the area may not be suitable for swimming. If the affected area extends into water that is not part of a designated beach, DES will issue a warning for the entire lake. DES will continue to monitor the water and will notify the appropriate parties regarding the results of initial and subsequent testing. Public notification occurs through press releases and the DES website. When monitoring indicates that cyanobacteria are no longer present at levels that could harm humans or animals, the advisory or warning will be removed.

Please visit http://des.nh.gov and search term "Beach" to access the most current advisories and warnings.

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WMB-4 1996

Road Salt and Water Quality

Background

The amount of snowfall in northern New England and the necessity of overland travel require the use of plows and de-icing materials to keep highways safe in the winter. Salt, or sodium chloride, is the most commonly used de-icing material in New Hampshire. In general, the purpose of salt is to: 1) reduce adherence of snow to the pavement; 2) keep the snow in a "mealy" condition and thereby permit nearly full removal by plowing; and 3) prevent the formation of ice or snow ice (hard pack).

Sodium chloride can negatively impact drinking water and aquatic life. Sodium is a drinking water concern for individuals restricted to low-sodium diets due to hypertension (high blood pressure), although a review of scientific evidence by the U.S. Environmental Protection Agency showed that the vast amount of sodium ingestion (90 percent) was from food rather than drinking water and that the linkage between sodium and hypertension was still not well documented. Chloride can affect the taste of drinking water, but is not a health concern. If levels of either sodium or chloride approach 250mg/l in drinking water, an alternative source should be found. Chloride ions were found by the U.S. Environmental Protection Agency to be toxic to certain forms of aquatic life at a four-day average concentration of 230 mg/l. Some plant species at the base of the food chain can be impacted at much lower concentrations.

Roadside vegetation is visibly impacted from road salt. Burned grass and shrubs, as well as burned foliage on roadside trees from salt spray are common in New Hampshire.

Road Salt Management Issues

The New Hampshire Department of Transportation's (DOT) winter maintenance goal is to obtain bare and dry pavements on most roads at the earliest practical time following cessation of a storm. Many municipal highway departments have similar goals. Traffic volume, speed, and gradient are the primary factors in determining the level of winter maintenance service for particular roads. When the temperature is 20^{o} F or greater, DOT applies 250-300 lbs. of salt per lane-mile and/or abrasive (sand) as needed. At temperatures below 20º F, DOT uses various combinations of salt, sand, and calcium chloride, depending on road conditions.

Salt storage facilities can have a greater potential for causing water pollution than roadway application. For maximum environmental protection, salt storage facilities should be roofed and paved, with adequate drainage controls to prevent runoff water from contacting salt.

Alternatives to Road Salt

Salt is the most commonly used highway de-icer. Its effectiveness decreases as temperatures drop. Salt is most effective at temperatures above 20º F. Below 10º F, salt cannot dissolve and cannot break the ice-pavement bond.

The second most commonly used de-icing chemical, calcium chloride, is effective in much lower temperatures than salt (as low as 0º F). Liquid calcium chloride can be used to pre-wet salt and sand, which can facilitate de-icing at lower temperatures. The disadvantages to calcium chloride are: 1) it costs more than salt; 2) it is difficult to handle and store; 3) if used alone it may contribute to slippery, black-ice conditions; and 4) the presence of chloride ions makes calcium chloride at least as corrosive to structural materials and toxic to aquatic life as salt.

Sand is sometimes considered an alternative to salt. Sand does provide additional traction in slippery conditions but it cannot melt snow and ice on the road surface. A disadvantage to sand is that great effort must be expended to clean the sand from road surfaces at the end of winter to prevent clogging of roadside ditches and catch basins, and eventually sedimentation in water bodies.

Calcium magnesium acetate (CMA) is another alternative to salt. CMA is made from limestone and acetic acid, the principal ingredient of vinegar. CMA is less damaging to soils, less corrosive to concrete and steel, and non-toxic to aquatic organisms. It is also benign to roadside vegetation. The components of CMA are not harmful to groundwater, although CMA, like salt, has the potential to mobilize trace metals (Fe, Al, Zn, Cu) through cationic exchange reactions in soil. A drawback of CMA is its cost, about $600/ton, compared to about $40/ton for salt. However, a full cost analysis, comparing CMA to salt is needed to determine the full cost of both alternatives. CMA use should lead to longer lasting bridges and cars and less environmental damage. Including avoided costs, CMA may be an economically viable alternative to salt, even though its initial cost is 15 times greater.

DOT Reduced Salt Pilot Program

Chapter 239, Laws of 1994, authorized and required the DOT, in cooperation with the Nashua Regional Planning Commission, to implement a pilot program to minimize salt use during the winters of 1994-95 and 1995-96. Three test sections were found on low traffic volume highways in the Nashua region, public hearings were held, and warning signs were posted on the roads. During the two winters, test sections were treated with approximately one half the amount of salt used on the control sections, which were treated using standard DOT procedures. DOT evaluated road conditions, accidents, costs, environmental benefits, and public acceptance of the pilot program. Monitoring wells were installed along test and control highway sections to measure chloride levels in groundwater.

The results of the pilot program were:

1. While poorer driving conditions were noted on the test sections, safety was not significantly compromised by the reduction in salt use. This was attributed to the absence of curves, hills, and heavy traffic on test sections, as well as the highway signing and public notification of the program.
2. While substantial savings for salt were noted, other costs such as sand and labor were higher. Additional costs were estimated by DOT at $16,774 during the two-year test period for the 8.3 lane-miles in the test sections. It was noted that additional costs could

be incurred due to sand cleanup for lawns, drainage ditches, and culverts. DOT also noted that the higher costs were partially due to the short length of the test sections.

3. Public acceptance of the test was mixed. Very few complaints were from the public, but local police were less than satisfied with road conditions during storms.
4. In each test section chloride levels in monitoring wells were substantially lower than those in corresponding control sections. Application of additional sand in test sections created environmental concerns due to sediment deposition, but these impacts were not measured.

DOT concluded that reduced salt application for winter maintenance is beneficial within very specific parameters. The type of highway to be included in a reduced salt program needs to be carefully considered. The highway must be relatively flat, without hills and curves, and in a low speed/low volume section. Based on the results of the pilot program, DOT will consider conducting other reduced salt programs in communities which request consideration and on roads which meet the specific requirements of the program. Local officials interested in the reduced salt program should contact the DOT Bureau of Highway Maintenance at 271-2693.

Best Management Practices for Road Salt Application

Storage and Handling

- Facilities should be located on flat sites away from surface water and on impervious surfaces that are easily protected from overland runoff.
- Salt should be stored under cover to prevent a loss due to runoff.

Application of Road Salts

- Sensitive areas, such as public water supplies, lakes and ponds, should be identified and made known to salt applicators. Consider de-icing alternatives in sensitive areas.
- Ground-speed controllers should be used for all spreaders.
- Give salt time to work; time plowing operations to allow maximum melting by salt, before snow is plowed off the highway.
- Know when to plow and reapply salt. The need for another salt application can be determined by watching melting snow kicked out behind vehicle tires. If the slush is soft and fans out like water, the salt is still working. Once the slush begins to stiffen and is thrown directly to the rear of vehicle tires, it is time to plow.
- For lesser traveled roads, consider applying salt in a windrow in a four to eight foot strip along the centerline of a two lane road. Less salt is wasted with this pattern and quickly gives vehicles clear pavement under at least two wheels. Traffic will soon move some salt off the centerline and the salt brine will move toward both shoulders for added melting across the entire road width.
- Determine levels of service for all roads in a service area. Salt application rates and frequency should be based on traffic volume, road grade and curvature, intersections, and weather conditions. Sand or sand/salt mix should be used based on the level of service requirements.

Snow Dumping

Dumping plowed snow directly into waterbodies is illegal. For recommended snow dump areas, please see DES Fact Sheet **WD-WMB-3.**

Appendix F

NHDES Septic System Fact Sheets

ENVIRONMENTAL
Fact Sheet
NEW HAMPSHIRE DEPARTMENT OF Environmental Services
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WD-SSB-2 2010

Care and Maintenance of Your Septic System

What is a septic system?
A septic system is a two part treatment and disposal system designed to condition untreated liquid household waste (sewage) so that it can be readily dispersed and percolated into the subsoil. Percolation through the soil accomplishes much of the final purification of the effluent, including the destruction of disease-producing bacteria.

A septic tank provides the first step in the process by removing larger solid materials, decomposing solids by bacterial action, and storing sludge and scum. The liquid between sludge and scum is then passed along to the leaching area for final treatment and absorption into the ground. Remember: A properly maintained septic system will adequately treat your sewage.

What should I do to maintain my septic system?
Know the location of your septic tank and leaching area.

- Inspect your tank yearly and have the tank pumped as needed and at least every three years.
- Do not flush bulky items such as throw-away diapers or sanitary pads into your system.
- Do not flush toxic materials such as paint thinner, pesticides, or chlorine into your system as they may kill the bacteria in the tank. These bacteria are essential to a properly operating septic system.
- Repair leaking fixtures promptly.
- Be conservative with your water use and use water-reducing fixtures wherever possible.
- Keep deep-rooted trees and shrubs from growing on your leaching area.
- Keep heavy vehicles from driving or parking on your leaching area.

For Further Information

If you have any questions concerning septic systems, contact DES Subsurface at (603) 271-3501, or 29 Hazen Drive, PO Box 95, Concord, NH 03302-0095; Fax: (603) 271-6683; http://des.nh.gov/organization/divisions/water/ssb/index.htm.

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WD-SSB-1 2010

Replacement of A Failed Subsurface Disposal System

What is a Failed Subsurface Disposal System?
New Hampshire RSA 485-A:2 defines failure as “the condition produced when a subsurface sewage or waste disposal system does not properly contain or treat sewage or causes or threatens to cause the discharge of sewage on the ground surface or into adjacent surface or groundwater.”

Special Requirements for Replacing a Failed Subsurface Disposal System.
To ensure prompt and effective replacement of a failed subsurface system, the following steps must be taken.

1. The town health officer, or other local official responsible for health code enforcement, must prepare a written statement verifying that the existing system is in failure. This statement must be submitted to DES with the application to replace the existing system.
2. If construction approval is granted, the construction must be completed within 90 days. Failure to complete construction and obtain operational approval of the system within the 90-day period will result in invalidation of DES approval.
3. In the event that your construction approval becomes invalid as a result of exceeding the 90-day construction period, a request for extension must be submitted to the Department of Environmental Services, Subsurface Systems Bureau. DES shall grant one 90-day extension. The request for extension must include all the information required by New Hampshire Administrative Rule Env-Wq 1004.11 (b).

This fact sheet is intended as a basic source of information concerning the replacement of a failed subsurface disposal system; it is not intended to replace the administrative rules contained in Env-Wq 1000. It is also important to remember that some municipalities have additional requirements, and you should check with your local officials before beginning any project.

For Further Information
If you have any questions concerning septic systems, contact DES Subsurface at (603) 271-3501, or 29 Hazen Drive, PO Box 95, Concord, NH 03302-0095; Fax: (603) 271-6683; http://des.nh.gov/organization/divisions/water/ssb/index.htm.

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WD-SSB-12 2010

Approved Technologies for Septic Systems

Over the past several years, the N.H. Department of Environmental Services has approved many new innovative technologies for the treatment and disposal of wastewater to subsurface systems. All new "innovative/alternative" systems for on-site treatment or disposal of wastewater below the ground (usually referred to as "septic systems") need approval from DES under the provisions of NH Administrative Rule Env-Wq 1024, which allows general and provisional approvals. The following is an overview of the various products and technologies that DES has approved to date. But before listing the currently approved systems, we must present these caveats and warnings:

- Systems are listed in random order.
- Mention of a company name, system or device in this list does not constitute DES approval to use that system or device to address any specific problem. Consult a licensed septic system designer to determine what solutions may be appropriate for your problem.
- PUMP OUT YOUR SEPTIC TANK **BEFORE** THERE'S A PROBLEM. Many times, a "technological" solution is not necessary because ordinary maintenance may solve the problem. See Env-Wq 1023 for operating requirements. Also see the other Fact Sheets in DES's SSB series for useful information on septic system operation.
- Where a designer specifies a certain product, such as a brand of septic tank effluent filter, and a different (but similar) brand is used in the actual installation, DES requires the written concurrence of the system designer before approving the tank/septic system for operation.

Leaching Systems

Stone/pipe - field, trench, drywell	"Standard" systems.
Chambers - concrete, plastic	"Standard" systems, but field sizing may be product-specific. See approved design manual.
"Enviro-Septic" system	A "standard" system, field sizing is product-specific. See approved design manual.
"Geo-Flow" system	A "standard" system, field sizing is product-specific. See approved design manual.
Eljen "In-Drain"	A "standard" system, but field sizing is product-specific. See approved design manual. Manufacturer's review for larger commercial systems.
Ruck "A-Fin"	A "standard" system, field sizing is product-specific. See approved design manual. Manufacturer's review required for larger commercial systems.

Mechanical treatment devices , with general DES Approval for leach field reduction:

Norweco "Singulair"	Biological treatment.
Amphidrome Recirculating Batch Reactor	Biological treatment.
Wastewater Alternatives Inc. "The Clean Solution"	Biological treatment.
Jet Package Sewage Treatment Plant	Biological treatment.
Spec Industries AIRR trickling filter	Biological treatment.
SeptiTech Recirculating Trickling Filter	Biological treatment.
BioMicrobics FAST system	Biological treatment.
Zabel SCAT biofilter	Biological treatment.
Orenco AdvanTex system	Biological treatment.
MicoSepTec EnviroServer system	Biological treatment.
CMS ROTORDISK	Biological treatment.
Aeration Systems, LLC, OxyPro system	Biological treatment.
BioClere system	Biological treatment.

Mechanical treatment devices, provisional DES Approval for leach field reduction:

Provisional approval is granted for newer technologies per Env-Wq 1024.06(d) for cases where DES finds that "… there is not sufficient operating history or other valid data to allow general use of the technology …." Provisional approvals are granted for a limited number of applications for a limited period of time. The applicant is required to do performance monitoring of each installation and report the results to DES.

SeptiTech Recirculating Trickling Filter	Biological treatment. The provisional approval is for leach field size reductions beyond that in SeptiTech's General approval.
BioMicrobics FAST System	Biological treatment. The provisional approval is for leach field size reductions beyond that in BioMicrobic's General approval.
WasteTech STM 2000 unit	Physical treatment.

For new construction where a mechanical treatment device with a reduced-size leach field, under a General or Provisional approval, is proposed for use on a lot that was created prior to adoption of DES subdivision rules, the design submitted shall demonstrate sufficient capacity to construct a full sized leaching facility on the lot.

All mechanical systems require on-going professional maintenance. The person doing the maintenance must be a licensed treatment plant operator. See DES fact sheet WD-WEB-2 for information in the licensure program. A Grade 1-OIT license is usually considered sufficient for systems listed here.

Other approved, or approvable, treatment devices and methods:

M.C.C. Inc. "Cajun Aire"	Mechanical unit, approved under Env-Wq 1024.
Cromaglass Sequencing Batch Reactor	Mechanical unit, approved under Env-Wq 1024.
"White Knight," "Pirana"	These are mechanical devices that are inserted into an existing septic tank to provide treatment of the effluent leaving the tank. They are allowed for rehabilitation of failed systems.
Constructed Wetlands	Innovative, has been approved for a few sites. Significant engineering required.
Spray Irrigation	Has been approved for a few sites. Very significant engineering and Groundwater Discharge Permit required. A major issue is control of access to the area where spraying occurs. There are significant public health concerns with coming into contact with partially-treated wastewater.
Sand Filters	Innovative, has been approved for a few sites. Significant engineering required.

Other systems & devices

Septic tank effluent filters	Allowed and encouraged.
Presby "Maze"	Device inserted into septic tank. 30 percent reduced field size allowed for commercial systems.
Holding Tank	Only applicable in very limited circumstances, see Env-Wq 1022.03
Composting toilets	Allowed, but no leach field reduction allowed for the remaining wastewater whenever the building has running water.
"Mini dry well" and privies	Only allowed for buildings with no running water (Env-Wq 1022.01 Prives & Env-Wq1022.02 Mini Drywell).

For more information

For more information about the above list, or to apply for approval of an innovative/alternative product from DES, please contact: Subsurface Systems Bureau, NH Department of Environmental Services, 29 Hazen Drive, PO Box 95, Concord, NH 03302-0095; (603) 271-3501.