Country Pond Watershed Management Plan
Phase 1: Direct Drainage Area

June 30, 2021

Version 1

Photo: Marie Sapienza

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ACRONYMS

Acronym	Definition
ALI	Aquatic Life Integrity
AUID	Assessment Unit Identification
BMPs	Best Management Practices
Chl-a	Chlorophyll-*a*
CPLA	Country Pond Lake Association
CWA	Clean Water Act
DKWRC	DK Water Resource Consulting
FC	Fish consumption
ha	Hectare
HWG	Horsley Witten Group
kg	Kilogram
LLRM	Lake Loading Response Model
m	Meter
MS4	Municipal Separate Storm Sewer System
NHDES	New Hampshire Department of Environmental Services
NHFG	New Hampshire Fish and Game Department
NLCD	National Land Cover Database
NPS	Nonpoint Source
NYDEC	New York State Department of Environmental Conservation
NWI	National Wetland Inventory
PCR	Primary Contact Recreation
ppb	Parts per billion
QAPP	Quality Assurance Project Plan
RPC	Rockingham Planning Commission
SDT	Secchi disk transparency
SOAK	Soak Up the Rain
TMDL	Total Maximum Daily Load
TP	Total phosphorus
UNHCE	University of New Hampshire Cooperative Extension
UNHSC	University of New Hampshire Stormwater Center
EPA	United States Environmental Protection Agency
USGS	United States Geological Survey
VLAP	Volunteer Lake Assessment Program

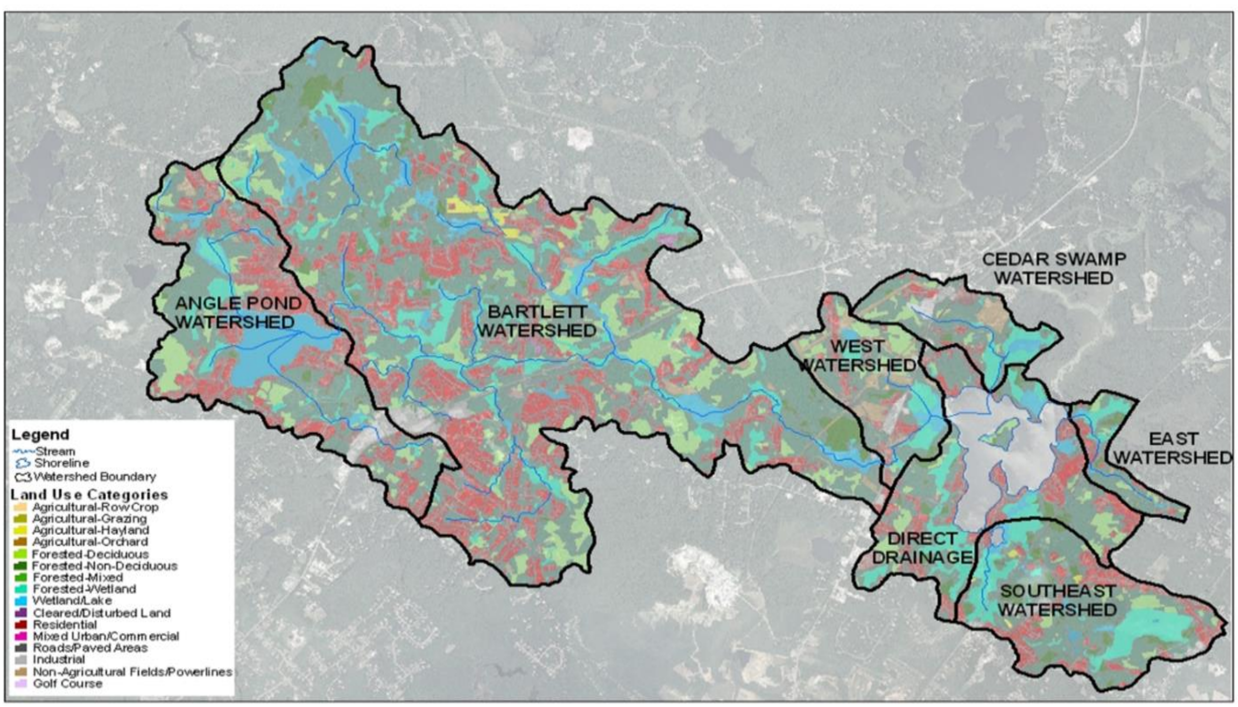
1.0 INTRODUCTION

Located in southeastern New Hampshire in the towns of Kingston and Newton, Country Pond is an important water resource that supports a diverse abundance of plants and wildlife. Country Pond is ideal for many recreational activities such as swimming, fishing, and boating. Country Pond is enjoyed by seasonal and year-round residents and its shores are also home to private campgrounds and youth camps.

In recent years, Country Pond has experienced cyanobacteria blooms and excessive plant growth in shallower areas of the pond. In response to these issues, a Total Maximum Daily Load (TMDL) study was completed for the pond in 2011. The TMDL identifies and quantifies potential sources of nutrient loading to the pond. To build on the TMDL, local efforts were initiated to better understand watershed dynamics and develop solutions and approaches for reducing pollutant loads to the pond to prevent cyanobacteria blooms.

This watershed planning project is the beginning of a phased effort to identify management opportunities for the entire Country Pond watershed. Due to funding limitations coupled with the size and complexity of the watershed, a phased approach for watershed planning is needed for Country Pond. This first phase of the watershed planning effort focuses on 1) setting a water quality goal for the pond, and 2) identifying management opportunities to reduce phosphorus in the direct drainage area, which is the sub-watershed that directly surrounds and drains to the pond (Figure 1). Future phases will tackle other sub-watersheds as funding and capacity becomes available.

Figure 1. Watersheds and land cover of Country Pond ***(AECOM, 2009)***



The *Country Pond Watershed Management Plan Phase 1: Direct Drainage Area* describes water quality conditions, watershed characteristics, and sources of phosphorus loading to Country Pond; plus, identifies actions to improve the pond's water quality. The plan establishes water quality goals, outlines nutrient management approaches, and describes management actions for meeting water quality improvement goals. The plan is the culmination of sustained efforts conducted under the leadership of Rockingham Planning Commission (RPC), Country Pond Lake Association (CPLA), and the New Hampshire Department of Environmental Services (NHDES) in cooperation with local and state partners. The *Country Pond Watershed Management Plan Phase 1: Direct Drainage Area* provides guidance for the first phase of a collaborative, engaged pond management approach.

The plan summarizes previous studies, water quality data, watershed survey information, and phosphorus loading modeling output. The plan incorporates this information into actions and recommendations for reducing pollutant loading to the pond.

The goals of the *Country Pond Watershed Management Plan Phase 1: Direct Drainage Area* are:

- Identify and quantify sources of phosphorus loading to the pond
- Establish a water quality goal for the pond
- Identify actions to reduce phosphorus loading from the direct drainage sub-watershed

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

Additionally, information from the plan may be used by communities to aid in compliance with the 2017 NH Small Municipal Separate Storm Sewer Systems (MS4) permit issued by the US Environmental Protection Agency (EPA). The permit is intended to minimize the discharge of harmful pollutants to waterbodies from municipal stormwater infrastructure. Five towns in the Country Pond watershed, Kingston, Newton, Danville, Sandown, and Hampstead are subject to requirements in the MS4 permit relative to Country Pond (EPA, 2017).

2.0 PLAN DEVELOPMENT PROCESS

The watershed planning process uses a series of cooperative, iterative steps to characterize existing watershed conditions, identify and prioritize problems, define management objectives, develop protection or remediation strategies, and implement and adapt selected actions as necessary (USEPA, 2008). Rockingham Planning Commission received funding in 2019 from the NHDES Water Quality Planning Grants program to develop a watershed management plan and approach for the pond in cooperation with CPLA. To develop the plan, RPC engaged several partners including NHDES, the Horsley Witten Group (HWG), the UNH Stormwater Center (UNHSC), and DK Water Resource Consulting (DKWRC). Additionally, RPC worked with local partners to collect water quality data and watershed information to include in the plan. The plan includes USEPA's nine key "a- i" planning elements to restore waters impaired by nonpoint source (NPS) pollution. Table 1 describes each element and the relevant section in the **Country Pond Watershed Management Plan: Phase 1 –Direct Drainage Area** where the element can be found.

Table 1. USEPA's nine elements of watershed planning

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

Additionally, this plan offers resources that may be of use for MS4 permit compliance. Section 11.0 of this watershed management plan provides a description of the watershed planning elements and outputs that municipalities could leverage for MS4 program work. Section 12.0 of the plan provides a list potential funding opportunities for implementation of management actions and future phases of watershed planning.

3.0 CHARACTERISTICS OF COUNTRY POND

Country Pond, NHLAK700061403-03-01, is in the Merrimack River Basin within the towns of Kingston and Newton, New Hampshire. The artificially impounded, 124-hectare (306 acre) pond has a maximum depth of 9.4 m (30.8 ft) and a mean depth of 2.5 m (8.2 ft). The pond volume is 3,150,722 cubic meters with a flushing rate of approximately 7.2 times per year. Lakes and ponds with watershed/lake area ratios greater than 10:1 can experience low water clarity, high phosphorus concentrations and algal blooms because total loading of nutrients to a lake is generally proportional to watershed size. The watershed (3,590 hectares or 8,624 acres) is 29 times the lake area making Country Pond particularly susceptible to excessive nutrient loading from anthropogenic activities in the watershed (Table 2).

Table 2. Characteristics of Country Pond

Parameter	Value
Assessment Unit Identification	NHLAK700061403-03-01
Lake Area (ha)	124
Lake Volume (m^3)	3,150,722
Watershed Area (ha)	3590
Watershed/Lake Area	29
Mean Depth (m, ft)	2.5, 8.2
Max Depth (m, ft)	9.4, 30.8
Flushing Rate (yr^{-1})	7.2
Impaired Uses and Causes of Impairment	*Primary Contact Recreation*: Hepatotoxic cyanobacteria (TMDL completed), Source Unknown
Hypolimnetic Anoxia	Yes

The Town of Kingston has grown 117 percent since 1970 and now has an estimated population of 6,244 (NHOSI 2019). Newton has experienced similar growth and in 2018 had an estimated population of 4,980 (NHOSI 2019). The lake is classified as a Class B water with designated uses of swimming, fishing, and other recreational uses. Country Pond has a warmwater fishery with smallmouth bass (Micropterus dolomieui), largemouth bass (Micropterus salmoides), chain pickerel (Esox niger), bullhead (Ameiurus sp.), black crappie (Pomoxis nigromaculatus), white perch (Morone americana), American eel (Anguilla rostrata), pumpkinseed (Leopomis gibbosus) and yellow perch (Perca flavescens) (NH Fish and Game 2019).

3.1 Dams

The dam at the outlet of Country Pond in Newton, NH is no longer used. There is a single lane roadway over the dam, Webster Grove Road. The dam was deeded to Merrimac Valley Power and Buildings Company in the early 1900's. The company sold off other dams in the area in the 1940's (Great Pond and Trickling Falls). The NHDES dam fact sheet dated November 6, 2018 still shows this company as the owner. The Town of Newton operated the dam until October 18, 1990 when it relinquished responsibility for its operation. At that time the stop boards were removed, and Country Pond's level is now determined by Powwow Pond's level which is downstream. Powwow Pond's level is controlled by the Trickling Falls Dam which is owned and operated by NHDES.

3.2 Land Uses

Country Pond is a vital recreational and economic resource to the towns of Kingston and Newton. There are approximately 160 private homes with deeded access to Country Pond, with about half the homes located in each town. While there are a few seasonal homes, the vast majority are year-round residences. The island in the middle of Country Pond is privately owned, but is currently undeveloped. Public access to Country Pond is available only to Newton residents at the town boat ramp and town beach.

There are two private campgrounds on Country Pond: one with 150 sites and approximately 50 boat slips; and another with 80 sites and fewer than 10 slips. Boat launching privileges are for seasonal campers only at both sites. There is also a private RV park with 80+ sites located on Colby Brook adjacent to the wetland on the east side of Route 125. There are two youth summer camps on Country Pond that offer swimming and non-motorized boating to campers.

The majority of the Country Pond shorelands are densely developed with residential and recreational uses with the exception of portions of the westerly side of the lake and a few widely distributed parcels that are undeveloped or maintain naturally vegetated shorelines. Most developed shorelands typically have hardened structures such as wood or stone retaining walls, bulkheads or riprap, sparse woody vegetation (trees and shrubs) and managed turf to the water's edge.

The Country Pond watershed is comprised predominantly of 39.7 percent mixed hardwood and coniferous forests and 24.3 percent low density residential development. The remaining areas are occupied by 15.3 percent wetlands, 7.5 percent surface waters, 6.3 percent mid-density residential and commercial development and roads, 0.9 acres of recreational lands and municipal facilities, and 0.8 percent row crop/agriculture, and 0.1 percent gravel roads.

Figure 2. Country Pond shoreline (*Photo: Tobi Howell*)

There are two conservation properties bordering Country Pond: the former Manuel property, owned and managed by the Town of Kingston under the Land Conservation Investment program, which totals 82 acres and has 1530' of frontage on the pond; and the Lone Tree Scout Reservation, with 72 of its 124 acres managed by the US Conservation Service Wetlands Reserve program and an additional 2300' of undeveloped shoreland.

3.3 Aquatic Vegetation

During the watershed planning process, local partners noted that Country Pond contains an abundance of aquatic vegetation. Questions and concerns were raised about this condition and DK Water Resource Consulting (DKWRC), a consultant to the project, reviewed information about vegetation in the pond. This information was summarized and is presented in this section for use in watershed planning efforts.

Country Pond features numerous types of aquatic vegetation, including but not limited to algae, submerged aquatic vegetation (underwater macrophytes), and emergent aquatic vegetation, which are plants that break the surface of the water and grow up and out of the water, such as cattails (*Typha latifolia*). Aquatic vegetation is critical lake ecosystems; however, excessive growth of aquatic vegetation in response to not-natural nutrient enrichment can be detrimental to a lake's natural balance. This unbalanced condition is more likely to occur with the presence of non-native species that often provide inferior habitat for other species, may not be preferred as food for other organisms, and can outcompete native species.

Currently, invasive plant species have not been documented in Country Pond. The CPLA maintains an active Lake Host program to educate recreationalists about invasive species and best practices for preventing infestations. This program plays a critical role in ensuring that the pond remains free of invasive species.

3.3.1 Algae and Cyanobacteria

Figure 3. Cyanobacteria bloom, Country Pond
(*Photo: Gregory Senko*)

Algae range in size from microscopic to larger algal masses that often appear to be plants when floating on or near the surface. There are both attached forms (filamentous and periphyton) and free-floating forms (phytoplankton). Cyanobacteria can be either free floating or attached. They are found throughout Country Pond and are most prolific in areas which receive higher concentrations of nutrients and sunlight. Algal (and cyanobacteria) blooms occur on Country Pond, changing the color of the water, increasing turbidity, and resulting in decaying masses (Figure 3). Benthic filamentous algae are found in Country Pond, where it can appear as brown or green mats of vegetation attached to either the bottom, boats or rooted aquatic plants.

While the entire Country Pond watershed is not developed, runoff from small intensively developed portions of the watershed, such as the direct drainage area, can add significant amounts of phosphorus to the pond and provide fuel for algal and cyanobacteria growth. Excessive algal growth has the potential to become the dominant condition in nutrient enriched lakes as algae shade out rooted aquatic plants.

Cyanobacteria are present in all lakes; however, their abundance increases as nutrients increase. Other conditions that may accelerate cyanobacteria blooms include temperature, sunlight, and activities that suspend sediment in the water column such as wind and motorboat activity. There are eight known types of cyanobacteria in New Hampshire: *Anabaena (Dolichospermum)*, *Aphanizomenon, Coelospharium, Gloeotrichia, Lyngba, Merismopedia,* and *Microcystis*. Some cyanobacteria produce toxins which can sicken humans, domestic animals, and livestock.

Cyanobacteria are a concern in Country Pond for several reasons – potential health effects for humans and animals, lake aesthetics, and economic impacts tied to blooms. The frequency and intensity of the blooms is likely tied to phosphorus loading to the lake from various sources including loading from the watershed, and particularly from developed areas such as the direct drainage area. Country Pond is currently on the State’s 303(d) list of impaired waters for Primary Contact Recreation (swimming) due to reoccurring cyanobacteria blooms. Table 3 provides a summary of cyanobacteria advisories issued by NHDES for the Newton Town Beach between 2004 and 2018.

Table 3. Cyanobacteria advisory summary 2004-2018, Newton Town Beach, Country Pond

Date Issued	Dominant Taxa	Total Cell Conc (cells/ml)	Days
7/29/2004	Microcystis	>70,000 or >50%	8
8/9/2005	Microcystis	>70,000 or >50%	17
8/17/2006	Microcystis	>70,000 or >50%	26
7/24/2007	Unidentified	>70,000 or >50%	24
8/15/2008	Microcystis	>70,000 or >50%	56
8/5/2009	Anabaena	>70,000 or >50%	9
9/28/2018	Microcystis	19,620,000	6

(NHDES, 2018)

While Table 3 describes blooms at the Newton Town Beach for which NHDES issued warnings, additional blooms have been observed and confirmed at other locations in Country Pond including some for which warnings were not issued. A bloom consisting of mostly Anabaena was confirmed on May 23 – 24, 2018 at several locations around the pond, and a bloom containing of Microcystis, Woronichinia, and Anabaena was confirmed from a sample taken from Country Pond on November 30, 2019 (G. Senko, personal communication, 2021). However, information about blooms observed in Country Pond has not been compiled in one location. Section 10.0 of this watershed management plan includes recommendations for the development of a cyanobacteria bloom database to aid in documenting historical and on-going blooms.

3.3.2 Macrophytes

Macrophytes are rooted plants, with stems, branches, leaves, and flowers. They are found throughout Country Pond and are most prevalent in the littoral zone (those portions of the Pond in which sunlight reaches the bottom). Country Pond is approximately 124 hectares in size and approximately half of the pond area is located within the littoral zone with a water depth <15 feet where sufficient light reaches the bottom to allow macrophyte growth. The plant community of Country Pond is currently characterized by a mix of native species. Non-native or invasive aquatic plants have not been reported in Country Pond to date.

Figure 4. CPLA's Lake Host educates boaters about invasive species *(Photo: Susan Zipkin)*

Macrophytes are critical to the healthy functioning of a lake ecosystem. They provide spawning areas, refugia for young fish and substrate for invertebrates to live and feed. A healthy community of native macrophytes leads to a balanced food web and a system that is more stable and resilient to external changes such as increased precipitation and warmer temperatures. Because macrophytes utilize some nutrients from the water column, promote settling and stabilize sediments nearshore, lakes with healthy macrophyte communities often have clearer water in deeper sections of the lake.

During daylight hours, macrophytes, like all photosynthetic plants, produce oxygen in excess of their metabolic needs and use more oxygen than they can produce at night. Very dense macrophyte beds can exhibit very low concentrations of oxygen that can be lethal to fish particularly at night when there is no photosynthetic oxygen production (Frodge et al. 1995). As plants die, oxygen production slows. Macrophyte decay, whether as a result of the natural life cycle of plants or use of herbicides or some other plant control technique, reduces dissolved oxygen concentrations in the water column and releases nutrients. Seasonal dieback of macrophytes may lower dissolved oxygen in the water column in the vicinity of macrophyte beds; however, this typically occurs in the fall when water temperatures are lower (cold water holds more oxygen) and mixing is increased as fall turnover occurs.

Macrophyte growth in Country Pond is largely a function of past nutrient loading and sediment deposition. Macrophytes derive much of their nutrients from the sediments although they may take some nutrients from the water column (Wagner 2004). The long-term accumulated mass of nutrients in the sediments of Country Pond will likely fuel macrophyte growth into the foreseeable future even with substantial reductions in nutrient loading to the pond. Annual growth of macrophytes return a large portion of their accumulated nutrients to the sediments as they die at the end of the growing season.

Dying and senescing plants in addition to depleting oxygen, can release substantial amounts of nutrients into the water column (Carpenter and Adams 1978, Madsen 2000). These nutrients may then be available to phytoplankton and result in an increase in growth of those phytoplankton. This can be expected to happen regardless of whether the plants naturally die back in the fall as available light and water temperatures drop or are killed by herbicides or through some other control measure. Nutrient concentrations are somewhat higher per unit of plant biomass during the early active growing phase of the plants than later in the growing season (Carpenter and Adams 1978), so a plant die-off early in the growing season perhaps from herbicide treatments could release a larger mass of nutrients per mass of plants. However, the mass of plants is generally smaller early in the growing season.

The flushing rate of Country Pond is roughly seven times per year so depending on the timing of rainfall and runoff, nutrients released in the early summer are more likely to be available for algal growth than nutrients released in the fall when plants naturally die back. Fall released nutrients would be much more likely to be flushed out of the pond before the growing season the following year. In both instances, a proportion of the nutrients would be reincorporated into the sediments with the plant matter rather than being released into the water column potentially fueling future macrophyte growth.

External nutrient loading reduction is necessary for long-term reduction in macrophyte biomass in the pond, but it may not be sufficient in and of itself in the shorter term to reduce macrophyte growth if that is desired. Short term reductions in nutrient loading may also result in less algal growth and a clearer pond which may make conditions more favorable for macrophytes, particularly at depth as light penetration increases. Watershed management efforts should target long-term, sustained efforts to reduce loading from external sources of nutrients. This approach will ensure that plant communities will remained balanced and appropriate for pond conditions.

4.0 ASSESSMENT OF WATER QUALITY

This section provides an overview of New Hampshire's water quality standards and criteria that apply to Country Pond, the methodologies used by the State to assess water quality, and a summary of lake water quality conditions for parameters of concern. The State's assessment process and lake water quality parameters of concern – phosphorus and chlorophyll-*a* – provide a foundation for the watershed management plan's water quality goals and success indicators which serve as targets for measuring water quality improvement as management actions are implemented.

4.1 Applicable Water Quality Standards and Criteria

To set the context for developing water quality goals and success indicators for this watershed management plan, the state's water quality standards and criteria were reviewed and applied to the water quality goal setting process for the pond.

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

New Hampshire's water quality standards are composed of three parts: designated uses, water quality criteria, and antidegradation. The standards provide a baseline measure of the quality that surface waters must meet to support designated uses. The standards are the "yardstick" for identifying water quality problems and for determining effectiveness of state regulatory pollution control and prevention programs. The CWA requires states to determine designated uses for all surface waters within the state's jurisdiction. Designated uses are the desirable activities and services that surface waters should be able to support, 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 (Table 4). Surface waters can have multiple designated uses.

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

Table 4. Designated Uses

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

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

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

According to the 2020 303(d) list of impaired or threatened waters, Country Pond is listed as impaired for Aquatic Life Integrity (formerly known as Aquatic Life Use) due to low pH levels, for Fish Consumption due to elevated mercury and polychlorinated biphenals (PCB) concentrations, and for Primary Contact Recreation due to recurring cyanobacteria blooms (Figure 5).

Figure 5. County Pond water quality assessment summary

Assessment Unit ID: NHLAK700061403-03-01
Assessment Unit Name: Country Pond
Town(s) Primary Town is Listed First: Kingston, Newton

Size: 305.2140 ACRES
Assessment Unit Category: 5-M
Beach: N

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

Designated Use Description	Desig. Use Category	Parameter Name	Parameter Threatened (Y/N)	Last Sample	Last Exceed	Parameter Category	TMDL Priority
Aquatic Life Integrity	5-M	Alkalinity, Carbonate As Caco3	N	2007	2007	3-ND	
		Chloride	N	2019	N/A	3-PAS	
		Chlorophyll-A	N	2019	NLV	2-M	
		Dissolved Oxygen Saturation	N	2019	2006	3-PAS	
		Nonnative Fish, Shellfish, Or Zooplankton	N	N/A	N/A	3-PNS	
		Oxygen, Dissolved	N	2019	2006	3-PAS	
		Ph	N	2019	2019	5-M	LOW
		Phosphorus (Total)	N	2019	NLV	3-PNS	
		Turbidity	N	2019	2019	3-PNS	
Fish Consumption	5-M	Mercury - Fish Consumption Advisory	N			4A-M	
		Pcbs - Fish Consumption Advisory				5-M	LOW
Potential Drinking Water Supply	2-G	Sulfates	N	2003	N/A	3-ND	
Primary Contact Recreation	4A-P	Chlorophyll-A	N	2019	N/A	3-PAS	
		Cyanobacteria Hepatotoxic Microcystins	N	2019	2018	4A-P	
		Escherichia Coli	N	2002	NA	3-ND	
Secondary Contact Recreation	3-ND	Escherichia Coli	N	2002	NA	3-ND	

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

The focus of this watershed planning project is to reduce the frequency of cyanobacteria blooms such that the pond supports the Primary Contact Recreation (PCR) designated use. Other listed impairments are not a focus of this planning effort. To reduce the frequency of cyanobacteria blooms, the watershed management approaches outlined in this plan will address parameters that accelerate cyanobacteria blooms in the pond, such as total phosphorus, or are indicators of conditions that could affect blooms (Chlorophyll-*a*). Therefore, although both total phosphorus and chlorophyll-*a* are listed as supporting of their designated uses, phosphorus is the parameter of concern for this watershed plan because of cascading influences that result from increased phosphorus feeding and fueling cyanobacteria blooms.

4.2 Role of Trophic Status in Water Quality Assessment

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

Country Pond has been assessed three times under NHDES's trophic survey program, in 1976, 1985 and 2002. It was determined to be eutrophic in 1976, but transitioned to mesotrophic in the 1985 survey due to improved dissolved oxygen levels on the pond bottom (possibly due to sampling being done at a higher depth). The pond was again classified as mesotrophic in 2002.

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

Table 5. Nutrient criteria by trophic class in New Hampshire
TP = total phosphorus.
Chl-*a* = chlorophyll-*a*, a surrogate measure for algal concentration

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

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

4.3 Designated Use of Concern: Primary Contact Recreation

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

Cyanobacteria scums interfere with aesthetic enjoyment, swimming, and may pose a health hazard. Country Pond was listed as impaired for PCR due to cyanobacteria blooms in 2008 and has remained impaired in subsequent 303(d) listings.

Water Quality Standards and Criteria Summary for Country Pond

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

5.0 WATER QUALITY SUMMARY (Element A)

This section of the plan provides an overview of pond water quality, identifies sources of phosphorus loading to the pond, and presents numeric water quality goals for Country Pond. The water quality goals presented here are essential for use in guiding and measuring results for management activities implemented to control phosphorus loading to the pond.

To identify restoration approaches for the lake, two key questions must be answered:

- How much phosphorus is entering the pond?
- Where is the phosphorus coming from?

To help answer these questions, a modeling analysis was conducted to identify the sources, pathways, and amount of phosphorus loading that will need to be controlled to achieve pollutant load reductions necessary for water quality improvement. This analysis built on previous work conducted by NHDES to identify and quantify sources of phosphorus loading to the pond.

5.1 Country Pond Total Maximum Daily Load (TMDL) and 2019 TMDL Update

In 2011, a TMDL study was released for Country Pond. A TMDL is required under the Federal Clean Water Act (CWA) - Section 303(d) for waters not meeting current state water quality standards due to pollution. The TMDL sets the maximum amount of phosphorus the pond can receive and then determines load reductions needed to meet water quality standards.

The 2011 TMDL for Country Pond included a phosphorus budget for the pond and set a target in-lake concentration goal of 12 µg/L for the pond such that hepatoxic cyanobacteria blooms would no longer impair Primary Contact Recreation. Additionally, the TMDL used output from a watershed loading model - the Lake Loading Response Model (LLRM) - to allocate phosphorus loads among sources of phosphorus. The TMDL analysis indicated that phosphorus loads would need to be reduced by 46% to meet the target in-lake concentration of 12 µg/L (AECOM 2009b, NHDES 2011).

In consideration of local concern over the age of the TMDL, recent updates to the land use loading coefficients used to estimate phosphorus loading by source, and the acquisition of additional water quality data since the TMDL was completed, the watershed planning team agreed to run an update of the TMDL LLRM for the purposes of updating the water quality goals for the watershed plan. The TMDL modeling update, however, does not supersede the 2011 TMDL and the updated results are to be used for watershed planning purposes only.

To perform the update, DK Water Resource Consulting LLC (DKWRC), the original author of the 2011 TMDL, was contracted to provide an updated water quality summary and to perform the updated run of the LLRM modeling conducted for the 2011 Country Pond TMDL to include updated land-use loading coefficients and water quality data collected from 2009 through 2019 (these water quality data were not used in the 2011 TMDL study).

The following section provides a brief review of water quality data used to support the LLRM update and a description of changes made to the LLRM model. Complete details on the original LLRM modeling can be found in the Country Pond TMDL report (AECOM 2009b, NHDES 2011).

Note: The modeling effort conducted as a part of this plan represents the most up-to-date approximation of Country Pond's water quality and should be used for watershed planning purposes only – the modeling update has not been approved by NHDES or EPA for water quality assessment purposes. Additionally, for MS4 compliance purposes, MS4s in the Country Pond watershed are subject to the water quality goals in the Country Pond 2011 TMDL as described in Appendix F of the 2017 MS4 General Permit.

5.2 Water Quality Data

Water quality data have been collected in Country Pond sporadically since 1976 (Table 7). The New Hampshire Department of Environmental Services (NHDES) conducted water quality monitoring of Country Pond as part of Lake Trophic Surveys in the summer of 2002 and as part of the Volunteer Lake Assessment Program (VLAP) in the summers of 2006, 2007 and 2011 (NHDES 2019). In the 2002 trophic survey sampling (NHDES 2003), Country Pond was classified as borderline meso-eutrophic and highly colored due to release of tannins and humic substances from adjacent wetland complexes.

Stratification occurs in the summer and the pond develops an anoxic (devoid of oxygen) hypolimnion. This phenomenon was reported as early as 1952 (New Hampshire Fish and Game 1970). Since 2018, water quality data have been collected more regularly as a part of the VLAP program.

The mean of water quality parameters for two periods (pre 2010 and post 2010) are summarized in Table 8. These periods are representative of water quality prior to and after the establishment of the TMDL. Total Phosphorus (TP) concentrations in the pond have declined at all three, summer-stratified levels in the water column although the observed decline is not statistically significant due, in part, to the small number of observations available for comparison. Phosphorus concentrations remain above the threshold for mesotrophic lakes in New Hampshire (12 µg/l). Chlorophyll-*a* has declined significantly from 5.5 to 3.0 µg/l and Secchi transparency has improved significantly from 2.2 to 3.2m. These values suggest that water quality in Country Pond is improving. Recent nutrient data at depth also suggest that there remains an internal loading component to the nutrient budget of Country Pond. A dissolved oxygen profile from late summer 2006 shows anoxia at depth in Country Pond which leads to release of phosphorus from the sediments to the water column (Figure 7). Collection of dissolved oxygen and temperature profile data in September consistently in future years is critical to confirming that this phenomenon persists in Country Pond. Country Pond's bathymetry is shown in Figure 6.

Water quality data from the end of 2019 was not received in time to be included in the water quality evaluation or model calibration however, it was subsequently reviewed and was found to be consistent with 2018 data and data from the first half of 2019. Nutrient and chlorophyll-*a* concentrations in late 2019 were similar to 2018-19 concentrations presented in Table 6. A dissolved oxygen profile from September of 2019 showed substantial dissolved oxygen depletion below six meters similar to the profile presented in Figure 7. Inclusion of these data would not substantially change the LLRM model calibration completed herein.

Table 6. Summer water quality through July 2019

	Epilimnetic Total Phosphorus	Metalimnetic Total Phosphorus	Hypolimnetic Total Phosphorus	Chlorophyll-*a*	Secchi Transparency (with viewscope)
Units	**mg/l**	**mg/l**	**mg/l**	**µg/l**	**m**
Mesotrophic criteria	*<0.012*	-	-	*<3.3*	-
Sampling Date	**Epi-P**	**Meso-P**	**Hypo-P**	-	-
8/9/1976	0.016	0.015	0.022	5.92	2.4
9/5/1985	0.016	-	0.014	6.22	-
8/13/2002	0.010	0.011	0.043	3.63	2.4
9/11/2006	0.021	0.024	0.029	5.62	1.5
6/25/2007	0.017	0.013	0.026	6.20	2.6
5/31/2011	0.018	0.015	0.017	4.40	2.8
6/12/2018	0.015	0.011	0.013	2.18	3.3
7/8/2018	0.013	0.015	0.022	3.49	3.3
8/12/2018	0.012	0.014	0.022	2.47	4.0
9/3/2018	0.011	0.015	0.025	2.74	3.5
5/21/2019	0.017	0.013	0.019	2.28	2.7
6/23/2019	0.016	0.014	0.026	3.85	-
7/14/2019	0.012	0.016	0.032	2.82	-

Figure 6. Bathymetry of Country Pond

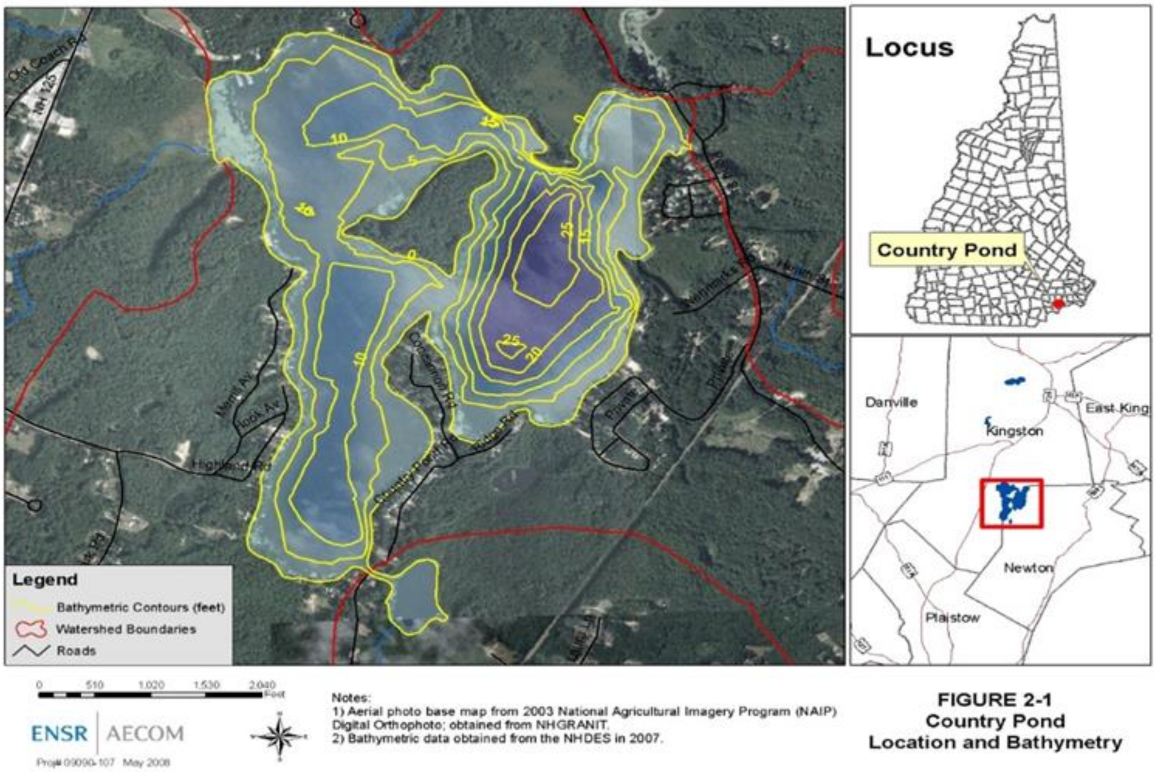
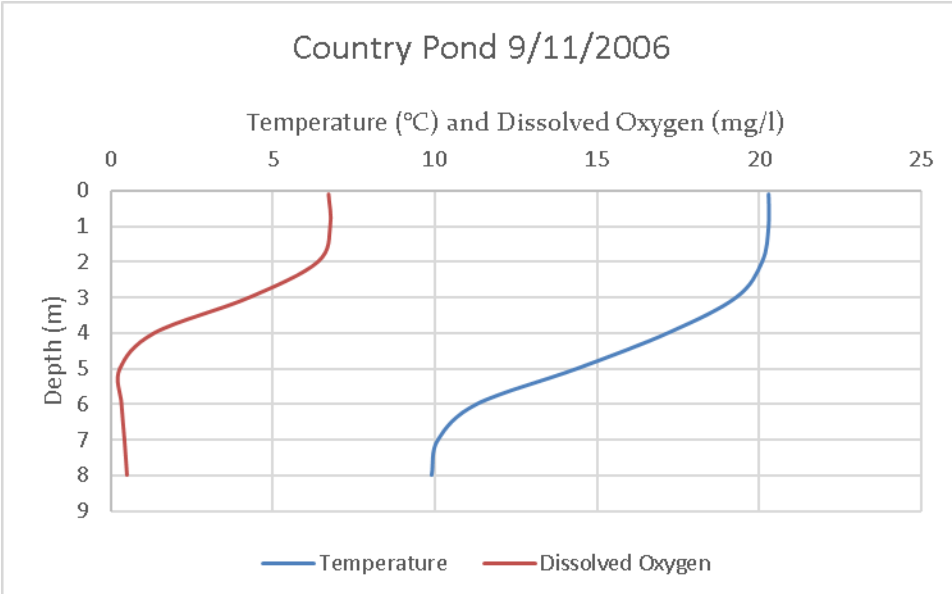


Table 7. Country Pond water quality pre and post TMDL development

	Epilimnetic Total Phosphorus (mg/l)	Metalimnetic Total Phosphorus (mg/l)	Hypolimnetic Total Phosphorus (mg/l)	Chlorophyll-*a* (µg/l)	Secchi Transparency (with viewscope) (m)
pre- 2010	0.016	0.016	0.027	5.52	2.2
2010-2019	0.014	0.014	0.022	3.03	3.2
Significant difference	no	no	no	yes	yes

Figure 7. Dissolved oxygen and temperature profile, Country Pond, September 2006



Water quality samples have also been collected from the primary tributaries to Country Pond and the outlet from the pond that flows into the Powwow River. A summary of phosphorus results from these samples are presented in Table 8. Phosphorus concentrations are moderate in the tributaries and similar to in-lake concentrations in the outlet. However, the samples were collected during the summer season when flows are expected to be low and vegetation and wetlands throughout the watershed would be expected to absorb phosphorus. It is likely that substantial loading to the pond occurs during periods of vegetative die-back in the fall and runoff from snowmelt and spring rains. Additional data collection would help more fully understand the sources of phosphorus loading to Country Pond. These additional data recommendations are presented in section 10.0 of this plan.

Table 8. Average tributary and outlet phosphorus concentrations for Country Pond

	Total Phosphorus (mg/l)	Number of observations (N)
Unnamed Tributary (Newton)	0.016	7
Unnamed tributary (Bartlett Res)	0.016	8
Powwow River (outlet)	0.013	7

5.3 Lake and Watershed Conditions

Current water and total phosphorus loading to Country Pond was initially calculated as a part of the Country Pond TMDL development (AECOM 2009a) assessed using the LLRM, which is a land cover export/lake response model developed for use in New England and modified for New Hampshire lakes by incorporating New Hampshire land cover TP export coefficients when available. The updated model was calibrated to current conditions using data through 2019.

The direct and indirect nonpoint sources of water and TP to Country Pond in this update include:

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

Hydrologic Inputs and Water Loading

Calculating TP loads to Country Pond requires estimation of the sources of water to the pond. The three primary sources of water are: 1) atmospheric direct precipitation; 2) runoff, which includes all overland flow to the tributaries and direct drainage to the pond; and 3) baseflow, which includes all precipitation that infiltrates and is then subsequently released to surface water in the tributaries or directly to the pond (i.e., groundwater). Baseflow is roughly analogous to dry weather flows in streams and direct groundwater discharge to the pond. The annual water budget for the updated model is broken down into its components in Table 9.

- Precipitation - Mean annual precipitation was assumed to be representative of a typical hydrologic period for the watershed. For the Country Pond watershed, 1.22 m (≈49 in) of annual precipitation was used.
- Runoff - For each land cover category, annual runoff was calculated by multiplying mean annual precipitation by basin area and a land cover specific runoff fraction. The runoff fraction represents the portion of rainfall converted to overland flow.
- Baseflow - The baseflow calculation was calculated in a manner similar to runoff. However, a baseflow fraction was used in place of a runoff fraction for each land cover. The baseflow fraction represents the portion of rainfall converted to baseflow. Baseflow is infiltrated into the ground and returned to the pond via groundwater flow and discharge to tributary streams and direct discharge to the pond.

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

Table 9. Country Pond annual water budget under current conditions as estimated using LLRM

WATER BUDGET	Country Pond
	m^3/yr
Atmospheric	755,180
Septic Systems	49,428
Watershed Runoff and Baseflow	21,934,196
Total	22,738,804

Nutrient Inputs

The Country Pond watershed boundaries from TMDL modelling were used for the LLRM update. Land covers within the watershed were determined using the most recent available GIS data (New Hampshire GRANIT 2019), Google Earth imagery and ground-truthing (when appropriate). Loads were calculated by sub-watershed. Upstream sub-watersheds were routed through downstream sub-watersheds and loads from all sub-watersheds which discharged to Country Pond directly were summed to calculate the total load to the lake.

Land Cover Export

The TP load for the watershed was calculated using export coefficients for each land cover type. These coefficients were updated for this effort based on more recent modeling efforts in New Hampshire. It is believed that the updated coefficients represent an improvement from those used when the LLRM model was run for the TMDL. The watershed loading was adjusted based upon proximity to the pond, 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, internal, septic system, and waterfowl) to calculate TP loading. The generated load to the pond was then entered into a series of empirical models that provided predictions of in-pond TP concentration, chlorophyll-*a* concentration, algal bloom frequency and Secchi transparency (i.e. water clarity). Current watershed land cover and export coefficients are summarized in Table 10.

Table 10. Land cover categories and export coefficients for 2020 Country Pond model update

Land Cover	Total (ha)	Percentage of land cover	Export Coefficient (kg/ha/yr)	Source for Export Coefficient
Urban 1 (Low Density Residential)	903.8	24.3	0.34	USEPA 2017
Urban 2 (Mid-Density Residential/Commercial)	46.7	1.3	0.55	USEPA 2017
Urban 3 (Roads)	91.8	2.5	0.82	USEPA 2017
Urban 4 (Industrial)	92.7	2.5	1.27	USEPA 2017
Urban 5 (Parks, Recreation Fields, Institutional)	34.4	0.9	0.29	USEPA 2017
Agric 1 (Cover Crop)	0.0	0.0	0.35	Dennis and Sage 1981- ME TMDL
Agric 2 (Row Crop)	27.9	0.8	1.50	Omernik 1976
Agric 3 (Grazing)	0.0	0.0	0.65	Schloss et al. 2000
Agric 4 (Hayland-Non Manure)	0.0	0.0	0.35	Dennis and Sage 1981- ME TMDL
Forest 1 (Deciduous)	0.0	0.0	0.03	Tarpey 2013
Forest 2 (Non-Deciduous)	0.0	0.0	0.03	Tarpey 2013
Forest 3 (Mixed Forest)	1474.2	39.7	0.03	Tarpey 2013
Forest 4 (Wetland)	566.5	15.3	0.03	Tarpey 2013
Open 1 (Wetland / Pond)	280.3	7.5	0.01	Schloss et al. 2000
Open 2 (Meadow)	0.0	0.0	0.29	USEPA 2017
Open 3 (Bare/Open)	66.9	1.8	0.80	Omernik 1976
Other 1: Gravel Roads	2.1	0.1	0.83	Hutchinson Environmental Sciences Ltd. 2014.
Brush or Transitional Between Open and Forested	126.4	3.4	0.06	between barren and forest (two times forest)
Total	**3713.7**	**100.0**		

Atmospheric Deposition

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

Waterfowl

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

Septic Systems
Total phosphorus export loading from residential septic systems was estimated within the 250-foot shoreline zone. These systems were split into new and old based on publicly available records. Systems built or rebuilt within the past 25 years were considered new. All others were considered old. It was assumed that there were the same proportion of seasonal vs year-round residents as was assumed for the TMDL modeling.

Internal Loading
Internal loading generally refers to the release of phosphorus from sediments in the pond, typically under low oxygen conditions but also from resuspension of sediments. Release of phosphorus from deep sediments was estimated based on observed accumulation of phosphorus in the hypolimnion (below 15 feet). The inclusion of the internal load calculated from recent data represents an improvement in the understanding of the sources of phosphorus to Country Pond. More years of data collection will increase confidence in the annual mean estimate of the internal load.

5.3.1 Phosphorus Loading Assessment Summary
The overall watershed land cover of Country Pond is primarily forest and low-density residential land. There are smaller amounts of commercial/industrial land cover as well as mowed fields/recreational uses. Because of their relatively high nutrient export coefficients when compared to forest, the developed areas of the watershed tend to yield a larger portion of the nutrient load to the pond than their land area might suggest. Total phosphorus loads were estimated based on runoff and groundwater land cover export coefficients. Attenuation describes how much of the load that leaves the land in a particular sub-watershed is settled out, sorbed to soil particles or taken up by plants before it reaches the lake or the next downstream sub-watershed. Attenuation was determined to be relatively high in parts of the watershed where there were upstream ponds and wetlands that serve to remove phosphorus through settling and uptake.

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

The estimated existing TP sources to Country Pond under current conditions by source are presented in Table 11. Loading from the watershed was overwhelmingly the largest source of phosphorus to the pond. Watershed management is the key to maintenance of pond quality and is discussed further in the management section of this plan.

Table 11. Country Pond modeled nutrient loading summary

DIRECT LOADS TO POND	TP (KG/YR)
INTERNAL	3.6
WATERFOWL	5.4
ATMOSPHERIC	13.6
SEPTIC SYSTEM	74.4
WATERSHED LOAD	431.0
TOTAL LOAD TO POND (Watershed + direct loads)	**527.9**

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

- Precipitation varies among years and hence hydrologic loading will vary. This may greatly influence TP loads in any given year, given the importance of runoff to loading.
- Spatial analysis has innate limitations related to the resolution and timeliness of the underlying data. In places, local knowledge was used to ensure the land cover distribution in the LLRM model was reasonably accurate, but data layers were not 100 percent verified on the ground. In addition, land covers were aggregated into classes which were then assigned export coefficients; variability in export within classes was not evaluated or expressed.
- Total phosphorus export coefficients as well as runoff/baseflow exports were representative but also had limitations as they were not calculated for the study water body, but rather are typical regional estimates.
- The internal load estimates are based on one year of data which may not be representative of long-term average conditions. Fully understanding this source would be improved with additional monitoring, particularly late in the stratification period (September).
- The TP loading estimate from septic systems was limited by the assumptions associated with this calculation described above and in the “Septic Systems” subsection of AECOM (2009b).
- Water quality data for the Country Pond tributaries are limited to concentration data, restricting calibration of the loading portion of the model. Because the empirical lake models predict an annual average concentration of phosphorus, comparison of modeled results to field data (summer epilimnetic concentrations) often results in a discrepancy where modeled predictions are higher. Collection of samples throughout the year (in particular, spring turnover samples) would give a better approximation of annual average conditions.

The major assumptions associated with development and calibration of the watershed model are:

- The output from the Angle Pond sub-watershed was calibrated to match recent observed data collected as a part of the VLAP program (14 µg/l).
- The Bartlett sub-watershed was calibrated to match current monitoring data (16 µg/l).
- The Cedar Swamp, Southeast and East watersheds were assumed to attenuate (capture before discharge to Country Pond) more phosphorus than direct drainage sub-watersheds due to the presence of substantial wetlands.

5.3.2 Pond Response to Current Phosphorus Loads

TP load outputs from the LLRM methodology were used to predict in-pond TP concentrations using empirical models. The models include: Kirchner-Dillon (1975), Larsen-Mercier (1976), Jones-Bachmann (1976), Reckhow (1977) and Nurnberg (1996) for TP. These empirical models estimate TP from system features, such as depth and detention time of the waterbody. The phosphorus load generated from the export portion of LLRM was used in these equations to predict in-pond TP. The mean predicted TP concentrations from these models was compared to measured (observed) values. Input factors in the export portion of the model, such as export coefficients and attenuation, were adjusted to yield an acceptable agreement between measured and average predicted TP. Because these empirical models account for a degree of TP loss to the pond sediments, the in-pond concentrations predicted by the empirical models are lower than those predicted by a straight mass-balance where the mass of TP entering the pond is equal to the mass exiting the pond without any retention. Also, the empirical models are based on relationships derived from many other lakes and ponds. As such, they may not apply accurately to any one lake, but provide an approximation of predicted in-lake TP concentrations and a reasonable estimate of the direction and magnitude of change that might be expected if loading is altered. These empirical modeling results and mean field data are presented in Table 12.

Predicted nutrient concentrations match field data for Country Pond. Because freshwater systems are most frequently limited by phosphorus, calibration focused on matching predicted phosphorus with field data. The model also predicts Secchi transparency levels well but somewhat over predicts chlorophyll-*a*. According to the model for Country Pond, there are sufficient nutrients in the pond to form algal blooms.

Table 12. Predicted and measured water quality parameters in Country Pond (2010-2019)

Water Quality Parameter	Country Pond (estimated from model)	Country Pond (measured 2010-2019)
Annual TP Load (kg/yr)	528	
Predicted TP (µg/l)	15.5	14.0
Predicted Chlorophyll *a* (µg/l)	5.5	3.0
Predicted Secchi (m)	3.2	2.8
Predicted Probability of Algal Bloom > 10 µg/l	7.4%	

The TP loads estimated using the LLRM methodology translates to a predicted annual mean in-pond TP concentration of 15.5 µg/l for Country Pond. This concentration is relatively high and would be expected to fuel substantial algal growth in the pond. This is somewhat supported by chlorophyll-*a* (a measure of the amount of algae) measurements which are moderate and Secchi transparency which is low. The apparent disconnect between phosphorus concentrations and chlorophyll-*a* may be a function of the frequent flushing of Country Pond (>7 times per year) that removes actively growing algal cells from the system. The relatively high color (NHDES 2018) of the water may also inhibit algal growth by blocking light. The model predicts that the Country Pond will experience algal bloom conditions 7.4% of the time which is consistent with observations over the past several years.

5.3.3 Water Quality Modeling Recommendations

The following specific and general recommendations are offered for future phases of watershed planning for Country Pond based on the review of the current water quality data and this lake model update.

1) To further evaluate the ecological condition of the pond, improve the LLRM model and evaluate progress in load reduction, monitoring for total phosphorus, Secchi transparency and chlorophyll-*a* as a part of VLAP and total phosphorus sampling in tributaries should be continued for the foreseeable future. Other monitoring components such as flow gaging, wet weather tributary sampling and documentation of stratification are discussed further in the monitoring section of the watershed plan.

2) Any future major changes proposed in the watershed such as development, changes in drainage, or logging should be evaluated in terms of their potential to influence pond quality. The updated LLRM developed as a part of this project can be readily adapted to evaluate any major watershed change.

3) Incorporate new water quality, land cover, septic or sediment data into LLRM as it becomes available. At a minimum, the model should be updated every five years.

4) Coordinate with NHDES TMDL staff to further update the model and approve its output for use in TMDL assessment and compliance activities.

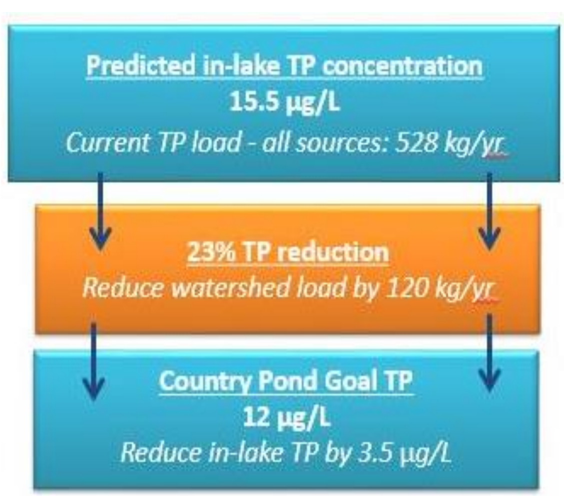
6.0 WATER QUALITY GOALS FOR COUNTRY POND (Element B)

Water quality goals are a critical component of watershed management plans. The goals are the "yardstick" by which management success will be measured. Essentially, the water quality goals describe the load reductions needed to see improvement in the pond's water quality. The establishment of water quality goals for Country Pond was guided by the TMDL, modeling conducted for the TMDL update, an analysis of water quality data, and with input from watershed residents on the attainment of desired uses for the pond. The 2011 TMDL calculated the reductions in phosphorus loading required to improve the status of the pond based on the limited data available at the time. Although recent water quality data suggests that pond quality has improved somewhat, Country Pond still exhibits some of the same water quality characteristics that led to its "impaired" listing, such as frequent cyanobacteria blooms.

Excessive nutrient loading has led to periodic algal and cyanobacteria blooms in Country Pond as well as dissolved oxygen depletion in the deeper sections of the pond. In addition to direct impacts to organisms that require oxygen for respiration, low oxygen levels at the sediment-water interface result in phosphorus release from the sediments, an additional source of phosphorus to the pond known as internal loading. Nutrient limitation of algae and cyanobacteria in freshwater is primarily related to phosphorus; therefore, efforts to control blooms (and aquatic plant growth) have focused on phosphorus which is typically more easily controlled than other nutrients such as nitrogen.

The 2011 Country Pond TMDL determined that reducing phosphorus loading to meet an in-pond concentration of 12 µg/L would reduce the frequency of cyanobacteria blooms such that the pond would attain water quality standards. Based on the output from the LLRM modeling update conducted for this plan, it is estimated that a reduction of 120 kg/yr of phosphorus is needed to meet the water quality goal of 12 µg/L (Figure 8). Additionally, reaching the water quality goal concentration of 12 µg/l TP would result in a 75 percent reduction in algal bloom frequency.

Figure 8. Country Pond water quality goals



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

7.0 MANAGEMENT ACTIONS TO CONTROL PHOSPHORUS LOADING (Elements C, D, and E)

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

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

Management measures to address sources of phosphorus are presented for each management action category, including a description of the approach, location, costs, partners, and pollution load reduction estimates (if known). Further, Section 12.0 of this plan offers a list of potential funding sources to implement the management actions.

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

Category 1: Structural Controls

Structural Stormwater Management

Structural BMPs are a critical management tool for reducing pollutant loads delivered to Country Pond from stormwater runoff. Typically, structural BMPs are stationary and permanent. Many structural BMPs rely on natural elements such as vegetation and soil processes to trap and remove pollutants. Additionally, structural BMPs designed to use infiltration mechanisms can also reduce the volume of stormwater runoff which can help to reduce the erosive force of runoff. Examples of structural stormwater BMPs include raingardens, swales, bioretention units, constructed wetlands and other similar practices. To function properly, however, structural BMPs require on-going maintenance and implementation efforts must take this critical need into consideration when working with partners to build BMPs – all structural BMPs need an "owner" that is willing to maintain the practice.

To identify potential stormwater structural control opportunities for Country Pond, the Horsley Witten Group and UNH Stormwater Center staff conducted a watershed assessment in the direct drainage area during the fall of 2019 to identify locations where structural approaches could be implemented to reduce phosphorus loading to Country Pond. The assessment focused on identifying areas in the direct drainage where erosion, stormwater runoff, impervious cover, lack of vegetated buffer or other factors were potentially contributing to nutrient loading to the lake. The team then developed recommendations for actions to address pollutant loading for identified problem areas. The BMPs were prioritized based on potential to reduce phosphorus loading to the pond, costs, and relative ease of implementation (Table 13). Appendix A includes a map of structural BMP locations (with the MS4 regulated areas delineated for reference).

Additionally, the Horsley Witten Group developed concept designs for five high priority sites. This information is included as Appendix B and is intended to be used to seek funding in early phases of watershed plan implementation for the design and construction of these high priority BMPs.

Table 13. Assessment of structural stormwater BMP opportunities in the Country Pond Direct Drainage Area

Site	Location	BMP Description	Property Owner	Potential Responsible Party	Sub-watershed	Phosphorus Load Reduction[1] (lb/yr)	Estimated Capital Cost Range[3]	Estimated 20-year Life-Cycle Cost[5]	Estimated Life-Cycle Cost per Pound of P Load Reduction ($/lb)	Drainage Proximity to Pond[6]	Potential Public Visibility & Education[7]	Feasibility to Construct & Operate[8]
1	Saddle Up Saloon and Colby Brook	Bioswale along auxiliary parking area in the back	Private	Property owner, CPLA	Bartlett Mill Pond	0.4	$10,000 - $14,000	$52,000	$129,000	Medium	Low	Low
2	Route 125 across from Saddle Up Saloon	Bioretention intercepting small storm flows from a DOT catch basin and a stable outlet to stream. Maintain existing conveyance for high flows.	NHDOT	NHDOT	Western Trib.	0.1	$5,000 - $7,000	$46,000	$333,000	Medium	Medium	High
3	Route 125 and Old Coach Road Junction	Bioswale intercepting small storm flows from a DOT catch basin and a stable outlet to stream. Maintain existing conveyance for high flows.	NHDOT	NHDOT	Western Trib.	0.1	$4,000 - $6,000	$45,000	$395,000	Medium	Medium	High
4	VFW Post 1088	Bioretention basin, enhanced shrub trench to treat roof runoff	Private	Property owner, CPLA	Western Trib.	0.5	$12,000 - $18,000	$55,000	$118,000	Medium	Low	Low
5	Newton Boat Ramp[2,4]	Rain garden, bioswale, and restored shoreline buffer. Regrade ramp. Resurface lower ramp with roll-out concrete pavers and remaining ramp with gravel.	Town of Newton	Town of Newton	Direct Drainage	1.8	$8,000 - $12,000	$50,000	$28,000	High	High	High
6	Camp Tasker - Private Property Adjacent to Newton Boat Ramp	Rain gardens and infiltration for roof runoff. At driveway entrance, address erosion and ponding as part of Newton Boat Ramp project.	Private	Property owner, CPLA	Direct Drainage	0.5	$13,000 - $19,000	$56,000	$102,000	High	Low	Low
7	Newton Town Hall	Bioretention basin to treat driveway and parking area runoff	Town of Newton	Town of Newton	Southeastern Trib.	0.2	$6,000 - $10,000	$48,000	$226,000	Low	High	High
8	74 Wilders Grove[2,4]	Berm or driveway apron to divert road runoff; wet swale to intercept/treat road runoff that is currently cutting a path across private property to the pond.	Private parcel, Newton ROW	Town of Newton	Direct Drainage	1.1	$7,000 - $11,000	$49,000	$43,000	High	Medium	Medium
9	14 Concannon Road[2]	Infiltration trench and level spreader along roadway low point where runoff is currently cutting a path across private property to the pond	Private parcel, Kingston ROW	Town of Kingston	Direct Drainage	2.8	$7,000 - $11,000	$49,000	$18,000	High	Medium	Medium
10	Gale Public Library	Bioretention basin to treat parking area runoff	Town of Newton	Town of Newton	Southeastern Trib.	0.1	$3,000 - $5,000	$44,000	$459,000	Low	High	High
11	Newton Town Beach Parking Area[4]	Bioretention basin to treat runoff from gravel parking area	Town of Newton	Town of Newton	Direct Drainage	0.3	$10,000 - $14,000	$52,000	$208,000	High	High	High
12	Wenmarks Road and Whispering Pines Beach	Extend curb to intercept runoff that is cutting a path through private beach; rehabilitate existing catch basins and leaching trench on Wenmarks Road.	Private parcel; Newton ROW	Town of Newton	Direct Drainage	2.6	$17,000 - $25,000	$61,000	$23,000	High	Medium	Medium
					Total potential phosphorus load reduction	10.5 lbs/yr						

Notes:
1 Phosphorus load reduction calculated using methodology in NH MS4 Permit, Appendix F Attachment 3
2 Additional phosphorus load reduction calculated using EPA Region 5 erosion control model for gully stabilization.
3 Capital costs calculated using Opti-tool methodology, with an adjustment factor of 2. Capital costs include construction/installation, plus an additional 35% for design, engineering, and contingencies, expressed in 2020 dollars.
4 Capital costs for Sites 5, 8, and 11 include an additional $5,000 for erosion stabilization measures.
5 Life cycle cost represents the total capital and O&M costs over the 20-year life span of the BMP, expressed in 2020 dollars. Calculated using the median capital cost for each BMP and an assumed O&M cost of $2,000 per year per site.
6 Drainage proximity to pond is a relative rating based on sub-watershed. Sites within the Direct Drainage sub-watershed score high, within Western Tributary score medium, and within Southeastern Tributary score low.
7 Potential public visibility and education is a relative rating based on public access and visibility. Sites that are visited often and are located in public places score high; those within a public ROW score medium; and sites on private property score low.
8 Feasibility to construct and operate is scored as High for BMPs located fully within public land, Medium for BMPs that would be implemented by Town but may require private-property owner cooperation, and Low for BMPs on private property.

Residential Stormwater Management

In 2018, the NHDES Soak Up the Rain (SOAK) program partnered with CPLA and watershed residents to conduct stormwater assessments to identify opportunities to reduce phosphorus loading to the pond from residential properties. The assessments focused on properties closest to the lake with the potential to directly contribute runoff. Seven properties were assessed (Table 14).

Proposed solutions for managing stormwater runoff from these properties include:

- Shoreline buffer plantings
- Dripline infiltration trenches
- Water diversion devices
- Raingardens
- Infiltration steps

Table 14. Residential stormwater management opportunities – Direct Drainage Area

						SOAK Priority Ranking		
Site Number	Date of SOAK visit	Address	Town	Problem Summary	Recommendations Summary	Low	Medium	High
CP-1	7/11/2018	Highland Road	Newton	Sheet flow runoff from Highland Ave. flowing over and ponding on property, but flow is not entering pond	Infiltration - pavers, steps, trenches.	X		
CP-2	7/11/2018	Wilders Grove	Newton	Stormwater travels across the road into a small swale and then over the beach creating channelized flow. Also, runoff enters driveway and then flows across the lawn to the beach.	Driveway infiltration trench, pavers for driveway, enhance exisiting vegetated swale to slow runoff; plant vegetated buffer near lake to slow and filter runoff		X	
CP-3	7/11/2018	Concannon Road	Kingston	Runoff from the road carryies sediment onto the property and towards the pond	Install permeable walkway/driveway; may have to consult with town to address runoff issues from road		X	
CP-4	7/24/2018	Highland Road	Kingston	Minor erosion plus lack of buffer in places; invasive species present	Infiltration steps, buffer enhancement	X		
CP-5	10/9/2018	Sunshine Drive	Kingston	Bare slopes leading to water's edge - lack of buffer	Buffer enhancement	X		
CP-7	10/9/2018	Ridge Road	Newton	Runoff moving over sloped front yard area toward pond; moderate erosion at shoreline/beach area.	Install water bars and/or infiltration steps on sloped areas to direct runoff away from pond; add plantings at top of slope locations		X	

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

For future phases of Country Pond planning, additional SOAK surveys are recommended to identify more properties for SOAK project implementation.

Living Shorelines

During the watershed planning and assessment process the project partners noted a number of armored retaining walls on the shoreline. Retaining walls were noted to be built with varying materials including concrete, bricks, rocks, wood, metal and other “hard” materials. While armoring was traditionally thought to be the best solution for stabilizing shorelines, it is now understood that hardened shorelines often make conditions worse and can compromise water and habitat quality.

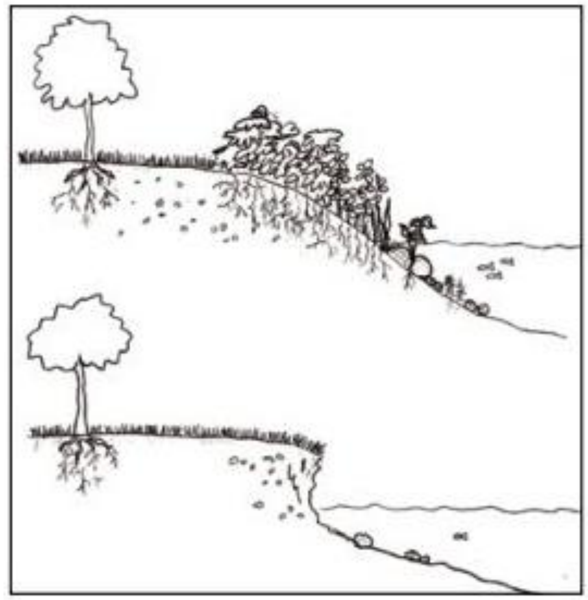


Figure 9. Shoreline stabilization with plantings *(NYS DEC)*

Armored shorelines are problematic for several reasons including:

- Reduced shelter for wildlife and loss of habitat for breeding and feeding
- Loss of native vegetation and buffers
- Decreased ability for wildlife to move between the pond and its upland habitat
- Changes to the physical structure of the pond’s shoreline and its hydrology
- Potential for invasive plant infestations due to loss of native vegetation and changes to the pond’s shore and bottom surfaces
- Water quality impacts including changes to temperature and increases in turbidity, nutrients and contaminants
- Wave energy hitting the wall may increase erosion of adjacent natural shorelines and scouring in front of the structure *(NYS DEC, 2008)*

Living shorelines are a natural approach to reducing impacts from erosion, ice damage, stormwater runoff, and wave action. Living shorelines use bioengineering techniques that incorporate the use of natural materials including logs, rocks, native vegetation, and live staking techniques (Figure 9). Living shorelines are often designed and constructed to accommodate low-impact access from the upland to the waterfront. Country Pond could greatly benefit from the implementation of living shoreline approaches.

Table 15. Living shoreline recommendations

Action Item	Description	Partners	Estimated Cost	Results
Identify living shoreline projects	Conduct planning and outreach to identify living shoreline projects	CPLA, NHDES	$1,000	List of potential projects
Living shoreline demonstration project(s)	Work with willing landowners to retrofit 1 -3 retaining walls using bioengineering techniques	CPLA, NHDES	Up to $100,000	4 – 8 lbs/yr of TP removed per project*

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

Culvert Improvement Sites

During the watershed planning process, residents identified culverts of concern located on Wilders Grove Road just before the Kingston town line. The culverts convey pond flow under the road. As Wilders Grove Road crosses the town line, it becomes Concannon Road which provides access to approximately 20 residences on a peninsula located in the town of Kingston.

Recommendations for this site include conducting a culvert assessment for the structure to further evaluate capacity, condition, and aquatic organism passage. This information could then be used to develop recommendations and seek funding for upgrades or maintenance needs (Table 16).

Table 16. Evaluate improvements for Wilders Grove Road culverts

Recommendation	Assessment Indicators	Outcome
Conduct engineering assessment for culverts on Wilders Grove Road	• Aquatic organism passage • Hydraulics • Sediment transport • Operation and maintenance • Stormwater impacts at site • Structural condition	• Alternatives analysis for culvert and drainage improvements • Concept designs for alternatives • Operation and maintenance recommendations

Category 2: Non-structural Controls

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

- **Municipal "good housekeeping" practices** such as street sweeping, catch basin cleaning, and leaf litter collection programs can reduce phosphorus loading by reducing transport of pollutants through stormwater systems.
- **Regulations** can be used to help affect behavior change and manage land uses practices; examples of regulatory tools include stormwater management regulations, septic system ordinances, fertilizer regulations, pet waste removal requirements, and more.
- **Outreach and education** can also be used to help change behavior and reduce pollutant loading by encouraging and promoting activities that reduce or prevent pollutant loading such as fertilizer reduction incentives, pet waste pick-up programs, pond-friendly landscaping workshops and more.
- **Land conservation** is a common tool that can be used to prevent loading from land conversion activities.

As part of the watershed planning effort for Country Pond, the Horsley Witten Group and the UNH Stormwater Center, project consultants, conducted an assessment and prioritization of non-structural BMP opportunities for the Country Pond watershed. The results of this assessment are summarized in Table 17. Additional non-structural approaches are described in the following sections of the action plan: Category 4 – Regulations, and Category 5 – Outreach.

Table 17. Prioritization of non-structural practices

BMP	Description	Responsible Party	Phosphorus Load Reduction[1] (lbs/yr)	Potential to Mitigate Future Increases in Phosphorus Load[6]	Potential Educational Benefits[7]	Ease of Implementation[8]	Priority Ranking[9]
Fertilizer Program[2]	Where phosphorus fertilizer has regularly been applied to maintain turf, switch to phosphorus-free fertilizer and certify that no phosphorus has been applied.	Town DPW/Highway Depts., NHDOT	18.3	Fair	Very good	Good	High
Street Sweeping[2]	Optimize street sweeping locations and frequency to achieve a frequency equivalent to weekly, year-round sweeping of 50% of roads in the watershed, using vacuum assisted sweeper.	Town DPW/Highway Depts., NHDOT	10.6	Fair	Fair	Good	Medium
Leaf Litter Management[4]	Provide municipal leaf collection at least 4 times during October and November. Within 24 hours of leaf collection, collect remaining leaf litter in the street using street cleaning machines, such as a mechanical broom or vacuum assisted street cleaner.	Town DPW/Highway Depts., NHDOT	6.8	Fair	Very good	Good	Medium
Shoreline Buffer[5]	Retrofit developed areas along shoreline with 20-ft no-mow/no-alteration grassed buffer and preserve existing buffers. Buffer restoration and protection could be achieved through regulations and incentive programs. Restoration of buffers can reduce existing loads while preservation of existing buffers is critical to mitigating future load increases resulting from land development and conversion.	Town Staff, Conservation Groups	3.5	Good	Very good	Good	High
Catch Basin Cleaning[2]	Remove accumulated materials from catch basins in the watershed such that a minimum sump storage capacity of 50% is maintained throughout the year.	Town DPW/Highway Depts., NHDOT	0.5	Fair	Fair	Very Good	Low
Regulations	Establish municipal regulations to enable/promote improved stormwater management, buffer protections, and shoreland controls. Regulations are critical to mitigating future load increases resulting from land development and conversion.	Town planning staff	Undetermined	Very good	Good	Fair	Medium
Land Conservation	Coordinate with groups to prioritize land conservation goals/target parcels. Land conservation is critical to mitigating future load increases resulting from land development and conversion.	Town planning staff	Undetermined	Very good	Very good	Good	High
Impervious Disconnection[3]	Divert runoff from impervious areas such as roadways, parking lots and roofs, and discharge it to adjacent vegetated permeable surfaces that are of sufficient size with adequate soils to receive the runoff without causing negative impacts to adjacent down-gradient properties.	Town DPW/Highway Depts., NHDOT	1.6	Fair	Good	Fair	Low
		Total potential phosphorus load reduction	41.3 lbs/yr				

Notes:
1. Reduction from current conditions; assumes each practice implemented as a stand-alone action. Calculated using the following methodologies:
   2. NH MS4 Permit, Appendix F Attachment 2
   3. Wisconsin Interim Municipal P Reduction Credit for Leaf Management Programs (March 2018)
   4. UNH Stormwater Center, "Pollutant Removal Credits for Restored or Constructed Buffers in MS4 Permits", June 2019
   5. NH MS4 Permit, Appendix F Attachment 3
6. Phosphorus load may increase in the future if forested land gets converted to developed pervious and impervious cover. Practices that could prevent future load growth are scored as “very good”; practices with lower potential are scored as “good” or “fair”.
7. Practices that are visible to the public and/or would incorporate public education are scored as “very good”; those with lower potential are scored as “good” and “fair”.
8. Practices that would require minor additional staff time or equipment are scored as “very good”; those that would require more significant investment are scored as “good” and “fair”.
9. The priority ranking aggregates the scores, with equal weighting, for phosphorus load reduction, prevention of future load increases, educational benefits, and ease of implementation.

Tracking annual metrics for non-structural BMPs is critical for estimating pollutant load reductions and for assessing progress toward attaining the plan's goals and milestones. Annual metrics for non-structural practices are described in Table 18.

Table 18. Metrics for tracking non-structural BMP implementation

Non-structural BMP	Annual Metrics
Street sweeping	Miles of road swept; volume or mass of material removed
Catch basin cleaning	Number of catch basins cleaned; Volume or mass of material removed
Fertilizer reduction	Pervious area (acres) converted from P fertilizer to P-free fertilizer
Leaf litter management	Number of participating households
Shoreline buffer	Length of shoreline retrofitted with vegetated buffer
	Length of shoreline vegetated buffer protected
Regulatory	Number and type of regulations implemented
Land conservation	Acres of land conserved
Impervious area greened	Impervious area (acres) retrofitted to divert runoff into a treatment system or permeable surface for infiltration

Category 3: Septic Systems

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

The LLRM for Country Pond shows that individual wastewater systems contribute roughly 74 kilograms per year of phosphorus to the lake. Phosphorus loading from septic systems can be addressed and reduced through various mechanisms including programs to promote septic pumping, replacement of older systems, and outreach to residents regarding proper septic system use and maintenance.

Modest reductions in phosphorus loading to the pond could be achieved if homeowners take responsibility to inspect their septic systems and conduct necessary maintenance or upgrades. Management measures to control phosphorus loading from septic systems include outreach, septic system pump-outs, and replacement of older systems (Table 19).

Table 19. Management actions to reduce phosphorus loading from septic systems

<table>
<tr><th>Action Item</th><th>Description</th><th>Lead Partner</th><th>Estimated Cost</th><th>Results</th></tr>
<tr><td>Septic system outreach</td><td>Provide information about proper septic system operation and maintenance</td><td>CPLA</td><td>$500</td><td rowspan="3">Based on outcomes from other New Hampshire septic system replacement projects, upgrades could result in 1.0 to 2.0 lbs/yr of phosphorus removed per upgraded system.</td></tr>
<tr><td>Pump-out program</td><td>Coordinate group discounts for septic system pumping in the watershed</td><td>CPLA, RPC</td><td>n/a</td></tr>
<tr><td>Septic system upgrades</td><td>Identify, prioritize and upgrade 2-4 older septic systems within 250 feet of the lake within ten years</td><td>CPLA, RPC</td><td>$4,000 - $10,000 per system</td></tr>
</table>

Category 4: Regulations

Municipal Regulatory Tools to Reduce Pollution

Towns in the Country Pond watershed have many options for protecting water quality of the lake and its contributing drainage systems. One option is to adopt regulatory standards that limit and place performance standards on land development and prohibit high risk land uses (e.g. land uses that have high potential of releasing contaminants into the atmosphere, on the land or in water resources). Another is to adopt regulatory standards that directly protect water resources such as groundwater/aquifers, and surface waters and wetlands and their buffer areas. Regulatory options include zoning ordinances and land development regulations which are summarized in Table 20.

Table 20. Regulatory mechanisms for protecting water quality

Zoning Ordinance	Land Development Regulations (Site Plan Review and Subdivision)
Aquifer and Groundwater Protection	Stormwater Management Standards
Wetlands, Very Poorly and Poorly Drained Soils	Erosion and Sediment Control Standards
Riparian and Shoreland Buffers	Impervious Cover Limitations
Septic System and Structural/Development Setbacks from sensitive areas	Road Width and Parking Lot Design Standards
Conservation/Open Space Subdivision	Prohibiting High Risk Land Uses

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

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

Recommendations for future phases of watershed planning: Conducting a municipal audit of regulations pertaining to water quality for all towns in the Country Pond watershed would provide an understanding of the regulatory picture in the watershed. This information could then be used to strengthen existing regulations or enact new ones to protect water quality in the pond.

Category 5: Watershed Outreach

Figure 10. CPLA Earth Day clean-up (*Photo: Tobi Howell*)

The Country Pond Lake Association conducts outreach efforts aimed at seasonal visitors, year-round residents, municipal decision-makers and more. Through CPLA's Lake Host program, annual meeting, Earth Day events, and other efforts, CPLA has a mission to communicate to the community about what can be done to protect and improve the water quality of Country Pond. In addition to CPLA's efforts, other entities in the watershed such as municipalities, RPC, NHDES, NH LAKES, UNH and others will likely have a role to play in communicating important information about lake water quality, restoration, and protection.

The importance of education and outreach cannot be understated. Outreach programs will enhance public understanding of the issues facing the pond and will encourage informed, engaged community-wide participation to ensure that the management actions in the plan are implemented. Table 21 below provides an overview of potential outreach activities and partners for implementation.

Table 21. Outreach matrix

OUTREACH ACTIONS	SCHEDULE	PARTNERS	DESCRIPTION OF ACTIVITIES
CPLA Annual and Yearly Meetings	Spring Annual Meeting, other meetings as convened	Newton and Kingston, Guest Speakers	• Publicize through email, postcards, flyers and social media • Presentations from RPC, UNH Cooperative Extension (UNHCE), NHDES and others on water quality, shoreline management, in-lake treatment needs • Review Country Pond Watershed Plan goals • Review protocols for invasive species identification and reporting • Review lake water quality testing program
CPLA Email List Serve and social media	Meetings, special events, town and regional events	Promote content from all partners	• Update email list serve frequently including elected officials and board/commission members • Include announcement from partnering agencies and organizations
CPLA Website	General information and announcements, fund raising, lake and watershed photos	Promote content from all partners	• NHDES Soak Up the Rain • RPC regional events and topical presentations • UNHCE fact sheets, workshops, soil testing, invasive species controls
Road Association Meetings	2 per year	CPLA Newton and Kingston RPC	• Road maintenance • Salt application and sweeping • Stormwater management and erosion/sediment control plans
Nutrient Control Outreach	Seasonal depending on the message	CPLA Newton and Kingston MS4 activities; RPC; UNHCE; NHDES	• Fertilizer application and turf management • Leaf and yard waste disposal • Pet waste management • Stormwater management and erosion control • Shoreline management and restoration • Back yard composting

OUTREACH ACTIONS	SCHEDULE	PARTNERS	DESCRIPTION OF ACTIVITIES
CPLA Fundraising	Ongoing annually	All partners	• Continue fundraising activities • Ask for sponsorship from watershed towns • Create an event-based sponsorship program to engage consultants and businesses in the watershed • Ask for donations from local landscaping companies to promote shoreland planting events
Implementation Funding	Ongoing annually	CPLA and all partners	• Seek funding sources to implement projects such as shoreline restoration, erosion and stormwater controls, infrastructure improvements, expanded water quality testing program, invasive species removal and management, Watershed Plan outreach and implementation
Implementation Outreach	Ongoing annually	CPLA and all partners	• Conduct survey to inventory shoreland conditions, erosion control and stormwater management, water quality best practices • Conduct outreach to property owners to gauge interest in implementing a new/improved practice(s); offer financial assistance through grants and other funding sources

8.0 SCHEDULE AND MILESTONES (Elements F and G)

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

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

8.1 Schedule

An Implementation Schedule for the Country Pond Watershed Plan Phase 1: Direct Drainage Area is presented in Table 22. The schedule will be evaluated annually and revised as needed according to actual progress.

Table 22. Implementation schedule

Implementation Task	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
1.0 Finalize Country Pond – phase 1 plan and distribute	■										
2.0 Implement Structural BMPs											
2.1 BMP implementation – implementation planning	■										
2.2 Round 1 BMP implementation		■	■								
2.3 Continue planning and implementing BMPs				■	■	■	■	■	■	■	■
2.4 BMP operation and maintenance tracking		■	■	■	■	■	■	■	■	■	■
3.0 Implement non-structural BMPs, septic systems and outreach	■	■	■	■	■	■	■	■	■	■	■
4.0 Conduct watershed planning for remaining sub-watersheds		■	■	■	■	■	■	■	■	■	■
5.0 Monitor water quality	■	■	■	■	■	■	■	■	■	■	■
6.0 Review progress and report to project partners		■			■			■	■		■

8.2 Milestones

A description of interim, measurable milestones for determining if NPS management measures are being implemented, is presented in Table 23.

Table 23. Country Pond watershed implementation milestones

Management Measure	Milestones
Watershed plan development	• Phase 1 of the Country Pond Watershed Plan is complete • Efforts are underway to identify funding to conduct planning for the remaining sub-watersheds
Structural BMP implementation	• Number of BMPs implemented and pollutant load reduction estimates documented • Operation and maintenance plans developed and tracked
Non-structural BMP implementation	• Annual metrics tracked and documented • Pounds per year phosphorus reduction credited for non-structural practices
Septic systems	• Number of systems upgraded • Pollutant load reduction estimates documented
Watershed outreach	• Number of outreach materials and events produced • Number of participants in outreach events
Water quality monitoring	• Monitoring conducted annually and reports/data evaluated to assess progress toward attaining water quality goals
Implementation tracking	• Plan implementation progress tracked and reported to stakeholders every two years • Adaptive management approaches developed, if needed

9.0 SUCCESS INDICATORS AND EVALUATION (Element H)

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

As discussed in Section 5.1, the current average modeled epilimnetic in-lake phosphorus concentration for Country Pond is 15.5 µg/L. In order to see fewer cyanobacteria blooms, the LLRM model and the 2011 TMDL recommend a target epilimnetic in-lake concentration target of 12 µg/L. To meet this goal, the annual phosphorus load to the lake from all sources needs to be reduced by approximately 120 kg/yr (264 lbs annually).

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

To determine if lake management measures are making progress toward attaining water quality goals, the restoration indicators and targets shown in Table 24 will be measured and tracked as this watershed plan and future phases are implemented to determine if substantial progress is being made towards attaining the plan's water quality goal.

Table 24. Success indicators and evaluation measures

Water Quality Indicator	Current Conditions [2010-2019]	Target
Annual total phosphorus load (modeled)[1]	528 kg	408 kg
Annual average phosphorus concentration (modeled)[1]	15.5 µg/l	12 µg/l
Summer epilimnetic phosphorus concentration (measured)[2]	14.0 µg/l	<10.8 µg/l
Annual average chlorophyll-a (measured)	3.0 µg/l	<3.0 µg/l
Secchi disk transparency depth (measured)	2.8 m	>3.4 m
Days of algal bloom (measured)[1,3]	27 days	6 days
Evaluation methods: If regular progress reporting as shown in **Table 22 – Implementation schedule** shows that the restoration targets are not being met, project partners will convene to evaluate and develop adaptive management approaches for meeting water quality goals and standards.		
1 Values based on TMDL model predictions, Water Quality Model Update (DK, 2020) 2 Incorporates a measure of safety of 10% over annual average of 12 µg/l 3 Current probability of algal bloom >10 µg/l is 7.4%; predicted future probability is 1.8%		

10.0 MONITORING PLAN (Element I)

Monitoring of Country Pond and its watershed should be continued for the foreseeable future however, the intensity of the monitoring effort is dependent on future findings. The minimal plan, consistent with recent monitoring and monitoring at other New Hampshire lakes should include parameters to measure trophic state or the relative fertility of the reservoirs and parameters related to the observed elevated specific conductance readings in the lake. The current VLAP program conducted at Country Pond in 2018 and 2019 meets these minimal requirements and should be continued.

Ideally, as efforts to reduce nutrient loading to Country Pond increase, the concentrations of parameters related to trophic state should decrease including decreases in phosphorus concentrations, decreases in the frequency and intensity of harmful algal blooms (cyanobacteria), decreased depression of oxygen at depth in the deep sections of the lake and increased water transparency. Documentation of these changes is critical to measure progress towards management goals that will result in Country Pond fully supporting its designated uses.

Figure 11. Country Pond VLAP monitors (*Photo: Gregory Senko*)

Suggested enhancements to the existing Country Pond water quality monitoring program

Current in-lake and tributary monitoring is conducted five times per year, roughly monthly from May through September. The following enhancements relative to the existing monitoring program are suggested. These enhancements could serve dual purposes for watershed planning ***and*** MS4 compliance.

- Monitoring for total phosphorus, Secchi transparency and chlorophyll-*a* as a part of VLAP and total phosphorus sampling in tributaries should be continued for the foreseeable future.

- Continued effort should be made to document stratification and accumulation of hypolimnetic phosphorus in Country Pond.

- A spring turnover sampling event should be conducted as soon as practicable after ice-out each year. Spring turnover represents the closest approximation to annual average conditions in a lake and provides insight into expected water quality during the next growing season.

- Once every two to three years, a set of samples should be taken through the ice at the deep spot late in the winter. Lakes sometimes exhibit anoxia under the ice so both a temperature, dissolved oxygen, specific conductance profile and samples should be collected. Since the profile is inverted in the winter, one sample should be collected immediately below the ice and analyzed for total phosphorus and chlorophyll a. Another sample should be collected one meter from the bottom and analyzed for total phosphorus.

- Wet weather tributary monitoring should be conducted three times each year. Monitoring should target three separate runoff events roughly coinciding with spring, summer and fall depending on precipitation patterns. Since flow in the smaller tributaries is primarily storm related, monitoring should occur as soon as practicable after a rainfall of at least 0.5 inches or a period of snowmelt. If a routine monitoring event meets these criteria in season, then the wet weather event can be forgone for that season. Wet weather is expected to result in water flow at more locations than the two tributaries currently monitored. Reconnaissance during a rainstorm will allow identification of these locations. It is expected that there will be approximately six locations identified in addition to the currently sampled locations for a total of eight sites. To cover most of the watershed an attempt should be made to sample from each major sub-watershed including Bartlett, Western tributary, Southeastern Tributary, Cedar Swamp and the Eastern Tributary. Tributaries should be sampled as close as practical to the pond but above the hydraulic influence of the pond to ensure that pond water is not part of the sample. Some of these may be best accessed from Country Pond. Bartlett Reservoir should be sampled at the outlet. Samples from all sites should be analyzed for total phosphorus and specific conductance. Chloride is an optional analysis on these samples.

- Consideration should be given to installing staff gages in the major tributary streams and establishing stage discharge curves for these gages. This will allow flow to be estimated during future monitoring events. Flow can be combined with concentration information to calculate loads from tributaries. These loads are a much more complete representation of the movement of phosphorus and other substances to Country Pond than concentrations alone.

- Water quality data is currently collected as a part of the VLAP program in Angle Pond in the Upper end of the Bartlett sub-watershed for Country Pond. These data can be used to evaluate Country Pond loading as well as Angle Pond. The higher the quality of water coming from Angle Pond, the better water quality will be in Country Pond. Data from Angle Pond should be added to the database for Country Pond.

- Conduct routine observations for cyanobacteria blooms and develop a bloom database to include information about historic blooms and recently observed blooms. Update the database as needed. Information to collect would include date of bloom, location of initial observation, dominant taxa, cell count, duration of bloom, and warning status

Table 25. Suggested monitoring enhancements – estimated cost and level of effort

Task	Duration	Cost/level of effort	Notes
1) Routine in-lake monitoring	For foreseeable future	Included in current monitoring	
2) Document thermal stratification/oxygen and hypolimnetic phosphorus	For foreseeable future	Included in current monitoring, purchase Temp, oxygen/conductivity meter $1600	1/2 hour added to monitoring program
3) Spring turnover event	For foreseeable future	Six TP samples * $20 per analysis = $120/yr plus volunteer time	Add one sampling event to current program
4) Winter monitoring (deep spot)	Every 2-3 years for foreseeable future	Six TP samples * $20 per analysis = $120/event plus volunteer time	
5) Wet weather tributary monitoring	Three events per year for foreseeable future	Eight TP samples * $20 per analysis = $160/event * 3 events per year = $480/yr plus volunteer time	Potential purchase of a conductivity meter or a combination Temp/DO/conductivity meter as a part of recommendation 2 ($1600.00)
6) Flow gaging	One time and recalibration every 5 years	Purchase and installation of four gages and gaging at a minimum of three different flows at each gage, $5000	Assuming installation of 4 staff gages
7) Integrate Angle Pond data	For foreseeable future	No cost, volunteer time	
8) Cyanobacteria observations and bloom documentation	For foreseeable future	No cost, volunteer time	Develop database of observed blooms (to include historical observations); data collected to include data, location, dominant taxa, bloom duration, and warning status

11.0 APPLICABLE SECTIONS FOR MS4 COMPLIANCE

The towns of Kingston and Newton, as well as a number of other towns in the Country Pond watershed, are subject to requirements to manage stormwater as described in the 2017 NH Small MS4 General Permit. Aspects of this plan may be leveraged by communities to aid in MS4 compliance. The Horsley Witten Group and the UNH Stormwater Center, project consultants, developed a crosswalk table showing MS4 requirements and watershed plan components that could be used to develop municipal approaches for MS4 compliance in two areas: Minimum Control Measures and Lake Phosphorus Control Plan development.

11.1 MS4 Permit Minimum Control Measures

The MS4 Permit requires all permittees to implement Minimum Control Measures (MCMs), regardless of receiving water quality or TMDLs. Table 26 describes where to find relevant information in the nine-element watershed plan to apply toward MCMs.

Table 26. Watershed plan components for MS4 Minimum Control Measure implementation

MS4 Permit Minimum Control Measure (MCM)	Corresponding Section of the Nine-Element Watershed Plan for Country Pond	Considerations
Part 2.3.2: MCM 1 Public Education • Stormwater education messages to target audiences • Additional annual messages for management of leaf and grass clippings, fertilizer, and pet waste (applicable to nutrient-impaired watershed without an approved TMDL)	**Section 7.0** describes public education measures that could help reduce phosphorus loading.	Additional public education resources for MCM 1 can be found on the NH MS4 blog: https://www4.des.state.nh.us/nh-ms4/?page_id=54
Part 2.3.4: MCM 3 Illicit Discharge Detection and Elimination (IDDE) • Ordinance prohibiting illicit discharges • Wet-weather catchment inspections	**Section 7.0** describes septic system maintenance and upgrades as a strategy to reduce phosphorus loading from properties near the shore. These strategies could be integrated into ordinances and IDDE Plans for preventing illicit discharges and reducing bacteria loading to the MS4. **Section 10.0** describes wet weather monitoring recommendations which, if implemented, could be leveraged for MS4 compliance.	Additional public education resources for MCM 3 can be found on the NH MS4 blog: https://www4.des.state.nh.us/nh-ms4/?page_id=54

MS4 Permit Minimum Control Measure (MCM)	Corresponding Section of the Nine-Element Watershed Plan for Country Pond	Considerations
Part 2.3.6: MCM 5 Post-Construction Stormwater Management • Post-construction stormwater management ordinance for new- and re-development, including P reduction and long-term operation and maintenance • Assessment of street design and parking lot guidelines for opportunities to minimize impervious cover. • Assessment of existing local regulations to allow green infrastructure practices. • Inventory and priority ranking of municipally owned property and existing infrastructure that could be retrofitted with BMPs designed to reduce the frequency, volume and pollutant loads of stormwater discharges to its MS4. • Annual reporting on retrofits to mitigate impervious area	**Section 7.0** describes regulatory tools that could reduce existing phosphorus loads and mitigate future growth in loads due to new development and land conversion. These tools may be applicable as municipalities update their ordinances to meet new MS4 Permit requirements. **Section 7.0** identifies structural best management practice (BMP) opportunities. This opportunity list could partially meet the MS4 Permit requirement to inventory and prioritize potential stormwater retrofits on MS4 permittee-owned land.	Under MCM 5, municipal retrofit opportunities may be located in MS4 areas outside the Country Pond watershed (e.g. to address drainage issues or mitigate stormwater pollution to other waterbodies). Section 4 of the watershed plan describes structural BMP opportunities within the Country Pond watershed only. Additional public education resources for MCM 5 can be found on the NH MS4 blog: https://www4.des.state.nh.us/nh-ms4/?page_id=54
Part 2.3.7: MCM 6 Good Housekeeping • Pollution prevention activities for municipal land and operations, including: – Street and parking lot sweeping – Catch basin cleaning – Landscape maintenance SOPs (fertilizer, leaf litter & grass clippings)	**Section 7.0** describes and ranks potential non-structural BMPs. These practices could be incorporated into the MS4's pollution prevention and operation and maintenance plans.	Additional public education resources for MCM 6 can be found on the NH MS4 blog: https://www4.des.state.nh.us/nh-ms4/?page_id=54
Note: This is not an exhaustive list of MS4 Permit requirements. Only those requirements addressed by the nine-element watershed plan are listed here.		

11.2 Lake Phosphorus Control Plan (LPCP)

As described in the MS4 Permit Appendix F Part III, MS4 communities within the Country Pond watershed are required to develop LPCPs that describe the permittee's plan to address the TMDL by reducing stormwater phosphorus loading within the watershed by 52% within 15 years of the permit effective date (by end of fiscal year 2033). Table 27 describes where to find relevant information in the nine-element watershed plan that may be useful for developing LPCPs.

Table 27. Watershed Plan components for LPCP planning

MS4 Permit LPCP Requirement	Corresponding Section of the Nine-Element Watershed Plan for Country Pond	Considerations
Legal analysis: Evaluate bylaws/ ordinances and identify changes necessary to effectively implement the LPCP. Adopt necessary regulatory changes by the end of the permit term.	**Section 7.0** describes regulatory improvements that could reduce existing phosphorus loads and mitigate future growth in loads due to new development and land conversion.	Model stormwater standards: https://www.unh.edu/unhsc/sites/default/files/media/swa_stormwater-ord.pdf
LPCP area: Choose area in which to implement the LPCP: 1) the entire watershed area within municipal boundaries, or 2) only in the urbanized portion of the watershed. If a municipality chooses to develop its LPCP for the urbanized portion of the watershed, it can only count P load reductions for controls implemented within the urbanized area in meeting the total required P load reduction.	The Watershed Plan applies to the entire watershed and is not limited to urbanized areas.	In most municipalities within the Country Pond watershed, the urbanized area covers only a small portion of the watershed. Choosing to limit the LPCP to urbanized areas instead of watershed area may make it more challenging to meet the 52% P reduction target, as it would be a smaller area in which to implement P controls.
Phosphorus Load Calculations: Calculate baseline phosphorus load, allowable phosphorus load and phosphorus load reduction requirement for the LPCP area (either the entire watershed area or only the urbanized portion of the watershed).	**Section 5.0** presents the stormwater phosphorus load calculated using export coefficients for each land cover type. The Watershed Plan does not include a breakdown of baseline phosphorus load by municipality, nor calculations of allowable phosphorus load and phosphorus load reduction requirement.	Load calculations for the Watershed Plan were based on watershed boundaries. If a municipality chooses to develop the LPCP for only the urbanized portion of the watershed, the phosphorus load and load reduction targets will need to be recalculated.
Nonstructural Controls: Describe planned nonstructural controls, including where the measures will be implemented and expected annual phosphorus reductions.	**Section 7.0** lists potential nonstructural controls, their potential P load reductions, and a prioritization scheme.	

MS4 Permit LPCP Requirement	Corresponding Section of the Nine-Element Watershed Plan for Country Pond	Considerations
Structural Controls: Describe planned structural controls, locations where the measures will be implemented, and expected annual phosphorus reductions.	**Section 7.0** describes Phase 1 structural control opportunities identified during Watershed Plan development and associated potential P load reductions.	Pollutant loading hot spot data available through UNH GRANIT can be used to sort and prioritize municipal lands with high phosphorus loading for retrofits located within the LPCP area. Hot spot data is available on the GRANIT web site for: Kingston, Newton, Sandown, and Danville. Hampstead is in development and will be available in summer 2021. Project Details (unh.edu)
Cost and Funding Source Assessment: Estimate cost for LPCP implementation and describe known and anticipated funding mechanisms.	**Section 7.0** presents planning level cost estimates for Phase 1 structural BMPs. **Section 12.0** describes potential grant funding sources.	Structural BMP cost estimates should be reviewed and refined before pursuing funding.
Implementation schedule: Develop a schedule to implement all nonstructural controls within 6 years of permit effective date and structural controls at specific milestones.	**Section 8.0** presents a recommended schedule for implementing watershed management actions.	Adjust the Watershed Plan recommended schedule to meet implementation milestones required for the LPCP.
Performance evaluations: Track and report on phosphorus reductions for structural and non-structural BMPs. Track increases in phosphorus loading from the LPCP Area.	**Section 8.0** presents project-specific indicators that may be used to track implementation and quantify load reductions.	MS4 Permit Appendix F provides methodologies that must be used to calculate changes in P load. The Great Bay Pollution Tracking and Accounting Project (PTAP) database is available to use for tracking and reporting on BMP implementation: https://ptapp.unh.edu/
Note: This is not an exhaustive list of MS4 Permit Appendix F Part III (LPCP) requirements. Only those requirements addressed by the nine-element watershed plan are listed here. The full list of LPCP components and milestones is provided in MS4 Permit Appendix F Table F-3.		

12.0 FUNDING FOR FUTURE WATERSHED PLANNING PHASES AND IMPLEMENTATION

Implementation of BMP projects, management recommendations, and additional phases of planning for Country Pond will require significant financial support from diverse sources. State and federal grants, municipal funding, CPLA contributions, private funding, and grants from other sources such as foundations will be required to conduct implementation activities and future phases of planning. As the plan evolves, the formation of a funding subcommittee would be a critical step for building local ownership and capacity for fundraising and project management. The following list summarizes some potential sources of funding; however, this is list is not exhaustive and efforts should be made at the local level to continue to identify potential sources of support for watershed planning and management.

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

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

- **Milfoil and Other Exotic Plant Prevention Grants**
  NHDES provides funding each year for eligible projects that prevent new infestations of exotic plants, including outreach, education, Lake Host Programs, and other activities.
  Rivers, Lakes and Coastal | NH Department of Environmental Services

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

- **New Hampshire Charitable Foundation**
  A statewide community foundation that awards multiple types of grants, including ones for environmental projects. Home - NH Charitable Foundation (nhcf.org)

- **NH State Conservation Committee (SCC) Grant Program (Moose Plate Grants)**
  County Conservation Districts, municipalities (including commissions engaged in conservation programs), and qualified nonprofit organizations are eligible to apply for the SCC grant program.

Projects must qualify in one of the following categories: Water Quality and Quantity; Wildlife Habitat; Soil Conservation and Flooding; Best Management Practices; Conservation Planning; and Land Conservation.
Conservation Grant Program | State Conservation Committee | NH Department of Agriculture, Markets and Food

- **Water Quality Planning Grants**
  Water Quality Planning grants are available to Regional Planning Commissions and/or the Connecticut River Joint Commissions for water quality planning purposes.
  https://www.des.nh.gov/business-and-community/loans-and-grants/watershed-assistance#faq37046

- **Watershed Assistance Grants**
  Competitive grant program offered annually through the NHDES Watershed Assistance Section for communities, nonprofits, and local government entities to support implementation of restoration actions to restore impaired waters and protect high-quality waters as described in completed "a – i" watershed-based management plans.
  https://www.des.nh.gov/business-and-community/loans-and-grants/watershed-assistance#faq37046

CONCLUSION

The goal of the **Country Pond Watershed Management Plan Phase 1: Direct Drainage Area** is to make strides toward limiting nutrient loading to the pond such that the frequency of nuisance algal blooms is reduced. The plan describes management and planning opportunities to meet those goals. Evaluation of the pond's historic water quality data suggests that while there have been episodes of poor water quality throughout the time period, there have also been times when water quality supported the designated uses of Country Pond. A water quality goal that includes supporting designated uses all of the time is a worthy one to pursue. Reaching that goal will require an aggressive commitment to continued planning, implementation of watershed management actions, and water quality monitoring.

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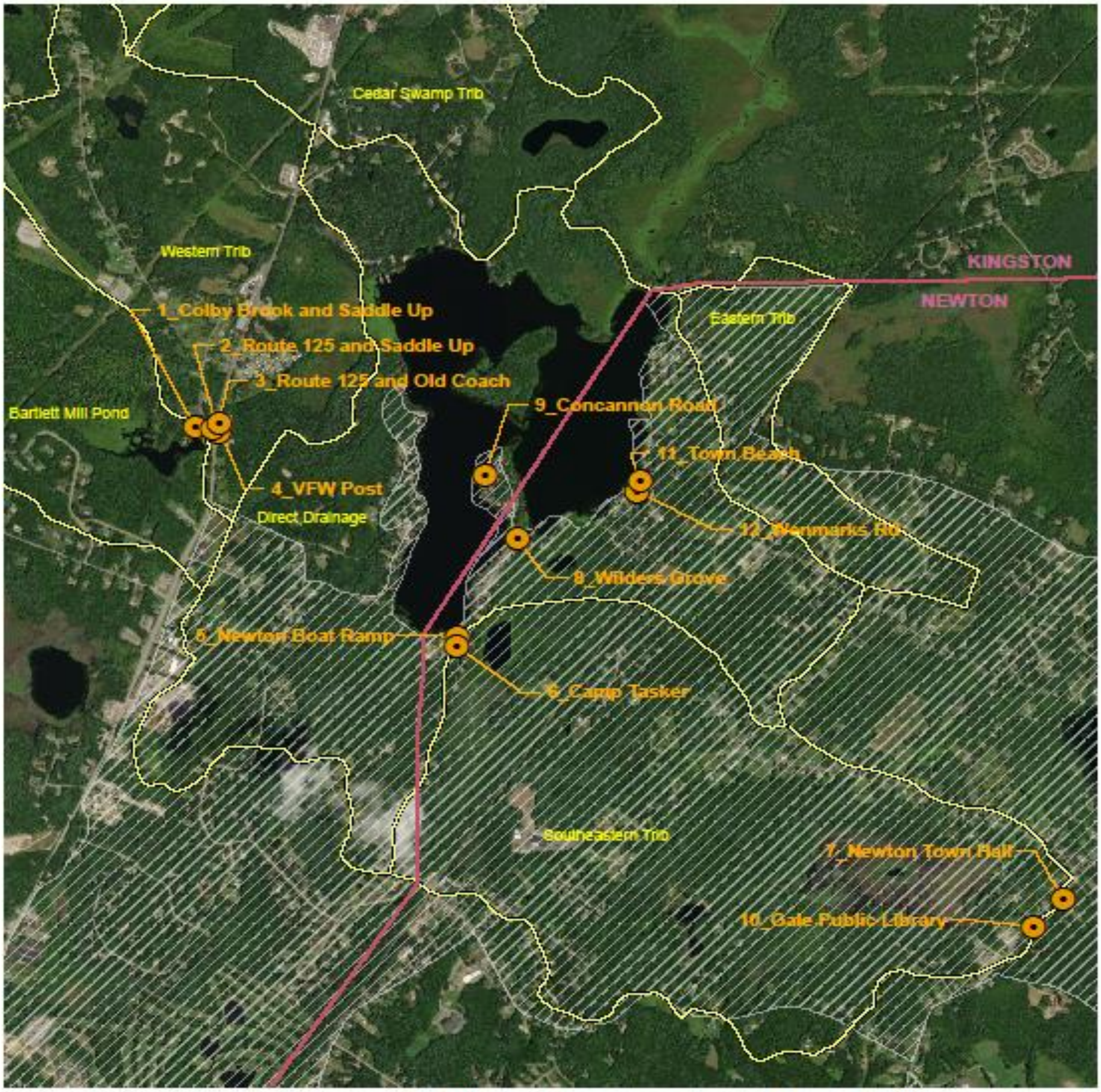
APPENDIX A

MAP OF STRUCTURAL BMP LOCATIONS



Path: H:\Projects\2019\19077 Country Pond Watershed Based Plan\GIS\Maps\200901_BMPLocationsFigure.mxd

Legend

- BMP Locations
- Town Boundary
- Watershed Boundaries
- MS4 Regulated Area

N

0 1,000 2,000 Feet

Horsley Witten Group
Sustainable Environmental Solutions

Proposed BMP Locations
Country Pond Watershed

Date: 11/3/2020

Figure 1

APPENDIX B

BMP CONCEPT DESIGNS

Country Pond Watershed Based Plan

Conceptual Design Report

September 9, 2020
Prepared by: Horsley Witten Group, Inc.

Introduction

This report presents stormwater management conceptual designs for five sites within the Country Pond Watershed. These sites and the proposed site improvements were selected through a process of desktop analyses, field reconnaissance, and stakeholder consultation. Stakeholders include the Rockingham Planning Commission, Country Pond Lake Association, and New Hampshire Department of Environmental Services.

In October 2019, the project team visited sites that had been identified as opportunities for structural best management practices (BMPs). Those sites included public parcels with higher potential phosphorus loads, private parcels with interested owners, and locations with known erosion issues. After the project team observed site conditions and evaluated BMP opportunities, stakeholders selected five priority sites to advance to conceptual design. These sites are shown in Figure 1.

The conceptual designs presented herein represent planning-level recommendations for stormwater management improvements at each site, along with planning-level estimates of costs[1] and potential phosphorus load reduction[2]. The overall goal of proposed improvements is to reduce phosphorus loading into Country Pond. These designs seek to accomplish phosphorus reduction by reducing erosion and by treating stormwater runoff using structural BMPs. Secondarily, these designs aim to maintain existing site uses, preserve and enhance ecological resources, minimize long-term maintenance requirements, and educate the public about water quality and stormwater management.

Operation and maintenance (O&M) for proposed systems is anticipated to incur 21 staff hours annually.[3] O&M includes general inspections and routine prescriptive and preventative maintenance activities such as the following:

1. Clean out trash and debris.
2. Clean out accumulated sediment.
3. Maintain vegetation (weeding, mowing, replanting, etc.).
4. Check for erosion within and downstream of facility; stabilize areas of erosion, if found.
5. Check for standing water (lack of drainage); investigate and correct clogging if facility does not drain within 48 hours following a rain event.
6. Observe and note condition of inlets, outlets, and overflow pipes.

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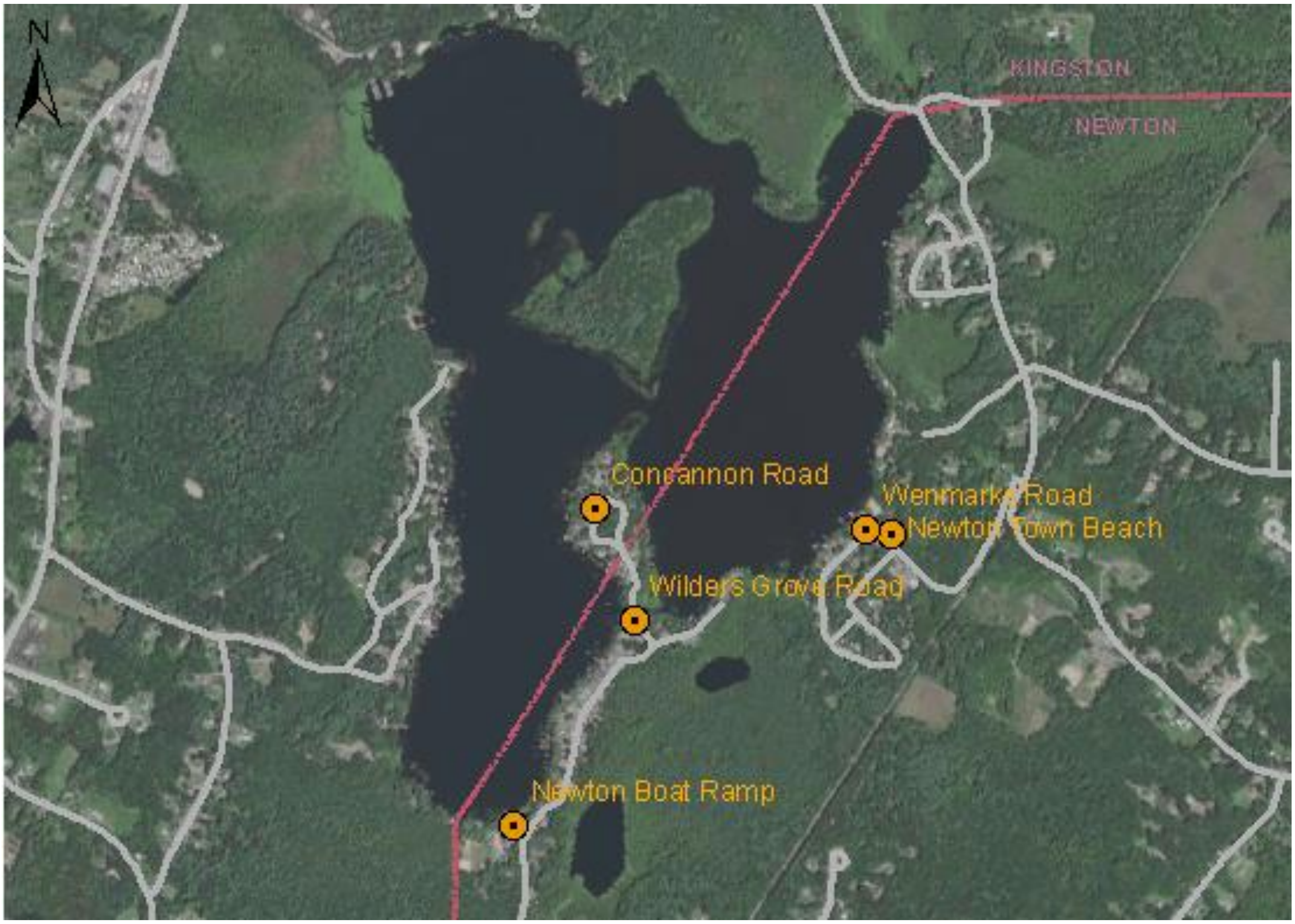
[1] Except as noted below, planning-level costs were estimated using EPA Region 1 (2016) *Methodology for Developing Cost Estimates for Opti-Tool*, based on an assumed volume of 0.4 inches from drainage area impervious cover and an adjustment factor of 2. Capital costs include engineering/design and construction/installation and are expressed in 2020 dollars. Cost estimates should be evaluated and refined, depending on timing before pursuing grant funding for BMP construction.
[2] Phosphorus reduction was estimated using NH MS4 Permit Appendix F and EPA Region 5 Erosion Control Model.
[3] Operation and maintenance for bioretention systems, as provided in EPA Region 1 (2016) *Methodology for Developing Cost Estimates for Opti-Tool*

Figure 1. Locations of Proposed Stormwater Management Improvements



Newton Boat Ramp

Existing Site Description:

Photo 1: View up the boat ramp with erosion along edges and down the approximate centerline.

- The boat ramp is located near 36 Country Pond Rd, on a narrow Town right-of-way (ROW) between two private parcels – vacant/beach property to the northeast and Camp Tasker to the southwest.
- Runoff from Country Pond Rd collects in a depression to the southwest of the ramp entrance, just downhill from the Camp Tasker driveway, and flows down the ramp.
- The ramp is eroding along both edges and down the approximate center.
- Soils at the site are categorized as hydrologic soil group (HSG) A[4].

Proposed Improvements:

Photo 2: View at boat ramp entrance where runoff ponds along the southwestern edge of pavement.

- At the boat ramp entrance, install a concrete dip pitched from east to west to direct road runoff toward the ramp's western edge. Ensure concrete dip is accessible for truck and trailer traffic.
- Enhance existing depression where water currently ponds. Consider installing a permeable paver, such as "Drivable Grass" Plantable Concrete System® by Soil Retention.
- Install educational signage about water quality and stormwater management.
- Construct a swale along the western edge of ramp. Swale should include periodic check dams, using reclaimed rocks and filter fabric. Consider terracing if space allows. Plant with low maintenance plants, such as Common Rush (*Juncus effuses)*, Blueflag Iris (*Iris versicolor*), and Northern Sea Oats (*Chasmanthium latifolium)*. Alternatively, install 6-inch depth of open-graded crushed stone underlain with filter fabric.
- Transition swale to meet level spreader and stone apron for energy dissipation.
- Plant dense groundcover vegetation from swale termination to meet shoreline. Potential plants to consider may include: *Juncus effuses*, *Iris versicolor*, *Dryopteris marginalis*, and *Carex stricta*.
- Resurface and regrade the ramp to super-elevate and pitch towards the western edge of ramp. Refer to UNHSC gravel specifications for ramp resurfacing.
- Install concrete paver system such as Driveable Grass® on lower portion of ramp to shoreline.
- Coordinate limits of disturbance and wetland resource protection with local permit authorities for approval. To minimize permitting effort, improvements could be limited to outside the 50-foot shoreline setback.

[4] Natural Resources Conservation Service Web Soil Survey https://websoilsurvey.nrcs.usda.gov

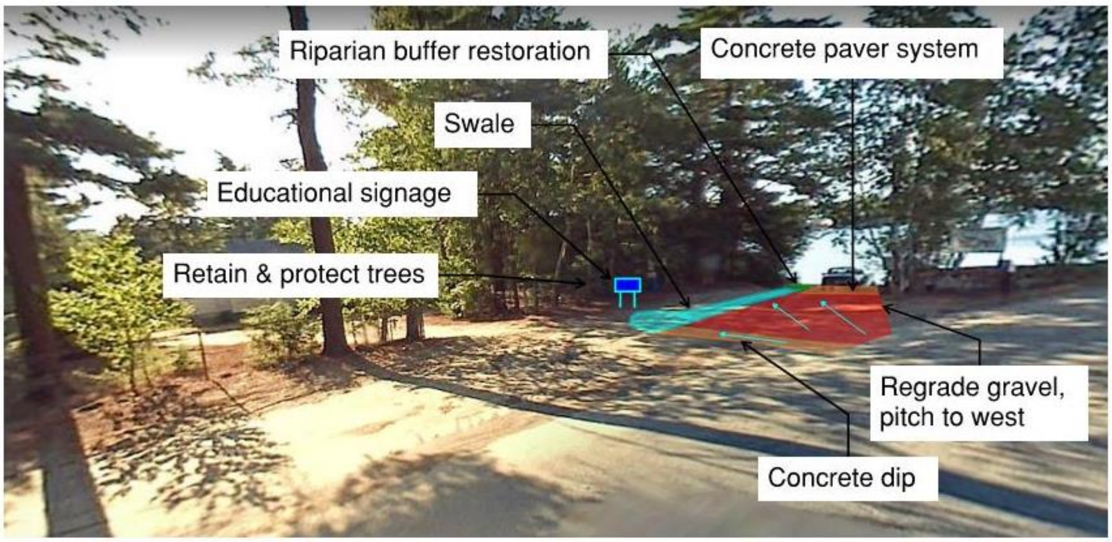
Owner: Town of Newton

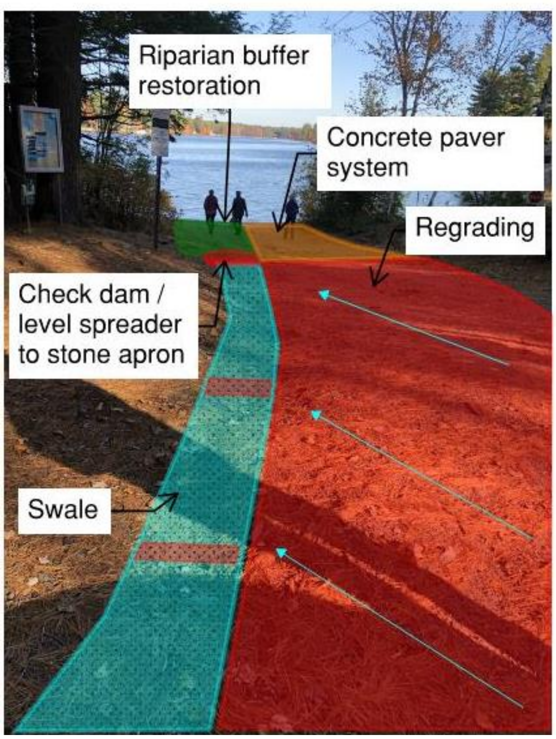
Subwatershed: Direct Drainage

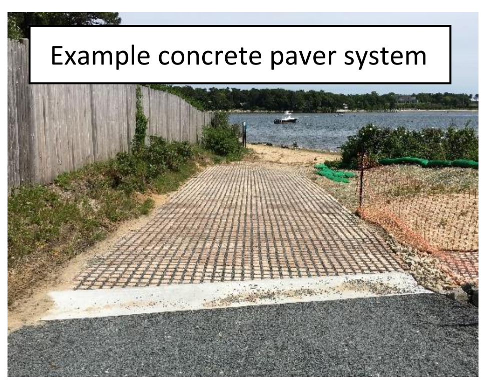
Phosphorus Load Reduction: 1.8 lbs/year

Costs[5]: Capital costs: $8,000-$12,000
Annual operation and maintenance costs: $2,000
20-year life cycle cost: $50,000

Figure 2. Newton Boat Ramp Proposed Improvements







[5] Capital costs include an additional $5,000 for erosion stabilization practices.

Concannon Road, Kingston

Photo 3: Concannon Road where runoff flows across private property to Country Pond.

Existing Site Description:

- Runoff flows south along Concannon Rd western edge and collects at a low point near the driveway of 14 Concannon Rd, where sediment deposits were observed.
- From the low point on Concannon Rd, runoff flows across private property to Country Pond. Gully erosion was observed along the flow path.
- Soils on the site are categorized as HSG A.

Proposed Improvements:

- Install a linear infiltration trench with level spreader at the low point within the right of way, to reduce erosion along the existing drainage path through private property.
- To construct the infiltration trench, excavate down 3 feet +/- and install filter fabric along the side walls to prevent adjacent soil from migrating into the trench. Backfill with double-washed crushed stone. Consider installing geogrid or a similar load distribution product.
- Re-use the excavated material to create an impermeable berm along the down-gradient side to encourage stormwater to settle and infiltrate. Construct a level spreader and overflow spillway using a timber-tie or granite curb with stone splash pad.

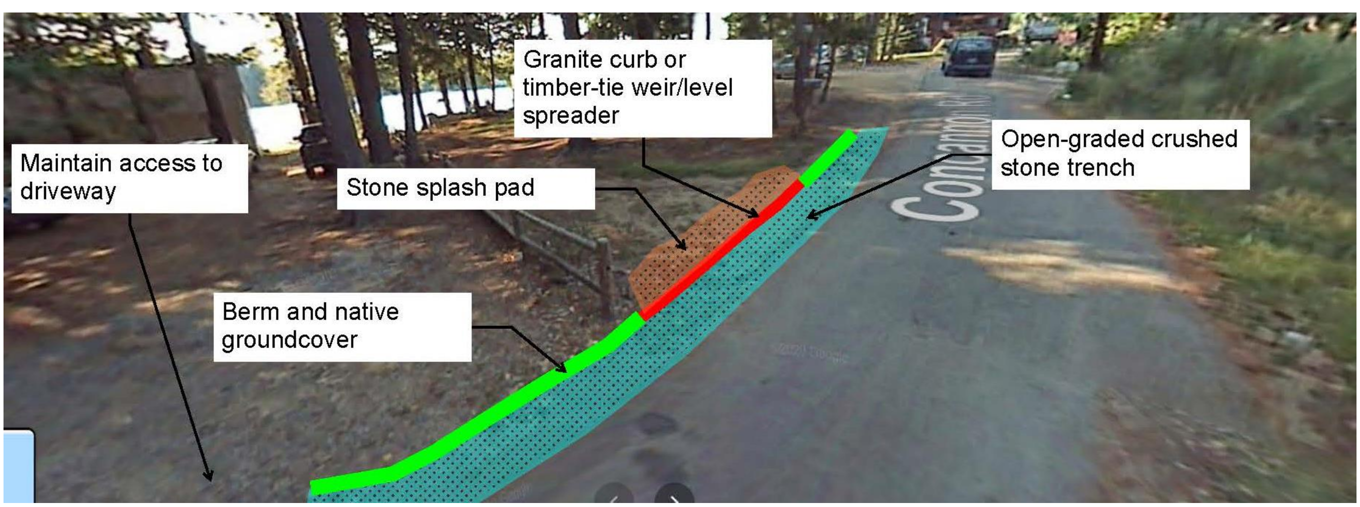
Owner: Town of Kingston

Subwatershed: Direct Drainage

Phosphorus Load Reduction: 2.8 lbs/year

Costs: Capital costs: $7,000-$11,000
Annual operation and maintenance costs: $2,000
20-year life cycle cost: $49,000

Figure 3. Concannon Road Proposed Improvements



Newton Town Beach Parking Lot

Photo 4: View southwest across the parking area towards Wenmarks Road.

Existing Site Description:

- The gravel parking area is located off Wenmarks Road, uphill from the Town Beach.
- Stormwater flows across the parking area toward the driveway, where it carries loose aggregate from the parking lot onto Wenmarks Rd.
- Erosion was observed within the parking area, along the entrance drive, along the northeastern edge of Wenmarks Road, and at the beach area.
- Soils at the site are categorized as HSG A.

Proposed Improvements:

- Construct a driveway apron at the parking lot entrance to stabilize the loose aggregate surface and prevent stormwater flow from exiting the parking area. The driveway apron should be constructed out of mountable bituminous concrete berm with a design lip of 3" +/-.
- Ensure that cars are unimpeded by the driveway apron and that the vertical reveal is significant enough to divert stormwater flow into a bioretention basin.
- Construct an infiltrating bioretention basin with a sediment forebay where the SUV is parked in Photo 4. One to two parking spaces may need to be eliminated to make room for the bioretention basin. The basin could be placed in a different location in the parking lot, depending on findings of the site survey.
- Construct a conveyance swale along the west edge of the parking lot, to intercept runoff that is causing erosion down to the beach and to redirect it to the bioretention basin.
- Formalize the footpath to the beach with a pedestrian bridge or other accessible path. Plant native vegetation in strategic locations to guide pedestrians and stabilize eroding areas.
- At the bioretention basin outlet, construct a level spreader and overflow spillway, using a timber-tie or granite curb with stone splash pad, to promote overland sheet flow toward the catch basins down-gradient on Wenmarks Road.
- Install educational signage about water quality and stormwater management.

Owner: Town of Newton

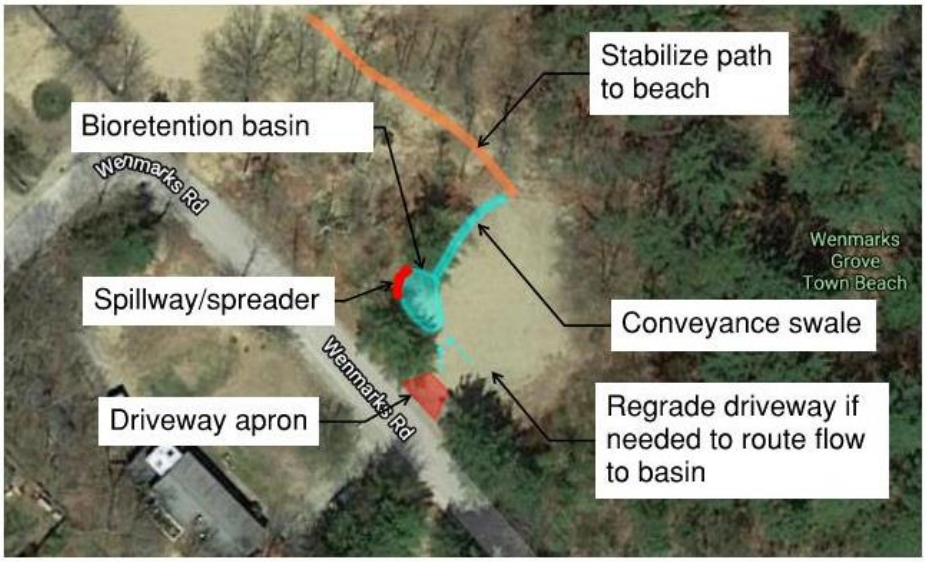
Subwatershed: Direct Drainage

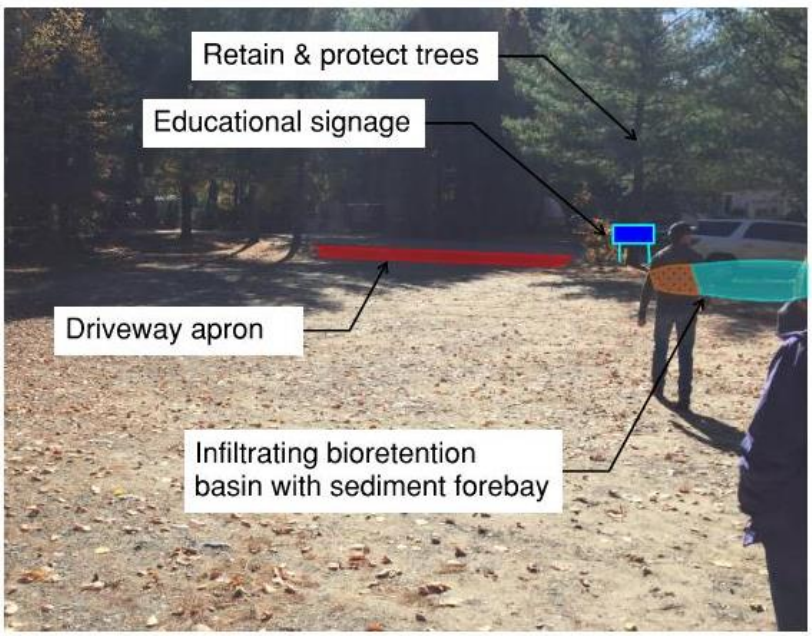
Phosphorus Load Reduction: 0.3 lbs/year

Costs[6]: Capital costs: $10,000-$14,000
Annual operation and maintenance costs: $2,000
20-year life cycle cost: $52,000

[6] Capital costs include an additional $5,000 for erosion stabilization practices.

Figure 4. Newton Town Beach Parking Lot Proposed Improvements





Wenmarks Road / Whispering Pines

Existing Site Description:

- Runoff from Wenmarks Road and adjacent properties collects at a low point with two existing catch basins.
- As communicated to the project team, the catch basins are likely connected by a perforated pipe set within a gravel infiltration trench under the existing pavement.
- As shown in Photo 5, a break in the curb allows stormwater to bypass the structures and continue down the beach. This has led to gully erosion across the beach.
- The private beach is owned by Whispering Pines Campground.
- Soils at the site are categorized as HSG A.

Photo 5: View northeast toward Town Beach. Stormwater bypasses the existing catch basins at the curb break in the foreground.

Proposed Improvements:

- Inspect and clean catch basins.
- Install hoods or other pretreatment devices in the existing catch basins.
- Rehabilitate and expand subsurface infiltration area.
- Establish high flow outfall, as there does not currently appear to be one.
- Install curb along the edge of pavement to prevent stormwater from bypassing the catch basins.
- Stabilize path to waterfront.
- Periodically clean catch basins and infiltration trench to prevent clogging.

Alternative:

If the paved parking spaces above Whispering Pines Beach are no longer needed, consider removing the pavement and installing a bioretention basin with sediment forebay. A bioretention basin would provide water quality treatment and storage capacity, as well as public education. The existing catch basins could serve as overflow structures for the bioretention basin.

Photo 6: Gully erosion through private beach to Country Pond.

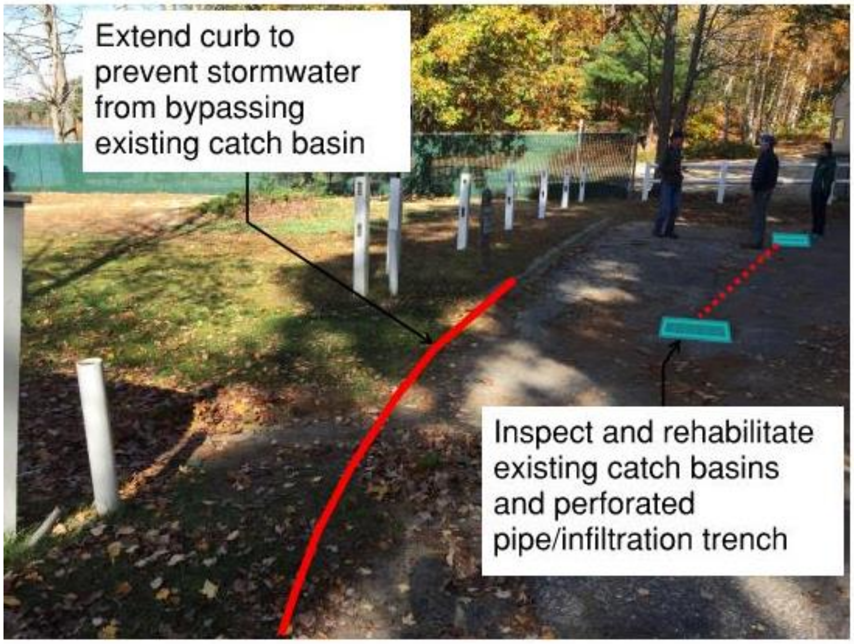
Owner: Town of Newton and Whispering Pines Campground

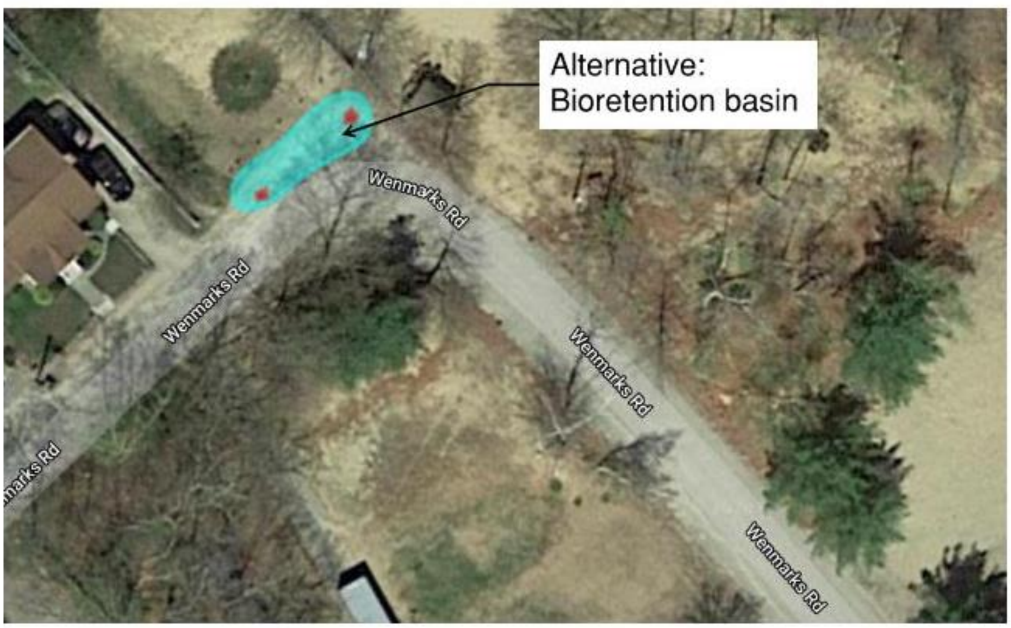
Subwatershed: Direct Drainage

Phosphorus Load Reduction: 2.6 lbs/year

Costs: Capital costs: $17,000-$25,000
Annual operation and maintenance costs: $2,000
20-year life cycle cost: $61,000

Figure 5. Wenmarks Road Proposed Improvements





Wilders Grove Road

Existing Site Description:

- Runoff from Wilders Grove Rd flows along the western edge of the road. As shown in Photo 7, sediment accumulates at the end of #74 driveway.
- Stormwater ponds in this location and overflows across private property, causing erosion into Country Pond.
- Based on conversations with the property owner, curb was installed by the property owner to stop stormwater from flowing toward and into their basement.
- Soils at the site are categorized as HSG A. Depth to high groundwater is unknown but suspected to be shallow due to proximity to the pond.

Photo 7: Driveway at 74 Wilders Grove Rd.

Proposed Improvements:

- Install an asphalt driveway apron at 74 Wilders Grove Rd to divert stormwater to the north edge of the driveway.
- Construct a sediment forebay to collect sediment and debris.
- Construct a wet swale by excavating a linear trench connecting the sediment forebay to Country Pond. Ensure positive drainage off and away from Wilders Grove Road by pitching the grade leading to the wet swale at approximately 2% slope. Slope the wet swale at or close to 0% slope.

Alternative:

To construct the proposed forebay and wet swale, the Town would need to reach an agreement with the property owner, who expressed interest in water quality solutions during the project team's site visit in 2019. If the proposed solution is unacceptable to the property owner, the Town could instead consider installing closed drainage for this segment of Wilders Grove Rd. That alternative would include curbing, catch basin, treatment device, and a drainage pipe outlet connection to the culvert under Wilders Grove Rd. A closed drainage system would be a significant investment beyond the costs of the proposed swale system.

Owner: Town of Newton and private property owner

Subwatershed: Direct Drainage

Phosphorus Load Reduction: 1.1 lbs/year

Costs[7]: Capital costs: $7,000-$11,000
Annual operation and maintenance costs: $2,000
20-year life cycle cost: $49,000

[7] Capital costs include an additional $5,000 for erosion stabilization practices.

Figure 6. Wilders Grove Road Proposed Improvements