Lake Warren Watershed Management Plan Development and Implementation Project, Phase 1

A Final Report to

The New Hampshire Department of Environmental Services

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NEW HAMPSHIRE DEPARTMENT OF Environmental Services

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Executive Summary

Located in southwestern New Hampshire, Lake Warren has been an important natural resource in the Town of Alstead for over 200 years. As the headwaters of Warren Brook, the lake was initially dammed to provide a source of water to downstream mills. With time, the lake has also become a highly valued recreational resource to both residents and visitors who enjoy its scenic beauty and calm, quiet character. The lake also provides critical habitat for a diverse abundance of plants, wildlife, and aquatic life. Because the water quality of lakes and streams can decline rapidly due to stormwater runoff from watershed development (including roads, agriculture, and residences), taking proactive steps to properly manage and treat stormwater runoff to protect these important water resources is essential for continued ecosystem health, including resources valued by humans.

The Lake Warren Watershed Management Plan is the culmination of several years of effort by the many individuals who care about the long-term protection of water quality in the lake. By partnering with the Southwest Region Planning Commission (SWRPC), the New Hampshire Department of Environmental Services (NHDES) awarded the group a Watershed Assistance Grant for implementation (Section 319 of the Clean Water Act) with funds from the United States Environmental Protection Agency (USEPA). Stakeholders from the local to state level have collaborated on this effort, including the Town of Alstead, New Hampshire Fish and Game Department (NHFGD), the Soak Up the Rain program, the Cold River Local Advisory Committee (CRLAC), and numerous watershed residents.

Introduction

Geographic Location and Profile

Lake Warren is located in the Southwestern portion of New Hampshire in the Town of Alstead, in Cheshire County. The population of Alstead is 1,937 according to the 2010 Census data. The town has an area of 39.7 square miles of land and .4 square miles of inland waters. The Cold River and Warren Brook flow through the northern part of Alstead and join together east of the village center. The two largest ponds are Lake Warren (also known as Warren Lake) in the east and Caldwell Pond in the south. Lake Warren is accessible from NH 123. It is 185.5 acres and is a relatively shallow lake with a maximum depth of 13.8 feet and a mean depth of 7.2 feet. The entire watershed for Lake Warren lies within the Town of Alstead. It is located within HUC 010801070203.

The project was the third project since 2011 to gather information to develop a plan, implement ways to improve the water quality, and ultimately have the lake removed from the NH DES List of Impaired Lakes. The lake is currently listed as impaired for aquatic life due to high levels of total phosphorus (TP), Chlorophyll-a (Chl-a) and low pH.

Previous studies

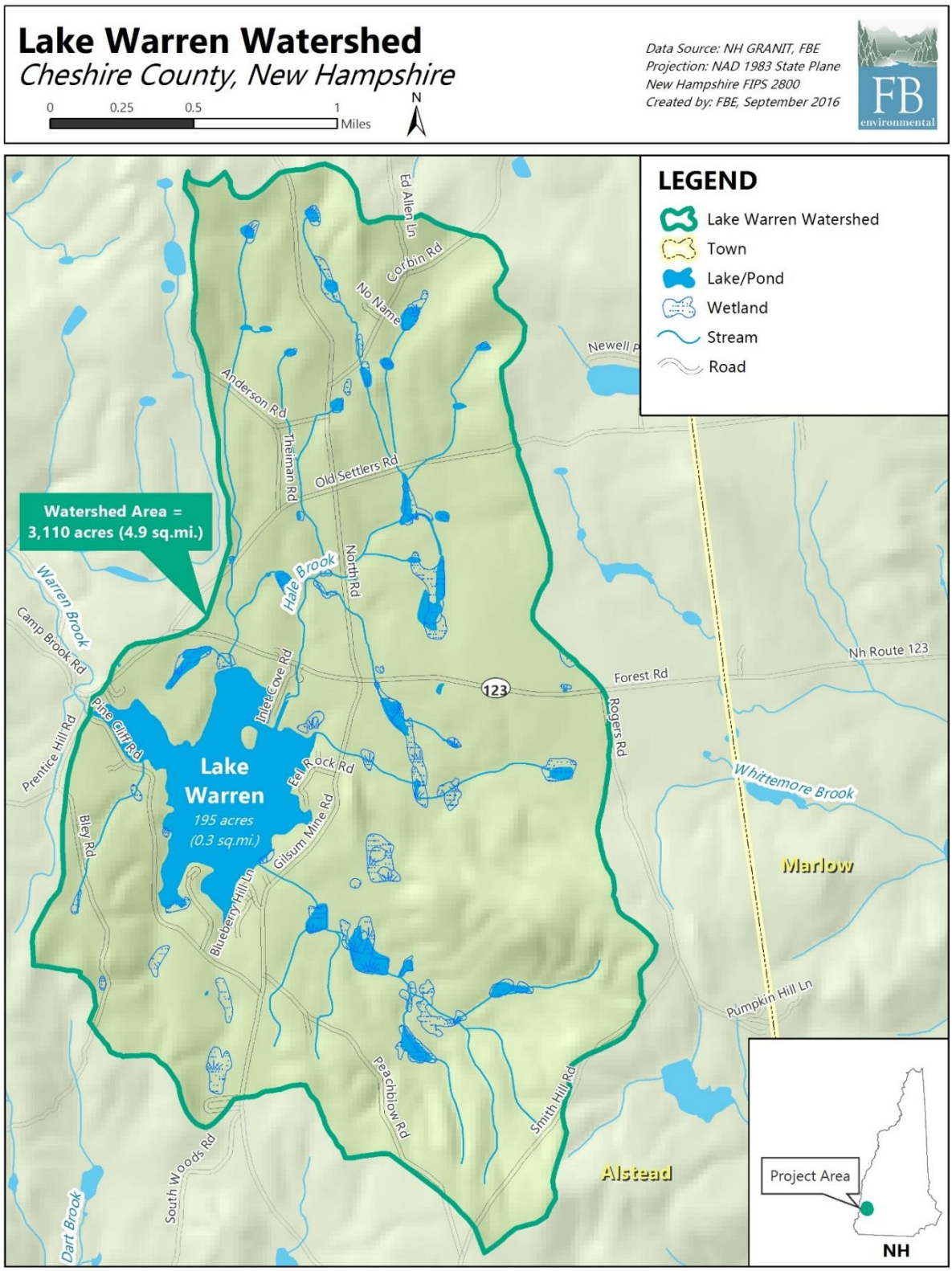
A water quality report was developed by the Cold River Local Advisory Committee that identified areas of concern for the health of the lake. Trends observed relative to long-term total phosphorous (TP), chlorophyll and transparency suggest that the overall water quality in the lake is declining at a rate that is much faster than the natural progression of lakes and ponds of its size. This led to the first of three funding rounds through the USEPA Clean Water Act.

In 2011, through a 604b grant, the Comprehensive Lake Inventory and Management Plan was developed. This was recommended as a first step to exploring the causes of contaminants to the lake.

In 2013, another grant was pursued to provide funding for the development of a Nutrient Loading Study to identify pollutant load reductions and methods of achieving the levels necessary to improve the classification from Mesotrophic to Oligotrophic and remove it from the “impaired” status.

Through that study, it was determined that a 28% reduction in phosphorus loading to Lake Warren was needed to restore water quality. The 2014 Lake Warren Modeling Report completed under that grant has shown that stormwater runoff and septic systems are the largest contributors of phosphorus to Lake Warren. Through a watershed survey conducted in the summer 2013, Pine Cliff Road and the Town Boat Launch were identified as primary areas of concern. Both locations had obvious signs of erosion directly impacting the lake and were prioritized for remediation under the Lake Warren Action Plan completed in June 2014.

This current project included the development of a watershed based management plan and two demonstration project as a first step in reducing non-point sources of stormwater runoff and erosion to Lake Warren.


Lake Warren Watershed
Cheshire County, New Hampshire
0 0.25 0.5 1 Miles
N
Data Source: NH GRANIT, FBE
Projection: NAD 1983 State Plane New Hampshire FIPS 2800
Created by: FBE, September 2016
FB environmental
LEGEND
Lake Warren Watershed
Town
Lake/Pond
Wetland
Stream
Road
Watershed Area = 3,110 acres (4.9 sq.mi.)
Lake Warren
195 acres
(0.3 sq.mi.)
Ed Allen Ln
Corbin Rd
No Name
Anderson Rd
Theiman Rd
Old Settlers Rd
North Rd
Hale Brook
Warren Brook
Camp Brook Rd
Prentice Hill Rd
Pine Cliff Rd
Inlet Cove Rd
Eel Rock Rd
Gilsum Mine Rd
Bley Rd
Blueberry Hill Ln
123
Forest Rd
Nh Route 123
Rogers Rd
Whittemore Brook
Marlow
Pumpkin Hill Ln
Peachblow Rd
Smith Hill Rd
South Woods Rd
Dart Brook
Alstead
Project Area
NH

Project Objectives

There were two objectives in this project including both planning and implementation. The planning objective was to develop a watershed based management plan for Lake Warren that incorporates the nine elements required by the US EPA guidelines for impaired waters. The implementation objective was to select two areas to implement demonstration projects.

Both of these objectives were achieved within the project schedule. The Lake Warren Watershed Management Plan has been completed and submitted to the NH DES for review and approval. A copy has also been sent to the Lake Warren Association and to the Town of Alstead.

The two demonstration projects sites were selected by the Lake Warren Steering Committee during the early phase of this project. Both sites have high public visibility, and were areas that needed restoration to reduce the stormwater runoff from entering the lake.

Pine Cliff Road bank restoration- This site was selected since it showed signs of erosion and compaction from higher than average public use. It is not a designated swimming area, however, it is sometimes used for that purpose. The restoration of the bank maintained a path for swimmers to still get to the water, but narrowed the access by planting a large portion of the bank with native, non-invasive plants.

Boat Landing Road- This is a Town owned road leading to the only boat access ramp on the lake. Signs of serious erosion indicated that this was an area that was a contributor of siltation that was being carried into the lake. To implement this work, we needed to include the cooperation of the Town of Alstead to regrade the road and improve the ditch.

Project Outcomes and Desired Goals

The desired outcome is to reduce the amount of phosphorus getting into the lake by 25% over the next 10-15 years. Median total phosphorus concentrations will need to be reduced from the current level of 11.0 ppb to 8.3 ppb, by preventing 97.6 lbs. (44.4 kg) of phosphorus from entering the lake annually. To achieve this, it will require an integrated and adaptive approach across many different parts of the watershed community.

To provide data for the watershed management plan, methods such as the Lake Loading Response Model (LLRM), was used to estimate the water budget and phosphorus load to Lake Warren based on land use, population, precipitation, watershed boundaries, wastewater treatment, bathymetry, waterfowl, and other information about the Lake Warren watershed. The model also makes predictions about Chl-a concentrations and SDT readings based on the estimated phosphorus loading.

Total Phosphorus and Water Loading Summary for Lake Warren

	CURRENT				HISTORICAL	
Predicted Median In-Lake TP	*13.1*				*6.8*	
Loads to Lake Warren	TP *(kg/year)*	TP *(%)*	Water *(m^3/year)*	Water *(%)*	TP *(kg/year)*	TP *(%)*
Atmospheric Deposition	8.2	4.6%	490,885	6.2%	8.2	9%
Internal Loading	4.0	2.3%	NA	NA	0	0%
Waterfowl	3.0	1.7%	NA	NA	3.0	3%
Septic Systems	25.5	14.4%	21,933	<1%	0	0
Watershed Runoff	136.7	77.1%	7,409,873	93%	84.1	88%
Total Load To Lake Warren	**177.4**	**100%**	**7,922,691**	**100%**	**95.3**	**100%**

Assimilative capacity was also used to determine the lake's capacity to receive and process nutrients without water quality impairment or harm to aquatic life. Based on the NHDES assimilative capacity analysis, Lake Warren falls in the Impaired category for oligotrophic lakes and Tier 1 category for mesotrophic lakes; under both classifications, there is no remaining assimilative capacity for additional phosphorus inputs to Lake Warren. To meet the oligotrophic AC threshold, TP would need to be reduced by 35%; for mesotrophic, TP would need to be reduced by 2%.

Summary of assimilative capacity analysis results for Lake Warren

Lake and Station	Existing Median TP (ppb)	TP WQ Threshold (ppb)	AC Threshold (ppb)	Remaining AC (ppb)	Analysis Results
Lake Warren Deep Spot (WARALSD)	11.0	8.0 (oligotrophic)	7.2	-3.8	Impaired
		12.0 (mesotrophic)	10.8	-0.2	Tier 1

Implementation of Demonstration Projects

The project included the implementation of two demonstration projects to be installed at locations chosen by the Steering Committee that would give the public an opportunity to see that work is being done to improve the water quality of the lake. The sites chosen were Pine Cliff Road, and Boat Landing Road.

Pine Cliff Road Buffer Plantings- On June 18, 2016, nine volunteers helped install a buffer planting along Pine Cliff Road. Previously, there was almost no vegetated buffer along a 26-ft stretch of this road, with patches of dirt and grass. Signs of erosion from large volumes of stormwater were visible along the road fill slope. The unvegetated area was planted with over 40 hardy plants to stabilize the slope and encourage infiltration of road runoff. Erosion control mulch was spread between plantings and along a footpath to the lake to help stabilize the bare soil and protect the plantings.

To provide an estimate for the pollutant load reduction for this site, the Water Erosion Prediction Project (WEPP) model was used. The soil in the area of Pine Cliff Road is fine sandy loam, so the sand soil correction factor was used. While it is recognized that all models have limitations, the WEPP model is appropriate for estimating erosion and pollutant load reductions for road BMPs.

Using this model, it is estimated that the Pine Cliff Road BMP controlled the following pollutants: sediment reduced by 0.1 tons/year, Total Phosphorus (*TP*) reduced by 0.1 pounds/year, and Total Nitrogen (*TN*) reduced by 0.2 pound/year.

Another method that can be used for this type of project is the EPA Region 5 Model. Using this method, the results were similar to the WEPP method: Total Suspended Solids (*TSS*) and Sediment reduced by 58 lbs/year and 0.1 tons/year, respectively; Total Phosphorus (*TP*) reduced by 0.1 pounds/year; Total Nitrogen (*TN*) reduced by 0.4 pound/year.

Boat Landing Road Regrading- This site had been previously identified in a 2013 Watershed Survey as a potential Best Management Practice (BMP) site due to visible surface erosion and direct flow to the lake. A site visit took place on August 25, 2015 after a heavy rain event and evidence of severe erosion was identified along the access road and along both sides of the boat ramp. On November 19, 2015, the road agent re-graded the access road to provide better road drainage of runoff into adjacent ditches (instead of down the road toward the lake).

To provide an estimate for the pollutant load reduction for this site, the Water Erosion Prediction Project model was again used, including the sand soil correction factor.

Using this model, it is estimated that the Boat Landing Road BMP controlled the following pollutants: Sediment reduced by 0.2 tons/year; Total Phosphorus (*TP*) reduced by 0.1 pounds/year; and Total Nitrogen (*TN*) reduced by 0.3 pound/year.

Conclusions and Recommendations

The results of the nutrient loading study indicate that the greatest phosphorus load comes from landscape runoff, which accounts for 77.1% of the total phosphorus loading to Lake Warren. Wastewater systems (septic and other types) were the second largest source at 14.4%. Direct atmospheric deposition accounts for 4.6% of the TP loading. Waterfowl inputs comprise less than 2% of the TP entering the lake. Internal loading (possibly from boat disturbances to the bottom of the shallow lake or low dissolved oxygen at lake bottom, though not frequent in Lake Warren) was calculated to contribute about 2.3% of the TP load.

The Management Strategies section of the Lake Warren Watershed Management Plan provide actions that should be taken to address these sources of pollutants that are contributing to the declining water quality of Lake Warren. This will involve actions taken primarily by homeowners within the watershed, infrastructure improvements by the Town of Alstead, and a strong leadership role by the Lake Warren Association to diligently pursue these recommended actions.

Some of the recommended actions involve the replacement of culverts, ditching improvements, and paving of a portion of Pine Cliff Road. It is recommended that the Town of Alstead consider making the recommended improvements and to seek funding sources if necessary to complete these projects.

Photo Documentation

Demonstration Project along Pine Cliff Road

One of the demonstration projects involved the restoration of a bank along Pine Cliff Road. The location was selected due to the compaction of the area and the stormwater runoff from the road. On June 18, 2016, a group of volunteers prepared the soil and planted native, non-invasive plants to provide stabilization and to deter the public from walking in that area. A path for public access was left for the public to use to enter the lake or to fish from the shore.

Before (left) and after (right) condition of vegetated buffer along Pine Cliff Road.

Demonstration Project on Boat Landing Road

The picture on the left shows the access road with gullies that have eroded during heavy weather events. The picture on the right shows the same location after the road was regraded. A ditch to the right of the access road will be redug in the spring of 2017 to better manage the stormwater runoff and to filter it prior to entering the lake.