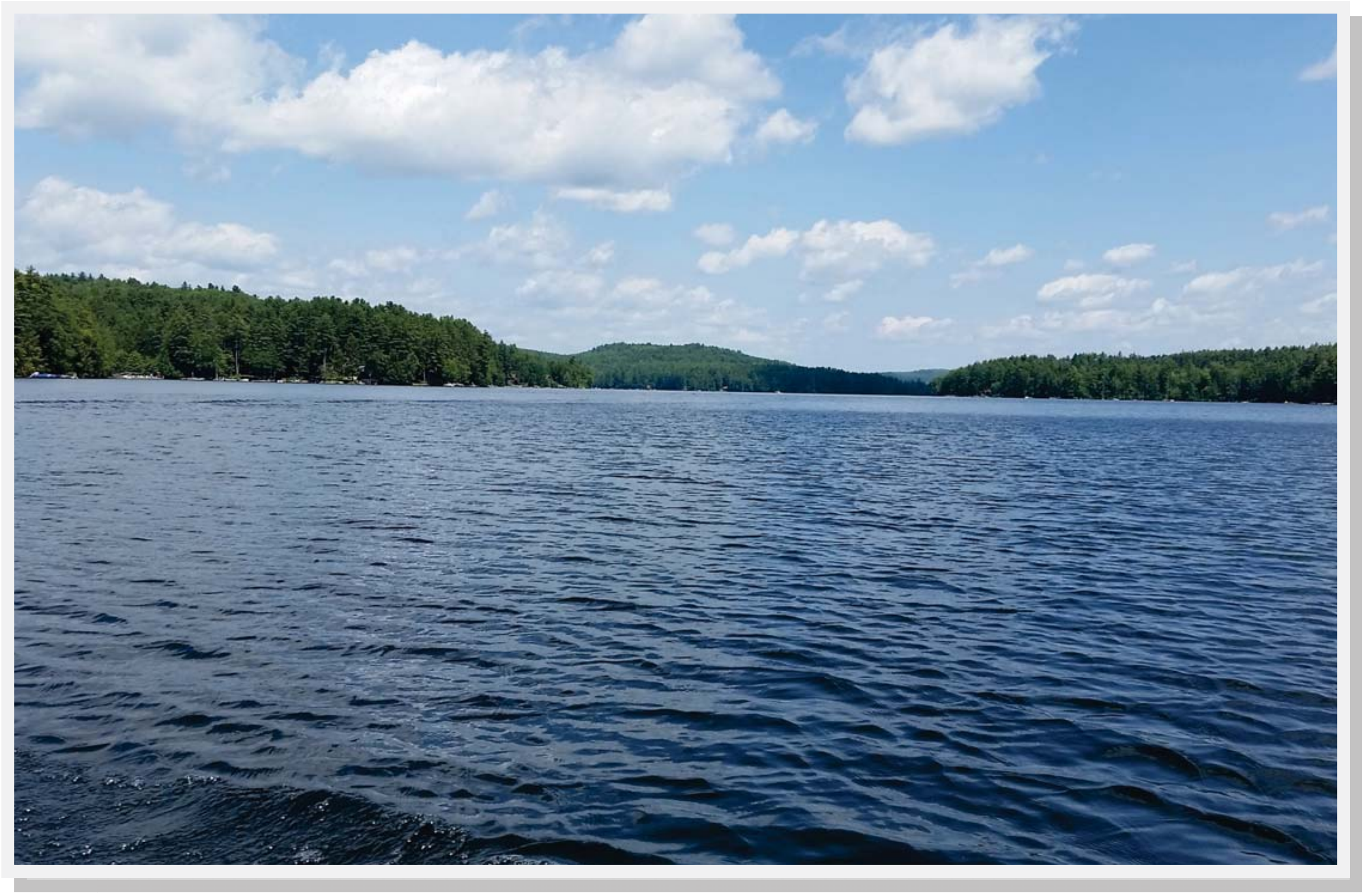

Friends Lake Watershed Assessment

Prepared for

The Town of Chester

Friends Lake Property Owners Association

Developed by the Warren County Soil and Water Conservation District

October 2017

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Introduction and Location

In 2016 the Warren County Soil and Water Conservation District was requested by the Town of Chester to develop a new watershed assessment for the Friends Lake Watershed. The District developed an assessment in 2003, with relatively few findings. However, changes to development, technology and information allows this assessment to be more inclusive of other aspects that include culvert assessments, hydrologic soil groups, and development and landowner Low Impact Development recommendations. Friends Lake and its watershed are wholly located in the Town of Chester, in Warren County.

This watershed is located within the Adirondack Park which encompasses 6 million acres of private and public lands. This lake is unique in the fact that there is no public access anyplace on the lakeshore, however it is not a private lake, as there are multiple lakeshore landowners and cottages that are rented to the public. The watershed is generally forested, with shoreline development being more predominant on the east side of the lake.

Characteristics at a Glance

Lakes Surface area (acres): 443

Watershed area (acres): 3,526

Road miles: 14.2

Stream miles: 9.6

Road/stream intersections: 11

Mapped wetland acreage: Approximately 230

Number of parcels: 482

Percent parcel developed: 64

Average % slope of watershed: 12.14

Retention time: 0.9 years

MSL Elevation range: 189.2 feet to 1,386.4 feet

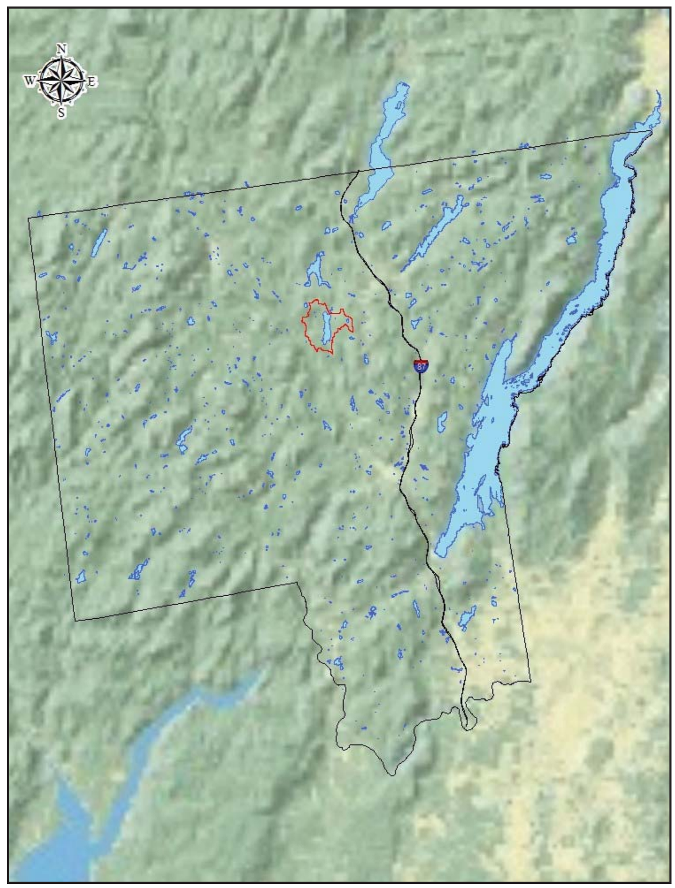


Figure 1 Location of Friends Lake Watershed in Warren County

Assessment Methodology

This report is an examination of the Friends Lake Watershed, which is located in the Town of Chester. District staff used Geographic Information System ArcView 10.3 (GIS) to assist with mapping of the roads and land use from existing data. These maps were referenced throughout the project as a guide and layout for final stormwater identification mapping. Each of the roads were driven, documenting the stormwater network within the watershed. Data was collected using a Global Positioning System (GPS) Trimble Juno SB. Data was logged and photographed to document the physical conditions of stormwater runoff from the conveyance system. The information collected was processed in the office and the GPS data was differentially corrected and exported as shapefiles for utilization in GIS maps.

Figure 2 Viewing point of Lake from dam, WCSWCD

Land Use and Land Cover

A review of the 2011 National Land Classification Data (NLCD) indicates that there are 13 discreet land classifications in the watershed (Table 1):

	Code	Area (acres)	%
1	Water	493	14%
2	Open Space	130	4%
3	Low Intensity	8	0%
4	Medium Intensity	3	0%
5	High Intensity	1	0%
6	Deciduous	506	14%
7	Evergreen	1252	36%
8	Mixed	789	22%
9	Shrub/Scrub	128	4%
10	Grassland	15	0%
11	Pasture	60	2%
12	Cultivated crops	19	1%
13	Woody wetlands	119	3%
	Sum	**3522**	100%

Table 1 National Land Classification Data within Friends Lake Watershed.

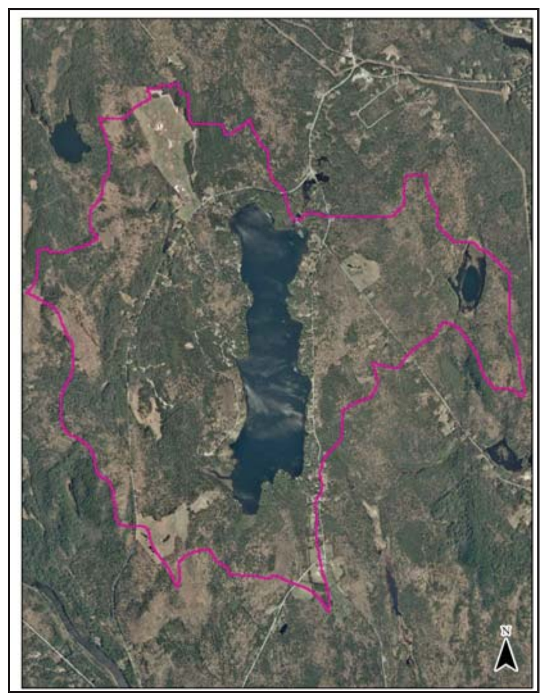


Figure 3 Friends Lake Watershed boundary

A summation of the data reveals that 75.9% of the land is classified as forest/wooded, 21.1% is open land or water, 2.6% is agricultural land and less than 1% is developed. Bear in mind that development includes roads along with buildings, driveways and other impervious surfaces. These numbers will likely change with increasing development and improved technology, however this should be a reasonable baseline of land classification.

A heavily forested watershed tends to keep water quality and habitat in good shape. However it is important to note that even with low amounts of development, the location of that development is critical. For example, if a road is running parallel to a stream or has multiple crossings, there can be significant impacts to water quality and instream habitat, even though it is a small area that causes the effects. This is why it is important to investigate and understand the types of development that are in the watershed and focus efforts to reduce stormwater at critical locations.

Hydrology

Friends Lake is classified by the NYSDEC as a AA-Special (AA-S) waterbody. The designation AA-S states that *"the best usages of Class AA-S waters are: a source of water supply for drinking, culinary or food processing purposes; primary and secondary contact recreation; and fishing. The waters shall be suitable for fish, shellfish and wildlife propagation and survival"(701.3 Class AA-Special (AA-S) fresh surface waters, 6 CRR-NY 701.3NY CRR*). According to this designation:

- These waters shall contain no floating solids, settle able solids, oil, sludge deposits, toxic wastes, deleterious substances, colored or other wastes or heated liquids attributable to sewage, industrial wastes or other wastes.
- There shall be no discharge or disposal of sewage, industrial wastes or other wastes into these waters.
- These waters shall contain no phosphorus and nitrogen in amounts that will result in growths of algae, weeds and slimes that will impair the waters for their best usages.

Figure 4 Northern end of Friends Lake
Image from WCSWCD.

- There shall be no alteration to flow that will impair the waters for their best usages.
- There shall be no increase in turbidity that will cause a substantial visible contrast to natural conditions.

AA-S waterbody classifications indicate that the designated waters are intended to be of high quality. It does not actually mean that the designation is currently being met, but it shall be the standard that the waterbody is held to. Brant Lake, Loon Lake and Lake George are other prominent AA-S waterbodies found in Warren County.

According to the NYSDEC 2014 Citizens Statewide Lake Assessment Program (CSLAP), Friends Lake has relatively high water quality, with low nutrients and algal levels. A lake's water quality designation is derived from the interpretation of several factors including: Trophic State Indices, aquatic plant diversity, pH readings and dissolved oxygen levels.

Friends Lake is 920 feet above mean sea level, with a surface area of 443 acres. The maximum depth found during our survey was 30.1 feet (9.1 m), the average depth of the lake calculated by the NYSDEC is 13.78 feet (4.2 meters).

Larger lakes tend to stratify by temperature layers during the summer months. The top layer (epilimnion) will maintain a relatively steady temperature and levels of dissolved oxygen. The bottom layer (hypolimnion) tends to be increasingly colder with falling levels of dissolved oxygen. The area between these two layers is called the metalimnion or the thermocline; it is an area with the greatest change in temperature over the shortest distance. This transition area between the top and bottom layers prevents the two waters from mixing and exchanging gases or nutrients. Twice a year, as the lakes warm in the spring and cool in the fall, the thermocline will disappear and waters in a lake will exchange places with the surface water falling to the bottom and bottom water rising to the top. This will bring oxygenated water to the bottom of a lake and nutrients from the bottom of the lake to the surface waters, this is the definition of a dimictic lake.

Figure 5 Friends Lake dam, WCSWCD

The retention time for a lake is the theoretical renewal time of the lake's water. For Friends Lake if you could mark a volume of water entering the lake, in theory it would take that unit of water approximately 11 months to flow over the dam. A benefit of this high flushing rate is that it is less likely to have significant bioaccumulation of excessive nutrients or pollutants within the lake if the sources of contamination can be found and eliminated.

The retention time assumes that a waterbody mixes well throughout the year, but in larger lakes during the summer months thermal stratification prevents the mixing of different water layers within the lake. The lake's retention time is formed from a mathematical equation that estimates flow-through times using inflow and outflow volume calculations and lake basin volumes. The NYSDEC estimates that Friends Lake's retention time is 0.9 years.

Dissolved oxygen and temperature readings were taken at two deep sites in Friends Lake during the month of July 2017. **Site 1** was at an area near a major inlet (Chester Creek) in the southern basin. Top layer temperature readings ranged from 79˚ F at the surface to 75˚ F at 13 feet (4 meters); dissolved oxygen (DO) readings ranged from 8.02 mg/L at the surface to 8.2 mg/L at 13 feet in depth. The thermocline was at 16.4 feet (5m) where the lakes temperature dropped from 75˚ F to 65˚ F in just over 6 feet; the bottom layer temperature ranged from 65˚ F to 63˚ F ; dissolved oxygen levels ranged from 6.3 mg/L to 0.7 mg/L a couple of feet off the bottom of the lake. **Site 2** was at the area known for maximum depth in Friends Lake. Temperatures ranged from 78˚ F at the surface to 75˚ F at 13 feet (4 meters); dissolved oxygen (DO) readings ranged from 8.3 mg/L at the surface to 8.4 mg/L at 13 feet in depth; the reading within the thermocline were consistent with the Site 1 readings. The bottom layer temperature ranged from 65˚ F to 60˚ F three feet from the bottom; dissolved oxygen levels ranged from 6.7 mg/L to 0.7 mg/L a couple of feet off the bottom. These readings are what we would expect to see at this time of year in Friends Lake.

Water clarity in Friends Lake was measured using a Secchi Disc. The mean depth between the two deep sites was 16.4 feet (5 meters). A Secchi reading can be used to estimate (roughly: Secchi depth X 2.5) the light extinction depth, which is the water depth that receives less than 1% of the sunlight entering the lake. These readings tell us that light is able to penetrate to the deepest portions of Friends Lake. Water clarity will fluctuate over the course of a year and over a period of years. This fluctuation can result from a number of natural phenomena such as algae blooms, zooplankton blooms, flooding, drought, temperature changes, species introduction, pollution and dredging. There are many documented cases of water clarity decreases, as well as when clarity increases. This is why long-term monitoring is so important to understanding the dynamics of water-bodies.

Streams

There are several permanent and intermittent streams located within this watershed, and in general, streams take on the classification of the receiving water. If a stream is not listed on the classification map and it runs year round, it takes on the waterbody classification of the receiving water (the waterbody it flows into), in which case a permit is needed to undertake any type of work in the stream. If the stream does not flow year round, then it falls into a "D" classification. A "D" classification *does not* require you to obtain a NYSDEC permit to do work, but does hold you to a "no contravention of water quality" standard. That is, if work is done and it affects a waterbody downstream (sedimentation, water clarity, etc.), then whomever did the work and is in charge of the project is liable for the damage to the affected waterbody. A good reference site for waterbody classifications is the NYSDEC Environmental Resource Mapper at http://www.dec.ny.gov/gis/erm/.

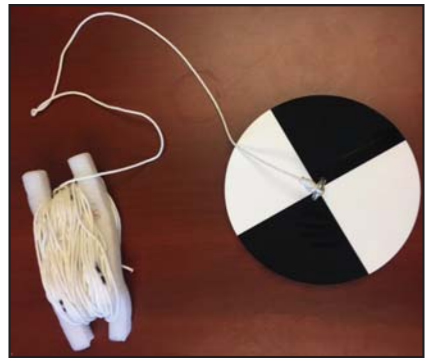


Figure 6 Secchi disk, WCSWCD

Figure 7 Outflow from Sullivan Pond, WCSWCD

Many of the streams within this watershed are cold water streams that harbor species such as the Eastern Brook Trout (*Salvelinus fontinalis*), Mottled Sculpin (*Cotus bairdii*) and the Eastern Blacknose Dace (*Rhinichthys atratulus*). These species, along with the macroinvertebrate community that primarily include stoneflies, caddis flies and mayflies are very sensitive to changes in water quality. In many cases, it is not necessarily the nutrient levels in water chemistry that cause a change, but the effects of water temperature fluctuation. Steering stormwater runoff directly to the stream without any mitigation or treatment can influence a streams daily mean temperature. Summer rainstorms, particularly summertime thunderstorms, can be disruptive to roadside stream ecology. The first flush of stormwater runoff flowing from the hot road pavement carries not only all of the automotive by-products, but "super-heated water." Now this is a relative term, most rainwater will be slightly cooler than the ambient air temperature, but after running off the blacktop, it will reach temperatures well over 100˚ F. Many of the streams in our area maintain flow throughout the summer with the aid of groundwater. As groundwater temperatures range between 55˚ F and 60˚ F in upstate New York. Heated stormwater runoff that passes directly to our streams can affect nearly every species. Changes in stream temperatures affect algae production, incubation times of eggs, oxygen levels of the waters, and the meta-

Figure 8 Brook Trout, Image from NYSDEC

bolic and photosynthetic processes of both animals and plants. Distinct changes in a stream's average temperature will lead to the loss of one group of species and promote the recruitment of another. Fish species that are more tolerant of warmer waters include, but are not limited to: Creek Chub (*Semotilus atromaculatus*), Golden Shiner (*Notemigonus crysoleucas*), Longnose Dace (*Rhinichthys cataractae*), Sunfish (*Lepomis sp.*), Bullhead (*Ameiurus sp.*) and Chain Pickerel (*Esox niger*). When water quality or habitats change, the general ecology of a stream will be altered to a new regime, this put simply is "survival of the fittest" and a stream or a section can quickly change from a cold water to a warm water system.

A contributing factor to the health of feeder streams are the road-stream passage structures. A properly sized culvert or bridge will aid in maintaining the integrity of a stream and its banks. Undersized crossings will result in damming of the higher flows, leading to flooding upstream and a slowing of the flow, which will then cause the stream to deposit material in front of the culvert. Downstream of the culvert, flow velocity will be increased (like a high pressure fire hose). These higher velocities will scour the streambed and banks directly below the culvert, mobilizing large amounts of sediment in the stream. This leads to a degradation of stream conditions and increased delta formation within the lake. Undersized and/ or poorly placed culverts will also prevent the passage of aquatic organisms from moving freely up and down stream. This inhibits the recruitment of native species, precludes access to reproduction areas and causes segmentation of watershed streams.

Figure 9 Outflow from dam, WCSWCD

Natural alterations within a stream channel can occur from such events as windstorms, torrential rains, beavers or wildfires. Human actions such as improper resource protection with regards to development, inadequate stream crossing structures or road construction projects may also cause alterations. Development will generally have an impact to a watershed, but proper resource protections, which include runoff and erosion controls, will help minimize the impacts.

<u>Wetlands</u>

Wetlands are a familiar landform in the Adirondacks. Within the Friends Lake Watershed, the National Land Classification Database estimates that wetlands make up 3% of the land. Mapped Adirondack Park Agency wetlands total 231 acres, while there are 601 acres of US Army Corps of Engineers (USACoE) wetlands. Most of these wetland areas overlap the agencies and the USACoE includes the entirety of Friends Lake, but note it is likely that there are additional unmapped/unclassified wetlands within the watershed. Wetlands are identified using a variety of techniques; which include groundwater, subsurface soil color and existing vegetation. Wetlands do not always need to have standing water and if you research land forms categorized as wetlands, there are many types that fall into the wetland category (i.e. wet meadows). Wetlands provide many positive benefits which include habitat diversity, nutrient uptake and flood retention/mitigation.

Figure 10 Wetland, WCSWCD

Wildlife

It was noted that of the 3,526 acres that encompass Friends Lake Watershed, only 119 acres are considered developed land. Land development is essential for understanding how species react to loss of habitat, fragmentation or direct impacts from building. Habitat fragmentation is when a division of large continuous habitats are separated into smaller isolated habitats by building infrastructure such as roads or bridges. Natural barriers such as streams also exist within the watershed. Friends Lake has about 14.9 miles of roads and 9.6 miles of streams or natural barriers within the watershed. Friends Lake Watershed is considered to have low development rates and still provides adequate space or habitat for a variety of species.

Figure 11 Common Loon
Image from Dean Moore

Within wetter areas, its is not uncommon to find Beaver (*Castor Canadensis)* damming a stream. Other common mammals found near Friends Lake, are the Fisher (*Martes pennant*) and white-tailed deer (*Odocoileus virginianus)* which utilize various habitats in the watershed prey on smaller mammals and fish. Another species that can be found within these areas is the Porcupine (*Erethizon dorsatum*). They feed on the cambium layer of the tree, just under the bark. This can kill a tree and is commonly referred to as *girdling*. Porcupines are not social creatures and when attacked, have the ability to release up to 30,000 quils at a time. Contrary to popular myth, they cannot throw or shoot quills.

Figure 12 Belted King Fisher
Photo Courtesy of Terry Allen

Figure 13 White-tailed deer
Image from Jim lleberum

The Belted kingfisher (*Ceryle alcyon*) is distinct for its rattling call and can be seen along flat water near deep sandy banks (http://www.adirondackalmanack.com/2012/04/adirondack-wildlife-the-belted-kingfisher.html). It should be noted that the majority of the shoreline along Friends Lake is generally undeveloped, making the area adequate nesting grounds for this species. Other birds such as the Great Blue Heron (*Ardea herodias)* and the Common Loon (*Gavia immer)* are found within the Watershed. Commonly seen amphibians and reptiles include the Blue Spotted Salamander (*Ambystoma laterale*), *Red Spotted Newt (Notophthalmus viridescens*), Green Frog (*Lithobates clamitans*), Bullfrog (*Lithobates catesbeianus*), the Snapping Turtle (*Chelydra serpentina*), and the Painted Turtle (*Chrysemys picta).*

Fisheries

Natural shorelines are a critical component for making the connection between shallow aquatic areas of a waterbody and the bordering uplands. These areas are also know as riparian zones, and they help to protect water quality and provide critical habitat for organisms. Shoreline development can disrupt and threaten the survival of these aquatic and terrestrial species that depend on these habitats. Prominent fish species of the Adirondack Park are the Eastern Brook Trout, Round Whitefish (*Prosopium cylindraceum)*, Black Nose Dace, White Sucker (*Catostomus commersonii)*, and Brown Bullhead (*Ictalurus nebulosus)*. The New York State Museum has records dating back to the original fish survey conducted on Friends Lake in 1932. The survey concluded that Northern Pike (*Esox Lucius)*, Banded Killifish (*Fundulus diaphanous)*, Brown Bullhead (*Ictalurus nebulosus),* Redbreast Sunfish (*Lepomis auritus)*, Largemouth Bass (*Micropterus salmoides*), Smallmouth Bass (*Micropterus dolomieui)*, Golden Shiner, and Yellow Perch (*Perca flavescens)* were present.

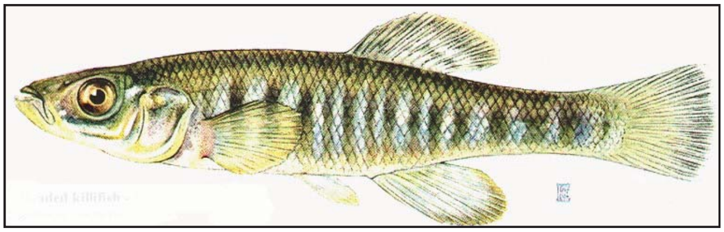


Figure 14 Banded Killifish, Rob Fiorentino

Figure 15 Yellow Perch, Smithsonian Environmental Research Center

In 1974, the NYSDEC conducted a minnow survey for rare species of fish, but only the White Sucker and Golden Shiners were found. A survey in 1984 sampled larger fish species within the lake by using a gill net to capture multiple species. The sampling revealed the greatest diversity of fish species since the original survey in 1932 which included Northern Pike, Creek Chub, Brown Bullhead, Rock Bass (*Ambloplites rupestris)*, Largemouth Bass, and Yellow Perch. Although Largemouth Bass are a native species to North America, they were introduced to the entire Upper Hudson River Watershed (which includes Friends Lake). It was assumed that the species found in 1984 are similar to the larger fish species found in the lake today. In addition to the 1984 study, a 2008 study was conducted for species as well. Golden Shiners, Banded Killifish, Brindle Shiner (*Notropis bifrenatus),* and Pumpkinseed (*Lepomis gibbosus)* were the only species reported in the survey. Overall, Friends Lake exhibits a fish population that is characteristic to many other Adirondack lakes.

Figure 16 Golden Shiner,
Courtesy of Uland Thomas

Watershed Soils

Soils within a watershed and along a shoreline lay the framework that all land uses are based upon. They have a direct correlation to the type of land uses that may be suitable for a particular location. Mineral and rock particles, decayed organic matter, live organisms, and space for air and water are the four major components that make up soil. Soils are a key component in understanding stormwater management, erosion and sediment control. There are specific characteristics or properties to soil such as porosity and its physical make up such as sand, silt, and clay. Understanding the uniqueness in the soil within the watershed can encourage effective land management practices for future infrastructure.

Figure 17 Soils atypical of Warren County, Hydrologic Soil Group D, WCSWCD

A group of soils having the same runoff potential under similar storms and cover conditions are considered to be a Hydrologic soil group (HSG). HSGs are used in equations that estimate runoff from rainfall. Soil properties that influence runoff potential are those that influence the minimum rate of infiltration for a bare soil after prolonged wetting and freezing. The soils of the U.S. are placed into four groups A, B, C, and D. Definitions of the classes are as follows:

Hydrologic Soil Groups	Area (Ac)	Percent Area
Water	489	13.90%
A	73	2.10%
B	2343	66.40%
C	3	0.10%
D	121	3.40%
A/D	219	6.20%
B/D	209	5.90%
C/D	69	0.0
Sum	**3,526.21**	**100%**

Table 2 Hydrologic Soil Groups in relation to acreage and percent land cover.

A. Soils with low runoff potential. Soils having high infiltration rates even when wetted and consisting chiefly of deep, well drained to excessively well-drained sands or gravels.

B. Soils having moderate infiltration rates even when thoroughly wetted and consisting chiefly of moderately deep to deep, moderately well drained to well drained soils with moderately fine to moderately coarse textures.

C. Soils having slow infiltration rates even when thoroughly wetted and consisting chiefly of soils with a layer that impedes downward movement of water, or soils with moderately fine to fine textures.

D. Soils with high runoff potential. Soils having very slow infiltration rates even when thoroughly wetted and consisting chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material.

(From www.nesoil.com)

Very sandy soils (A) have a high infiltration rating allowing precipitation to pass quickly through the soil layers to the groundwater table. Soils with high clay content (D) have the opposite issue in terms of infiltration. The runoff potential is very high with clay soils due to the fine particulate sizes that reduce the interstitial space preventing water from filling the voids and infiltrating to the groundwater table. Soil (B) covered the largest area within the Friends Lake Watershed, totaling 66.4% of the area. B soils have a low runoff potential when fully wet.

A quick evaluation of the watershed HSG's indicates that 20% of the soil is Hydrologic Soil Group D or in soil groups that have a duel rating (A/D, B/D or C/D). If a soil has a dual rating, it is understood when soils are thoroughly wetted and are in an undrained condition, they perform as D rated soils. Soils with a high runoff potential and a slow infiltration rate lead to a decreased lag time for stormwater runoff throughout the watershed. Lag time is the period between precipitation hitting the ground and its flow to a waterway. Usually this may be one of the more important issues in the watershed as far as increased runoff rates during events. That being said, it is reasonable to assume that no homes or roads will be moved, but modifications to existing homes may be encouraged. If the soils are appropriate and there is sufficient area to work in, then landowners may consider low impact ways to reduce runoff, which has several positive benefits.

Figure 18 Example of coarse, sandy soils typical of Warren County (Hydrologic Soil Group A), WCSWCD

First is that there is a reduction in water quantity (volume). There are numerous ditches that drain the roadways, many of them with asphalt swales to guide water away from homes. However, these swales do not allow for any reduction in water volume. Many homes and driveways in the watershed slope towards a road, which allows their excess water to flow from their property. In some cases it may be necessary if there is too much water and it is causing an issue with a septic system or a basement. However, it is likely that many landowners believe that it is necessary to get water away as fast as possible. Infiltration of rainfall and snowmelt is extremely important to maintain groundwater levels during summer and early fall season. Without that, the groundwater water levels may drop, which will stress vegetation, including lawns.

Secondly with a reduction in water volume, there will likely be a reduction in the nutrients, sediment and bacteria that typically runs off of developed land. There are potentially several sources of nutrients in our watersheds with atmospheric deposition, fertilizers and improperly functioning septic systems being the most common. Sediment will come from unprotected areas without vegetation or from winter roadside maintenance activities. While nutrient inputs such as phosphorus and nitrogen may originate and runoff from soils, fertilizers or septic effluent.

Watershed Slope

The average slope of this watershed is approximately 12.6%. Development on steep slopes can cause particular challenges and potentially increase resource impacts. The NYSDEC defines steep slopes as greater than 25% (1:4, rise/run).

Slopes play a critical role in stormwater runoff as common sense would dictate that the steeper a slope, the faster the water can travel. In addition, increased velocity has the potential for greater erosion.

Figure 19 Example of steep, sandy streambank on Schroon River, WCSWCD

Depending on the construction regulations, there is the potential for significant stormwater inputs from even a fairly level developed lot. Vegetating disturbed slopes is especially important to reduce the loss of soil and negative water quality impacts.

In Chester, there are a three specific codes pertaining to slope: First on any new development of land above 1,400 feet in elevation *or* on a slope of 15% or more, shall require planning board review and approval. A second town regulation pertains to the development of water-front access properties with slopes that exceed 25% grade. Slopes on Waterfront Access lots cannot exceed 25% over 25% of surface area of a waterfront access lot.   Any proposal to exceed this thresh-old may require additional planning and/or zoning board review and approval. A third regulation states '*There shall be no grading within 10 feet from the top of the slope of any stream bed or drain-age way*'. This is for the protection of bed and banks of a stream.

Class	Acres	%	Acres/no lake	% (no lake)
0-3%	661	19%	219	7%
3-8%	806	23%	806	26%
8-15%	900	26%	900	29%
15-25%	710	20%	710	23%
25-35%	287	8%	287	9%
>35%	162	5%	162	5%
	3526	**100%**	**3084**	**100%**

Table 3 Percent slope by Class

When looking to stabilize land disturbances, one cannot just use the average of the watershed slope since there will be a number of locations that will exceed the average. Slope is an often over-looked consideration when any land disturbance occurs due to the potential difficulty of stabiliza-tion and water movement. Stabilizing a steep hillside requires additional practices and mainte-nance to ensure long term stability.

Geology

Figure 20 Quartz, WCSWCD

Glacial topography shaped the drainage system of the Adirondack region from the accumulated debris and melting ice. Adirondack soils are considered to be young, developed only 10,000 years ago when the last glacial retreat occurred. The debris from ice formed lakes and ponds by damming rivers. However, even though this retreat was considered a major event, the Adirondack Park remained relatively unchanged by glaciation. According to the Adirondack Park Agency (APA), roughly 30,000 miles of streams surfaced and took the paths of least resistance through the moun-tains and forests of the Adirondacks, allowing for the streams to merge within a watershed. Gneiss is the most common type of bedrock found within the park and around the Friends Lake Watershed area. Gneiss was formed during the metamorphic process of an existing igneous rock. Granite is also found within the watershed, but was formed from igneous rock which is comprised of quartz, mica and feldspar.

Stormwater Runoff

A concern in any watershed is the impact of stormwater runoff on the nearby water bodies. Along roadways, driveways, rooftops and parking areas, runoff is often channeled into drains and pipes, which frequently outlet directly into a stream or a lake. Impervious surfaces such as concrete, as-phalt or compacted soils do not allow water from precipitation or snowmelt to infiltrate into the ground. As the water courses across these surfaces, it can collect sediment, phosphorus, de-icing materials (sand and salt), petrochemicals, fertilizers, herbicides and other pollutants.


Figure 21 Inspection of a roadside culvert crossing, WCSWCD

Roadside ditches also contribute to stormwater runoff issues when improperly installed or poorly maintained. A poor roadside ditch can increase stormwater runoff velocity leading to increased erosion and sedimentation. During summer months this runoff can also be significantly warmer than the stream's water. Warmer water will cause thermal pollution and overtime effect the stream's aquatic communities.

Stormwater discharges are a major contributor to stream sedimentation and delta formation in lakes, and can also have significant negative impacts on aquatic communities. Calcium from road salt can create enhanced conditions at the mouths of streams suitable for the colonization of zebra mussels. Phosphorus transportation by sediment creates multiple problems including the eutrophication of water bodies, increased habitat for invasive aquatic plants and animals and cause a general reduction in water quality. This runoff directly affects the stream systems long-term stability.

As land becomes more developed from urbanization or expanded use, typically more water runs off into nearby streams following a precipitation event. This increased volume entering a stream in a short period of time, can cause an over widening of the stream channel in order to accommodate the increase in volume. These channel widening processes occur through accelerated stream bank erosion and ultimately contribute to more downstream deposition, referred to as deltas.

Streambank/In-stream Effects

Streams are the transport mechanism within a watershed for two major constituents: water and sediment. In an undisturbed watershed, a stream will achieve a balance. Stream course will move gradually with the erosion of banks and the stream bottom during high flows. Sediment will then be deposited with the gradual slowing of the flow. These changes occur slowly over long periods of time. Changes in the flow path will occur both horizontally and vertically, depending on the slope and substrate of its route and the condition of the vegetation along its banks. Streams meander in order to reduce the velocity and the amount of sediment they carry. When a stream becomes disconnected from flood plains or when changes within the watershed increase the amount of stormwater runoff, the ability of the stream to reduce its velocity is severely limited.

Flood plains are areas of land that act as depositories of large amounts of inorganic and organic materials carried during periods of high flow. Since they are generally flat broad areas, flood plains have been sought out as ideal building locations. In addition to the loss of developed flood plains, there is usually a removal of vegetation within the riparian zone (the area adjacent to the land – water interface) that secures the stream banks and mitigates stormwater runoff within a watershed. A decrease in total area of flood plains within a watershed, can cause vast amounts of damage to a stream system, with problems above and below the initial impacted area. Increased stream velocities will scour and deepen a channel as faster moving water transports sediment from the streambed, downstream. This situation is known as a degradation of the stream channel. Changes to a stream can cause an imbalance between the stream and its components.

Figure 22 Example of center bar deposition
Courtesy of Delaware County SWCD

A degrading stream channel can lead to the destruction of the stream, wetland, and riparian habitat balance. Bank failures may occur when streambanks become too high and steep, which ultimately results in an unstable or an undermined bank that collapses into the stream, creating a wider, shallower channel. The addition of excessive sediment will cause an aggrading of the stream channel. The sediment that is transported downstream gradually rebuilds the streambed in an effort to reach equilibrium. Too much deposition of material, can cause various types of impediments in a stream such as gravel bars. Depositional bars such as channel or transverse bars can cause an alteration to the stream flow regime and its ability to transport sediment, also having negative impacts to the system.

Development

When evaluating development in a watershed there are numerous factors that can be investigated which can have impacts to the natural resources including land use, vegetation cover, soil type (HSG), slope, topography and drainage network patterns. A search of the 2016 GIS real property data reveals that there are 484 parcels or portions of parcels within the watershed. Undeveloped parcels account for 37% of these parcels (178), leaving 306 parcels with some form of development (home, garage, other structure).

Typically in Warren County, a majority of structures were built in the post World War II years and this era is generally identified as the 1950s and 1960's. However in the Friends Lake Watershed, 35% of the development occurred in the 1960's and 1970's. During that period there were few if any ordinances that required developers to account for stormwater runoff. This is a main reason why many associations or local municipalities are developing plans and assessments to use as a planning tool for future developments and to address current issues.

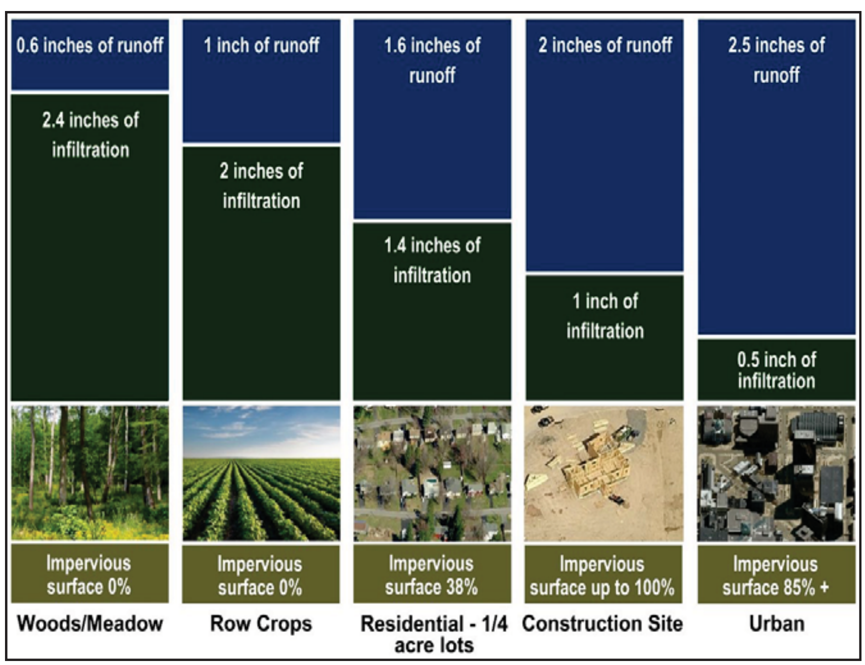


Figure 23 Represents the infiltration rate based on common impervious surfaces.
Image from the New York State Department of Environmental Conservation.

With proper development and stormwater controls, much of the concern of stormwater can be mitigated relatively easily. Due to the predominate hydrologic soil group within the watershed (HSG B), water is readily infiltrated into the ground during non-frozen soil conditions. The NYSDEC has used an example of varying development to illustrate the change in hydrology due to impervious surfaces - utilizing a 3 inch rainfall (approximately a 5yr – 24 hour storm event in the watershed) in a woods/meadow site condition (0% impervious) indicates that 2.4 inches of rain will infiltrate into the ground, leaving 0.6 inches as runoff. In a residential ¼ acre lot situation (38% impervious), 1.4 inches of rainfall are infiltrated and 1.65 inches runoff and in an urban situation (85% impervious) 2.5 inches of the 3 inches rainfall is runoff. This makes sense as impervious surfaces collect the runoff and moves the water along to a stormwater conveyance, which generally ends up in a waterbody, as fast as it can flow.

The more development that a watershed has generally will correlate with a decline in water quality. This of course can be altered depending on what proactive and/or remedial activities are utilized. Even though 63% of the watershed parcels are developed, these parcels only account for 28% of the land. Since there is not an impervious surface cover layer to utilize in ArcGIS, we cannot tabulate the actual amount of land that has some sort of cap – roads, roofs, driveways, but regardless it is beneficial for water quality that so much of the watershed is not developed. Another item of note is that 165 parcels are located along the lakeshore and 114 are developed, which translates to 69% lakeshore parcel development.

Along with a noted decline in water quality due to stormwater impacts, it has been suggested that when a watershed achieves 10% of impervious surfaces there:

1. Is an increase in floods and an alteration in stream flow, which directly impact the morphology of a stream.
2. Is increased erosion, leading to loss of trees and vegetation along the banks. At 8% to 10% impervious surface coverage, streams double in the size of the bed due to the increased volume.
3. Increased pollutant loads.
4. Increase in stream temperature which interferes with many biological processes.
5. Increased bacteria, often as a direct source of a high density of household pets.
6. Decreased summer /base flow.
7. Decreased woody debris, a crucial habitat element for aquatic insects.
8. Decrease in substrate quality.
9. Decreased fish passage during dry weather flow periods due to the enlarged stream bed.
10. Decrease in insect and fish diversity. At 12% imperviousness, trout and other sensitive species can no longer survive in the stream. (Developed from http://www.pwconserve.org/issues/watersheds/stormwater/impervious.htm)

Supplementary Regulations for Construction and Disturbance

The Town of Chester complies with the New York State Department of Environmental Conservation Article 7– Supplementary Regulations when there is construction or a disturbance within the Friends Lake Watershed. Section 7.01 *Shoreline Regulations* states that the intent of the regulation is to "minimize the impact to the shoreline environment and its natural character." In order to maintain the shoreline environment and natural character, landowner's must maintain aesthetics by reducing runoff into the waterway and to limit the amount of natural vegetation removed in an area. The town also regulates new commercial development by requiring that the new infrastructure "enhance community character and protect the scenic natural landscape" (Section 7.20 - *Commercial Siting and Design Guidelines).* Enforcing these general rules, will ensure that developers consider the natural landscape, where parking lots are placed and access to them, as well as general guidelines. In addition, when developing within the town, there are natural resource considerations. These natural resources include water, land, air, noise, and critical resource areas. The town requires landowners to understand the objectives behind considering these natural resources. For example, when developing on land an objective to "prevent accelerated soil erosion and the potential for earth slippage" should be prioritized. The result of these types of objectives, guidelines, and regulations will enhance the aesthetics of the town, while also enhancing the community. More information on the regulations and guidelines can be obtained from the Town of Chester.

Figure 24 Stormwater runoff, WCSWCD

Landowner Opportunities

Rain Gardens

According to the University of Rhode Island's Healthy Landscaping program, a rain garden is "a planted depression or a hole that allows rainwater runoff from impervious urban areas, like roofs, driveways, walkways, parking lots, and compacted lawn areas, the opportunity to be absorbed. This reduces rain runoff by allowing stormwater to soak into the ground (as opposed to flowing into storm drains and surface waters which causes erosion, water pollution, flooding, and diminished groundwater). Rain gardens have become quite popular for addressing stormwater runoff for landowners. These are specifically sited to allow water to collect and infiltrate instead of directly running off a property. Specific plants are selected that will thrive and provide water quality benefits. In many rain gardens, plants such as Joe-Pye Weed, New England Aster or various ferns are planted, however the plants should be native to the area to ensure their survival.

Figure 25 Rain garden on Lake George, Photo courtesy of LGA

Infiltration Structures

When impervious structures are placed on the land, it is estimated that runoff rates climb from 10% to 55%. If a homeowner has the ability to infiltrate water on their own property, and is willing to do so, it would be a positive impact to any watershed. Reducing the potential peak rate of discharge to a ditch or stream will result in a decrease in erosion and downstream impacts. There are various types of infiltration structures including drywells and stormwater infiltration chambers.

Figure 26 Residential infiltration, The Code Store, United Kingdom

If the soil conditions allow for infiltration, then roof gutters and driveway runoff may be directed to an infiltration structure. This will help reduce downstream volumes and will aid in recharging the groundwater. These structures may require some maintenance depending on the amount of sediment and debris they receive.

Grassed Swales

Put simply, a grassed swale is a low area that collects water and allows for infiltration and nutrient uptake. Swales can be very effective in treating stormwater as they can detain water for periods of time allowing vegetation to readily utilize the water and phosphorus. These are minor practices and can be successfully installed in many locations on a property. A swale may be wet or dry.

Figure 27 Grassed swale, Virginia Cooperative Extension

Permeable Paving

Permeable paving is comprised of various designs and materials. The idea behind this practice is to allow the movement of water through a previously impervious surface. Some examples of where permeable paving may be utilized are: roads, multimodal paths, emergency access lanes, road shoulders, parking lots and residential sidewalks and driveways. Permeable paving may refer to paving stones, blocks, asphalt or concrete.

There is an increase in the number of examples in the Lake George area where this practice has been installed, with the largest project being Beach Road. The University of New Hampshire has done extensive research in the subject and have an excellent video of porous concrete posted at http://www.youtube.com/watch?v=ScsQYHMfabU

Cisterns and Rain Barrels

Cisterns and rain barrels function in similar ways. They collect roof water runoff and store it for irrigation. Typically rain barrels are 55 gallons and have an overflow feature. Some landowners will run a series of rain barrels to collect larger volumes of water for use. Rain barrels are available from a variety of companies, but are also very easy to make and can be a simple and fun family project.

Figure 28 Rain Barrel, WCSWCD

Cisterns are larger containers that can capture and store significant volumes of water. These are structures that are generally placed in the ground and utilize pumps for pressurized water. In arid regions, many landowners utilize cisterns for drinking water and in the less arid regions, they may be utilized for irrigation or fire suppression. Larger cisterns can store 10,000 gallons of water.

Streambank Buffers

Along many of the streams, lakes or wetlands where homes are located, some landowners mow their yards to the water's edge. This reduces the stability of the streambank or lakeshore as only the root system from turf grasses are holding the soil in place. In some locations buffers can be a challenge to encourage, since landowners may view shrubs and tall grasses or vines as aesthetically unpleasing, especially in a yard that is mowed and has numerous flower beds. This vegetation along a waterbody is extremely important as it provides additional rooting systems to stabilize the soil and allows for sediment to be deposited, water to infiltrate and nutrients to be taken up by the vegetation.

Figure 29 Residential lakeshore buffer
Photo courtesy of LGA

There are several plants that one can select to provide benefits. Shrubs can include Buttonbush, Common Elderberry, Silky Dogwood, and Arrow Wood. Lower growing vegetation can include species of ferns or sedges and many native wildflower such as Beebalm, Spotted Joe-Pye Weed, Milkweed and New York Aster (for more information, please contact the Warren County SWCD or Lake George Association).

Other benefits of buffer plantings are a decrease in the amount of sunlight that is hitting the surface of the stream. By cooling the water, the plants are utilized by many birds and insects for habitat, while also creating a visual barrier from the road. Some maintenance may be required as many non-native plant species are found in the Warren County and they will try and propagate in the buffer area. These species can include Phragmites, Japanese Knotweed, Garlic Mustard, non-native honeysuckles, Oriental Bittersweet and Purple Loosestrife. Routine inspection and removal of these plants will ensure a healthy diverse streambank buffer that will benefit the aquatic organisms and downstream landowners.

The Lawn Factor

In general it is recommended that an overall reduction in the amount lawns may be warranted, especially when the watershed is steeply sloped, or is lacking in canopy cover or woody vegetation. However, if a landowner desires to maintain a lawn, it can be done responsibly. Many homes have a sizeable lawn that is made up of common turfgrasses. These grasses are effective at filtering out sediment and increasing infiltration, but as with most things, maintaining it's health is the key to reap those benefits.

It is important to recognize that not all parts of a lawn are the same. There are some areas in a yard that likely only have foot traffic when it is being mowed and in other areas the turf is worn, as it is tromped on daily. The soil becomes compacted in those locations reducing infiltration and the health of the grass. When a lawn is not managed properly, it can become thin and erosion can occur. In order to reduce compaction and keep turf density high, annual aeration of heavily used areas is recommended. In addition to aeration, the District strongly suggests a soils test be done to evaluate the nutritional health the soil. It is not uncommon to find that certain nutrients are either under or over applied, both of which can have negative water quality consequences. A correct fertilizer application (including timing) can provide the boost and long term vigor for a lawn and other upland plants, and can reduce stormwater impacts.

Another effective way to improve a lawn's health would be to consider using compost as a soil amendment. If you have clay soils, a good compost will improve the soil structure, reduce compaction, promote infiltration and drainage and provide necessary nutrients. In sandy soils, water and nutrient availability increases. This is a holistic approach that improves the establishment of a healthy root system and the overall health of the turfgrass. This effort if done properly, should reduce the reliance on fertilizers and pesticides. This management starts with a soils test that identifies what the needs of the soils and plants are.

Septic System Maintenance

A properly designed, installed and maintained septic system can provide years of service for a residence. However if the septic tank and drain field are not functioning together then a multitude of issues may occur, which may impact the water quality.

Figure 30 Surface septic failure
Image courtesy of EPA and King County, WA

There are two types of septic failures that may occur: surface and subsurface. The surface failure is one that many people would recognize. A dark water that appears on the ground around their septic system, especially with a foul odor, is typical of a surface failure this is the more easily recognizable failure. A subsurface failure is more difficult to ascertain as it is below the ground. If a local waterbody has experienced an increase in productivity, and there are no other potential source of nutrients, then the septic system may have a subsurface failure. Nutrient and bacterial testing may be needed to confirm this.

In order to reduce the likelihood of a septic failure, routine maintenance needs to be conducted. The first step is to identify the style and the location of the system. Understand how your system is designed to function (i.e. is it a traditional system, is it a dosing system, is it gravelless) and if there are any special requirements. In general it is good to pump out and inspect a system every 3-5 years. If there is a food waste grinder or additional people in the house long term, then the pump out frequency should be increased. Reduce the use of harsh chemical going to the system for treatment. Many household items that are used should not be disposed of down a drain, and that goes for too many antibacterial products. The antibacterial soaps cannot differentiate between "good" or "bad" bacteria, and an excessive amount in a septic system can kill off the good bacteria that help the system function. To find out more about septic systems, visit http://www.soil.ncsu.edu/publications/Soilfacts/AG-439-13/ or contact the Town of Chester.

Municipal Storm Water Mapping and Retrofit Recommendations

Figure 31 Culvert that is full of sediment and debris, WCSWCD

Recommendations to the state, county and town highway departments are for the continued use of best management practices (BMP's) for the reduction and/or treatment of stormwater runoff. Reducing the bulk of stormwater being introduced to the numerous streams within the Friends Lake Watershed is paramount to keeping both the lake and its tributaries in the best possible condition. The most effective practice the local municipalities can do for water quality is to have a properly constructed stormwater convenience system. The critical components are correctly sized and vegetated roadside ditches, hydroseeding of newly formed ditches, and check dams on the steeper slopes. In addition, the municipalities should install infiltration structures wherever possible and reduce the number of the direct turnouts from the roads to the stream. The more efficient application of winter de-icing materials is also an important discussion to have with town officials. Excessive amounts of sand and salt will have negative effects on the health of streams. Encouraging the municipalities to use BMP's will improve water quality conditions within the watershed.

Lake Water Quality Monitoring

Landowners have followed through on nearly every recommendation to lake associations for resource protection. Friends Lake has conducted aquatic plant surveys, invasive plant reconnaissance, managed to participate in programs such as the NYSDEC's Citizen Statewide Lake Assessment Program (CSLAP) and Adirondack Lake Alliance, and become members of the New York State Federation of Lake Associations (NYSFOLA). Landowners should continue to stay informed by talking to neighbors and friends about concerns around the lake. The more information lakeshore owners have, the more vigilant they can be about water quality trends and threats that may be occurring.

Septic Systems

One of the single largest expenditures for landowners after the purchase and upkeep of their home is the septic system. An individual's tank maintenance cost may be reduced by organizing interested association members, neighborhood groups, or road associations into a contracted lump sum bid. If a number of households agree to service their systems during a specified contract period, they can often negotiate a more favorable rate with local waste haulers.

Private Road Maintenance and Road Crossing Structures

There are a considerable amount of private roads that surround the shoreline of Friends Lake. These unimproved roads should be maintained to reduce the influx of sediment and associated nutrients entering directly into the lake. Maintaining a good crown on unimproved roadways will prevent or reduce rutting and head-cuts that are produced during high flow runoff events. Clearing the roadside ditches and culverts of accumulated sediment and debris will inhibit over-topping of the road

Figure 32 Driveway head-cut, WCSWCD

during those same high flow events. On the steeper sections of unimproved roads or driveways the use of water-bars on the road and check dams in ditches will help to slow stormwater velocity, reduce sediment transport and minimize damage to roadways. Roads that have a year round stream crossings should consider the upsizing of culverts or bridge openings if a history of high event flooding or road topping commonly occurs. Assistance with the sizing of culverts and small bridges can be attained from both the District and the NYSDEC.

It is vital that landowners continue to be a strong advocate for the lake, as a clearing house for information and as a sounding board for residences. Landowner presence within the community is invaluable. The influence of a strong association with local, county and state agencies can not be overstated. Whether it is the NYS DOT, DEC, APA, Warren County or the Town of Chester a united voice is a strong voice. Interaction within the association is also important by sponsoring informational talks, hosting water quality workshops and keeping open lines of communication within the association's membership.

Local Governmental Support

Figure 33 Roadside culvert crossing, WCSWCD

Whether you were born to the property or moved here, property taxes provide support from agencies in the area. Contact those agencies that are here for support whether it's Cornell Cooperative Extension, Warren County Soil & Water Conservation District, NYSDEC or Warren County or Town of Chester Boards and Highway Departments. Cornell Cooperative Extension is a source for educational materials on a number of subjects including septic system workings, maintenance, failures and water saving practices. CCE provides recommendations on soil health and evaluations for lawn fertilization and native plants. They can be contacted at the Warrensburg office at 518.623.3291. Warren County Soil & Water Conservation District is the contact for stormwater related issues, stream and lake habitat improvement and remediation, roadside ditch enhancement and vegetation, invasive species identification, green infrastructure and assistance with permitting for other governmental agencies. The office is located in Warrensburg, the phone number is 518.623.3119. New York State Department of Environmental Conservation is an invaluable resource for free information to the land owners within the state. All issues relating to water quality, wildlife, invasive species, land use development and permitting all fall under the purview of NYSDEC. The NYSDEC region 5 local contact number is 518.623.1200. Town of Chester Supervisor and Town Board are representatives for the community on the county board. Though the majority of the public roads within the Friends Lake Watershed are maintained by the Warren County Department of Public Works, the Town of Chester Supervisor voices community concerns to the board. Work with your supervisor and town board on any concerns with roadway maintenance, stormwater ditching and de-icing practices on roads.

Site Specific Recommendations

Friends Lake Road

Continued maintenance of roadside ditches and culverts is necessary for the proper functioning of the stormwater system. Several culverts along this road have become obstructed with accumulated sediments. Ditches need to be cut to appropriate depths and the newly bared soils re-seeded so they are well vegetated. In addition, check dams need to be properly placed along the steeper sections to slow runoff velocities and the accumulated sediments need to be removed from the culverts. This will prevent the existing ponding at the inflow side of the culverts along the road.

Figure 34 Culvert crossing, WCSWCD

Figure 35 on the northeast side of county route 8 would be an ideal location for erosion and sediment control improvements. It is recommended that there be a more defined vegetated ditch on the east side of the road and to install rock check dams along the pitched roadway. In addition, the existing stormwater runoff path should have a ditch turnout with outfall protection matting. Protective matting should also be installed at the culvert invert from the drop inlet on the opposite side of the road. The addition of a series of stone check dams should be placed in this newly expanded stormwater ditch.

Figure 35 Culvert crossing, WCSWCD

Atateka Road

Seasonal maintenance of the roadside ditches and culverts is necessary for the stormwater system to work. Culverts along this section of the road have become obstructed with accumulated sediments. The buildup of sediment is a direct result of the culverts being undersized and the ditches lacking vegetation. The ditches need to be cut to appropriate depths and the disturbed soils re-seeded to establish vegetation.

Figure 36 Drop inlet, WCSWCD

Hill Park Road

Many of the previously mentioned general roadway recommendations can be put into practice on Hill Park Road. When the time comes for road repairs, three standard practices for well constructed roads should be implemented at this location. The first is the proper crowning of both paved and the connected unpaved road would reduce maintenance upkeep costs, shed stormwater and reduce pot holes. Secondly, once stormwater is off the road, having cleared vegetated ditches to move the water away from the roads is paramount. Third, as the need for new replacement culverts arise, sizing the culverts to handle the spring runoff and large precipitation events will help to reduce road flooding, streambank scour, ditch erosion and decrease sediment to the lake.

The introduction of a bioretention area (rain garden) to take the remaining runoff from lower Hill Park Road near the Hill Park Road Association Beach area will lessen the amount of sediment and associated nutrients entering the lake in Fiddlehead Bay.

<u>McPhillips Pine Lane</u>

General conditions along this road are in good shape. However there are two recommendations for improving the road's condition. The placement and spacing of drainage culverts along the road are well designed, but when the current culverts are in need of replacement the present culverts should be larger. The current 8" or 10" diameter culverts should be upsized to 15"+ diameter culverts. The correctly sized culverts will prevent pooling at the inflow invert and reduce the velocity of the flow leaving the culvert. This will prevent scour of the water way and reduce the amount of sediment flowing toward the lake. On the steep section of the road approximately 0.35 miles southeast from Hill Park Road, the application of water bars should be used to direct stormwater off the road and into the expanded ditches. The use of rock check dams or concrete sediment traps in the ditches at this steeply pitched location will reduce head-cutting on the road, damage to the ditches, and decrease sediment from building at the low end culvert.

Figure 37 Culvert crossing, WCSWCD

Figure 38 Mcphillips Pine Road, WCSWCD

<u>Conclusion</u>

Within many watersheds there are land disturbances that include home building, roads, logging, and agriculture and this watershed is no exception. However even with these circumstances, in general it appears that Friends Lake and its watershed are in a reasonably stable condition. The good news is that there are relatively few site specific issues that were identified during this assessment. These have been noted, along with watershed or lake wide programs that could be considered for implementation.

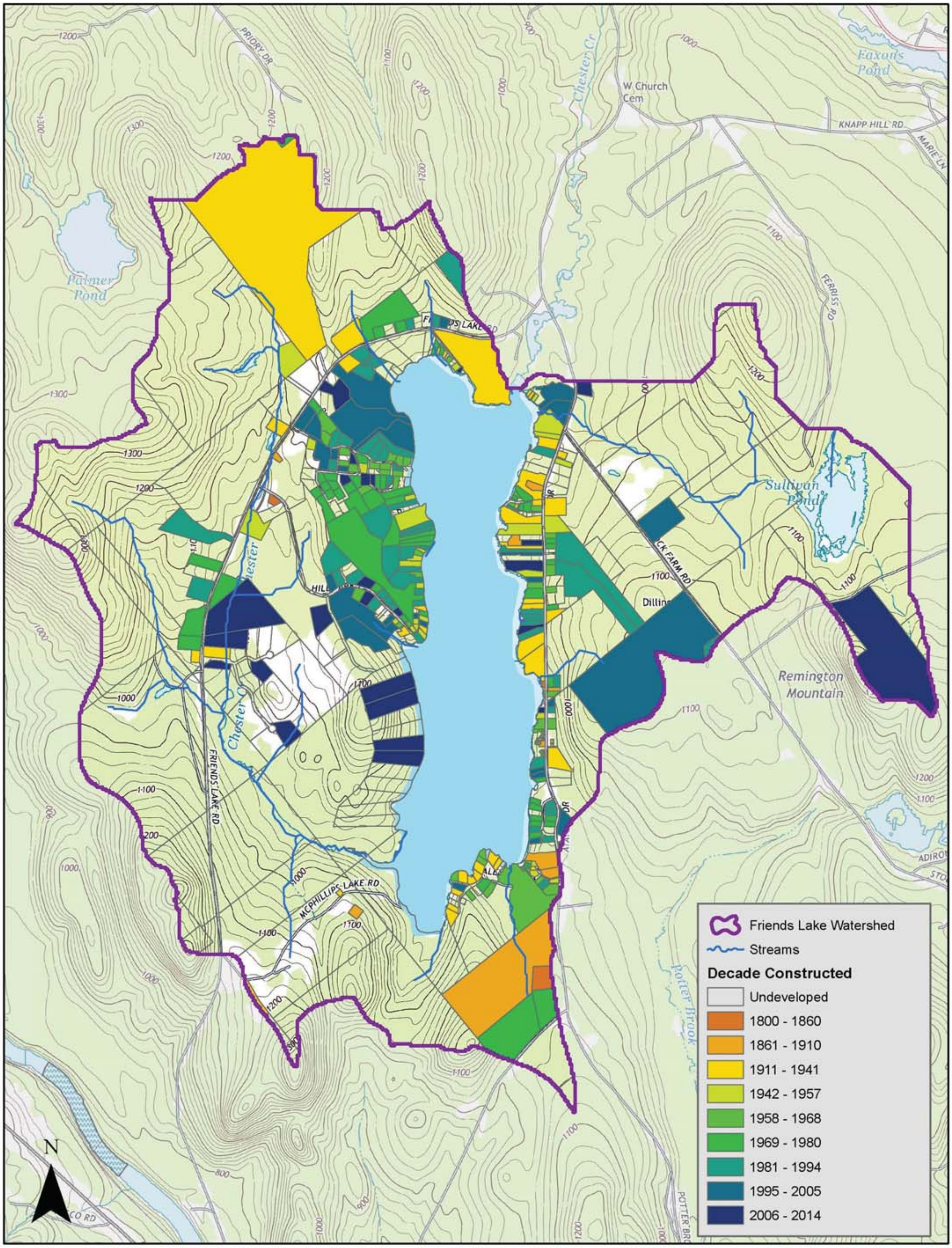
There are several factors for that reason: there is a significant amount of watershed area that is forested, there is a relatively low amount of development and impervious surface, the predominate types of soil in the watershed infiltrates water well, and there are steep slope protections in place from the town. In combination, these factors are a benefit to water quality.

Figure 39 Culvert crossing, WCSWCD

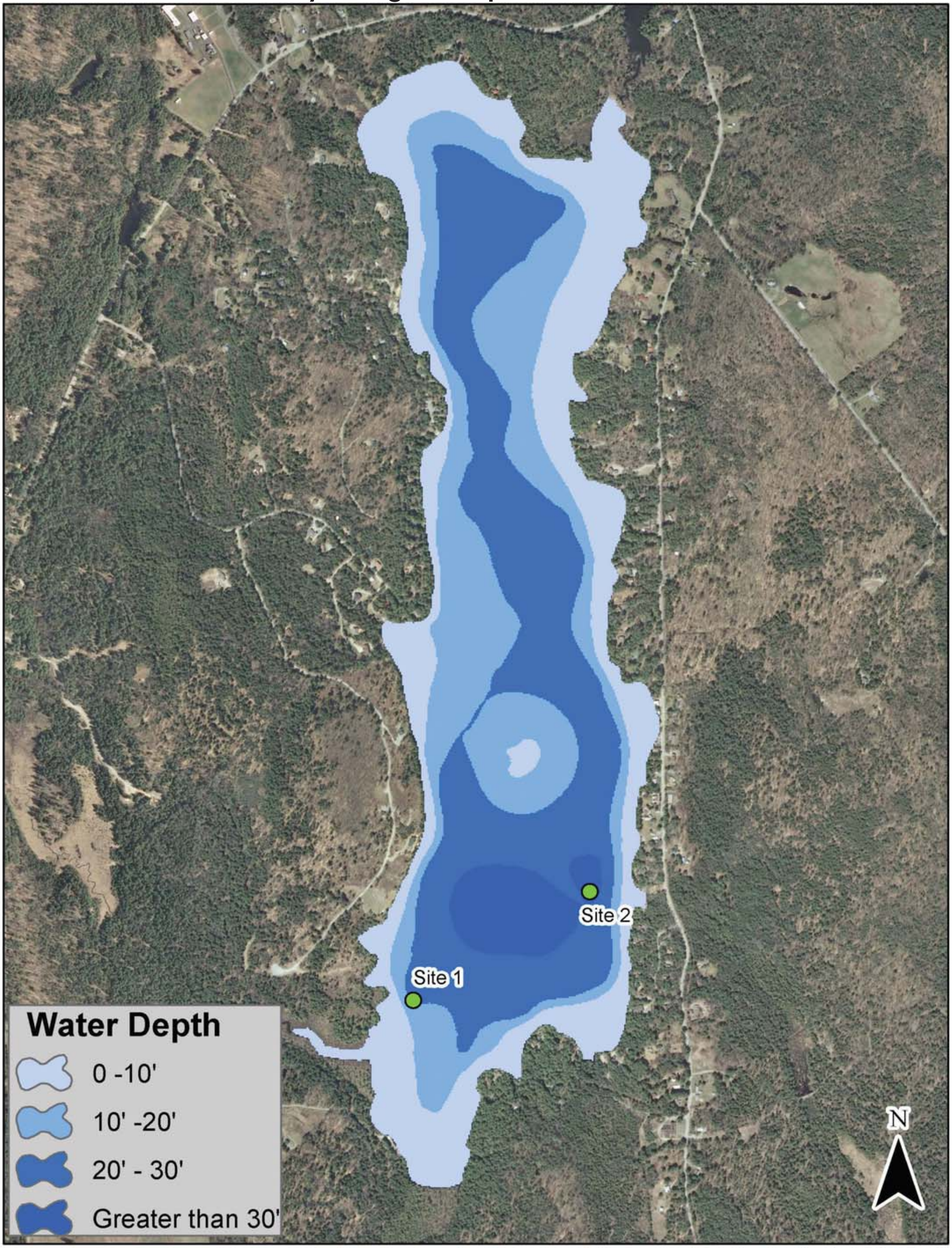
Changes can quickly occur as development increases and the potential for subdividing and creating smaller lots becomes more prevalent. It may be a challenge to maintain the current status quo, therefore, it is imperative that landowners, association members and the town work together to continually identify potential issues. Sources of concern, which may occur over time or happen due to an event, include development trends, invasive species, and severe storm impacting stream beds and roadways. Therefore, it is necessary to determine the appropriate strategies to reduce resource impacts and implement that corrective action.

Remember that this assessment is developed to be used as a guide to remediate existing issues and to reduce future impacts to the lake and its watershed. It is a dynamic document to be revised and updated as necessary to meet the needs of the watershed and the future generations that will benefit from Friends Lake and its surroundings.

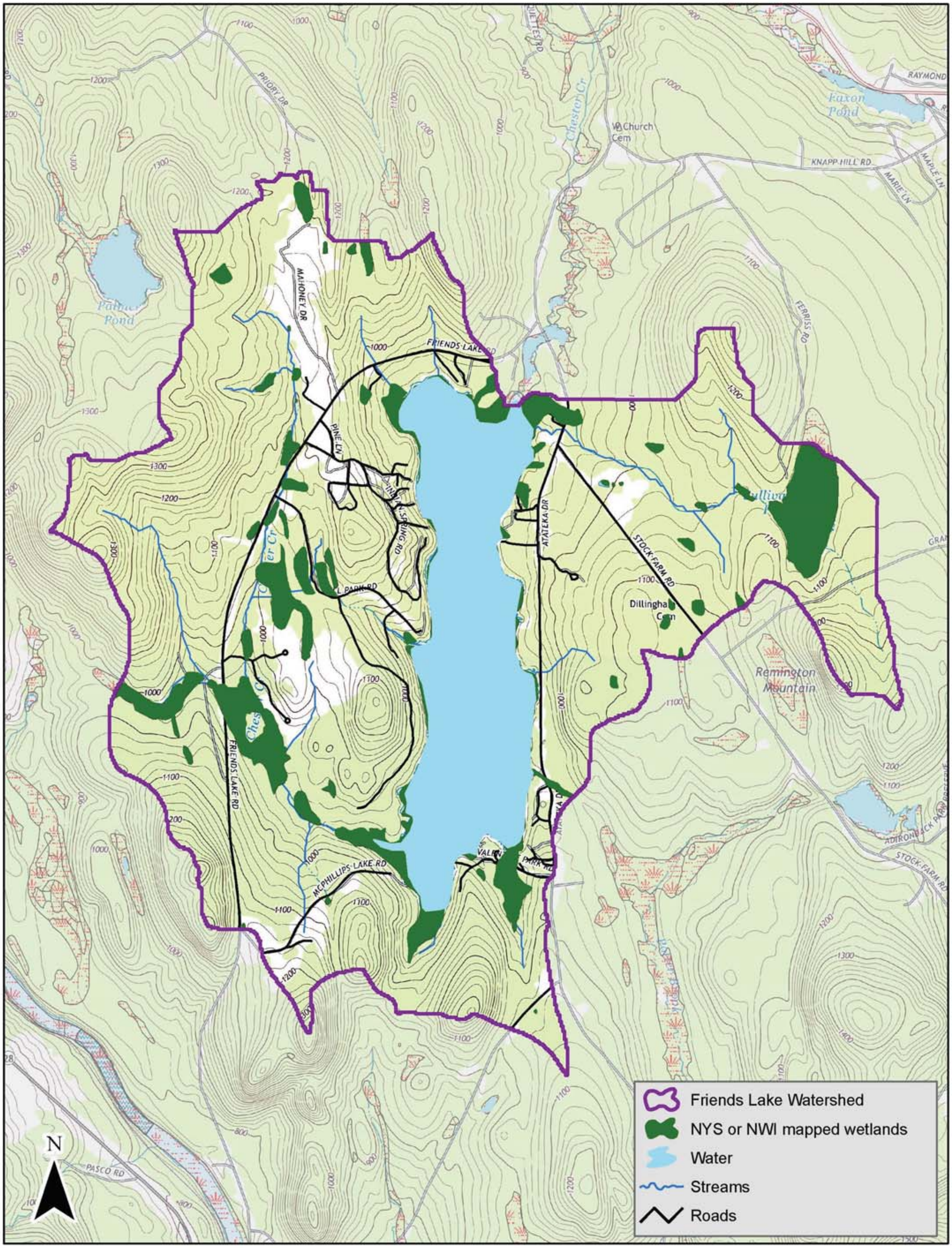
Appendix 1: Development by Decade



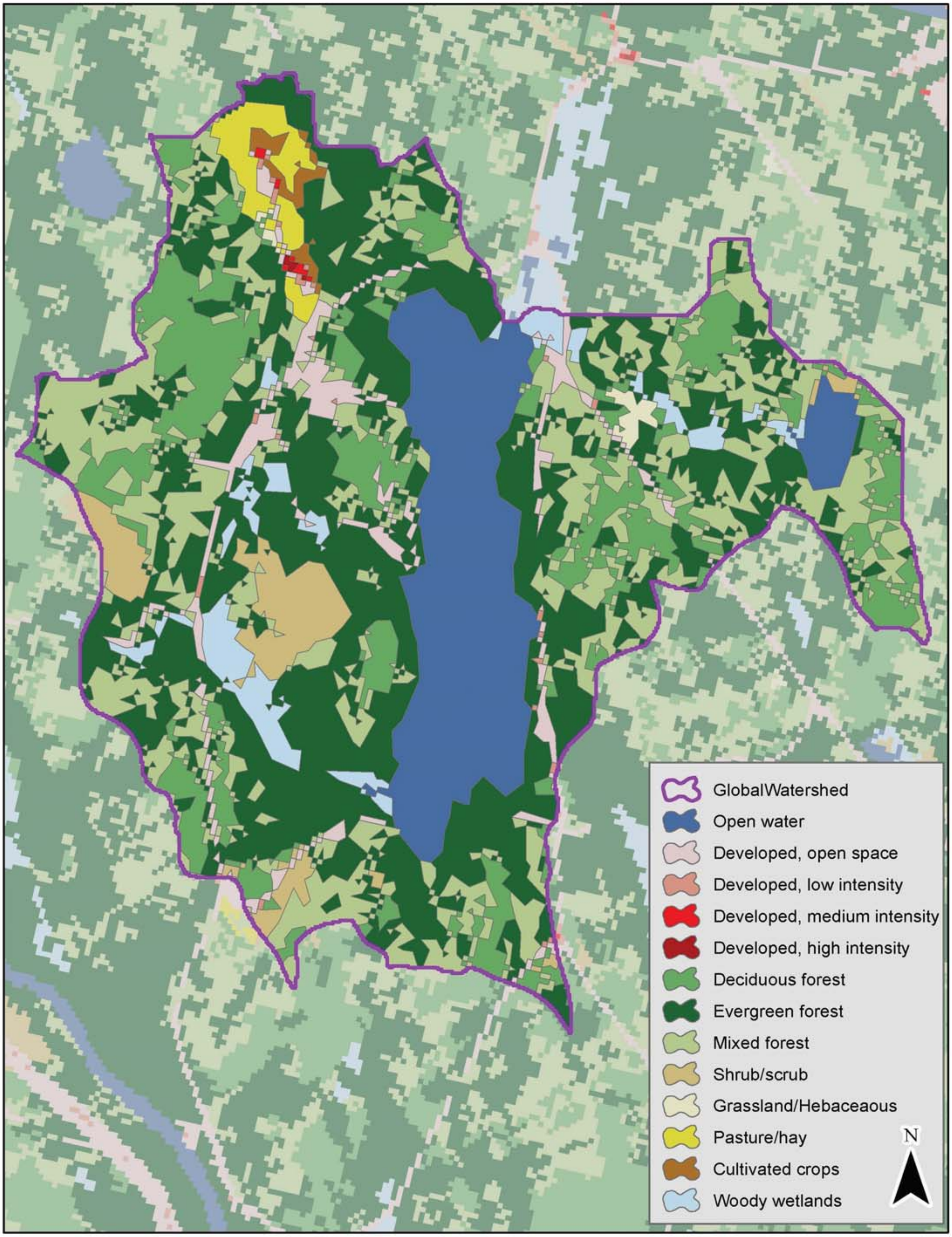
Appendix 2: Bathymetric Map with Hydrologic Sample Locations



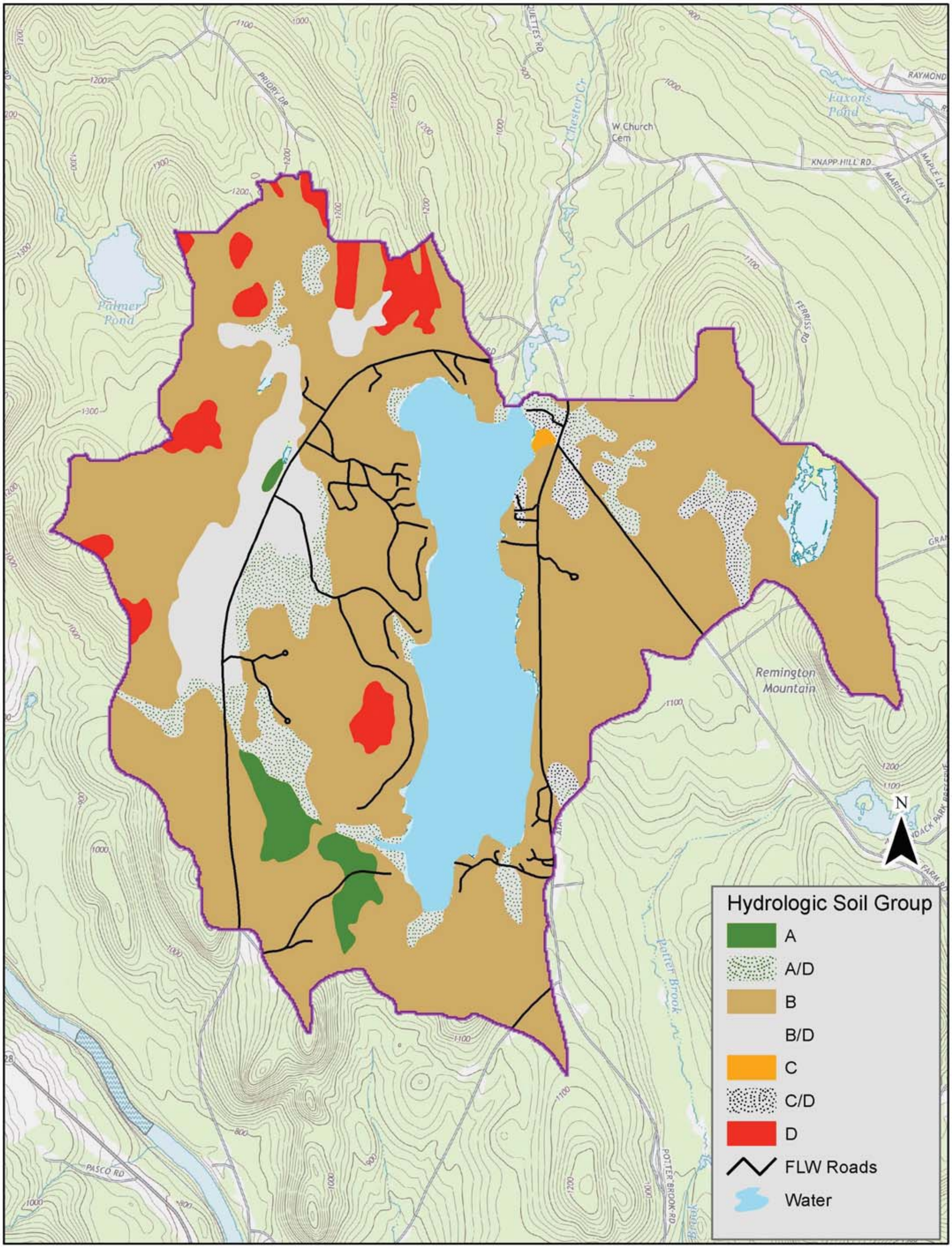
Appendix 3: Watershed Wetlands



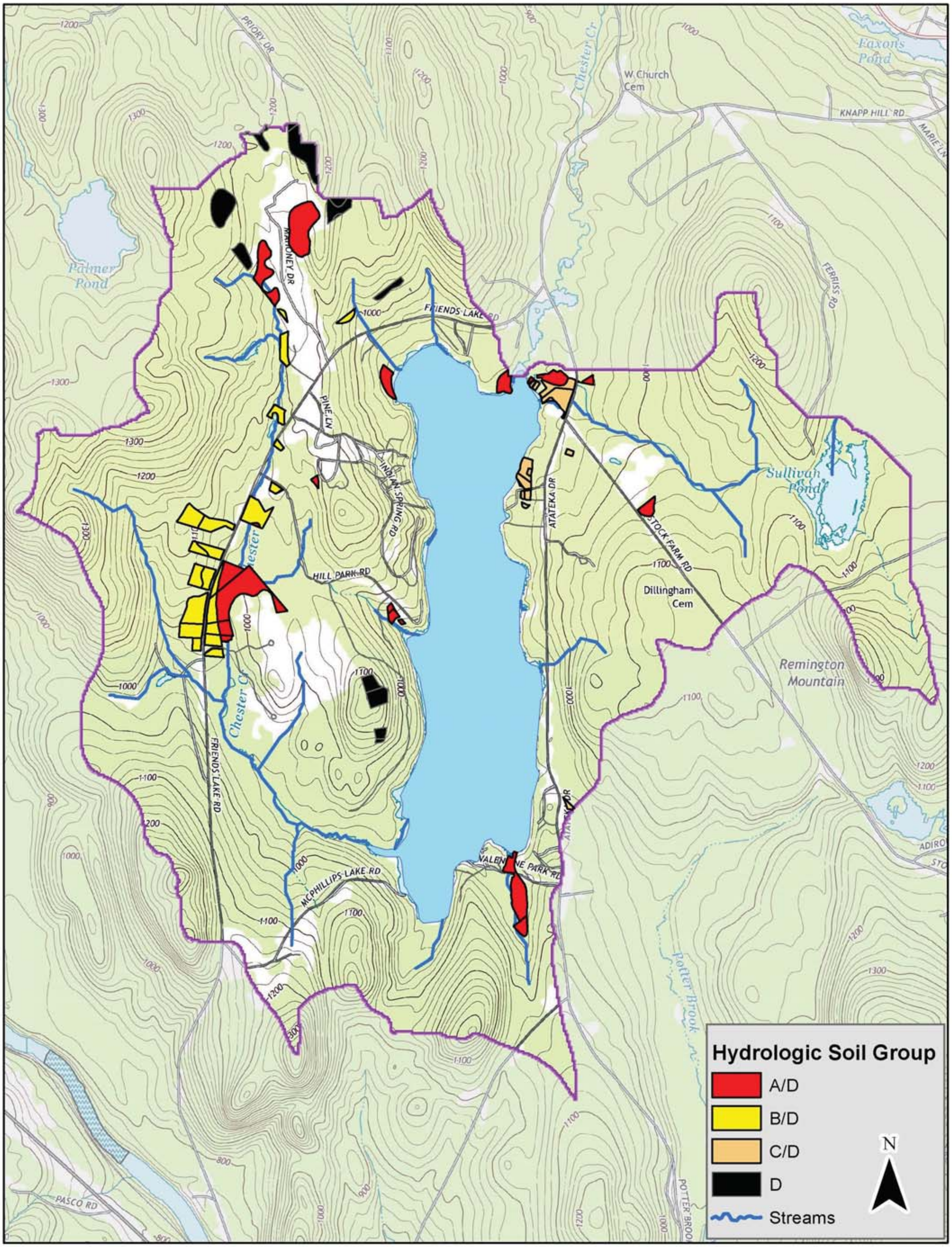
Appendix 4: National Land Cover Database



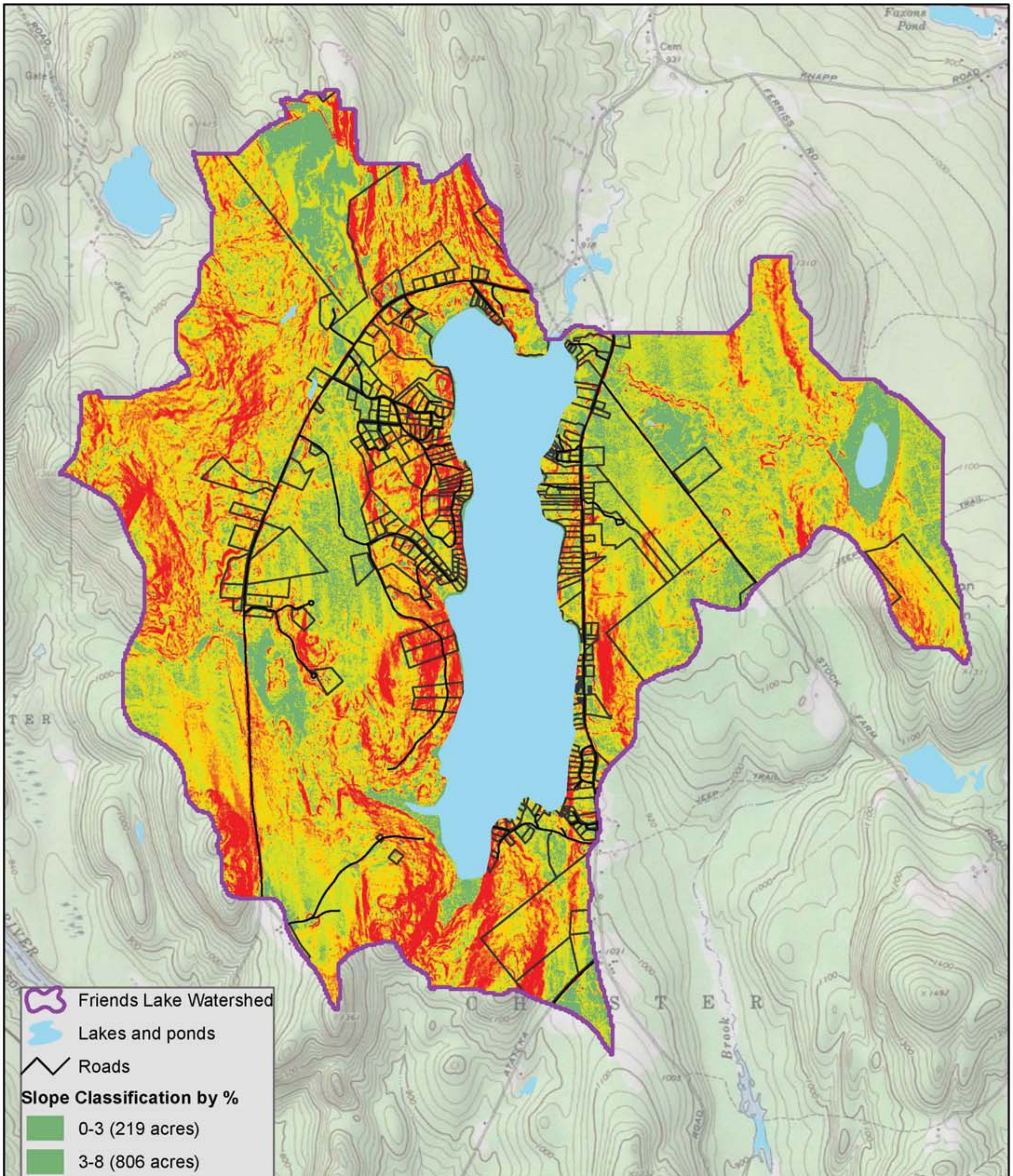
Appendix 5: Hydrologic Soil Groups



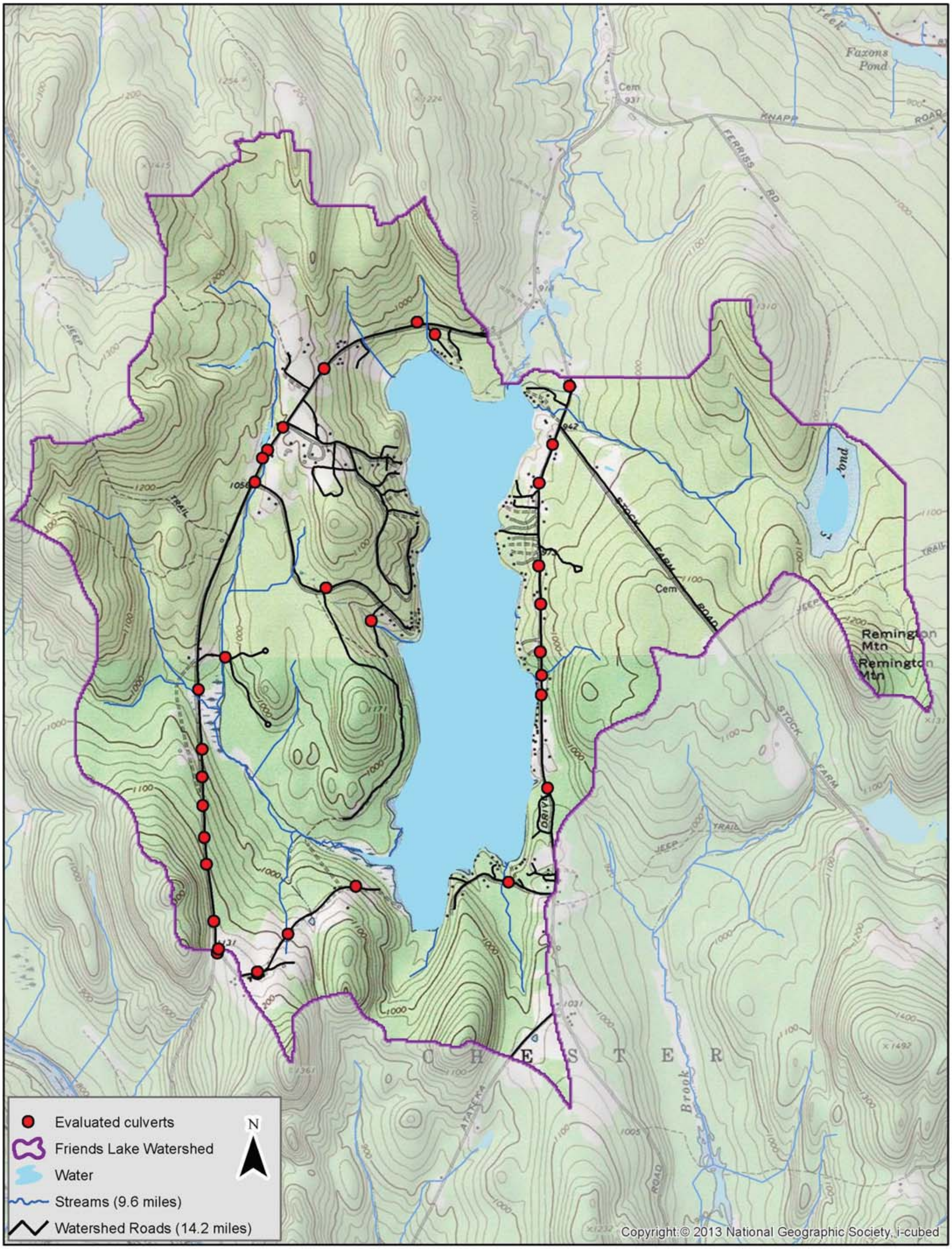
Appendix 6: Developed Areas of Concern based on Hydrologic Soil Groups



Appendix 7: Watershed Slopes



Appendix 8: Roads and Streams



Appendix 9 : Water Bars

Go to http://www.dec.ny.gov/chemical/29066.html

for complete the BMP practice sheets

STANDARD AND SPECIFICATIONS FOR WATER BAR

Definition & Scope

A **permanent** or **temporary** ridge, ridge and channel, a structural channel, or flow deflector, constructed diagonally across a sloping road or utility right-of-way that is subject to erosion to limit the accumulation of erosive velocity of water by diverting surface runoff at pre-designed intervals.

Conditions Where Practice Applies

Where runoff protection is needed to prevent erosion from increased concentrated flow on narrow, steep access roads, driveways, and entrance ways to lot parcels as well as utility access right-of-ways generally up to 100 feet in width

Design Criteria

Design computations are not required.

1. The design height shall be minimum of 12 inches measured from channel bottom to ridge top.
2. The side slopes shall be 2:1 or flatter, a minimum of 4:1 where vehicles cross.
3. The base width of the ridge shall be six feet minimum.
4. The spacing of the water bars shall be as follows (Site spacing may need to be adjusted for field conditions to use the most suitable areas for water disposal):

Slope (%)	Spacing (ft.)
<5	125
5 TO 10	100
10 TO 20	75
20 TO 35	50
>35	25

5. The positive grade of the water bar shall not exceed 2%. A crossing angle of approximately 60 degrees is preferred.
6. Once diverted, water must be conveyed to a stable system (i.e. vegetated swale or storm sewer system). Water bars should have stable, unrestricted outlets, either natural or constructed.

See Figure 3.22 on page 3.53 for details.

Appendix 10: Grassed Waterway

Go to http://www.dec.ny.gov/chemical/29066.html

for complete the BMP practice sheets

STANDARD AND SPECIFICATIONS FOR GRASSED WATERWAY

Definition & Scope

A natural or **permanent** man-made channel of parabolic or trapezoidal cross-section that is below adjacent ground level and is stabilized by suitable vegetation. The flow channel is normally wide and shallow and conveys the runoff down the slope without causing damage by erosion.

Conditions Where Practice Applies

Grass waterways are used where added vegetative protection is needed to control erosion resulting from concentrated runoff.

Design Criteria

Capacity

The minimum capacity shall be that required to confine the peak rate of runoff expected from a 10-year 24 hour frequency rainfall event or a higher frequency corresponding to the hazard involved. This requirement for confinement may be waived on slopes of less than one (1) percent where out-of-bank flow will not cause erosion or property damage.

Peak rates of runoff values used in determining the capacity requirements shall be computed by appropriate methods. Where there is base flow, it shall be handled by a stone center, subsurface drain, or other suitable means since sustained wetness usually prevents adequate vegetative cover. The cross-sectional area of the stone center or subsurface drain size to be provided shall be determined by using a flow rate of 0.1 cfs/acre or by actual measurement of the maximum base flow.

Velocity

Please see Table 3.1, Diversion Maximum Permissible Design Velocities on page 3.10, for seed, soil, and velocity variables.

Cross Section

The design water surface elevation of a grassed waterway receiving water from diversions or other tributary channels shall be equal to or less than the design water surface elevation in the diversion or other tributary channels.

The top width of parabolic waterways shall not exceed 30 feet and the bottom width of trapezoidal waterways shall not exceed 15 feet unless multiple or divided waterways, stone center, or other means are provided to control meandering of low flows.

Structural Measures

In cases where grade or erosion problems exist, special control measures may be needed such as lined waterways (see page 3.27), or grade stabilization measures (see page 3.21). Where needed, these measures will be supported by adequate design computations. For typical cross sections of waterways with riprap sections or stone centers, refer to Figure 3.8 on page 3.24.

The design procedures for parabolic and trapezoidal channels are available in the NRCS Engineering Field Handbook. Figure 3.9 on page 3.25 also provides a design chart for parabolic waterway.

Outlets

Each waterway shall have a stable outlet. The outlet may be another waterway, a stabilized open channel, grade stabilization structure, etc. In all cases, the outlet must discharge in such a manner as not to cause erosion. Outlets shall be constructed and stabilized prior to the operation of the waterway.

Stabilization

Waterways shall be stabilized in accordance with the appropriate vegetative stabilization standard and specifications, and will be dependent on such factors as slope, soil class, etc. See standard for Vegetating Waterways on Page 4.78.

Construction Specifications

See Figure 3.10 on page 3.26 for details.

Appendix 11: Retaining Walls

Go to http://www.dec.ny.gov/chemical/29066.html

for complete the BMP practice sheets

STANDARD AND SPECIFICATIONS FOR RETAINING WALLS

Definition & Scope

A **permanent** structural wall constructed and located to prevent soil movement by retaining soil in place and preventing slope failures and movement of material down steep slopes.

Conditions Where Practice Applies

A retaining wall may be used where site constraints will not allow slope shaping and seeding to stabilize an area. Slope areas that demonstrate seepage problems or experience erosive conditions at the toe can utilize retaining walls to help stabilize these areas. Retaining walls can be built from mortared block or stone, cast-in-place concrete, railroad ties, gabions, and more recently, precast concrete modular units and segmented walls that form a gravity retaining wall (see Figure 4.16 and 4.17). These precast units allow for ease and quickness of installation while their granular backfill provides drainage. Selection of materials and type of wall should be based on hazard potential, load conditions, soil parameters, groundwater conditions, site constraints, and aesthetics.

Design Criteria

The design of any retaining wall structure must address the aspects of foundation bearing capacity, sliding, overturning, drainage and loading systems. **These are complex systems that should be designed by a licensed professional engineer.**

Bearing Capacity – A minimum factor of safety of 1.5 should be maintained as the ratio of the ultimate bearing capacity to the designed unit loading. Spread footers and other methods may be used to meet factor requirements.

Sliding – A minimum factor of 2.0 should be maintained against sliding. This factor can be reduced to 1.5 when passive pressures on the front of the wall are ignored.

Overturning – A minimum factor of safety of 1.5 should be used as the ratio of the resisting moment (that which tends to keep the wall in place) to the overturning moment.

Drainage – Unless adequate provisions are made to control both surface and groundwater behind the retaining wall, a substantial increase in active pressures tending to slide or overturn the wall will result. When backfill is sloped down to a retaining wall, surface drainage should be provided. Drainage systems with adequate outlets should be provided behind retaining walls that are placed in cohesive soils. Drains should be graded or protected by filters so soil material will not move through the drainfill.

Load systems – Several different loads or combination of loads need to be considered when designing a retaining wall. The minimum load is the level backfill that the wall is being constructed to retain. Its unit weight will vary depending on its composition.

Additional loads such as line loads, surcharge loads, or slope fills, will add to make the composite design load system for the wall.

Construction Specifications

Concrete Walls

1. Foundation will be prepared by excavating to the lines and grades shown on the drawings and removing all objectionable material.
2. Subgrade will be compacted and kept moist at least 2 hours prior to placement of concrete.
3. Steel reinforcing will be in accordance with the schedule on the drawings and kept free of rust, scale, or dirt.
4. Exposed edges will be chamfered ¾ inches.
5. Drainfill will meet the gradations shown on the drawings.

Appendix 12 : Rock Outlet Protection

Go to http://www.dec.ny.gov/chemical/29066.html

for complete the BMP practice sheets

STANDARD AND SPECIFICATIONS FOR ROCK OUTLET PROTECTION

Definition

A section of rock protection placed at the outlet end of the culverts, conduits, or channels.

Purpose

The purpose of the rock outlet protection is to reduce the depth, velocity, and energy of water, such that the flow will not erode the receiving downstream reach.

Scope

This standard applies to the planning, design, and construction of rock riprap and gabions for protection of downstream areas. It does not apply to rock lining of channels or streams.

Conditions Where Practice Applies

This practice applies where discharge velocities and energies at the outlets of culverts, conduits, or channels are sufficient to erode the next downstream reach. This applies to:

1. Culvert outlets of all types.

2. Pipe conduits from all sediment basins, dry storm water ponds, and permanent type ponds.

3. New channels constructed as outlets for culverts and conduits.

Design Criteria

The design of rock outlet protection depends entirely on the location. Pipe outlet at the top of cuts or on slopes steeper than 10 percent, cannot be protected by rock aprons or riprap sections due to re-concentration of flows and high velocities encountered after the flow leaves the apron.

Many counties and state agencies have regulations and design procedures already established for dimensions, type and size of materials, and locations where outlet protection is required. Where these requirements exist, they shall be followed.

Tailwater Depth

The depth of tailwater immediately below the pipe outlet must be determined for the design capacity of the pipe. If the tailwater depth is less than half the diameter of the outlet pipe, and the receiving stream is wide enough to accept divergence of the flow, it shall be classified as a Minimum Tailwater Condition; see Figure 5B.12 on page 5B.25 as an example. If the tailwater depth is greater than half the pipe diameter and the receiving stream will continue to confine the flow, it shall be classified as a Maximum Tailwater Condition; see Figure 5B.13 on page 5B.26 as an example. Pipes which outlet onto flat areas with no defined channel may be assumed to have a Minimum Tailwater Condition; see Figure 5B.12 on page 5B.25 as an example.

Apron Size

The apron length and width shall be determined from the curves according to the tailwater conditions:

Minimum Tailwater – Use Figure 5B.12 on page 5B.25
Maximum Tailwater – Use Figure 5B.13 on page 5B.26

If the pipe discharges directly into a well defined channel, the apron shall extend across the channel bottom and up the channel banks to an elevation one foot above the maximum tailwater depth or to the top of the bank, whichever is less.

The upstream end of the apron, adjacent to the pipe, shall have a width two (2) times the diameter of the outlet pipe, or conform to pipe end section if used.

Appendix 13 : Check Dam

Go to http://www.dec.ny.gov/chemical/29066.html

for complete the BMP practice sheets

STANDARD AND SPECIFICATIONS FOR CHECK DAM

Definition

Small barriers or dams constructed of stone, bagged sand or gravel, or other durable material across a drainage way.

Purpose

To reduce erosion in a drainage channel by restricting the velocity of flow in the channel.

Condition Where Practice Applies

This practice is used as a temporary or emergency measure to limit erosion by reducing velocities in small open channels that are degrading or subject to erosion and where permanent stabilization is impractical due to short period of usefulness and time constraints of construction.

Design Criteria

Drainage Area: Maximum drainage area above the check dam shall not exceed two (2) acres.

Height: Not greater than 2 feet. Center shall be maintained 9 inches lower than abutments at natural ground elevation.

Side Slopes: Shall be 2:1 or flatter.

Spacing: The check dams shall be spaced as necessary in the channel so that the crest of the downstream dam is at the elevation of the toe of the upstream dam. This spacing is equal to the height of the check dam divided by the channel slope.

Therefore:

$$S = h/s$$

Where:

S = spacing interval (ft.)
h = height of check dam (ft.)
s = channel slope (ft./ft.)

Example:

For a channel with a 4% slope and 2 ft. high stone check dams, they are spaced as follows:

$$S = \frac{2\ ft}{.04\ ft/ft} = 50\ ft.$$

Stone size: Use a well graded stone matrix 2 to 9 inches in size (NYS – DOT Light Stone Fill meets these requirements).

The overflow of the check dams will be stabilized to resist erosion that might be caused by the check dam. See Figure 5A.9 on page 5A.24 for details.

Check dams should be anchored in the channel by a cutoff trench 1.5 ft. wide and 0.5 ft. deep and lined with filter fabric to prevent soil migration.

Maintenance

The check dams should be inspected after each runoff event. Correct all damage immediately. If significant erosion has occurred between structures, a liner of stone or other suitable material should be installed in that portion of the channel.

Remove sediment accumulated behind the dam as needed to allow channel to drain through the stone check dam and prevent large flows from carrying sediment over the dam. Replace stones as needed to maintain the design cross section of the structures.

Appendix 14 : Vegetating Waterways

Go to http://www.dec.ny.gov/chemical/29066.html

for complete the BMP practice sheets

STANDARD AND SPECIFICATIONS FOR VEGETATING WATERWAYS

Definition

Waterways are a natural or constructed outlet, shaped or graded. They are vegetated as needed for safe transport of runoff water.

Purpose

To provide for the safe transport of excess surface water from construction sites and urban areas without damage from erosion.

Conditions Where Practice Applies

This standard applies to vegetating waterways and similar water carrying structures.

Supplemental measures may be required with this practice. These may include: subsurface drainage to permit the growth of suitable vegetation and to eliminate wet spots; a section stabilized with asphalt, stone, or other suitable means; or additional storm drains to handle snowmelt or storm runoff.

Retardance factors for determining waterway dimensions are shown in Table 5B.1 and "Maximum Permissible Velocities for Selected Grass and Legume Mixtures," are shown in Table 3.6.

Design Criteria

Waterways or outlets shall be protected against erosion by vegetative means as soon after construction as practical. Vegetation must be well established before diversions or other channels are outletted into them. Consideration should be given to the use of synthetic products, jute or excelsior matting, other rolled erosion control products, or sodding of channels to provide erosion protection as soon after construction as possible. It is strongly recommended that the center line of the waterway be protected with one of the above materials to avoid center gullies.

1. Liming, fertilizing, and seedbed preparation.
   A. Lime to pH 6.5.
   B. **The soil should be tested to determine the amounts of amendments needed.** If the soil must be fertilized before results of a soil test can be obtained to determine fertilizer needs, apply commercial fertilizer at 1.0 lbs/1,000 sq. ft. of N, P_2O_5, and K_2O.
   C. Lime and fertilizer shall be mixed thoroughly into the seedbed during preparation.
   D. Channels, except for paved section, shall have at least 4 inches of topsoil.
   E. Remove stones and other obstructions that will hinder maintenance.
2. Timing of Seeding
   A. Early spring and late August are best.
   B. Temporary cover to protect from erosion is recommended during periods when seedings may fail.
3. Seed Mixtures:

Mixtures	Rate per Acre (lbs)	Rate per 1,000 sq. ft. (lbs)
A. Birdsfoot trefoil or ladino clover[1]	8	0.20
Tall fescue or smooth bromegrass	20	0.45
Redtop[2]	2	0.05
	30	0.70
OR		
B. Kentucky bluegrass[3]	25	0.60
Creeping red fescue	20	0.50
Perennial ryegrass	10	0.20
	55	1.30

[1] Inoculate with appropriate inoculum immediately prior to seeding. Ladino or common white clover may be substituted for birdsfoot trefoil and seeded at the same rate.

[2] Perennial ryegrass may be substituted for the redtop but increase seeding rate to 5 lbs/acre (0.1 lb/1,000 sq. ft).

[3] Use this mixture in areas which are mowed frequently. Common white clover may be added if desired and seeded at 8 lbs/acre (0.2 lb/1,000 sq. ft.)