

*Warner Conservation Commission  
Warner, New Hampshire*

# **Willow Brook Watershed Natural Resource Inventory and Conservation Plan**



**Prepared in conjunction with  
the Warner Conservation Commission  
by Chris Kane**

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# Willow Brook Watershed Natural Resource Inventory and Conservation Plan

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# **Willow Brook Watershed Natural Resource Inventory and Conservation Plan Warner, New Hampshire**

## **Introduction and Background**

The Town of Warner, a largely rural New Hampshire town situated on two corridors, the Warner River and Interstate 89, has experienced an increased rate of commercial and residential development in the past 20 years. In 1997 the Warner Conservation Commission, recognizing the need to plan for the protection of water resources and ecologically sensitive areas, developed a plan to identify and document key natural resources in the town of Warner.

A pilot project was designed which would yield a report with two components: a Natural Resource Inventory to document certain natural resources and features in a portion of the town, and a Conservation Plan to make recommendations for appropriate use of these resources. This project was conceived as a model for future projects in other watersheds in Warner and beyond.

The watershed of Willow Brook, a tributary of the Warner River, was chosen as the area to carry out the pilot project. This area was chosen because it is a tributary to the Warner River, it is close to the downtown area, has a documented abundance of wildlife, and is valuable for recreation. See Map 1 for the location of the watershed.

Watersheds are geographically defined segments of the landscape which are based on a single outlet for the flow of all surface waters, and thus make convenient, practical and ecologically based units for study. This watershed, which covers nearly 3,000 acres is the drainage area for Willow Brook. It extends in a north to south direction with its headwaters in the town of Salisbury and its outflow confluence with the Warner River in the downtown area of Warner. The study area is most populated along the eastern and western peripheries and where it crosses the central village area. Portions of the watershed are already protected as conservation lands.

In early 1997 the Conservation Commission applied for and received a Local Incentive Grant from the New Hampshire Department of Environmental Services. The grant, which was matched by the Wharton Foundation and by in-kind donations from the Conservation Commission, supported the hiring of a project coordinator/data collector, as well as services and supplies related to the work, including computer mapping.

This report, which may be amended or updated in the future, will help to inform planning on a town-wide basis, including the town master plan. It is also an important step toward promoting voluntary natural resource conservation in the Town of Warner.

# Part A

## Natural Resource Inventory

### Overview

The inventory focused on certain key natural resource features of the watershed, some of which required field work, and others of which were done with the aid of published works. Field work provided information on watershed boundaries, wetland locations and descriptions, forest cover, wildlife and water quality.

The large array of Geographic Information System computer files maintained by the State of New Hampshire in the GRANIT database, as well as results of the field work were utilized in preparing the accompanying maps. The final preparation was done by Complex Systems Research Center at the University of New Hampshire. The coverages included in the accompanying maps are: watershed boundaries, topographic elevation contours, soils, soils with limitations, steep slopes, land use types, forest types, surface waters (with water quality sample points), wetlands, floodplains, aquifers, roads and political boundaries. Maps illustrating all of these features can be found at the back of this report in Appendix I.

# I. Water Resources

## Watershed

The Willow Brook watershed is drained by Willow Brook, one of many drainages which supply the Warner River. The Warner River flows into the Contoocook River, which in turn flows into the Merrimack River which empties into the Atlantic Ocean in Massachusetts. Willow Brook is classified as a second order stream.

The total Willow Brook watershed area is 2,946 acres. 2,343 acres are in Warner, with the remaining 613 acres in Salisbury. This amounts to 6.6% of the total area of the town of Warner (refer to Map 1). For the purposes of this report, references to the "watershed" shall mean the Warner portion of the Willow Brook watershed including the Children's Brook portion. Children's Brook is the name given to the lower portion of Willow Brook.

By virtue of a common drainage and clear boundaries, watersheds are often viewed as natural units in the landscape. In the case of some larger watersheds, their boundaries may separate ecologically distinct regions. This is not the case with the Willow Brook watershed, as plant and animal species are generally not restricted to either this watershed, or to surrounding ones. Certain species may, in fact depend on certain resources in one watershed, and on different resources in another.

## Streams

The streams are a prime resource feature of the watershed. They collectively drain waters from all sources in the watershed, and consequently supply the larger Warner River. Willow Brook itself is 4.5 miles long from the source, Duck Pond, in Salisbury to the Warner River, not including Duck Pond and Tory Hill Meadow, through which it runs. 3.5 miles of other unnamed perennial streams also supply Willow Brook, for a total of 8 miles of streams watershed-wide. This does not include the numerous minor drainages which exist across the watershed, but which only flow for limited periods during the year.

Five perennial streams, one of which is Willow Brook, drain the central and northern portions of the Willow Brook Watershed (refer to Map 3, Water Resources). These streams all flow into a large wetland complex called Tory Hill Meadow, which in turn drains to the south as Willow Brook again. A series of wetlands in the southeast portion of the watershed drains that segment, and the outflow of the lowest of these joins Willow Brook where it meets Pumpkin Hill Road. Willow Brook is known as Children's Brook below the point where this wetland complex drains into it. Another series of wetlands also drains the southwest portion of the watershed and flows into Willow Brook (Children's Brook) at the south junction of

Pumpkin Hill Road and Bartlett Loop. Willow Brook passes under Main Street before joining the Warner River at the lower terminus of the watershed.

The physical and chemical qualities of the water affect not only the plant and animal life of these streams and the wetlands they supply, but also those downstream. Human uses, including ground water for wells, water for livestock and game fishing are also directly impacted by conditions in these surface waters. These streams are the veins of the watershed, and the quality of the overall watershed can be monitored in part by using the streams as indicators of ecological health.

A broad range of conditions occurs in these streams, including varying degrees of width, depth and grade, acidity, rate and consistency of flow, substrate composition and exposure to sunlight. A diverse group of plant and animal species have evolved to utilize these different niches. For instance, Northern Dusky Salamanders often prefer reliably wet stream sections, while Two-lined Salamanders can tolerate drier stream beds under rocks. A variety of plant species also occur in and beside streams, depending on the combination of conditions present. Streams may also support communities of aquatic insects. Several species of insects require flowing water habitat for their adult and/or nymph life stage. The measure of the diversity of insects and other small invertebrates, collectively called "macro-invertebrates" can be a sensitive indicator of stream health.

### **Water Quality Testing Procedures**

A series of water quality samples were taken from seven locations on Willow Brook. The locations of these sample points are shown on Map 3. Tests were performed for *Biological Oxygen Demand*, *E. coli* and *Total Suspended Solids* on water samples taken from these points on three different dates in the Fall of 1997. On the final testing day the *pH*, *Temperature* and *Dissolved Oxygen* were recorded at each sample point as well. The following are brief explanations of the purpose for each test, along with their potential significance. These data will serve as a baseline for future monitoring on Willow Brook.

*pH*: This test measures the acidic level of a water sample, and is stated as a value from 1 (very acidic) to 14 (very alkaline or "basic"). Extremes or wide fluctuations of acidity can affect the health and reproductive capacity of the organisms in a stream.

*Temperature*: Temperature can determine which types of animal or plant life will occur in a portion of a stream. Temperature also affects the amount of dissolved oxygen which the water can hold; colder water is capable of higher levels of oxygen. Shading by stream-side vegetation helps to maintain lower water temperatures.

*Dissolved Oxygen (DO)*: This test measures the amount of oxygen dissolved in stream water. Oxygen is necessary for aquatic plant photosynthesis and for respiration by both animals and plants. In general, biological diversity is greater in streams with higher levels of oxygen. Trout require such levels to thrive.

*Biological Oxygen Demand (BOD)*: Certain bacteria and other microscopic decomposers which live on the stream bottom use oxygen in the water at a measurable rate as they break down organic matter in the stream. By monitoring this rate, the level of organic matter in the stream can be measured. Sources of this organic matter can include natural inputs, agricultural runoff of fertilizer or manure, and leaking septic systems. Elevated BOD levels indicate excessive amounts of organic matter, or in some cases the effects of industrial pollutants.

*E. coli*: This test measures the amount of certain bacteria in the stream water. Elevated *E. coli* bacteria levels can indicate the presence of fecal matter introduced from either animal or human activity, such as manure run-off or a leaking septic system.

*Total Suspended Solids (TSS)*: Sediments of various kinds are present in all flowing waterbodies, but elevated levels due to soil erosion can adversely affect the biology of a stream. This test measures the amount of suspended solids, which can also include plant pollen, algae or other particles.

## **Water Quality Testing Results and Conclusions**

Test results from the water quality monitoring indicate that Willow Brook is by and large a healthy stream system. According to the monitoring results, Willow Brook meets water quality goals set for Class B waterbodies. A Class B waterbody is suitable for swimming, fishing, general recreation and other activities involving water contact.

One result is of particular interest. The test for *pH* at the inflow to Tory Hill Meadow (sample point WB1) recorded 8.0, which is somewhat more alkaline than expected for this area. A possible explanation for this reading might be the presence of calcareous, or "basic" soils somewhere in the upper watershed. This alkalinity may help to buffer acidic inputs from the forest and wetlands plant matter and acidic precipitation, helping to maintain the slightly above neutral *pH* trend of the sample points downstream.

Slightly elevated *E. coli* bacteria levels were recorded below Tory Hill Meadow pond. These findings can probably be credited to beaver and waterfowl activity in the pond.

The fact that the central and northern parts of the watershed have relatively sparse development probably contributes to the maintenance of

good water quality in Willow Brook. This area is mostly forested, which further protects the streams from any erosional runoff from the surrounding residences and farms.

### **Department of Environmental Services Water Quality Survey**

In October, 1997 the Biology Branch of the Surface Water Quality Bureau of the N.H.D.E.S. performed a water quality survey at Willow Brook as part of a state-wide study. This survey collected data on in-stream chemistry, habitat variables and macro-invertebrate diversity.

The chemistry tests performed were very similar to those conducted during the present watershed inventory, and found the in-stream chemistry to be excellent. Dissolved oxygen and cold temperatures in the brook were sufficient to support coldwater fish such as trout.

A set of 12 stream habitat parameters were rated. The resulting assessment found all but four of the parameters to be in the optimal range. Of these four parameters the report voiced the most concern about sediment deposition. Small particles become deposited in the spaces between cobbles on the stream bottom, eliminating habitat space for bottom dwelling organisms, and thereby reducing food resources for other species which depend on them. This finding is probably due to the proximity of gravel roads in the Children's Brook area which are without adequate erosion control measures, according to the D.E.S. report.

Stream invertebrates are particularly sensitive to degraded stream quality conditions, making them excellent barometers of stream health. The report found the diversity of stream invertebrates to be high, including a high number of pollutant intolerant species, also indicating a healthy coldwater stream.

### **Wetlands**

The Willow Brook watershed contains a variety of wetland types and sizes which together comprise 6% of the total watershed area (refer to Map 2, Wetlands). The dominant wetland is Tory Hill Meadow Marsh, a large, diverse system located between Pumpkin Hill and Tory Hill. While this area historically may have been a complex of uplands and wetlands, beavers have flooded an expansive tract to create an area of ponded water, cattail marsh and sedge meadow.

Wetlands provide a variety of functions depending on their type, location and hydrology. Among these functions are water quality maintenance and improvement, wildlife habitat, floodwater storage, ground water recharge/discharge, aesthetics and recreation.

Water quality is impacted by the suspended particles, nutrients and other pollutants that are carried into the water by runoff from the uplands. These elements remain suspended in the water column in the quick moving streams of the watershed. The flowing water loses its velocity in the flatter terrain of the wetlands. The slow moving watercourse through the wetland and the numerous wetland plants allow the suspended particles in the water to settle to the bottom of wetland. Here they either are bound into the soil or are taken up by the plants. Both of these outcomes remove them from the flowing water, improving its clarity and quality.

The size of the wetland does not in itself determine its importance for wildlife. All types and sizes of wetlands provide habitat for a variety of species that rely on wetlands for some phase of their life cycle. From the smallest isolated woodland pool that may be an important amphibian breeding area to the largest of the watershed wetlands that is home to beaver, otter and numerous waterfowl, the local wildlife rely on these wetlands.

Many of the wetlands along the stream channel help to store floodwaters during storms and spring melt. This helps to protect areas downstream from potential flooding and releases the stored water over time, helping to maintain a flow in the stream during dry times.

All of the wetlands in the watershed add to the diversity of plants and animals in the region but they also offer diversity of scenery. These open spaces in a forest-dominated landscape provide opportunities for recreation, early and brilliant fall colors, and wide vistas such as the view of Mt. Kearsarge seen from the Tory Hill Meadow.

All of the wetlands along the course of the stream have been impacted by the presence of beavers. Several still support active beaver colonies while others have been abandoned due to lack of an adequate food source. Beavers are part of an important cycle that occurs along streams throughout the region. Beavers move into an area of suitable terrain and vegetation, build a dam flooding the lowlands along the brook, and take down numerous hardwood trees and shrubs.

Eventually the suitable foods are used up and hemlock trees, which are not a favored food of beaver begin to dominate the area. Lacking an adequate food supply, the beavers move on to a new site. The abandoned dam eventually fails, draining the water and leaving behind a mudflat that is quickly revegetated by grasses, sedges and rushes. Over time this area develops a shrub layer and eventually supports a diverse forest community. At this time beavers may move in again and start the whole process anew. This cycle may take between 100 and 200 years and has been occurring on the New Hampshire landscape for over 10,000 years.

Through all phases of this process, beaver-managed wetlands provide habitat to a large number of plant and animal species, each of which has

evolved to utilize the different aspects of each phase. Beaver impoundments and several of the plant communities that follow the failing of a dam create some of the few natural openings in a region otherwise dominated by forest. This supplies habitat for numerous species that require open water, grasslands and shrublands for some phase of their life cycle.

In the lower reaches of the Willow Brook watershed the topography flattens out and there are a number of wetlands located in small depressions or along intermittent streams. Most of these wetlands occur because of soil type or topography, without the aid of beaver dams. These too provide many of the functions described earlier.

## **Wetland Classifications and Descriptions**

Wetland classification recognizes five broad wetland systems; Palustrine, Lacustrine, Riverine, Estuarine and Marine. Within each of these systems more specific classes are also designated. Marine and Estuarine systems are wetland or deepwater habitats which are affected by tidal waters. The Riverine system comprises wetland and deepwater habitats contained within a channel and which are not otherwise classified Palustrine or Estuarine. Only Palustrine and Lacustrine wetlands were inventoried for this report, and they are described here.

Palustrine wetlands are freshwater wetlands not directly adjacent to a major river or lake, and are dominated by trees, shrubs or emergent vegetation. The different classes within the palustrine system are defined by the dominant vegetation type and/or substrate features.

Lacustrine wetlands are situated in a topographic depression, are not dominated by persistent vegetation, and are greater than 20 acres in area and/or deeper than 6.6 feet in depth. Specific classes are primarily based on the particular substrate or shore characteristics of a wetland.

## **Wetland Classes of the Willow Brook Watershed**

While the following descriptions address distinct types, it is important to remember that in most cases several of these wetland types may be found interspersed in a single wetland and that a diversity of wetland types enhances the value of a wetland.

Below is a description of the major wetland types which occur in the watershed. These wetlands are illustrated on Map 2.

**Table 1. General Wetland Types in the Willow Brook Watershed**

<u>Wetland Type</u>	<u>Acreage</u>	<u>Percent</u>
Palustrine Emergent	44.6	32%
Palustrine Scrub/Shrub	27.4	21%
Palustrine Forested	24.0	20%
Palustrine Unconsolidated Bottom	5.1	12%
Lacustrine Unconsolidated Bottom	20.4	15%

### **Palustrine Emergent Wetlands**

Wetlands of this type include areas that contain a majority of erect, herbaceous water-loving plants such as cattails, pickerel weed, sedges and rushes. Marshes, wet meadows and fens are examples of emergent wetlands. This wetland type, which is relatively uncommon in New Hampshire provides critical habitat for waterfowl, wading birds, reptiles and amphibians. Many of Warner's emergent wetlands are associated with beaver activity and are in this phase only temporarily. These wetlands are also important for water quality maintenance and wildlife habitat, and provide pleasant open vistas in a forested landscape.

Most of the approximately 44.6 acres of emergent wetland were associated with Tory Hill Meadow itself. Here it is dominated by persistent emergent plant species, including tussock sedge, lake sedge, and bluejoint grass. A patch of broad-leaved cattail occurs on the east side. Sphagnum mosses form a dense understory across much of the vegetated marsh, with open unvegetated "holes" of saturated organic muck. Other common herbaceous species include Canada rush, soft rush and several asters. Shrub species include leatherleaf, maleberry, sheep laurel, speckled alder, and meadowsweet. In zonation typical of such sites, the shrubs dominate at the edge of the marsh and become more stunted and sparse with distance into the marsh. Throughout the watershed, other smaller areas of emergent marsh occur in association with perennial flowages and beaver dams. The marshes in the hayfield east of Pumpkin Hill Road are an excellent example. Close to the road this marsh has open water interspersed with cattail. Further upstream, lake sedge and bluejoint grass dominate.

### **Palustrine Scrub/Shrub Wetlands**

This wetland type is dominated by woody vegetation less than 20 feet in height. As with forested wetlands these plants may be deciduous, coniferous or dead. Scrub/shrub wetlands represent a rare stable shrub community in New Hampshire. Most shrublands represent a successional stage in forest development. However, the water regime of some wetlands may facilitate the establishment of a long-term scrub/shrub community.

Scrub/shrub wetlands are less common than forested wetlands and support a unique community of plants including many fruit-bearing plants. These wetlands are also important for water quality maintenance, provide cover and feeding opportunities for many wildlife species and usually provide us with our first brilliant colors of fall.

The approximately 24 acres of scrub/shrub wetland are distributed in 17 small wetlands throughout the study area (Map 2). Several are associated with beaver flowages, others are in depressions that remain wet enough to discourage establishment of trees. The largest scrub/shrub wetland is in the southwest corner of the watershed, east of Pumpkin Hill Road. Dominant shrub species in many of these wetlands include speckled alder, red maple, highbush blueberry and winterberry holly. Common herbaceous species include blue-joint grass, woolgrass, sensitive fern and sphagnum moss. Dead trees, usually simply tree trunks indicating that they have been dead for a while, were scattered through the shrub swamps in beaver flowages. Pit-and-mound microrelief was the typical structure of these wetlands, with shrubs and dead trees on the mounds, and herbs and/or water in the pits. At the top of Tory Hill Meadow, the shrub swamp is a uniform stand of speckled alder, with an occasional red maple sapling.

### **Palustrine Forested Wetlands**

This wetland class is characterized by a dominance of woody vegetation greater than 20 feet in height. These trees may be deciduous, coniferous or dead-standing. This is the most common type of wetland in New Hampshire. While trees may be the dominant feature, palustrine forested wetlands may also have a thick understory of ferns, shrubs and mosses. These areas are important for water quality maintenance and provide habitat to many of our common wildlife species.

There are 27.4 acres of palustrine forested wetland within the Willow Brook study area. Most were located in the lower sections of the watershed associated with smaller drainages that feed into Willow Brook along Pumpkin Hill Road (Willow Brook is officially Children's Brook along this stretch). The forested wetlands are primarily either conifer-dominated or a mixture of coniferous and deciduous trees. Deciduous swamp occurs in only a few locations. Eastern hemlock is by far the most abundant conifer, with a small component of white pine. Red maple is the dominant deciduous species, with occasional yellow and paper birches. In the deciduous-dominated wetlands, yellow birch can attain co-dominance. The understory is sparse in the conifer wetlands and includes mostly regenerating canopy species. These wetlands have pronounced pit-and-mound microrelief, often with abundant boulders and exposed bedrock. Sphagnum mosses, goldthread, and cinnamon fern are common herbaceous species. In the mixed and deciduous wetlands, species diversity is much higher in both the shrub and herb layer. Shrub species include winterberry holly, speckled alder and eastern hemlock as well as regenerating red maple and yellow birch. Dominant herbs include cinnamon fern, goldthread, sensitive fern

which is completely surrounded by mature forest, is the watershed's most notable example of a healthy, fully functioning wetland system.

Tory Hill Meadow remains the most outstanding wetland in both area and general functional value within the watershed. It contains three wetland classes (emergent, scrub/shrub and open water/unconsolidated bottom) and is the largest wetland at a total of over 50 acres. Its size, habitat diversity, and undeveloped setting allow it to provide a number of wetland functions, including habitat for abundant and diverse wildlife, flood protection, downstream hydrologic support, nutrient transformation, sediment retention, and recreational and aesthetic values. The remaining wetlands offer habitat diversity and, in the cases of the vernal pools and several other wetlands, important wildlife habitat values.

## Aquifers

Sources of ground water for wells are often referred to as aquifers. While ground water can be extracted from many types of soils or even bedrock, certain parts of the landscape which possess deep, sandy and gravely soils and which are topographically positioned to efficiently collect, filter and store ground waters are especially valuable. These so-called stratified drift, high yield aquifers are predictable, reliable and generous sources of potable water which are important as potential municipal or industrial water supplies. Aquifers are important and dependable sources of drinking water, and thus are important to identify and protect.

The State of New Hampshire has located and mapped the high-yield aquifers state-wide. The Willow Brook watershed contains an 84-acre portion of the Warner River high-yield aquifer at the Children's Brook/Warner River confluence. The municipal water supply of the Town of Warner draws water from this aquifer upstream of Willow Brook. See Map 3 for an illustration of this area.

## II. Physical Features

### Soils

The foundation of much of the ecology of the Willow Brook watershed is its soils. They determine in large part the character of the vegetation there, which in turn affects the presence or absence of certain animal species. The soils are also affected and altered over time by physical forces such as the local moisture and climate regime. The soils underlying the watershed today originated as mineral materials transported by water or ice since the last Ice Age, approximately 14,000 years ago. These materials have been altered over time by the decomposition of the underlying bedrock, the passage of water through them, and the addition of organic compounds from the decomposition of animal and plant detritus.

The specific qualities of a soil in a particular area also affect that area's suitability for certain human uses. Deep, well drained sandy soils in upland areas are often conducive to development, while wet, poorly drained soils present problems to development. Also, careless development activities can cause excessive erosion of irreplaceable soils.

### Soil Survey

The descriptions of soils and the areas within the watershed where they occur are based on the 1961 Soil Survey from the U.S.D.A. Soil Conservation Service. Soil surveys for the entire United States were conducted and published for farmers, engineers, foresters and others to use in planning the best use of lands based on soil qualities.

Many physical properties of a soil are considered when it is classified, including color and darkness, thickness of layers, texture, grain size, parent material, organic content and moisture content. The origin of the soil is also considered, for instance the outwash materials deposited by glacial meltwater streams (glacial outwash), or the glacier-carried material which remains in place after melting (glacial till).

The names associated with a particular soil, such as Hermon or Windsor, come from the location where that soil type was first encountered, described and mapped, or from the typical geographic feature where it occurs. Further descriptors may also be added to the soil name in specific mapped areas which reflect other attributes such as slope or stoniness. The surveys also rate soils based on their suitability for certain functions, such as road building, cropland or pine woodlot.

There are some 35 mapped soil units within the watershed area, and 15 of these are actually slope or grain variants of 13 basic soil series. Three soil series account for 82.5% of the surface area of the watershed (refer to

and partridgeberry. Sphagnum mosses dominate the tops of the mounds and boulders, while aquatic mosses were observed in the pits near the drainages.

### **Palustrine Unconsolidated Bottom Wetlands**

This type of wetland represents areas of open water with less than 30% vegetative cover and with sandy or muddy substrates. Water depth for this wetland type will be less than 6 feet and its sparse plant community may include pond-weed and pond-lilies. These areas provide habitat for some warm-water fish species and aquatic turtles (snapping and painted turtles) as well as such mammals as the moose and otter. This wetland type can offer good recreation opportunities, and has value for water quality improvement.

A number of small ponds occur within the study area that meet the definition of Palustrine unconsolidated bottom. One is a beaver flowage on a perennial stream in the center of the watershed. The remaining ponds are small natural or excavated depressions, that have no perennial stream inflows, and have intermittent outflows. Groundwater appears to be the primary source of water in these ponds. Several of the smaller ponds were observed to support vernal pool amphibians.

### **Lacustrine Unconsolidated Bottom Wetlands**

While this wetland type is similar in some ways to the palustrine unconsolidated bottom type, it differs by being typically larger than 20 acres in size, and with water depth which can exceed 6 feet.

The only water body classified Lacustrine in the study area is Tory Hill Meadow. At just over 20 acres, the open water portion of the Meadow is currently large enough to be considered lacustrine. Although water depths are not known on the Meadow, it appears to be quite shallow throughout most of the area, as would be expected given its beaver flowage origins. Rooted and floating aquatic vegetation occur over most of the open water, including pond lily, white water lily, watershield, and duckweed. Submerged aquatic species were not inventoried.

### **Summary of the Wetlands of the Willow Brook Watershed**

The watershed supports variants of five different wetland classes. Several of the larger wetland areas contain multiple wetland classes. While Palustrine Emergent is the most common type in the watershed and Palustrine Unconsolidated Bottom is the least common, each general wetland type present is well represented in the watershed. Several specific classes, including vernal pools are relatively uncommon for the watershed.

The wetlands of the watershed are generally healthy and intact, free to perform their natural functions. The Tory Hill Meadow wetland complex,

Map 4, Soils). These series, Gloucester, Paxton and Hermon are described below. The remaining 10 minor soil series are described in Appendix II.

## Soil Descriptions

### Major Soil Series in the Willow Brook Watershed

**Gloucester:** *sandy loam, very stony sandy loam and extremely stony sandy loam*  
(Gc, Gr, Gs)  
35.5% of watershed.

The Gloucester series includes soils which are well drained to somewhat excessively drained on gentle to steep slopes. They are strongly acidic soils that formed in deep, sandy glacial till which originated as granite, gneiss and schist. Stones and boulders commonly occur at all depths. Forest trees common to Gloucester soils include mixed hardwoods featuring mainly beech, birch, maple and red oak, as well as hemlock and white pine.

**Paxton Series:** *loam and very stony loam*  
(Pa, Pn)  
26% of watershed.

The Paxton series soils are well-drained, medium to moderately coarse textured and strongly acid soils which formed in glacial till. They also feature a pan layer 18 to 24 inches below the surface, and fewer stones and boulders than other glacial till soils. The origin of the parent material was mica schist, gneiss and granite. Paxton soils occur on the sharper crests of drumlins (elongated, rounded hills of glacial origin) and on moderately sloped to steeply sloped hillsides. Forest species featured on these soils include red oak, white oak, sugar maple, red maple, beech, birch, white pine and hemlock.

**Hermon Series:** *extremely stony sandy loam*  
(Ho, Hs)  
21% of watershed.

The Hermon series is characterized by well-drained to somewhat excessively drained soils which are very strongly acid, deep and sandy and occur in glacial till. These soils developed over time in parent material derived from granite, gneiss and schist. Stones and boulders are prominent in these soils, which occur on gently sloping to steeply sloping upland areas. The native forest species typically associated with Hermon soils include spruce, hemlock, white pine, beech, birch and sugar maple.

**Table 2. Soil Units of the Willow Brook Watershed**

<b>Soil Series</b>	<b>% of Area</b>	<b>Developability</b>
Gloucester	35.5%	very low to high
Hermon	21%	medium
Paxton	26%	low to medium
Colton	1.5%	low to medium
Au Gres	<1%	very low
Acton	1.5%	medium
Rumney	1%	very low
Ridgebury	4%	very low
Scarboro	1%	very low
Shapleigh-Gloucester	2.5%	low
Woodbridge	3%	medium
Muck & Peat	<1%	very low
Marsh	1.5%	very low

### **Summary of the Soils of the Willow Brook Watershed**

The Soil Survey rates each soil unit for its potential suitability for septic, dwelling and road construction at a reasonable cost, as well as for overall development (labeled Developability in Table 2.). The soil series often comprise multiple soil units, each with a separate rating. Thus Table 2 gives the Gloucester Series a developability range from very low to high, depending on the particular Gloucester soil unit that occurs in a given area, in a possible range of very high to very low. This often is dependent on slope, thickness to bedrock or degree of rockiness.

The soils of the watershed are predominantly glacial tills, with some water-deposited soils and organic soils in low-lying places. The dominant soils are upland soils classified as Gloucester, Paxton or Hermon. The great majority of the Gloucester soils are rated medium to high for developability. The Hermon soils are all rated medium, and the Paxton soils are mostly rated medium. These three major groups are thus fairly suitable for a variety of uses, including forestry, agriculture or housing development.

The floodplain, organic and poorly drained soils which together account for 8.3% of the watershed area are rated low to very low for overall development potential. They may be appropriate for some forms of agriculture or forestry, but are not suitable for housing development. The areas where these soils occur in the watershed can be seen on Map 5 combined under the category "Limiting Soils".

## Floodplains

Low-lying lands adjacent to flowing water are subject to periodic flooding as spring snow melts, or following severe rainstorms. These areas, known as floodplains, are geological features which were created over time by the periodic flooding of watercourses, and the subsequent deposition of water-borne sediments. Although flood control systems of dams and containment areas have reduced the likelihood of the disastrous floods of the past, most small to moderate size streams have no controls, and continue to flow naturally. There are currently no flood controls or man-made dams in the Willow Brook watershed.

Many floodplains qualify as wetlands, since they are inundated for a significant portion of the year. They also provide special habitat for plant and animal species which are adapted for life there. The floodplain areas typical of the Willow Brook watershed, often dominated by red maple and hemlock, are small and restricted to the stream courses. Tory Hill Meadow basin is larger and has greater flood potential.

The Federal Emergency Management Agency has mapped the documented floodplain areas across the State. Two areas occur in the watershed. 83.8 acres are classified as Zone A (most likely to flood) in the Tory Hill Meadow basin and an adjacent area to the southwest. Two acres of floodplain are also mapped at the extreme bottom of the watershed along the Warner River. These areas are illustrated in Map 5, Limitations to Development.

## Slopes

The landscape of New Hampshire is highly variable, and like much of New England, the terrain of the Willow Brook watershed is characterized by rolling hills and flat valley bottoms. Level ground is relatively uncommon in the watershed, being found primarily in floodplains beside streams and ponds (refer to Map 2).

Steeply sloped areas of the landscape can pose limitations to certain uses such as forestry, road building or construction. Access to these areas can be difficult to impossible for construction machinery, and the disturbance to the soils resulting from such work introduces the added risk of soil erosion and excessive stream-borne sediments.

Those areas within the watershed which are considered excessively sloped were identified by a Geographic Information System on computer, using existing elevation data. Three categories of slope range were chosen, and the computer then searched for and mapped the watershed accordingly. The three slope categories are: *gently sloped*, 0% to 8%; *moderately sloped*, 8% to 25%; and *steeply to excessively sloped*, over 25%. Depending on the other

properties of the soil in an area, slopes over 25% can pose serious limitations to land use. Refer to Map 5 for the location of slopes exceeding 25%.

Within the watershed, a total of 829.3 acres (35.4 percent) were classified as 0% to 8% slope, 1,415.5 acres (60.4 percent) as 8% to 25% slope, and 98.2 acres (4.2 percent) as exceeding 25% slope.

### **III. Biological Resources**

#### **Wildlife**

The broad range of wildlife habitats found within the watershed provide all or some of the needs of a wide variety of species from the black bear to the black fly. However, the inventory for this project limited its scope to mammals, birds, amphibians and reptiles; what most people would call wildlife.

The wildlife of an area can serve as a gauge of its ecological health. A watershed with a relatively high biological diversity suggests that the basic ecosystem functions which support so many species are basically intact. Certain species, when present are considered indicators of ecological health.

In general, a more diverse assortment of habitat types in an area will support a greater number of species. The Willow Brook watershed contains a variety of habitats, including open fields, mature softwood forests, mixed forests, sedge meadows, marshes, forest edges and riparian zones, each of which supports certain wildlife species.

#### **Birds**

Many species of birds depend on habitat suitable for a variety of purposes in the Willow Brook watershed. Breeding birds find nesting sites and materials, and a reliable and sufficient food supply for rearing a brood of chicks. Migrating birds find cover and food to support their trips to and from wintering grounds. Wintering birds find protection from the elements and food to sustain them until spring. Each bird species has individual requirements, and the more of these requirements are met by a particular natural area, the greater the bird diversity is likely to be.

#### **Breeding Bird Field Survey**

One of the most critical periods of the year for bird populations occurs at the time of breeding. The observance of territorial songs and calls in a nesting range is generally considered confirmation of breeding. The presence of breeding birds of a particular species in the Willow Brook watershed is positive proof of a reliance of that species on the resources of the watershed for survival and support for part of their life cycle. Breeding birds truly "live" in the watershed for a critical portion of the year.

Beginning in the spring of 1997, selected areas of the watershed were surveyed for breeding birds. Early morning walks were conducted to record the calls and songs of birds on their nesting territories. The routes were selected to maximize the coverage of the area given the time available. All species heard or observed along each route were noted. A series of recorded

bird calls and songs were also broadcast around Tory Hill Meadow in an attempt to elicit a response from any secretive wetland bird species. The results of this survey are compiled in Table 3.

**Table 3. Breeding Birds Survey Results**

**Bird Species Observed**

Alder Flycatcher	Northern Flicker
American Crow	Northern Oriole
American Goldfinch	Northern Parula
Barn Swallow	Ovenbird
Black & White Warbler	Pileated Woodpecker
Black-capped Chickadee	Pine Warbler
Black-headed Cowbird	Red-breasted Nuthatch
Black-throated Blue Warbler	Red-eyed Vireo
Black-throated Green Warbler	Red-winged Blackbird
Blue Jay	Redstart
Bobolink	Robin
Brown Creeper	Rose-breasted Grosbeak
Chestnut-sided Warbler	Ruffed Grouse
Chipping Sparrow	Scarlet Tanager
Common Yellowthroat	Solitary Vireo
Downy Woodpecker	Song Sparrow
Eastern Kingbird	Swamp Sparrow
Eastern Pheobe	Tree Swallow
Eastern Wood Peewee	Tufted Titmouse
Gray Catbird	Veery
Great Blue Heron	Warbling Vireo
Great Crested Flycatcher	White-throated Sparrow
Hermit Thrush	Winter Wren
Least Flycatcher	Wood Duck
Mourning Dove	Wood Thrush
Northern Cardinal	Yellow Warbler

**New Hampshire Bird Records**

The Audubon Society of New Hampshire maintains a database of bird reports for the entire state of New Hampshire. The database records of bird sightings in the town of Warner between the summer of 1986 and early spring of 1998 were researched. To date an additional 40 species of birds have been recorded in the vicinity of the watershed by this program. The actual locations of the sightings are often not specified in the records, nor is breeding verified, but those sightings potentially in the vicinity of the

Willow Brook watershed area are included as a part of this report. The NH Bird Records, found in Table 4 include only those species not already recorded in the Breeding Bird Survey.

**Table 4. New Hampshire Bird Records for Willow Brook Area**

American Goldfinch	Cooper's Hawk	Pileated Woodpecker
American Kestrel	Dark-eyed Junco	Red-tailed Hawk
American Pipit	Eastern Bluebird	Ring-necked Pheasant
Bald Eagle	Eastern Meadowlark	Ruby-crowned Kinglet
Blackburnian Warbler	Golden-crowned Kinglet	Rufous Hummingbird
Broad-winged Hawk	Great Blue Heron	Scarlet Tanager
Brown Thrasher	Indigo Bunting	Sharp-shinned Hawk
Canada Goose	Merlin	Snowy Owl
Cedar Waxwing	Nashville Warbler	Swainson's Thrush
Chukar	Northern Goshawk	Turkey Vulture
Cliff Swallow	Northern Harrier	Whip-poor-will
Common Nighthawk	Northern Shrike	White-throated Sparrow
Common Raven	Osprey	Wild Turkey
Common Redpoll		

### **Summary of Birds of the Willow Brook Watershed**

A total of fifty two (52) bird species were recorded over the course of the breeding bird survey. Since only a relatively small portion of the watershed was surveyed during one season, this represents a partial tally of the species which use the watershed. Representatives of several different bird groups were observed, including ducks, wading birds, songbirds and woodpeckers. Ten species of warbler were also noted. Forty additional species are also recorded in the New Hampshire Bird Records from the vicinity, and many of these probably also use the watershed.

Tory Hill Meadow supports an active rookery of Great Blue Herons. In 1997 four nesting pairs were observed there. Herons are notoriously wary and skittish during nesting, and require a minimum of disturbance for a successful brood. Also in 1997 the Meadow was home to a successful breeding pair of Great Horned Owls and 3 owlets.

### **Mammals**

Mammals also rely on certain areas of the watershed for survival. Certain critical resources for mammals include den sites, wintering den sites, deer yards, food supplies and water. Areas near water are often the most actively used by mammals. The relatively unfragmented nature of the

central watershed area makes it highly suitable for wildlife. As with birds, an area with a variety of different habitat types and sizes, such as mature hardwood forests, open marshes or abandoned fields will support a wider variety of species.

No systematic method of assessing the mammal populations of the watershed was developed or used. Instead, incidental observations were recorded as they were made during other field work. Knowledge of mammals in the area from a variety of other sources is also included in this report.

### **Summary of the Mammals of the Willow Brook Watershed**

A total of 10 species of mammals or their sign were observed in the field during the course of the project (see Table 5). The Fox, Coyote, Fisher, Black Bear and Moose have relatively large ranges and therefore will thrive in larger areas of open space with a minimum of fragmentation by roads or other development, and may be using habitat in other watersheds as well.

The presence of Black Bear near Tory Hill Meadow is a strong indicator of a relatively large and pristine natural area. Bear are shy under normal circumstances and depend on the mast (nuts) of mature beech trees and to a lesser extent that of oaks for the production of fat to carry them through the winter. During the warmer months their diet includes quantities of berries and insect larvae.

Other species of mammals which were either reported from other sources or are very likely to be present at times in the watershed include Gray Squirrel, Striped Skunk, Mink, Raccoon, Little Brown Bat, Longtail Weasel, Shorttail Weasel, River Otter, Gray Fox, Snowshoe Hare, Eastern Cottontail, Deer Mouse, White-footed Mouse, Boreal Redback Vole and Meadow Vole, Masked Shrew, Shorttail Shrew, Opossum and Muskrat.

**Table 5. Mammals Observed in the Willow Brook Watershed**

Beaver	Black Bear
Fisher	Moose
Coyote	Porcupine
Red Fox	Whitetail Deer
Northern Flying Squirrel	Red Squirrel

### **Amphibians & Reptiles**

Amphibians all spend at least part of their life cycle in water, therefore they are completely dependent on a reliable amount of clean water for development and breeding. Certain species of salamanders inhabit perennial

streams, while other salamander and frog species require temporary or "vernal" pools. Yet others spend their lives in or close to permanently flooded wetlands.

Many reptiles, especially turtles, are also dependent on water habitat for their food supply, courting or other needs, and may spend most of their time in or around ponds, marshes or streams.

The maintenance of water levels and water quality are vital to the welfare of amphibian and reptile species of the area. Excessive levels of water-borne sediments flowing into a wetland can adversely affect amphibians in a variety of ways. In the case of vernal pools, the protective forest cover in and around the pools helps minimize premature heating and evaporation of the pool water.

Any observations of amphibians made during the field work were recorded. This includes areas with habitat which exhibited evidence of breeding amphibians such as egg masses or larvae.

### **Summary of Amphibians & Reptiles of the Willow Brook Watershed**

All but two of the species of amphibians known to inhabit this part of New Hampshire were observed during this survey (see Table 6). Most species were actually seen, while some species of frogs were identified only from their calls. Only a few species of reptiles were observed, although at least 8 species are very likely to reside in the watershed.

Several streams above Tory Hill Meadow were found to hold Two-lined Salamanders. The egg masses of Wood Frogs and Spotted Salamanders were found in two vernal pools, also close to the Meadow. Redback Salamanders were often found concealed beneath logs or stones, while Pickerel Frogs were found in grass bordering a wetland. Spring Peepers, American Toads and Red-spotted Newts were often seen moving across the forest floor in early summer. Jefferson Salamanders breed in certain vernal pools within the watershed boundary as well. Bull Frogs inhabit the larger, deeper wetlands, their booming call emanating from bordering vegetation. The banjo-like calls of Green Frogs frequently punctuated the air around Tory Hill Meadow, and Gray Tree Frogs were heard trilling from the forest bordering wet areas, but were never seen. Northern Leopard Frogs, a species of concern in New Hampshire were heard calling in the general vicinity of Tory Hill Meadow as well.

Garter Snake and Painted Turtle were the two reptile species observed during the survey. Other species are likely to spend at least part of their life cycle in the watershed, including Snapping Turtles, Wood Turtles, Northern Water Snakes, Eastern Ribbon Snakes, Redbelly Snakes, Smooth Green Snakes and Milk Snakes.

**Table 6. Amphibians Observed in the Willow Brook Watershed**

Two-lined Salamander	Gray Tree Frog
Spotted Salamander	Wood Frog
Jefferson's Salamander	Bull Frog
Red-spotted Newt	Green Frog
Redback Salamander	Pickerel Frog
Spring Peeper	Northern Leopard Frog
American Toad	

Since amphibians are relatively small and often secretive, other species are likely to occur in the watershed also. Northern Dusky Salamanders probably inhabit the upper reaches of the perennial streams of the watershed. Higher, reliably wet stream pools may harbor the large and uncommon Spring Salamander.

Other sources have records of several species not observed during this inventory. These include Wood Turtles in the Willow Brook stream corridor, and Painted Turtles and Snapping Turtles in Tory Hill Meadow.

### **Critical Wildlife Habitat Areas**

Certain habitat areas in the watershed are especially important to wildlife. Wetlands at the north end of Tory Hill Meadow, and in the southeast part of the watershed are sedge/rush dominated and scrub-shrub types which may be associated with the fluctuating water levels of beaver impoundments or seasonal flooding. They are host to a specific collection of bird and reptile species which rely on the habitat they provide, including Swamp Sparrows, Alder Flycatchers, Common Yellowthroats, Wood Ducks and Tree Swallows. Great Blue Herons depend on dead standing trees in Tory Hill Meadow as a communal nesting area, or "rookery (refer to Map 8)."

Forested wetlands in the southeast and southwest portions serve as habitat for other species, including Spotted Salamanders and Wood Frogs. Vernal pools are vital to the life cycle of a whole suite of amphibians, and can be very useful to certain reptiles including Wood Turtles. Pools are located at the southern end of Tory Hill Meadow and along the western side of Bartlett Loop. See Map 2 these locations.

The clear, cold water of Willow Brook and its tributaries supports cold-water fish species including brook trout, along with several reptile and amphibian species including Wood Turtles and Two-lined Salamanders as well as many species of invertebrates. The stream-side, or riparian areas in general are widely used by many species of birds, mammals, reptiles and amphibians.

Mature forests in the watershed, with their broad range of tree ages, contain a variety of habitats not found in younger forests, including large dead or dying trees used by cavity-nesting birds and mammals, including Flying Squirrels and Pileated Woodpeckers. The larger, more isolated forest tracts in the central and northern parts of the watershed are necessary for the continuing support of wide ranging mammals such as the black bear and moose. Hemlock groves are especially important for winter shelter and food for deer, snowshoe hare and other mammals active during the cold months.

## IV. Land Use

Virtually the entire watershed has experienced human use of one sort or another in the past. These uses have changed and shifted over time as economies, markets and populations have changed. By the early 1800's most of the watershed was probably cleared for cropland or pasture. By the mid 1800's much of the land had been allowed to go fallow as farms were abandoned, and forest cover began to return.

Today, most of the watershed is forested, although a significant portion continues to be used for agriculture, and residential and other types of development are increasing. The network of roadways in the watershed indicates the areas of past agriculture and residence, and may also suggest areas where future development might likely occur. The major roads outline the western watershed boundary and the general southeastern and eastern portions. They are absent in the central portion which remains largely forested and undeveloped.

Map 6 illustrates the areas of the watershed which are currently under different categories of use; forest, agricultural, residential, residential/commercial, old field, wetland or power line corridor. At more than 82% of the land cover of the watershed, forests are clearly the dominant land use. These forest resources were studied and summarized for this report.

**Table 7. Land Use in the Willow Brook Watershed**

<u>Land Use</u>	<u>Percent Cover</u>
Forest	82.7%
Agriculture	8.5%
Residential	3.0%
Wetland (open water)	2.6%
Residential/Commercial	1.6%
Old Field	0.7%
Agriculture/Residential	0.5%
Power Line	0.4%

### Forestry

Forests are one of the major natural features of the landscape. Forest cover is the natural condition for the majority of the landscape in this region. The values of the forest as habitat for wildlife are many, including deer wintering areas, den sites and migration stop-overs. In addition, most species of wildlife found in the area have evolved in forested regions and rely on forest during some phase of their life cycle.

Human oriented values of the forests in the Willow Brook watershed include saw-timber and firewood, water retention, erosion control, temperature control and scenic beauty. Forests have become an intrinsic feature of the region, and contribute greatly to its character and identity.

### **Forest Region Overview**

The lower elevation forests of the southern part of New Hampshire have been generally categorized as Transitional Forest. This denotes the geographical location between the more southerly Central Hardwood Forest Region and the more northerly, or higher elevation Spruce-Fir-Northern Hardwood Forest Region.

Several species typical of both major forest regions can be found in the transitional forest region which includes the Willow Brook watershed. Tree species very common to the south, but which also occur here include Northern Red Oak, White Oak, White Pine, Eastern Hemlock and Black Birch. Northerly species whose ranges extend this far south include Yellow Birch, Sugar Maple, American Beech, Red Spruce, Balsam Fir and Red Pine.

### **Forest Survey**

A forest survey was conducted to assess the forest resources of the watershed. The primary intent was to be able to make statements about the general forest cover types in the watershed, with considerations for known and potential wildlife habitat.

Forest stands were characterized and delineated using both analysis of aerial photographs and field reconnaissance. Data were collected on general canopy species composition, estimated size/age class, evident logging history/activity, importance values for wildlife habitat, and identification of any unusual or exemplary natural communities. The central area around Tory Hill Meadow was field checked first, and other major areas were checked as time allowed. Areas not visited were characterized primarily from aerial photography. A map of the area was produced which identifies different forest stands (Map 7).

### **Forested Cover Types**

Six generalized cover types were used to describe the forest stands in the watershed. These are listed below, with the proportions for each species.

*White pine-hemlock*; at least 80% pine and hemlock

*Hemlock*; at least 80% hemlock

*Mixed softwoods*; at least 80% mixed softwoods (white pine, hemlock, red spruce)

*Mixed softwoods-mixed hardwoods*; approximately 60% mixed softwoods and 40% mixed hardwoods

*Mixed hardwoods-mixed softwoods*; approximately 60% mixed hardwoods and 40% mixed softwoods

*Mixed hardwoods*; at least 80% mixed hardwoods

Three other descriptors were used for certain stands where they applied: *Mature*, for forest stands of larger than average stature or age; *Young*, for stands which are at the early stages of return from cutting or field succession; and *Selectively Cut*, for stands which show apparent evidence of selective logging sometime in the past twenty five years or so. For clarity, these categories were not included on the Forest Types Map .

The forest stands were delineated and characterized by viewing stereo aerial photographs of the watershed taken in 1993. Some changes to the forest such as new timber harvesting have probably taken place since these photographs were taken. Refer to Map 7 for an illustration of the forest stands.

**Table 8. Forest Types of the Willow Brook Watershed**

<u>Forest Type</u>	<u>Acreage</u>	<u>Percent</u>
Mixed Softwoods/Mixed Hardwoods	1,135.6	58%
Mixed Hardwoods/Mixed Softwoods	490.5	25%
Mixed Softwoods	66.9	4%
Mixed Hardwoods	18.8	1%
White Pine/Hemlock	213.7	11%
Hemlock	17.6	1%

### **Summary of Forests of the Willow Brook Watershed**

The forest in the Willow Brook watershed is highly variable in composition and structure from one stand to another. The successional history, or response to disturbance of a site is the primary factor in this region which determines how a forest stand appears today. If, for example a forest has returned after abandoned pasture or cropland, it will be quite different from a forest which has been selectively cut from time to time. The soils and topographic location of a site can also affect the nature of a forest stand, as can the amount of soil moisture.

In general, the dominant forest trees watershed-wide are White Pine, Hemlock, Red Oak, Beech, Red Maple, Sugar Maple, Black Cherry, White Ash, Yellow Birch, Black Birch and Paper Birch. Pines tend to thrive in old pastures and along stream banks, while Oaks are often found in drier and

warmer locations. Black Cherry and Paper Birch compete well following fire. Sugar Maple and White Ash prefer richer, moister soils and Hemlock, Beech and other Birches tolerate a fairly wide range of conditions. As the disturbance history, seed source and physical properties of each tract differ, so do the mixtures of tree species.

The most common forest types in the watershed are Mixed Softwoods/Mixed Hardwoods and Mixed Hardwoods/Mixed Softwoods. Together these account for 94% of the forest cover (refer to Table 8). This is at least partially due to the fact that the forest is so variable, and that more exact stand composition distinctions are difficult to make from aerial photographs alone.

The Mixed Softwoods, Hemlock and Mixed Hardwoods forest types are present, but relatively uncommon in the watershed. Mixed softwoods and hemlock stands are valuable as habitat for mammals including snowshoe hare and whitetail deer. Large hemlock-dominated stands, such as one bordering Willow Brook above Tory Hill Meadow in fact may be used regularly by local deer populations for forage and shelter in the winter. Mature hardwood stands, such as those in the north and northeast sections, which have a strong component of beech or oak support those mammals which depend on the nuts they produce. These include black bear, turkey and red squirrel.

## V. Conclusions of the Natural Resource Inventory

The Willow Brook Watershed is an ecologically diverse and healthy area which also supports a variety of human endeavors. The relatively low population density coupled with the continuation of traditional low-intensity land use could continue to maintain this balance. Certain resources are especially sensitive to further development, most notably surface waters, aquifers, sensitive wildlife habitat and wetlands, and may merit special protection.

The use of various map overlays in GIS format in conjunction with field work has highlighted several specific areas in the watershed which are especially significant from a natural resource stand point. These have emerged as Priority Areas in special need of conservation. The criteria for selecting these Priority Areas are as follows: 1) they are relatively large, ecologically cohesive areas, 2) they contain resources which are exemplary or otherwise uncommon in the watershed, 3) resources are especially concentrated there, or 4) the area has the potential to significantly affect other areas if degradation should occur. In addition, there are some aspects of each area which make it unsuitable for development.

The Natural Resource Inventory identified four Priority Areas within the watershed which met most or all of the above criteria (refer to Map 8, Priority Areas). These areas are listed below, along with some of the qualities that make them significant or problematic for development. It should also be noted that other Priority Areas may surface following further study of the watershed.

### Priority Areas for Conservation

*Tory Hill Meadow Area:* (including wetlands and 300 ft. surrounding upland border). High diversity of wetland types; less common wetland types; vernal pools; heron rookery and other wildlife habitat; within floodplain area; soils with limitations; high scenic value.

*Willow Brook above Tory Hill Meadow:* (including an upland border extending 100 ft. from each stream bank). Diverse wildlife and fish habitat; limiting soils; tributary to Warner River and Tory Hill Meadow.

*Southeast Wetland Complex:* (including an upland border extending 100 ft. from each wetland boundary). Forested and wet meadow wetland; high visibility and proximity to roadway; direct connection to Willow Brook; soils with limitations.

*Southwest Wetland Complex:* (including an upland border extending 100 ft. from each wetland boundary). Unusual suite of forested

wetlands; special wildlife habitat including vernal pools; partially within floodplain area.

### **Other Areas of Concern: Uncommon Forest Types**

Two other areas of concern were identified by the Natural Resource Inventory. These two areas are actually forest types which are relatively uncommon in the watershed, and which have special value for wildlife habitat and/or resource protection. They are not as site-specific as the priority areas, and since forest types tend to grade into one another, the boundaries of these forest stands is not always clear. Also, over time they may change in composition to another forest type. For these reasons they were not included in the list of Priority Areas, but deserve mention as natural communities which should be preserved if possible.

*Mature Mixed Hardwood Forest Stands:* Uncommon forest type for watershed; high wildlife value, including black bear and wild turkey

*Hemlock-dominated Forest Stands:* Relatively uncommon forest type for watershed; high value as wildlife habitat; maintains shade, coolness and oxygenation of streams.



## Part B

# Willow Brook Watershed Conservation Plan

## I. Town Regulatory and Other Actions for Natural Resource Conservation

The overall goal of the Willow Brook Watershed Conservation Plan is protection of the area's natural resources for today and for the future. Such a broad goal, encompassing many facets both human and natural, will require the cooperation of a varied constituency within the town.

This section contains recommendations for conservation in the Willow Brook watershed which are directed to the Town of Warner, its Board of Selectmen, Planning Board and Conservation Commission. Some of these recommendations involve changes to Town ordinances, and would therefore effectively conserve natural resources town-wide.

Watershed landowners and the public can also play important parts in seeing this plan realized. The public will have an opportunity to be involved in adopting changes proposed to the zoning ordinance and in the public outreach activities proposed. Land owners are encouraged to manage their own properties according to voluntary sustainable approaches recommended in the next two sections.

## Water Resources

### Streams and Ponds

#### *Findings*

The Willow Brook watershed contains more than 8 miles of streams.

The streams of the watershed provide habitat, fishing, scenic enjoyment and groundwater recharge

The results of any human activities that adversely affect stream water quality, such as agricultural runoff, road salt and unwise forestry practices can potentially affect downstream areas, including the Warner River and it's aquifer.

Maintaining shade along the stream corridor is important for clear, well oxygenated stream water. Keeping vegetation intact along stream corridors maintains shade, stabilizes sediments, promotes cool temperatures and helps to filter out pollutants.

The Town zoning ordinance currently requires a building setback of 75 feet from ponds greater than 10 acres, perennial waterways or streams, buildings or storage tanks and the maintenance of at least 50% of the existing natural vegetation within this buffer zone (Article IV, Provision J.). However, the "50% natural vegetation" clause is not specific enough to prevent excessive clearing within the 75 foot buffer zone.

A water quality survey of Willow Brook conducted by the NH Department of Environmental Services in 1997 found elevated levels of sedimentation in the brook, primarily caused by inadequate erosion controls on gravel roads adjacent to the brook.

There is currently no program in place for long-term water quality monitoring in the watershed.

*Recommendations:*

- *Board of Selectmen:* Ensure landowner compliance with the 75 foot zoning setback.
- *Board of Selectmen:* Take measures to control erosion from gravel roads in the proximity of Willow Brook and its tributaries.
- *Planning Board:* Propose an amendment for Town approval to Section J, Article IV, General Provisions of the zoning ordinance to read as follows (Bold text is new):

J. Warner River, bodies of water and waterways: Any lot bordering the Warner River shall have a minimum frontage of 100 feet. All buildings, including storage tanks, shall be set back a minimum of 75 feet from the Warner River, ponds greater than 10 acres and all perennial waterways and streams as shown on standard 7.5 minute USGS quadrangle maps. **In addition, where existing, a natural woodland buffer shall be maintained within 75 feet of the Warner River, all great ponds and perennial streams. Not more than 50 percent of the total number of trees, and not more than 50 percent of the total number of saplings shall be removed for any purpose in a 20 year period. A healthy, well-distributed stand of trees, saplings, shrubs and ground covers and their living, undamaged root systems shall be left in place. Replacement planting with native or naturalized species may be permitted to maintain the 50 percent level.**

In addition to these changes, add two new definitions to Article III, as follows:

AB. "Sapling" means any woody plant which normally grows to a mature height of greater than 20 feet and has a diameter less than 6 inches at a point 4.5 feet above the ground.

AC. "Tree" means any woody plant which normally grows to a mature height of greater than 20 feet and has a diameter of 6 inches or more at a point 4.5 feet above the ground.

- *Conservation Commission:* Inform citizens about the importance of observing the existing 75 foot setback and vegetated buffer zoning restriction.
- *Conservation Commission:* Develop a long term water testing program to monitor stream water quality using N.H.D.E.S. or other model.
- *Conservation Commission:* Promote and actively seek private land conservation in key stream corridor areas, especially along Willow Brook.

## **Aquifers**

### *Findings*

The watershed contains 84 acres of the high-yield Warner River Aquifer, as well as other smaller aquifers.

The Warner River Aquifer provides the water for the Town water supply. Other smaller aquifers are used as private water sources.

Human activities at the aquifers or their sources, such as street runoff of salt and automobile fluids or industrial chemical leakage have the potential to adversely affect the portion of the Warner River aquifer in the watershed.

Portions of two Wellhead Protection Zones are located in the watershed, one of which is for the town water supply.

The Town Subdivision Regulations prohibit the inclusion of land in areas necessary for the protection of aquifers and aquifer recharge areas toward the required minimum buildable lot size (Section IV, A., 1., b.).

No comprehensive aquifer protection regulations currently exist in the Warner Zoning Ordinance.

### *Recommendations:*

- *Planning Board:* Establish aquifer protection overlay zoning districts for all high-yield aquifers in the watershed.
- *Planning Board:* Adopt an Aquifer Protection Ordinance.

## Wetlands

### *Findings*

Nearly 140 acres of wetlands have been identified in the Warner portion of the watershed.

Wetlands serve several important functions, including water quality maintenance and improvement, wildlife habitat, floodwater storage, ground water recharge/discharge, aesthetics and recreation.

The State of New Hampshire has jurisdiction over any activities that may directly impact a wetland, including dredging, filling, placement of structures and certain discharges. The U.S. Army Corps of Engineers and other agencies may also have jurisdiction over certain wetlands.

Wetlands are unsuitable for building or septic system installation.

Wetlands not categorized as ponds greater than 10 acres or as streams lack protection by any building setback or vegetation buffer in the Warner zoning ordinance.

### *Recommendations:*

- *Planning Board:* Amend the zoning ordinance to require a building setback and vegetated buffer of 75 feet from any wetland identified in the Willow Brook Watershed Natural Resource Inventory. This wording could be included in Section J, Article IV of the Zoning Ordinance (see page 33).
- *Planning Board:* Amend Town site plan review and subdivision regulations to require that all wetlands within a proposed impact area be delineated and mapped by a Wetlands Professional as part of the application process.
- *Conservation Commission:* Inform citizens about the importance of maintaining wetland buffers.
- *Conservation Commission:* Encourage and actively seek private land conservation by the use of easements or other methods in key wetland areas, especially in the southern portion of the watershed.

# Biological Resources

## Wildlife Habitat

### *Findings*

A wide range of habitat for wildlife is located in the watershed, with especially high concentrations in the vicinity of Tory Hill Meadow and other wetlands. The watershed is known to support at least 118 species of animals for a portion of their life cycle.

Both game and non-game species of wildlife provide a significant recreational opportunity for residents and visitors, and help to support the local economy.

Fragmentation of open space by road construction and development decreases its value as wildlife habitat, and may extirpate certain species.

Protection of wildlife populations must concentrate on the protection of wildlife habitat to be effective.

Wildlife does not recognize property or political boundaries when utilizing habitat.

### *Recommendations:*

- *Conservation Commission:* Promote and actively seek private land conservation in key wildlife habitat areas, including the Tory Hill Meadow area, softwood-dominated forestlands and stream corridors.
- *Conservation Commission:* Inform citizens of the value and diversity of wildlife habitat in the watershed.
- *Conservation Commission:* Encourage the enhancement or restoration of wildlife habitat by landowners.

## Forests

### *Findings*

Forested lands constitute more than 82% of the land area of the watershed

Forests provide wildlife habitat, timber and firewood, water retention, erosion control, temperature control and scenic beauty.

Erosion of soils exposed by construction or careless timber harvesting can cause the loss of nutrients essential for productive forest growth.

*Recommendations:*

- *Conservation Commission:* Inform and encourage landowners to use sustainable forest management practices on their forest lands, as outlined in *Good Forestry in the Granite State*.
- *Conservation Commission:* Promote the benefits to landowners of developing and following a forest management plan, and of using the services of a qualified, certified forester.

## **Physical Resources and Features**

### **Soils**

*Findings*

The erosion of soils diminish the productivity of forest and agricultural lands, and degrade surface water quality.

Soils with limitations for land use due to hydrology, including poorly drained and very poorly drained soils, floodplain soils and organic soils account for 8.3% of the watershed area.

The Town Subdivision Regulations encourage the use of practices which conserve soil during construction.

The Town Subdivision Regulations prohibit the inclusion of lands with ledge which is exposed or lying within 4 feet of the soil surface, or land covered by any soils listed by the NH Water Division as Groups 5 and 6 (hydric soils) toward the required minimum buildable lot size (Section IV, Provision A., 1., c & e..).

*Recommendations:*

- *Conservation Commission:* Inform and encourage landowners to use practices which conserve soils by minimizing erosion and preventing contamination from the dumping or leaking of hazardous materials.

### **Floodplains**

*Findings*

87 acres of floodplain areas have been mapped within the watershed. 84 of these acres are in the Warner River floodplain, and are classified zone "A" as most likely to flood.

Floodplains provide unique plant and wildlife habitat, as well as scenic enjoyment and recreation.

The Town of Warner recently adopted a Floodplain Development Ordinance which addresses construction standards, water and sewer systems and development standards for construction in flood-prone areas as they appear on Town maps. This ordinance applies to portions of the Willow Brook watershed which are designated flood hazard areas, most notably the 87 acres in Zone "A" at the confluence with the Warner River.

The Town Subdivision Regulations prohibit the inclusion of lands designated as Flood Plain toward the required minimum buildable lot size (Section IV, Provision A., 1., a.).

*Recommendations:*

- *Conservation Commission:* Familiarize landowners with the specific areas which are designated as flood plains on Town maps, especially those areas in high-density and high-use parts of town, such as the downtown area.
- *Conservation Commission:* Inform landowners of the practical and ecological reasons for avoiding development and certain incompatible uses in flood plains.

## **Slopes**

*Findings*

The watershed landscape has a variable topography with 3.8% of the area exceeding a 25% grade slope .

Areas with steep slopes, especially those over 25%, pose problems for forest management, and are unsuitable for road or building construction, due to their inaccessibility to equipment the high potential for soil erosion.

The Town subdivision regulations prohibit the inclusion of land with slopes in excess of 25% toward the required minimum buildable lot size (Section IV, Provision A., 1., c.).

*Recommendations:*

- *Conservation Commission:* Inform landowners of the practical, legal and ecological reasons for avoiding construction and road building on slopes greater than 25% grade.

## Priority Areas for Conservation

The Natural Resource Inventory identified four areas within the watershed which were judged to be in special need of conservation, and were thus designated as Priority Areas.

*Tory Hill Meadow Area:* (including wetlands and 300 ft. surrounding upland border) High diversity of wetland types; less common wetland types; vernal pools; Heron rookery and other wildlife habitat; within floodplain area; soils with limitations; high scenic value.

*Willow Brook above Tory Hill Meadow:* (including an upland border extending 100 ft. from each stream bank) Diverse wildlife and fish habitat; limiting soils; tributary to Warner River and Tory Hill Meadow.

*Southeast Wetland Complex:* (including an upland border extending 100 ft. from each wetland boundary) Forested and wet meadow wetland; high visibility and proximity to roadway; direct connection to Willow Brook; soils with limitations.

*Southwest Wetland Complex:* (including an upland border extending 100 ft. from each wetland boundary) Unusual suite of forested wetlands; special wildlife habitat; partially within floodplain area.

### *Recommendations*

The Conservation Commission should focus its efforts to:

- Identify land parcels within the Priority Areas which are key to their protection.
- Approach landowners in the Priority Areas and encourage and assist them in preparing management plans for their properties which would protect the sensitive resources there.
- Identify an existing demonstration project which has applied sustainable land management practices to a property. Introduce Priority Area landowners to the Project and encourage them to adopt sustainable practices on their own land.
- Determine if all eligible parcels in the Priority Areas are under Current Use assessment. Encourage the owners of any parcels that have not been so placed to consider reassessment.
- Initiate a program to inform landowners in the Priority Areas of the benefits and techniques of formal land protection.

- Work with landowners in the Priority Areas for the donation or bargain sale of property or conservation easements to protect these areas.

### **Other Areas of Concern: Uncommon Forest Types**

These two relatively uncommon forest types which have special value for wildlife habitat and/or resource protection were also identified by the Natural Resource Inventory.

*Mature Mixed Hardwood Forest Stands:* Uncommon forest type for watershed; high wildlife value, including black bear and wild turkey

*Hemlock-dominated Forest Stands:* Relatively uncommon forest type for watershed; high value as wildlife habitat; maintains shade, coolness and oxygenation of streams.

#### *Recommendations*

The Conservation Commission should focus its efforts to:

- Identify landowners whose property supports these forest types and inform them of the special resource on their property.
- Provide information to the landowners of the importance of these resources and of ways that they can help to preserve them, such as the use of sustainable forestry practices or granting of conservation easements.

## **II. Permanent Land Protection Methods**

Often landowners are concerned about what will happen to their land in the future. Perhaps their land is a farm, has special scenic qualities, supports important wildlife habitat or has been an actively managed forest. For any number of reasons, some landowners take steps to permanently protect those qualities of their land that they value. There are many options for doing this, depending on the wishes of the landowner. In many cases, there are also financial benefits to land protection as well. The three most commonly used methods for protecting land are summarized here.

### **Conservation Easement**

If a person wants to continue to own their land and protect its long-term resource values by restricting certain types of future land use, a Conservation Easement is a good option. An easement may be donated, sold or willed to the easement holder who in turn agrees to monitor and enforce the easement from future infractions. The owner may sell or will the land in the future as they wish, but the restrictions in the easement document continue to apply to the land forever, no matter who the future owner may be. Also, easements can apply to all of the land or to a portion of it.

The landowner typically works with a non-profit conservation organization such as a Land Trust, or with a government agency such as a Conservation Commission to draft an easement document which specifies which activities will or will not be allowed on the land. Depending on the easement agreement, farming, timber harvesting, or limited housing development may be allowed. Each conservation easement is unique, tailored to the needs of the landowner, while meeting the conservation criteria of the land trust or government agency acting as easement holder. The easement language also spells out the legal responsibility of the easement holder to enforce the terms of the easement in perpetuity.

There may be tax benefits to landowners with a conservation easement on their property. Income taxes, property taxes and/or estate taxes may be lowered as a result of granting an easement.

### **Land Donation**

Some landowners decide to donate their land outright to an organization which agrees to protect its conservation values. Certain situations may make this an attractive option for conserving property, such as when a landowner with no heirs, or heirs who will not or cannot protect the land; a highly appreciated property which would cause a high capital gains tax if sold; a landowner who is no longer able to manage their property in the way they would like.

Property may be donated to a conservation organization or a government agency such as a Conservation Commission, which agrees to protect its conservation value. In some cases a conservation easement can also be placed on the property at the time of donation. The owner donating their land can continue to live on their land if they arrange this in advance with the new land holder. One way to do this is to write the gift of the land into a will. Thus the ownership of property transfers to the chosen recipient at the time of death.

Income tax deductions and estate tax savings are often substantial for the land donor. Also, since the land is donated, capital gains taxes are avoided. Land still subject to a mortgage can also be donated. In this case it is considered a bargain sale, since the unpaid portion of the mortgage must be paid by the recipient of the land.

### **Bargain Sale**

For landowners who feel they need some income from their land but who also want it protected, a Bargain Sale may be the best option. In this method, the land is sold to a conservation organization, conservation commission or other qualified entity at below fair market value. The purchasing entity agrees to protect the land in accordance with whatever agreement has been made with the seller.

The difference between the land's fair market value and the bargain sale price can be claimed as a charitable donation. This amount can be claimed for an income tax deduction. It will also decrease the value of the landowner's estate by that amount, also resulting in an estate tax savings.

### III. Conservation Practices for Landowners

#### Introduction to Land Conservation Programs

Landowners can contribute to the ecological health of their community by using sound, sustainable management practices on their own land. A variety of programs have been established by governmental and private organizations to help landowners with good land stewardship.

There are three general types of programs. Incentive Programs involve a cost-share in which the sponsoring agency or organization provides technical and financial assistance to the landowner, on the condition that the landowner also contribute to the project.

Another category, Volunteer Programs offer extensive education on certain topics. Following some course training, participants become volunteers and share their new knowledge with others in the community or beyond.

A third category of Educational Programs offer courses or publications about land management. In some of the programs the participant receives certification for completion of the program, or for exemplary management practices. Several of the more prominent or appropriate programs of the many available will be highlighted here.

#### Cost Share Programs

A number of programs which involve a matching contribution from the applicant are sponsored by the USDA under the 1996 Farm Bill. The sponsor is the Agricultural Stabilization and Conservation Service. The programs which are administered on the state level are summarized here.

The *Conservation Reserve Program* is designed to help reduce soil erosion, reduce sedimentation in streams and lakes, improve water quality, establish wildlife habitat and enhance forest and wetland resources.

The *Farmland Protection Program* provides funds to help purchase development rights to keep productive farmland in use, typically by working with State or local governments to acquire conservation easements.

The *Forestry Incentive Program* supports good forest management practices on privately owned, non-industrial forests lands nationwide. Eligible practices include tree planting, timber stand improvement, site preparation for natural regeneration, and other related activities.

The *Wetlands Reserve Program* is a voluntary program to restore wetlands. Landowners establish conservation easements or enter into cost-

sharing restoration agreements. In return, the landowner receives payment up to the agricultural value of the land and 100% of the restoration costs.

The *Wildlife Incentives Program* provides financial incentives to develop habitat for fish and wildlife on private lands. Participants agree to implement a wildlife habitat plan and USDA agrees to provide cost-share assistance for the initial implementation of habitat development practices.

The *Stewardship Incentive Program* is part of a nationwide stewardship initiative to increase the awareness of private forest landowners and the level of management on their forestlands. A series of separate cost-share practice programs which offer financial assistance are available to qualified landowners. These practice topics include Stewardship Plans, Reforestation, Forest Improvement, Windbreaks, Erosion Control, Waterways and Wetlands, Fish Habitat, Wildlife Habitat, and Recreation.

Agricultural Stabilization and Conservation Service  
10 Ferry Street  
Suite 212  
Box 22  
Concord, NH 03301  
225-5931

## **Volunteer Programs**

The *New Hampshire Coverts Project* is a volunteer program that promotes wildlife habitat improvement through forest stewardship. Participants receive extensive training in many facets of wildlife ecology and management, and in return volunteer in the community to share their knowledge. Sponsored by UNH Cooperative Extension, New Hampshire Fish & Game and the Ruffed Grouse Society.

New Hampshire Coverts Program  
UNH Cooperative Extension  
110 Pettee Hall  
55 College Rd.  
Durham, NH 03824-3599  
862-3592

The *New Hampshire Community Tree Stewards Program* offers a series of courses relating to trees and forestry in the community setting. Following the completion of the program, Tree Stewards volunteer in their community on shade tree projects. Sponsored by the New Hampshire Division of Forests and Lands and UNH Cooperative Extension.

New Hampshire Community Tree Stewards Program  
UNH Cooperative Extension  
468, Route 13 South  
Milford, NH 03055  
673-2510

## **Educational Programs**

The *Granite State Woodlot and Wildlife Management Course* is an annual, one week series of courses related to many aspects of forestry and wildlife. A long list of specialists instruct participants in such topics as land stewardship, timber inventory skills, boundary location and wildlife management. Sponsored by the UNH Cooperative Extension, Hillsborough County Office.

UNH Cooperative Extension  
Hillsborough County Office  
468 Route 13 South  
Milford, NH 03055-3445  
673-2510

The *New Hampshire Tree Farm Program* “encourages forest owners to actively manage their forests in a sustainable manner for multiple uses”. Forest tracts of 10 acres or more qualify for this program. Newly certified Tree Farmers receive the latest forestry information and other benefits. Sponsored by the New Hampshire Tree Farm Committee.

NH Tree Farm Committee  
54 Portsmouth Street  
Concord, NH 03301  
224-9945

The *Backyard Tree Farm Program* is intended for parcels less than 10 acres. This educational program teaches the owner how get to know their property better and to enhance it's values for wildlife, forestry and recreation. Sponsored by UNH Cooperative Extension, the Beaver Brook Association and the New England Forestry Foundation.

Backyard Tree Farm Program  
UNH Cooperative Extension  
108 Pettee Hall  
55 College Rd.  
Durham, NH 03824

UNH Cooperative Extension makes *Water Resources Educational Materials* including guides, manuals, equipment and audiovisual materials available for water quality and wetland ecology activities. Sponsored by the UNH Cooperative Extension County Offices.

UNH Cooperative Extension  
Merrimack County Office  
327 Daniel Webster Hwy.  
Boscawen, NH 03303  
796-2151

*Forestry and Shade Tree Publications* are available for free from UNH Cooperative Extension. The long list of topics includes Care of Apple Trees, Transplanting Native Trees and Shrubs, Guide to Timber Harvesting Laws and Harvesting and Marketing Christmas Trees.

Tim Fleury, Extension Educator  
UNH Cooperative Extension  
327 Daniel Webster Hwy.  
Boscawen, NH 03303  
796-2151

## **IV. Summary of Recommendations**

### **Regulatory Controls**

The Town of Warner already has in place ordinances and regulations that protect some of the natural resources in the town. Action on the above recommendations will put in place further protections which will have lasting benefits to the aquifers, streams and wetlands of the watershed and the town in general. Growth in the town and its associated pressure on resources are an all but inevitable trend, but proactive measures taken now will put the town in a better position to cope with these pressures.

### **Outreach Initiatives**

The Conservation Commission should act as a resource to the citizens on matters related to conservation. A series of outreach programs and informational materials should be developed or adopted which implement these recommendations. Existing programs developed by the Audubon Society of New Hampshire, UNH Cooperative Extension and the Society for the Protection of New Hampshire Forests which assist landowners in managing their property sustainably could be sponsored for the public in Warner. The Pillsbury Library, Kearsarge High School and the Warner Elementary could all cooperate with the Commission in presenting programs and compiling informational materials.

### **Land and Resource Protection**

Areas of the watershed which have exceptional ecological value and which are relatively large and intact should be formally protected if possible, especially the four Priority Areas listed in Part A, Section V. A versatile and efficient mechanism for perpetual land protection is the conservation easement. The Commission already holds two such easements. Being a functioning arm of the local government, it is a logical party to hold future easements and to enforce their terms.

In cases where it may be preferable for another party to hold an easement, the Commission could work with the landowner to establish an easement to be held by a local Land Trust such as the Ausbon Sargent Land Preservation Trust, or a state-wide organization such as the Society for the Protection of New Hampshire Forests or the Audubon Society of New Hampshire.

## **Project Summary**

The Willow Brook Watershed Project has been the most comprehensive study of natural resources in the Town's history. It was conceived as a pilot, the design of which could be applied to the other watersheds in Warner. Several of the conservation recommendations in this report should be applicable not only to the Willow Brook watershed, but to other areas throughout the town as well.

This report can also serve as an educational resource. The results may be of interest to landowners in the area, or to students of conservation. The report findings, as well as the numerous maps will be made available to the public for their use.

The results of this Conservation Plan will be considered for inclusion in the updated Master Plan for the Town of Warner. As a planning tool the report will play a central part in shaping the future of natural resource conservation in Warner.

## V. Suggestions for Further Study

This project focused only on the Warner portion of the Willow Brook watershed. The Town of Salisbury may want to build on the present effort by completing a natural resource inventory and conservation plan, or other form of study on its portion of the watershed. This would benefit people and resources in both towns.

No effort was made to locate undocumented occurrences of rare and endangered plant or animal species, or potential suitable habitat for them. Although this can be controversial, the increasing threats to these sensitive and scarce species makes the knowledge gained from a survey of this sort especially valuable.

In the interest of monitoring potential threats to water quality in the watershed, an inventory of ground waters sources and the potential pollution sources which could threaten them should be done. This could include the location and capacity of underground storage tanks, septic systems, wells, salt piles, junk yards and agricultural sites.

Geological resources in the watershed, most notably sand and gravel deposits, were not identified in this study. The excavation of these areas could affect water quality, wildlife habitat and forest resources. These areas could be easily located using existing GIS data, and taken into consideration for conservation planning.

Continued monitoring of water quality, stream macro invertebrates, breeding birds, vernal pools, etc. would not only build on the knowledge base achieved so far, but would also help to track the long-term ecological health of the watershed.

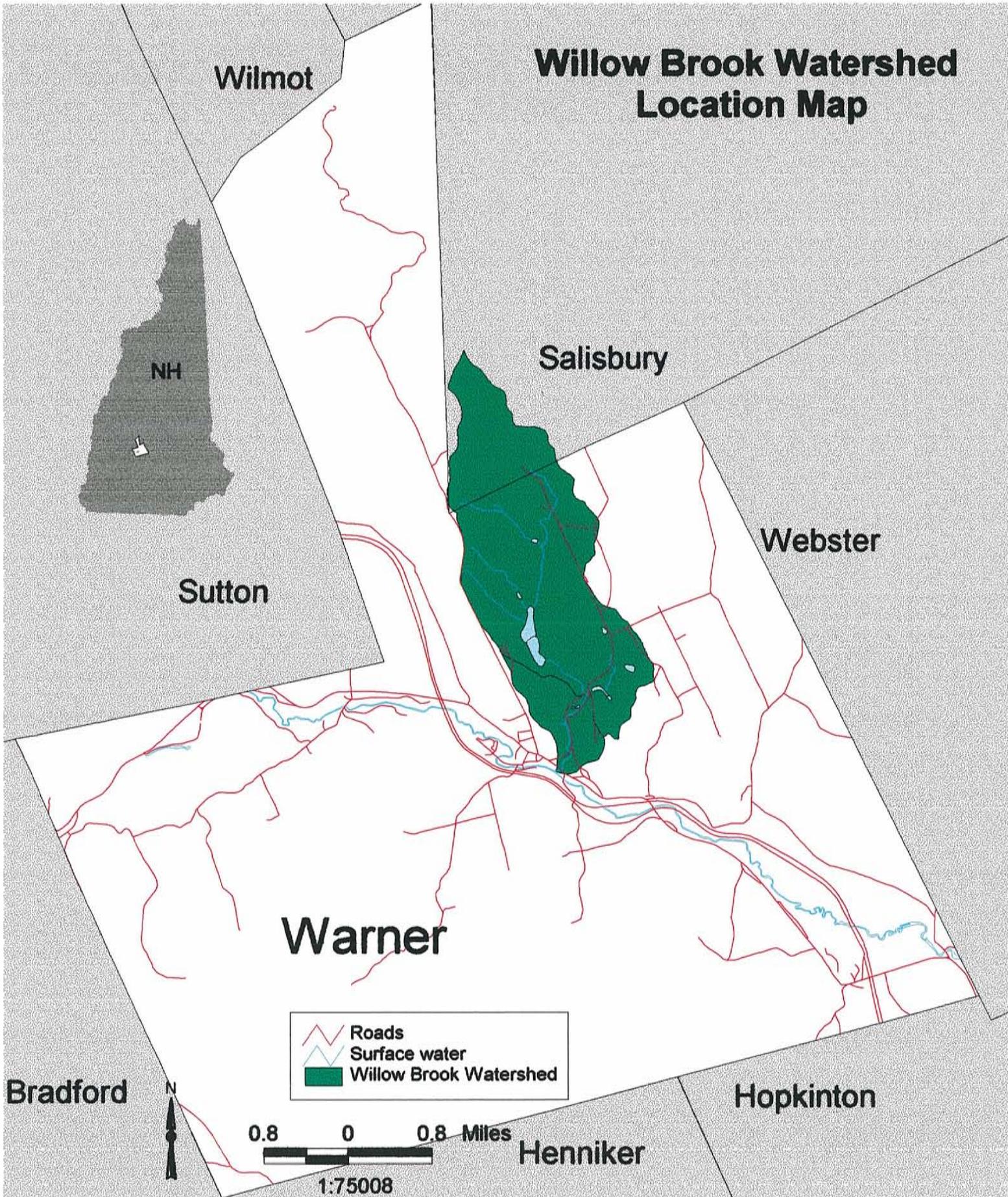
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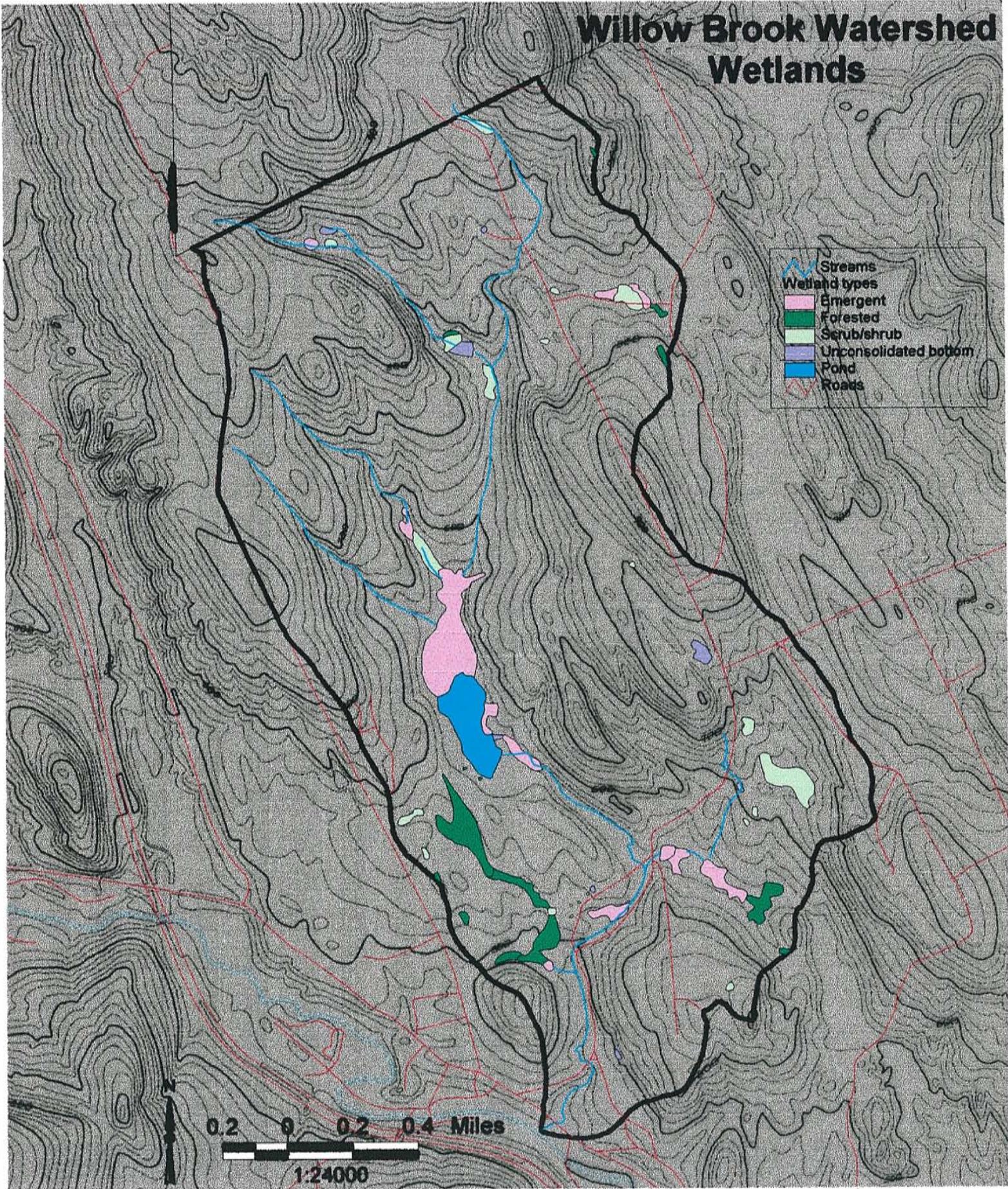
## **Appendix I**

### **Maps of the Willow Brook Watershed**



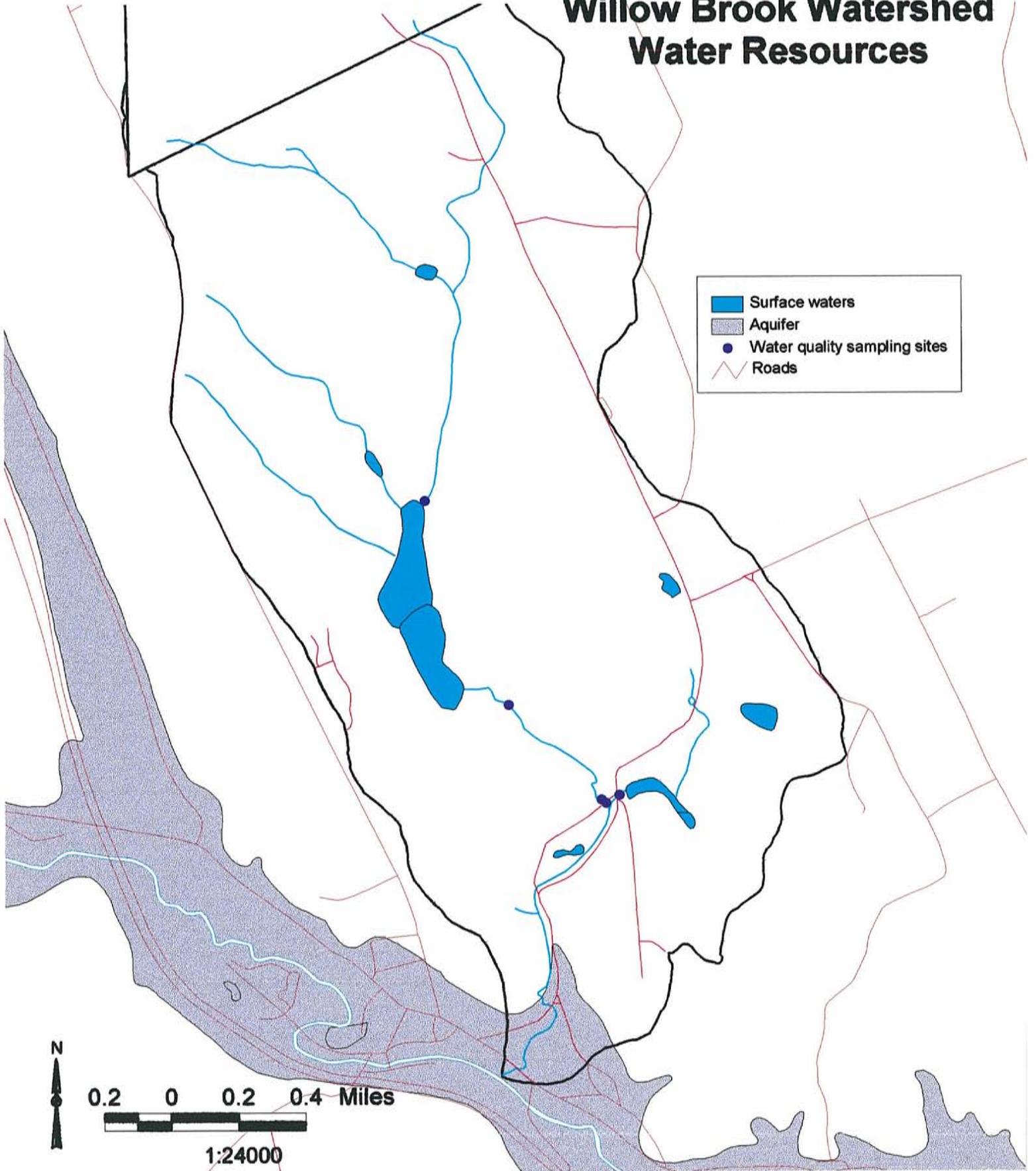
Map 1.

# Willow Brook Watershed Wetlands



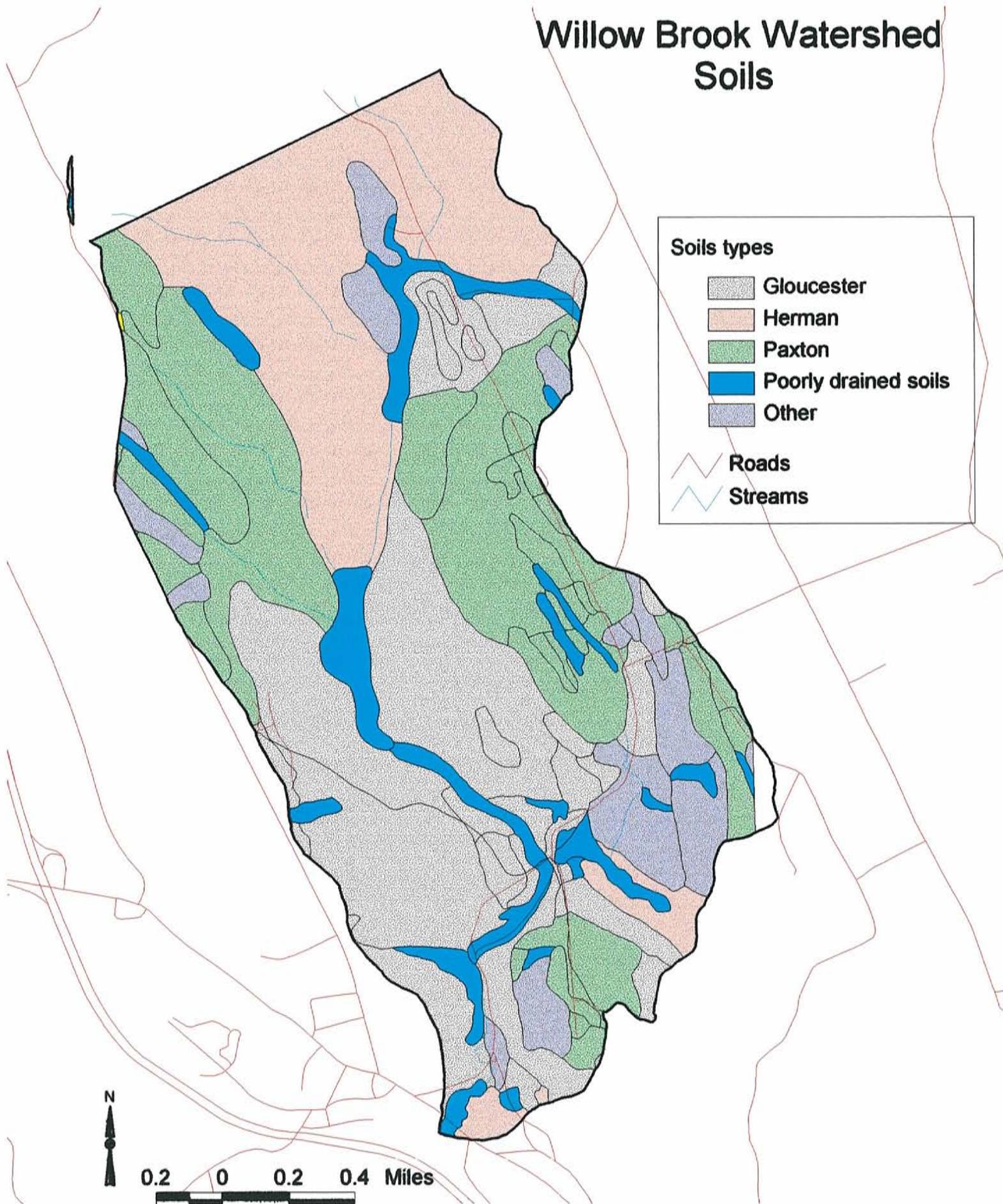
Map 2.

# Willow Brook Watershed Water Resources



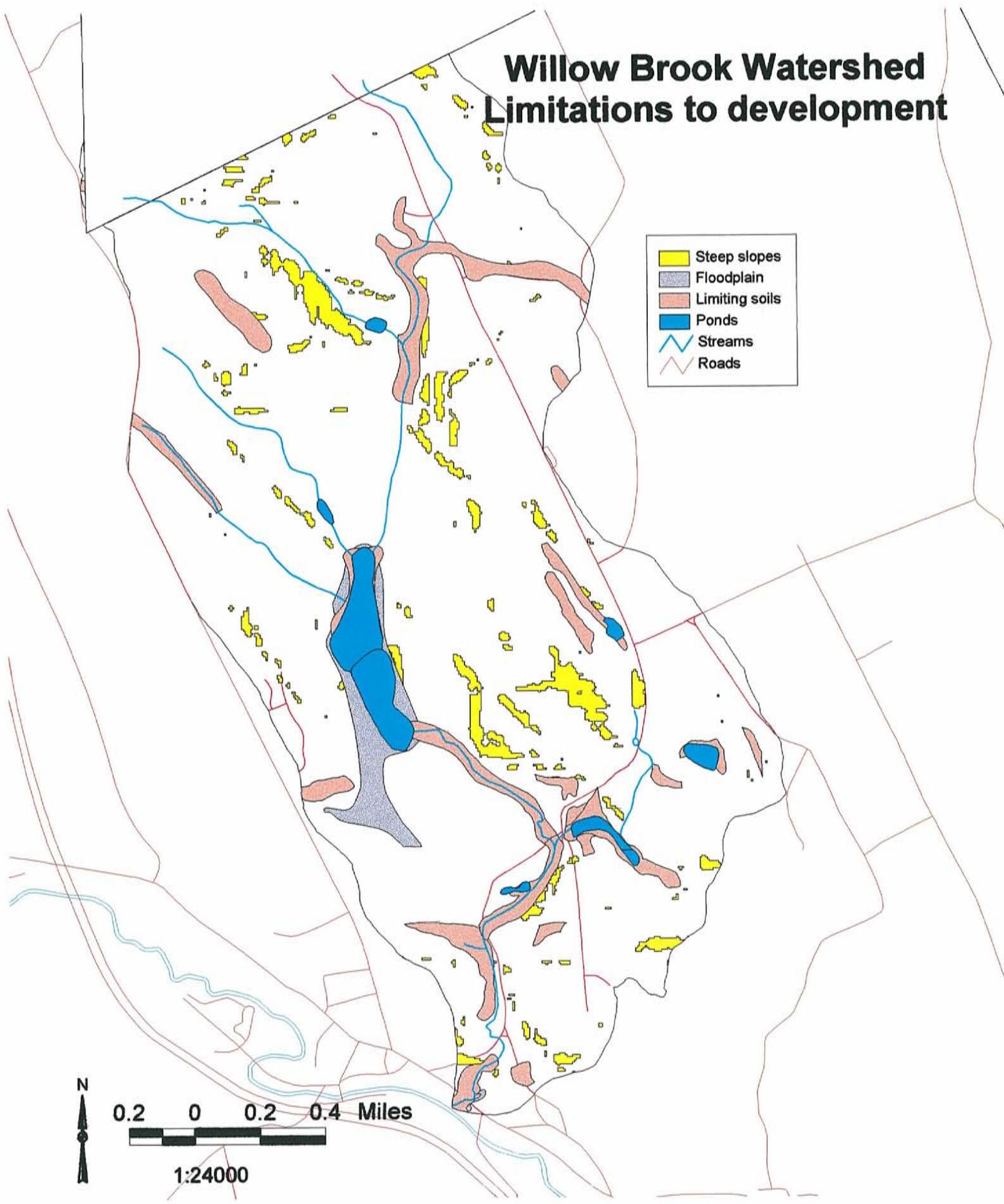
Map 3.

# Willow Brook Watershed Soils



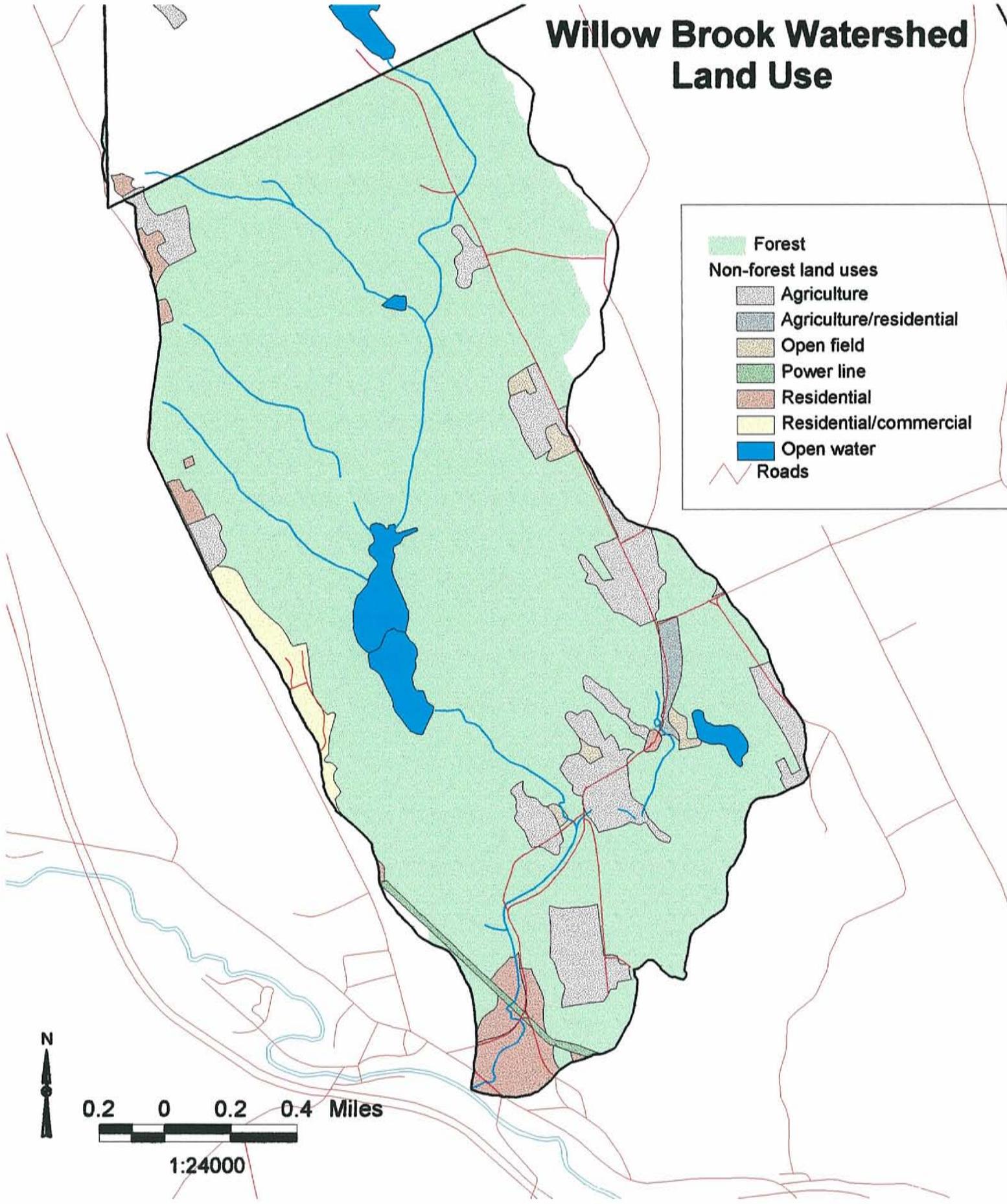
Map 4.

# Willow Brook Watershed Limitations to development



Map 5.

# Willow Brook Watershed Land Use



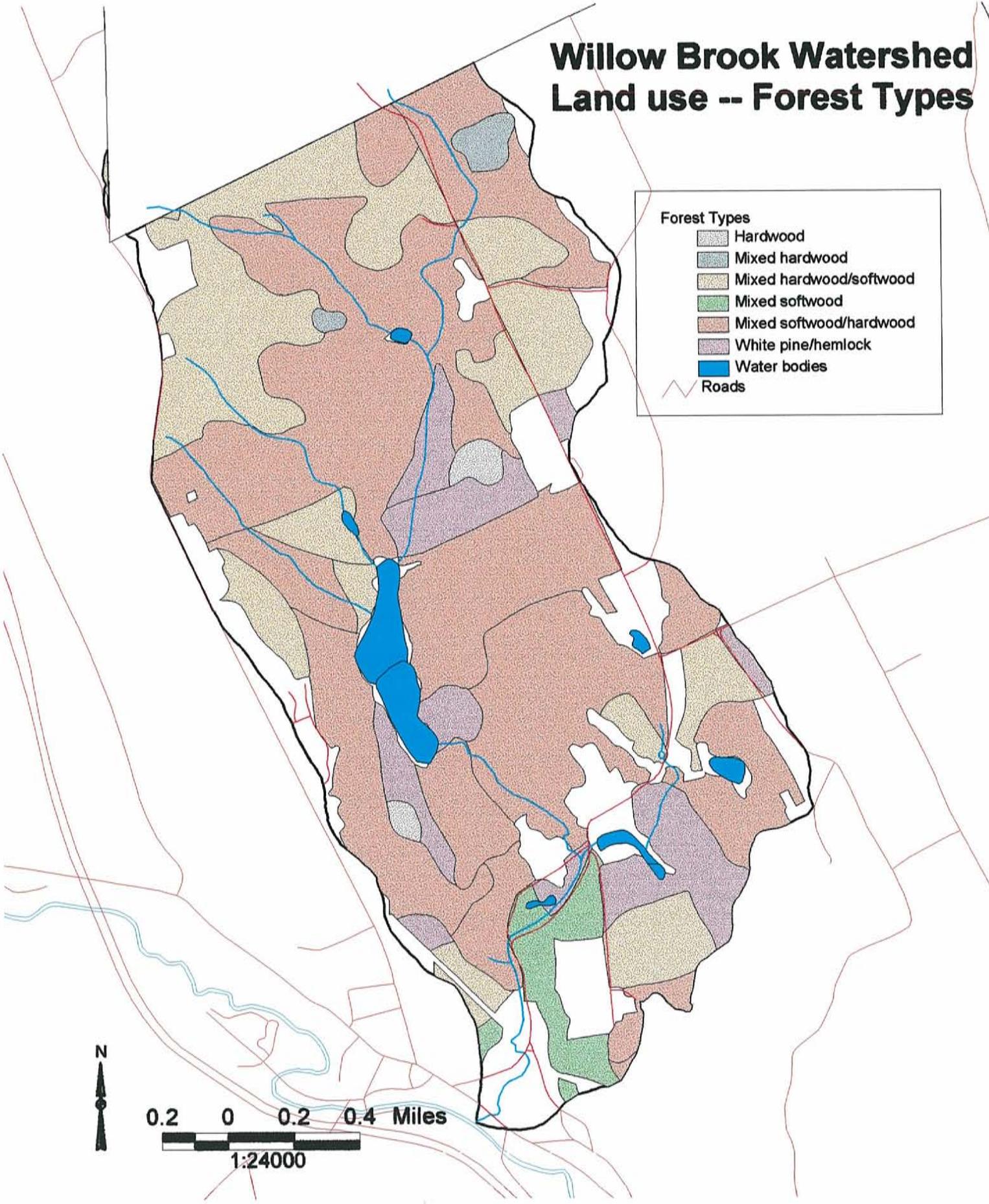
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1:24000

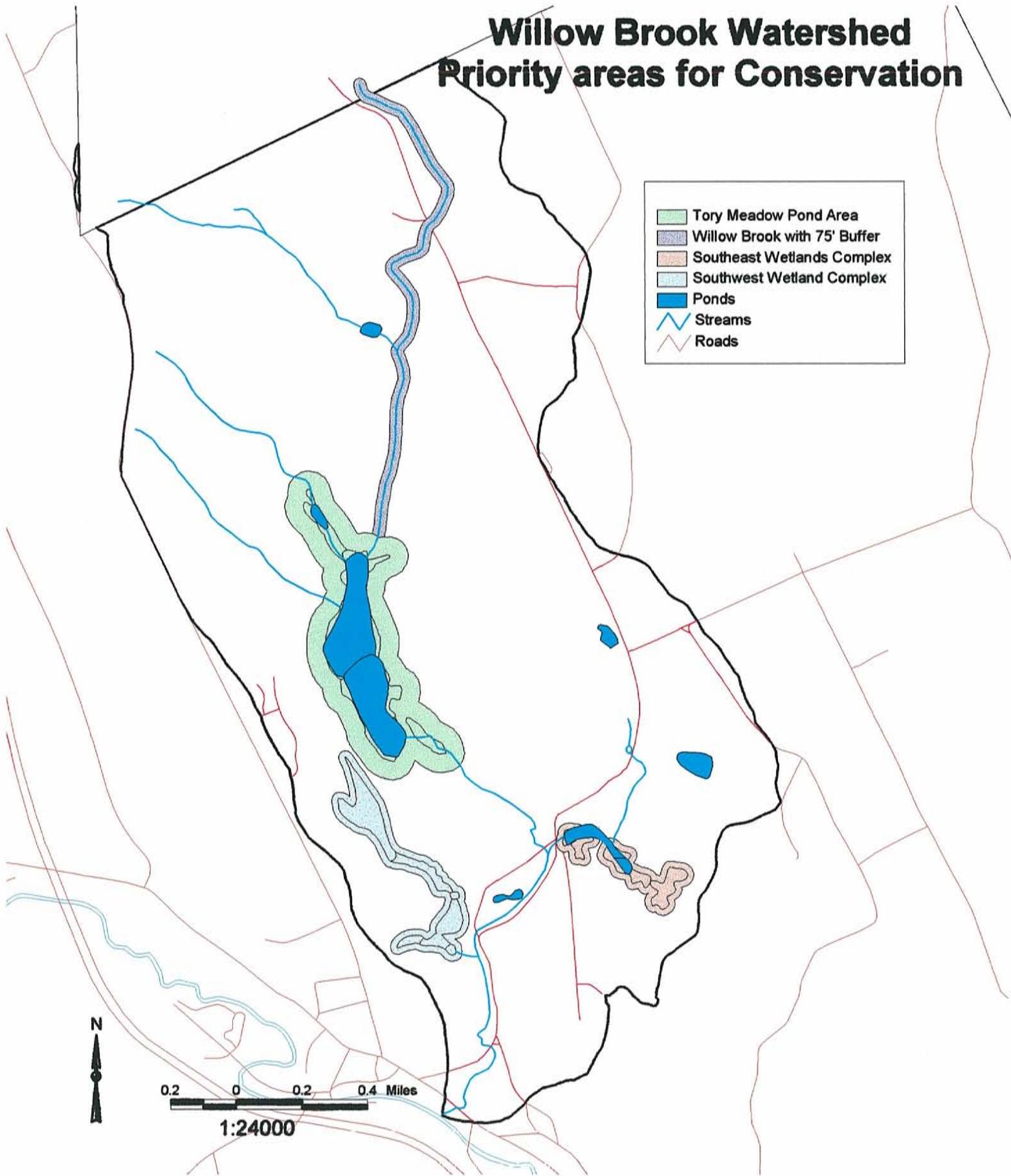
Map 6.

# Willow Brook Watershed Land use -- Forest Types



Map 7.

# Willow Brook Watershed Priority areas for Conservation



Map 8.

## Appendix II

### Minor Soil Series in the Willow Brook Watershed

**Acton, (Ac, Ad):** *very stony fine sandy loam*; moderately well drained, moist, sandy soils on moderate slopes which are underlain by sand, silt, clay, gravel, stones and boulders, and may have a hardpan layer at 30 inches; originated as glacial till. 1.5% of watershed.

**Au Gres, (Au):** *loamy sand*; poorly drained, strongly acid, sandy soils in depressions on nearly level plains or gently sloping stream banks; originated as water-sorted, sandy material. <1% of watershed.

**Colton, (Co):** *loamy sand*; excessively well drained, sandy soils on variously sloped terrain which are underlain by sand or gravel at 18 to 24 inches; originated as stratified glacial outwash. 1.5% of watershed.

**Ridgebury, (Rb, Rd):** *loam*; poorly drained, wet, loamy soils on nearly level terrain with stones and boulders throughout the profile and a pan layer at one to two feet; originated as glacial till. 4% of watershed.

**Rumney, (Ru):** *fine sandy loam*; poorly drained, wet sandy and silty soils which are often waterlogged and subject to flooding; these soils were deposited by the streams which they border. 1% of watershed.

**Scarboro, (Sc):** *fine sandy loam*; very poorly drained, very wet waterlogged sandy soils on nearly level terrain; originated as sandy sediments from glacial outwash or deltas. 1% of watershed.

**Shapleigh-Gloucester, (Sh):** *very rocky sandy loam*; somewhat excessively drained, sandy soils with stones and boulders on variously sloped terrain underlain by bedrock within 24 inches; originated as glacial till. 2.5% of watershed.

**Woodbridge, (Wo, Wv):** *loam and very stony loam*; moderately well drained, moist, sandy soils with stones and boulders, and a pan layer at about 24 inches occurring on gently sloping terrain; originated as glacial till. 3% of watershed.

**Marsh, (Mh):** organic soils which are usually ponded with shallow water, they occur in open wetlands of various types. 1.5% of watershed.

**Muck and Peat, (Mp):** very wet soils with at least 12 inches of accumulated organic matter which occur in depressions in uplands, sandy plains or floodplains; these areas, which are often extremely acidic qualify as wetlands, and may be wet forested areas, bogs or fens, or open, wet sedge and shrub meadows. <1% of watershed.