2.1 Regional Setting

The Upper Schoharie Creek watershed is located in the southeastern region of NY State (Fig 2.1.1). Approximately 80% of the 93 mi^2 main stem watershed lies within the towns of Hunter, Jewett, Lexington, and Prattsville. The remainder of the watershed lies within Gilboa and Roxbury, with small pieces in Ashland and Conesville. The entire watershed basin is 316 mi^2 and receives waters from other creeks such as the Batavia Kill, West Kill and East Kill. The entire watershed basin also includes Windham and small parts of Jefferson, Stamford, and Halcot (Fig 2.1.2). Approximately 75% of the Schoharie Creek watershed is located within the Catskill Park.

Figure 2.1.1 Schoharie Creek watershed counties

In 1885, the Catskill and Adirondack Forest Preserves were established by the NY State Assembly. An 1894 amendment to the New York State Constitution (now Article 14) directs "the lands of the State now owned or hereafter acquired, constituting the forest preserve as now fixed by law, shall be forever kept as wild forest lands. They shall not be leased, sold or exchanged, or be taken by any corporation, public or private, nor shall the timber thereon be sold, removed or destroyed" (NYS DEC, 2006).

In 1904, the Catskill Park was designated, establishing a boundary or 'blue line' around the Forest Preserve and private land as well. Over the years the Catskill Park grew, and now comprises roughly 700,000 acres, about half of which is public Forest Preserve. The Catskill and Adirondack Parks are nationally unique because they are a checkerboard of public and private land; a grand experiment in how nature and human society can

State Land historical marker

coexist in a landscape (Catskill Center$_1$, 2006).

The Schoharie Creek meets up with route 23A in the town of Hunter and roughly follows the road northwest. This is the major highway for this part of the region, connecting the Hudson Valley region of Catskill with the western part of New York State. Tourists get off the New York State Thruway in Leeds and use route 23A to reach this part of the Catskill Park, namely the Hunter Ski region.

A dominant characteristic of the Schoharie Creek watershed's regional setting is its location within the 2,000 square-mile New York City Watershed. The NYC Watershed is the largest unfiltered water supply in the U.S., providing 1.4 billion gallons of clean drinking water each day to over nine million residents in New York City and some smaller municipalities (nearly half the population of New York State) (Catskill Center$_2$, 2006).

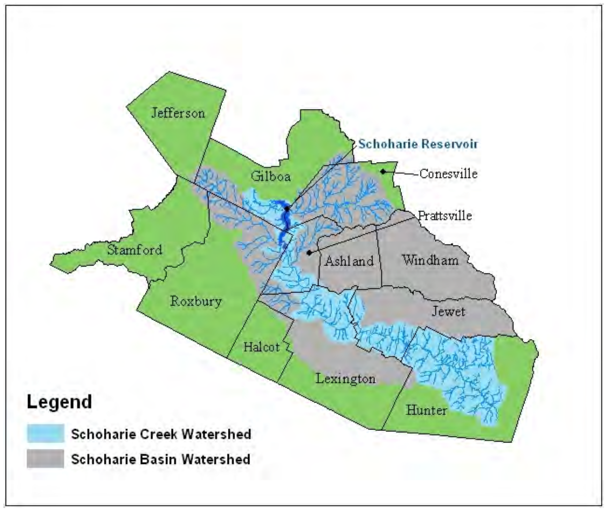

Figure 2.1.2 Schoharie Creek watershed towns

The Schoharie Creek is dammed by the Gilboa Dam, creating the Schoharie Reservoir just outside the Catskill Park. The reservoir covers 1.9 mi^2, is 140' deep, and receives 80% of its water from the Schoharie Creek. The other 20% comes from local direct drainage basins. At the reservoir part of the water is transfer through the Shandaken portal to the Esopus Creek and Ashokan Reservoir. The Ashokan provides approximately 10% of NYC's drinking water. The NYC Department of Environmental Protection (DEP) operates this drinking water supply under a Filtration Avoidance Determination (FAD) issued by the Environmental Protection Agency and the New York State Department of Health. Central to the maintenance of the FAD are a series of partnership programs between NYC and the upstate communities, as well as a set of rules and regulations written to protect water quality.

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2.2. History of the Schoharie Valley

The name “Schoharie” is of Native American decent, derived from a tribe of Mohawks who inhabited the Schoharie Valley area before the arrival of the Europeans. It is thought to be a word meaning “driftwood”. The correlation between driftwood and this region can be seen throughout the valley, with debris accumulating at various locations on the creek, often from bank to bank. The name “Schoharie” is also similarly translated as a corrupted version of a Native American word meaning "The Great Jampile," or a natural bridge formed by driftwood (Frisbie, 1996).

Northern view of the Schoharie Valley.

The Germans were the first Europeans to settle the area in significant numbers. A territory known as Palatinate, stricken by the toils of war, would provide a flush of immigrants from Germany to America. The first group arrived in New York in 1710, most settling just south of the Schoharie Valley. They were expected to work out expenses to Governor Hunter of New York by producing tar, pitch, and turpentine from the local pine trees. In return the immigrants received food and supplies as well as land to live on. Governor Hunter and the English government (who funded this project) overlooked one significant detail. The local pines did not have enough pitch to make this prosperous. Unlike true “pitch pines” the white pines of the New York region were low in resinous material. Upon realizing that the results were less than prosperous, the English redirected their funding elsewhere. In September of 1712 Governor Hunter was forced to cease subsistence supplies to the immigrants.

This came at a terrible time for the Palatines, just before winter. Food was scarce and the loss of their subsistence supply line came quite suddenly. Many of the Palatines, no longer able to rely on government aid, decided to retrieve agreement from the native Mohawks to settle the nearby Schoharie Valley, which was rich in farmland. Although the English already held claim to this land, the Palatines worked out their own agreements with the natives to purchase it. The lack of regard for the prior ownership of the land would prove to cause trouble, resulting in the owners demanding rent. Many Palatines would leave while others would decide to stay and pay the rent. (Frisbie, 1996); (Smith, 2006).

Upon settling the valley, the Palatines proved to be good farmers, practicing more careful and advanced farming techniques than most pioneers. In the clearing of forested land for example, they did not practice the common technique of girdling the trees and leaving them to die for firewood the next year. Instead they cut them down and burned the brush, leaving the ground more suitable for cultivation the next year. They made many of their own farming tools and built fences and barns of very high quality. Over the course of time, the Palatines would play a significant role in introducing many improved farm tools to the area as well as creating beautiful works of art through the meticulous crafting of their tools (Meyer, 1997).

Much of the Schoharie Valley's cultural heritage is derived from these early settlers. One of the earliest settlers to establish a farm in the area was Adam Vroman (est. 1713). His memory lingers along the Long Path, a hiking trail which stretches from the George Washington Bridge in New York City all the way to White Face Mt. in the Adirondacks. The path darts along the Schoharie Valley, reaching a spot called Vroman's Nose. At the summit one can view the rolling farmlands of the Schoharie Valley. This hiking destination was also involved in the military's production of the M1 smoke generator during World War II. In 1942 the secretive projects' debut test was viewed by scientists and military officials from Vroman's Nose. Overlooking the test site, officials watched as the smoke generator filled the Schoharie Valley with smoke. The device proved successful overseas, obstructing the view of fighter pilots and thereby foiling German air attacks (Simonson, 2004).

View from Vroman's Nose.

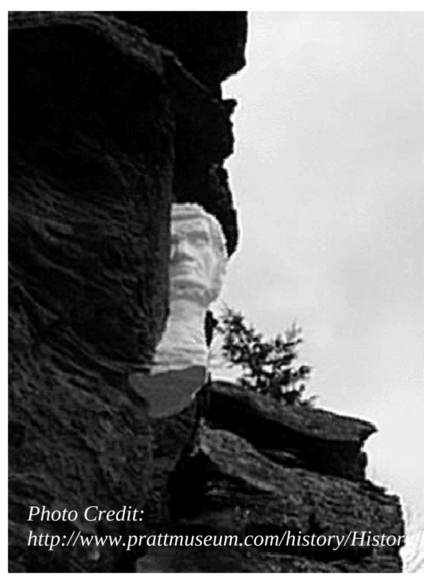
The Schoharie Creek begins in the southeast corner of Greene County near the Village of Tannersville. Tannersville grew from the local tanning industry, and was duly named in 1895. The creek was used for its power to run mills for the tanneries. As the tanning industry passed, the town remained popular and continued to grow. Businesses sprung up as a result of the area being a popular vacation destination. The Schoharie Creek continues through the town of Hunter, then through the town of Lexington before it enters the Schoharie Reservoir in Prattsville. Hunter and Lexington were both formed from the town of Windham in 1813. Hunter was then called Edwardsville and Lexington was called New Goshen. The two towns received their current names shortly thereafter. As with Tannersville, the tanning industry had a major impact on these towns, followed by a boom in tourism. Hunter continues to be an especially popular tourist destination because of its ski resort.

The Tanning Industry

The Schoharie Valley has a long history of farming. Many families still farm the land and can trace their ancestry back to the original farmers. Logging also took place in the valley. While these industries may have had positive effects on the local economy, they often adversely affected the local environment. None however match the impact that the tanning industry had. In the early-to-mid 1800's, the tanning industry exploded in the Schoharie Valley. Zadock Pratt, a former militia colonel, built a tannery in Prattsville in 1824. While other tanneries of the era were mere small shanties using the local neighborhood hemlocks for their tanning, Pratt's was much bigger. By the 1840's Pratt's industry had stripped the surrounding mountains bare of all the hemlocks. He was forced to close the business in 1846 as a result, but not before it had a chance to make him very wealthy.

The land was then used for cultivation and was quite productive. However, the tanning industry had a tremendously negative effect on the local environment. It was not until after the devastation of the forests that people began to consider the industry's environmental ramifications. Over time, the forests were allowed to re-grow. The effects of the tanning industry can still be seen today in the mountains' young second-growth forests.

Prattsville and the surrounding area owe much of their history to Zadock Pratt. He helped build or rebuild all of Prattsville's churches. Along Rt. 23 there is a picnic area near a cliff called Pratts Rock. It was here that Pratt commissioned a stone sculptor to carve a bust of Pratt himself in the hillside. This sculpture, as well as several other carvings, are accessible to the public and can be viewed via a very short climb up the hillside (Evers, 2002).



Pratt's Rock, located along Rt. 23 in Prattsville.

The clearing of land for farms and local industry can often worsen flood issues and cause receiving waters to become polluted. The Schoharie's industrial history caused periods of intense pollution from sediment laden runoff and the toxic pollutants that accompanied the tanning industry. However, water quality improved with the reforestation of the basin. Despite this, challenges still remain from increased development and reverberations from the watershed's industrial past.

Schoharie Reservoir

The Schoharie Reservoir, located at the intersection of Schoharie, Delaware and Greene Counties, was formed by the construction of the Gilboa Dam. Construction of the dam began in 1920, with completion in 1927. The flooding of the valley for the creation of the reservoir effectively inundated the town of Gilboa, forcing the relocation of 350 of its residents. The Schoharie Creek provides approximately 80% of the water to the reservoir, with the remainder coming from direct drainage streams such as the Bear Kill and Manor Kill (Joint Venture, 2004). An 18-mile conduit between the reservoir and the Esopus Creek called the Shandaken Tunnel was completed in 1926. With the capacity to transfer 615 MGD, this underground system connects the Schoharie reservoir basin to the waters of the Ashokan reservoir basin in Ulster County (Figure 2.2.1). The Schoharie and Ashokan reservoirs were designed to allow the exchange of water from the Schoharie basin to the Ashokan basin thus forming the Catskill water supply system which ultimately drains to the Kensico Reservoir in Westchester County (Figure 2.2.1). Reservoir Release Regulations (Part 670) stipulate that the tunnel operators must seek to maintain an adequate flow of water downstream to sustain the trout fishery in the Esopus Creek and support recreational uses.

The Shandaken tunnel also operates under a New York State Pollutant Discharge Elimination System (SPDES) permit that stipulates levels of turbidity, solids, temperature and phosphorus that can be released into the receiving waters of the Esopus Creek. The State Pollutant Discharge Elimination System (SPDES) program, Article 17 of the Environmental Conservation Law, was approved by the United States Environmental Protection Agency in accordance with the Clean Water Act. The program's goal is to maintain the highest quality of water possible to protect public health, promote public enjoyment of the resource and allow for the protection and propagation of fish and wildlife, while allowing for industrial development in the state.

Through the Catskill Turbidity Control Studies, NYCDEP analyzed the effectiveness of several measures to help meet the turbidity and temperature permit requirements. These measures included watershed protection, multi-level intake at the Schoharie Reservoir, turbidity curtain, in-reservoir baffle, modification of operations and engineered treatment. Upon thorough review, the options that would offer some level of turbidity reduction and temperature control were the modification of operations and a multi-level intake at the Schoharie reservoir (Joint Venture, 2006). Computer model simulations indicated that Schoharie Reservoir operations could be modified to reduce peak summer temperatures and the incidence of elevated turbidity levels (median reduction of less than 8 NTUs), and to substantially lower solids loading (up to 60% reduction) to Esopus Creek (Joint Venture, 2006). An Operations Support Tool will be developed to maximize reservoir operations to reduce turbidity, solids and maintain temperatures. Based on computer modeling, the multiple level intake option would provide minimal benefit to turbidity in May, June and the beginning of July, but at substantial cost for installation. However, this option remains as a possible measure to be included in turbidity control. Knowing that major threats to the water supply occur following large storms and the erosive nature of the Catskill's geology, watershed protection measures were not considered as viable options. However, these programs remain important for the long-term protection of the basins to prevent any further deterioration of water quality during non-storm periods.

The Schoharie Reservoir is made up of one diversion basin, which is approximately 4.2 miles in length, with a surface area of 1.9 square miles, a maximum depth of 140' and can hold 19.6 billion gallons of water ((Joint Venture, 2004). It is considered a diversion basin since the reservoir has a relatively small storage capacity (19.6 billion gallons) compared to its large watershed (314 square miles). For example, the Ashokan Reservoir has a storage capacity of 127.9 billion gallons and a watershed area of 257 square miles. Therefore, the Schoharie Reservoir fills rapidly and is primarily used to supplement the supply in the much larger Ashokan Reservoir. However, the reservoir contributes approximately 15% of NYC water annually (Joint Venture, 2004). The Blenheim-Gilboa Reservoir is located just a few more miles down the Schoharie Creek. It is operated by the New York Power Authority which uses it to produce hydro-electric power.

Figure 2.2.1. The New York City Water Supply.

The Gilboa Dam and Schoharie Reservoir.

Following an engineering analysis in 2005, it was determined that the Gilboa Dams did not meet NYS Dam Safety requirements. The fear was that in the case of a bad flood (larger than the flood of record in 1996), the water in the reservoir could rise to a level which would break through the structure and cause terrible damage to downstream communities (DEP, 2006). In 2006, the NYC Department of Environmental Protection implemented a $24 million dollar project targeted at bringing the eighty year old dam up to current New York State dam safety standards. The plan, expected to be completed in December of 2006, includes the installation of debris protection structures, drainage units, an overflow notch and anchoring cables. A full scale $300 million dollar reconstruction of the dam is expected to begin in 2008 which will bring the dam up to an even higher standard of safety.

Significant Historical Sites Downstream of Reservoir

The Schoharie Valley is a region which prides itself on its farming history. There are many antique fairs for those interested in seeing the old tools used to farm the land in the past (Fairbairn, 2005). While visiting these fairs, one may also visit one of the area's oldest buildings, the Palatine House. It is located on Rt. 30 in the town of Schoharie and is the oldest existing building in the village, built in 1743. It is one of the few frame-buildings left after Schoharie was burned during the Revolutionary War (Round the Bend, 2004).

The Blenheim Bridge, built in 1865 by Nicholas Montgomery Powers in the town of North Blenheim, also holds historical significance in that it is the longest single span bridge in the world (226 ft.) and one of only six remaining "double barreled" bridges in the world. On the bridge a sign tells the story of a "freshet" (old word for flood) in 1869. The sign reads, "In the spring of 1869, a severe freshet washed out a wide channel across the western approach. A wooden extension was added to the Blenheim Bridge to span the new channel. In 1895 it was replaced by an iron extension. The wooden covered bridge was retired from use in 1931 and the Board of Supervisors voted to retain the bridge as a public historic relic." (NYS Covered Bridge

Society, 2006). Today these as well as several other museums and relics offer the visitor a glimpse into the history of the Schoharie Valley.

Photo Credit: http://www.nycoveredbridges.org/page20.html

The Blenheim Bridge in North Blenheim.

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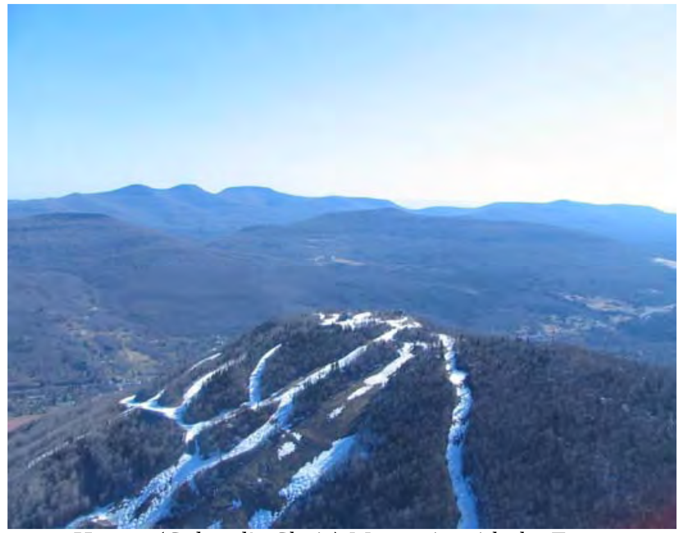
2.3 Physical Geography of the Schoharie Watershed

Physical geography encompasses the physical elements and processes that comprise the earth's surface features and associated processes. These processes include: energy, air, water, weather, climate, landforms, soils, animals, plants, and the Earth itself. The study of physical geography attempts to explain the geographic patterns of climate, vegetation, soils, hydrology, and landforms, and the physical environments that result from their interactions.



Hunter (Colonel's Chair) Mountain with the East Kill/Batavia Kill valley divide in background.

The Schoharie watershed is located in the Appalachian Plateau physiographic province (Figure 2.3.1). The erosional characteristics of the sedimentary rock formations of the Appalachian Mountains are responsible for the characteristic valley and ridge topography of the Catskills. Durable layers of sandstone and conglomerate form ridges and less resistant limestone and shale underlie the Schoharie valley as it winds its way to the Mohawk River. During the height of glaciations, the Schoharie watershed was covered by an ice sheet up to a mile thick. Upon retreat, these ice sheets left a layer of unsorted and unconsolidated glacial debris, glacial till, ranging from clay particles to huge boulders. Following the retreat of the ice sheet, the landscape was covered with glacial tills and bedrock and was wiped clean of plants and animals, leaving a clean slate for the migration and colonization of the modern plant and animal communities. Today, the Schoharie watershed lies within the Northeastern Highlands ecoregion. This ecoregion is characterized by nutrient poor soils blanketed by northern hardwood and spruce fir forests.

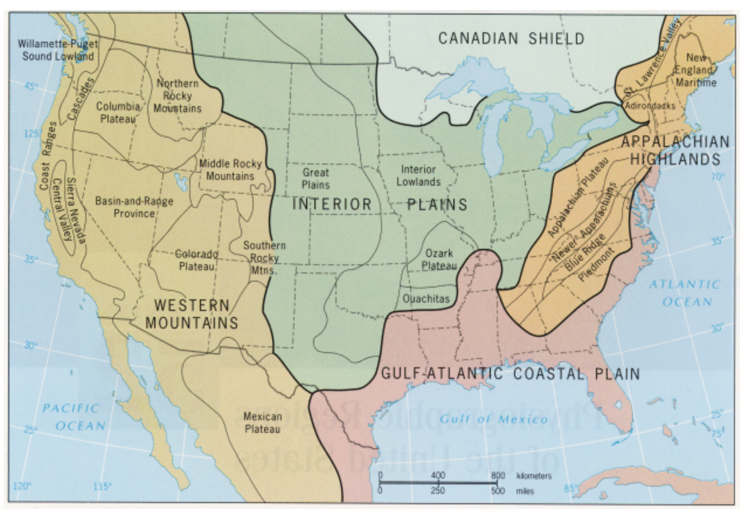


Figure 2.3.1. Physiographic Regions of the United States, including the Appalachian Plateau (NASA Earth Observing System (EOS) Goddard Program Office).

Elevations in the watershed vary from a high of approximately 4,040 feet above sea level in the Town of Hunter at the West Kill/Schoharie Creek watershed boundary, to a low point of 1,140 feet above sea level at the Schoharie reservoir. The average elevation of the watershed is approximately 2,590 feet above sea level. Studies indicated that the temperature drops approximately 3.0˚ F per 1000' of elevation (Thaler, 1996). The Schoharie Creek starts as a mountainous stream dropping approximately 520 feet in its first mile (Southeastern Hunter), but then reducing in slope to an average of 36 feet/mile to its approximate midway point (intersection of Route 23A and Cty Rte 17). From this midway point to the reservoir, the stream slope drops approximately 24 feet/mile. The more notable high peaks (>3,500') that form the Schoharie main stem watershed boundary are Rusk, Hunter, Plateau, Sugarloaf, Twin, Indian Head and Kaaterskill High Peak (Figure 2.3.2).

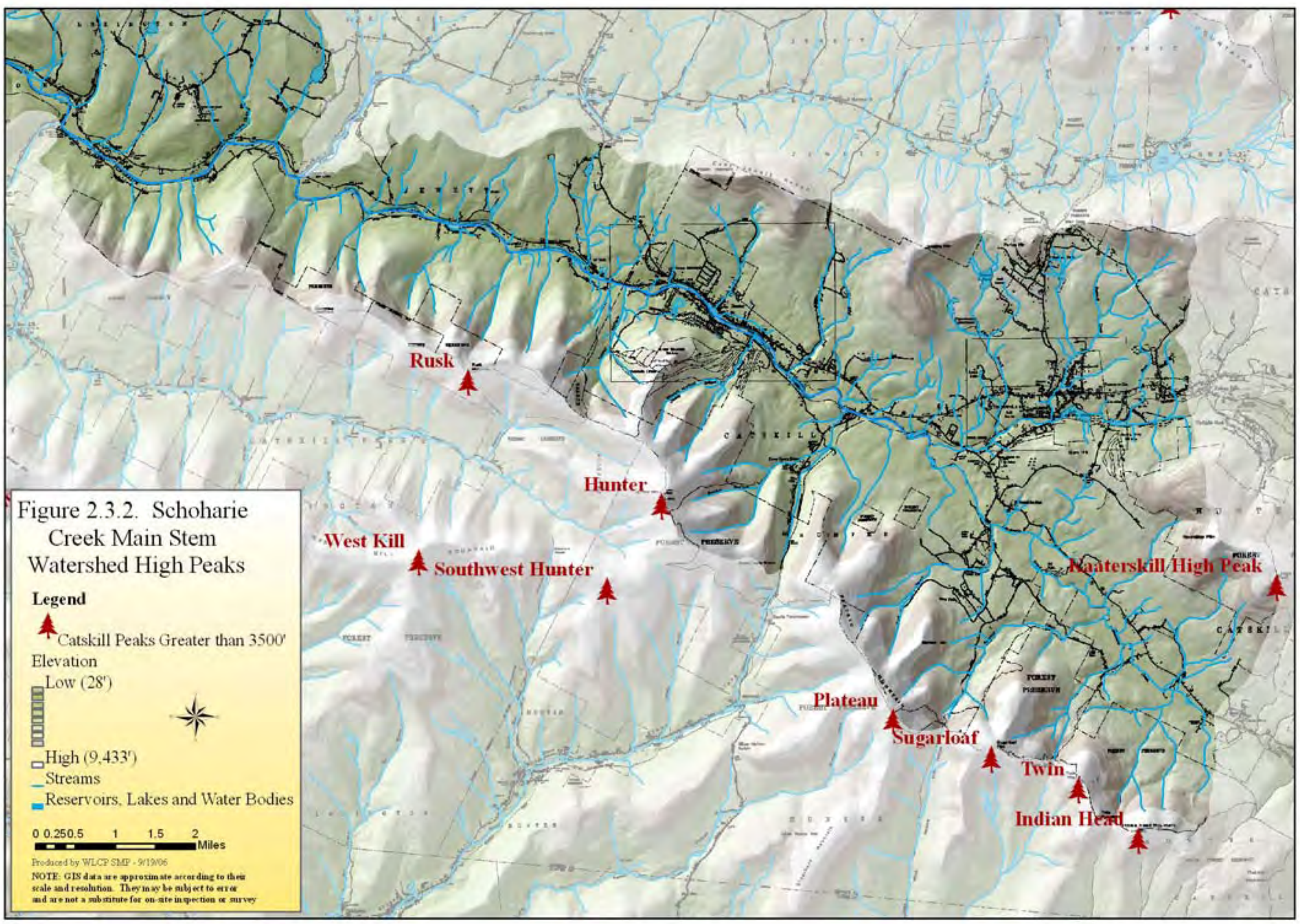


Figure 2.3.2. Schoharie Creek Main Stem Watershed High Peaks

The Schoharie Creek flows northwest through the Towns of Hunter, Jewett, Lexington and Prattsville before exiting the Schoharie reservoir where it turns north on its path to the Mohawk River. Traveling from east (Hunter) to west (Prattsville), the primary tributaries that drain into the Schoharie (and their watershed areas) are the East Kill (36.6 m^2), West Kill (31.5 m^2), Little West Kill (8.2 m^2), Batavia Kill (72.8 m^2) , Huntersfield Creek (7.9 m^2), Johnson Hollow Brook (5.2 m^2), and directly into the reservoir the Bear Kill (26.1 m^2) and Manor Kill (34.4 m^2). The watershed (including reservoir) contains approximately 706 miles of stream.

Climate

The climate of the Schoharie basin is primarily driven by the humid continental type, which dominates the northeastern United States. The average annual temperature for the area is 44.8˚ F and the area typically receives approximately 41" of rain/year (Table 2.3.1 and Figure 2.3.2). Due to up-sloping and down-sloping, the character of the mountaintop topography can affect the climate of the basin. Up-sloping occurs when air is lifted up over the mountains, the air expands, cooling and condensing into moisture, which takes the form of clouds and precipitation (Thaler, 1996). Down-sloping occurs when air sinking within a dome of high pressure or air that is forced downslope of a mountain range, warms up and loses moisture, as is shown by a drop in relative humidity (Thaler, 1996). These weather phenomena can be responsible for differences in cloud cover and precipitation between the Catskills and the surrounding area, and helps to explain the sometimes drastic variations in rainfall between Catskill basins (Figure 2.3.3).

Table 2.3.1. Average annual temperature, precipitation, snow fall and winter and summer temperatures for Windham, NY from the period 1961-1990 (Thaler, 1996).

Average Annual Precipitation	41"
Average Annual Temperature	44.8 ˚ F
Average Winter Temperature	25.6 ˚ F
Average Summer Temperature	64.7 ˚ F
Seasonal Snowfall	60"

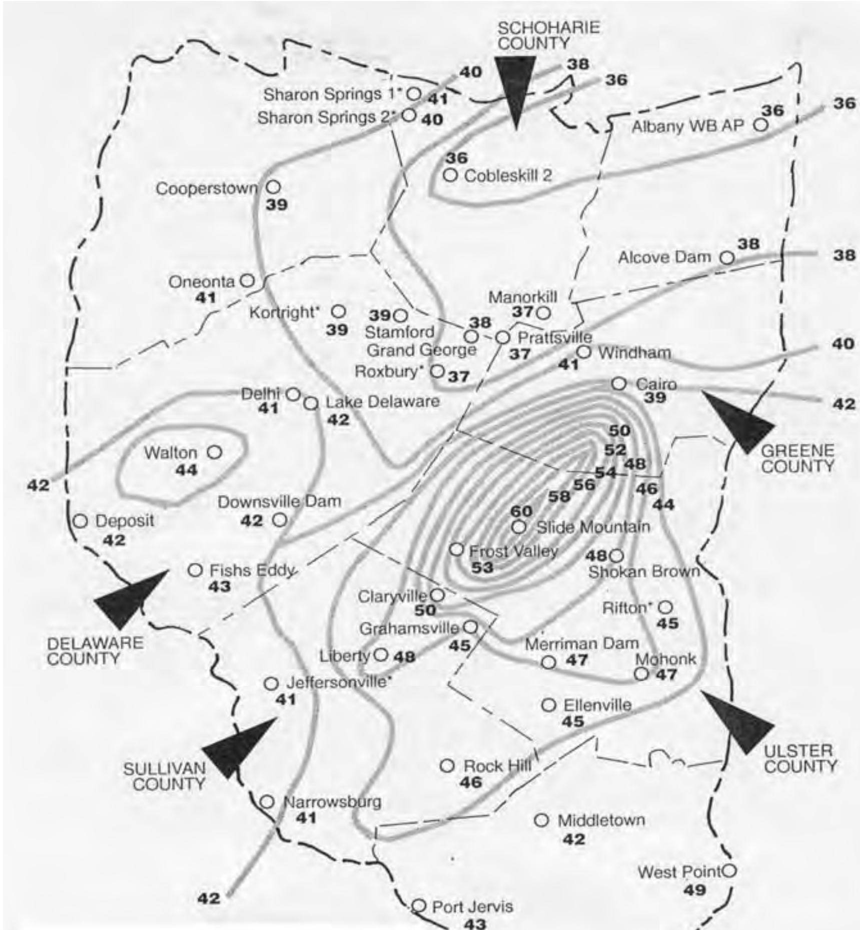


Figure 2.3.2. Average annual precipitation in the Catskills (Thaler, 1996).

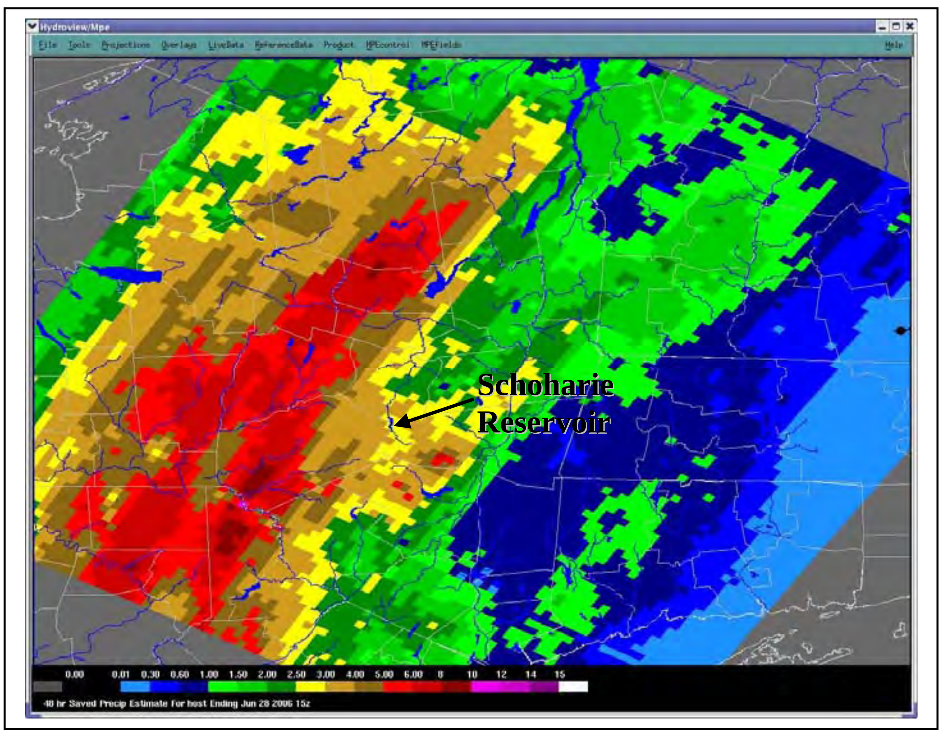


Figure 2.3.3. Radar showing the rainfall intensity that caused the flooding in the Western Catskills in June 2006. The isolated pockets of heavy rain (dark red) within individual Valleys help explain why flood damages can be so dramatic from one basin to the next (National Weather Service Forecasting Office).

Global Climate Change Effects on the Watershed

Global warming will impact the Schoharie basin in coming years. Greenhouse gases are trapping energy in our atmosphere that would normally be lost to space and causing global temperatures to rise. This warming is a natural phenomenon that provides enough heat to allow humans to thrive on earth, but the burning of fossil fuels, and the atmospheric concentration of other gases such as methane, has dramatically increased the rate of warming (Figure 2.3.4). Based on local data collected between 1952 and 2005, researchers have concluded that a broad general pattern of warming air temperatures, increased precipitation, increased stream runoff and increased potential evapotranspiration has occurred in the Catskills region (Burns et al., 2007). In coming years, there is no doubt that the effects of global warming will impact management decisions in the Schoharie watershed.

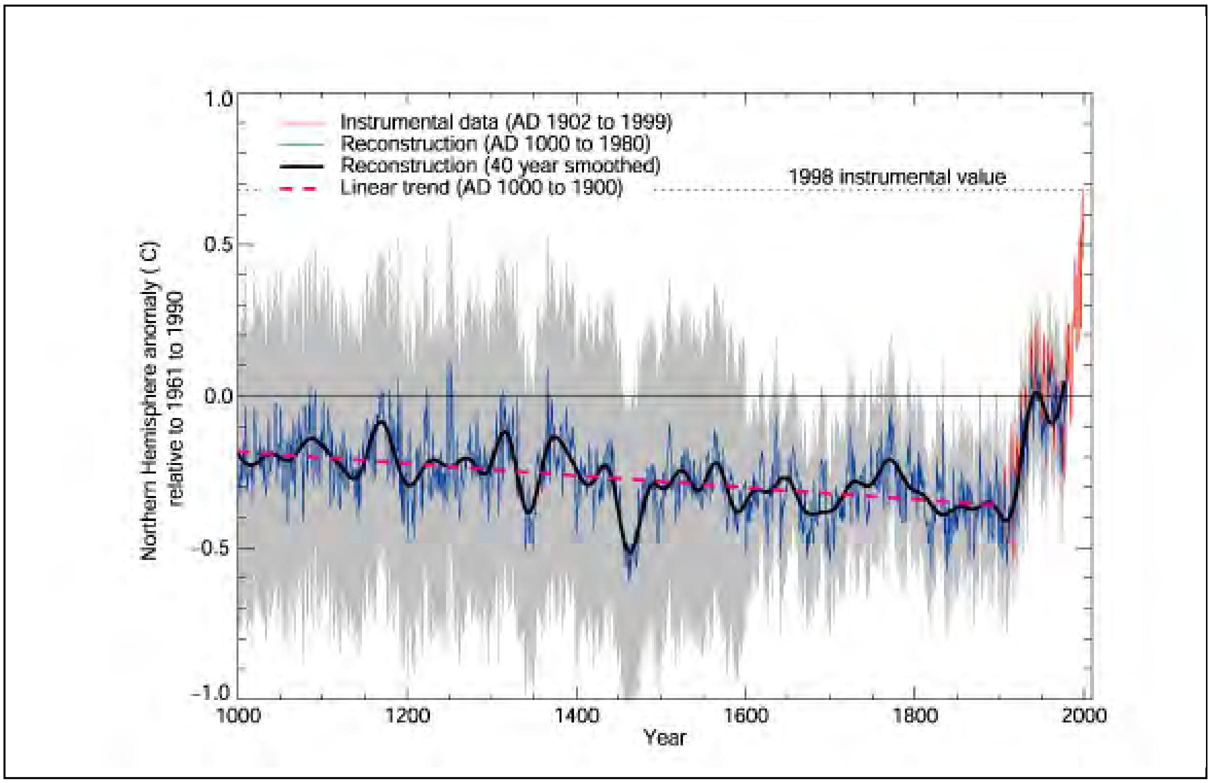


Figure 2.3.4. Millennial northern hemisphere temperature reconstruction, based upon ice core data, relative to actual temperatures recorded from 1902 through 1999. Despite large variation, the recent trend of rapid heating in the industrial era is apparent (National Climatic Data Center adapted from Mann et al., 1999).

Temperature increases will have effects on food production, plants, wildlife, invasive species, flooding, drought, snowfall and the economy. Based upon current climatic trends, our climate may migrate to the extent that by the end of the century, summers in upstate New

York may feel like Virginia (Figure 2.3.5) (Frumhoff et al., 2006). This climatic migration will have deleterious effects on plant and animal life, allowing new warmer climate species to thrive at the expense of our traditional plants and animals. The number of snow-covered days across the Northeast has already decreased, as less precipitation falls as snow and more as rain, and as warmer temperatures melt the snow more quickly. By the end of the century, the southern and western parts of the Northeast could experience as few as 5 to 10 snow-covered days in winter, compared with 10 to 45 days historically (Frumhoff et al., 2006). Decreased snowfall and increased rainfall would have negative effects on stream flows and the economy of the Catskills.

With the lack of snow fall, streams and groundwater will not receive a slow sustaining release of water through the winter and spring. Replacing the slow release will be more intense storms, which will sporadically dump large quantities of water into the system potentially causing damaging flooding (Figure 2.3.6). However, streams will return to base flow relatively quickly once the rain stops. Modeling predictions indicate that in the next century we will see more extreme stream flows that will cause streams to flow higher in winter, likely increasing flood risk, and lower in summer, exacerbating drought (Frumhoff et al., 2006). Changing the dynamic of the hydrologic cycle would also impact the NYC water supply system, forcing potential changes in operational measures.

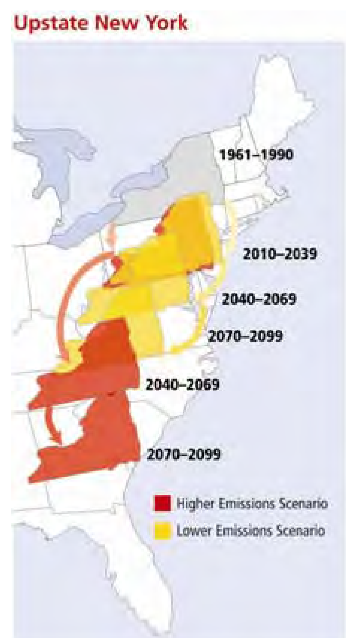


Figure 2.3.5. Projected climate "migrations" for Upstate, NY based on average summer heat index, under the lower (yellow)- and higher-emissions (rust) scenarios. Based on the average of the GFDL, HadCM3 and PCM model projections (Frumhoff et al., 2006).

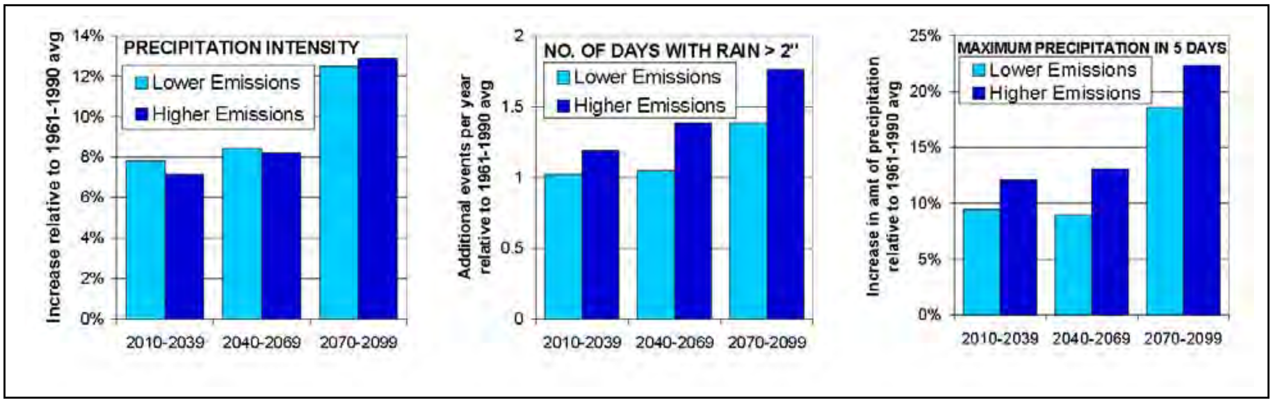


Figure 2.3.6. Projected increases in three indices of extreme precipitation: (1) precipitation intensity, (2) number of days per year with more than two inches of rain, and (3) maximum amount of precipitation to fall during a five day period each year (Frumhoff et al., 2006).

Because we don't have a clear understanding of all of the coming impacts of climate change, stream managers need to employ the "no-regrets policy" with regard to their current management actions and policies. The no-regrets policy is the recognition that lack of certainty regarding a threat or risk should not be used as an excuse for not taking action to avert that threat, that delaying action until there is compelling evidence of harm will often mean that it is then too costly or impossible to avert the threat. Stream managers –including streamside landowners-- will need a basic understanding of how streams are formed and evolve to effectively adapt to coming changes. They will need to anticipate and compare the consequences of different management options, and will need to act conservatively: oversizing culverts and bridge spans, leaving larger buffers of undisturbed streamside vegetation, and consider limiting new development of infrastructure or personal property in areas where conditions indicate a high risk of the stream channel shifting across the floodplain. The humid continental climate has been an unquestionable asset to the historical development of the Schoharie basin and its many occupants and uses. With proper planning and implementation of the no-regrets policy, undoubtedly, the climate will continue its important role in Schoharie basin life.

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2.4 Hydrology and Flood History

Introduction

Hydrology is the study of the properties, distribution, and effects of water on the earth's surface, in the soil and underlying rocks (groundwater), and in the atmosphere. The *hydrologic cycle* includes all of the ways in which water cycles from the landscape (both underground and in streams and water bodies) to the atmosphere (as water vapor and clouds) and back (as snow, rain and other forms of precipitation) (Figure 2.4.1). Understanding the hydrology of the Schoharie Creek will assist us with making land use decisions in the basin that work within the constraints of the hydrologic cycle and won't exacerbate flooding or cause water quality impairment.

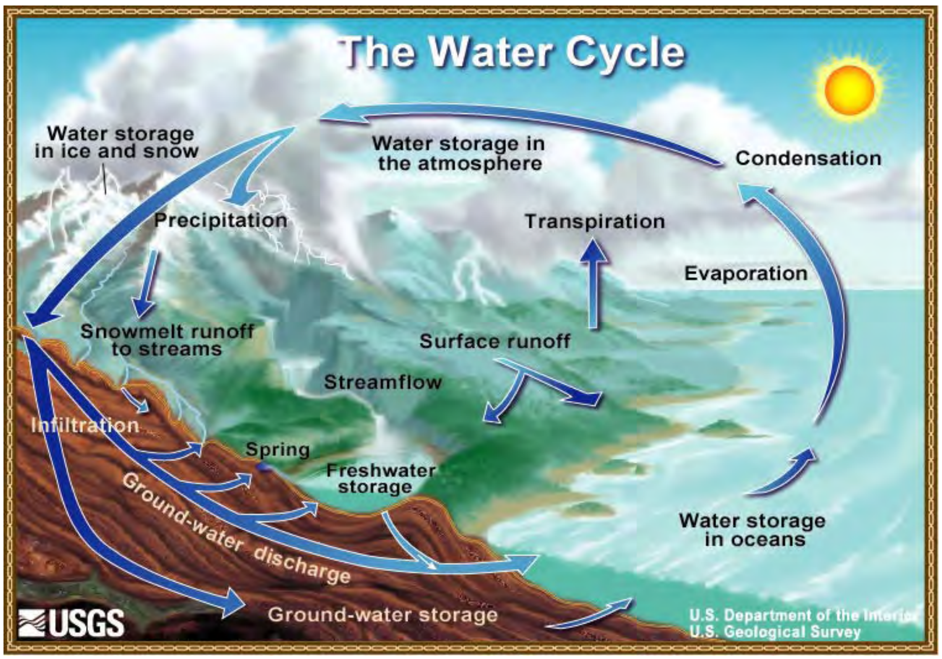

Figure 2.4.1. The Hydrologic (water) Cycle (http://ga.water.usgs.gov/edu/watercyclesummary.html).

Water flowing through the Schoharie Creek reflects the integrated effects of all watershed characteristics that influence the hydrologic cycle. Characteristics include climate of the drainage basin (type and distribution patterns of precipitation and temperature regime), geology and land use/cover (permeable or impermeable surfaces and materials affecting timing and amount of infiltration and runoff, and human-built drainage systems), and vegetation (uptake of water by plants, protection against erosion, and influence on infiltration rates). These factors affect timing and amount of stream flow, referred to as the stream's *hydrologic regime*. For example, a stream with an urbanized watershed where water will run off the hardened surfaces directly into the stream will have higher peak discharges following storms than a watershed, such as the Schoharie Creek, which is predominantly forested and allows a higher percentage of rain water to infiltrate before it reaches the stream, releasing it more slowly over time. Understanding the hydrology of a drainage basin is important to the stream manager because stream flow patterns affect aquatic habitat, flood behavior, recreational use, and water supply and quality.

Schoharie Creek Basics

Encompassing approximately 315 square miles of watershed area, the New York City Watershed portion of the Schoharie Creek is located primarily in Greene County, NY. The stream drains eight Greene County municipalities, not including direct drainage to the reservoir, including large sections of the Towns of Prattsville, Lexington, Jewett, Hunter, Ashland, Windham and the Villages of Hunter and Tannersville. The Schoharie Creek is typical of major streams within the Schoharie watershed in that it is a long, narrow watershed running east to west. This drainage pattern is controlled by the steep topography, formed in large part during the last period of glacial activity. Streams in the Schoharie valley are primarily perennial streams, that is, they flow year-round except in smaller headwater streams or in extreme drought conditions.

The Schoharie Creek watershed averages approximately 46 inches of precipitation per year in the upper reaches (Hunter), 42" per year in the mid-sections (Lexington) and 38.5" per year near the reservoir (Prattsville). This rainfall often comes in dramatic summer downbursts, remnants of autumn hurricanes, or late winter rain-on-snow events. Average slope of the upper watershed is 22% (watershed elevation drops 22' feet for every 100 feet horizontal distance), 18% in the mid-section and 15% near the reservoir. *Drainage density*, or how much stream length is available to carry water off the landscape per unit area of watershed is slightly lower than average for the Catskills, at $0.0012 m/m^2$. Given the average drainage density, combined with steep mountainous slopes, and high precipitation, the Schoharie system is relatively *flashy*, that is, stream water levels rise and fall quickly in response to storm events. This flashiness is somewhat mitigated by heavy forest cover throughout much of the watershed. Therefore, efforts to protect upland, as well as riparian, forest are important to reduce flooding impacts.

Stream flow Primer

There are two general categories of streamflow: storm flow (also called flood flow) and base flow, between which streams fluctuate over time. Storm flow fills the stream channel in direct response to precipitation (rain or snow) or snowmelt, whereas base flow is primarily groundwater fed and sustains streamflow between storms and during subfreezing or drought periods. A large portion of storm flow is made up of *overland flow*, runoff that occurs over and just below the soil surface during a rain or snowmelt event. This surface runoff appears in the stream relatively quickly and recedes soon after the event. The role of overland flow in the Schoharie watershed is variable, depending upon time of year and severity of storms or snowmelt events. In general, higher streamflows are more common during spring due to rain, snowmelt and combination events, and during hurricane season in the fall. During summer months, actively growing vegetation on the landscape draws vast amounts of water from the soil through *evapotranspiration*. This demand for groundwater by vegetation can significantly delay and reduce the amount of runoff reaching streams during a rain storm. During winter months, precipitation is held in the landscape as snow and ice, so precipitation events do not generally result in significant runoff to streams. However, frozen ground may increase the amount of overland flow resulting from a rain storm if the air temperature is above freezing, particularly in spring on north facing slopes.

Subsurface storm flow, or *interflow*, comes from rain or snow melt that infiltrates the soil and runs down slope through the ground. Infiltrated water can flow rapidly through highly permeable portions of the soil or displace existing water into a channel by “pushing” it from behind. In the Schoharie valley, subsurface flow can occur fairly rapidly along layers of essentially impermeable glacial lake silt/clay deposits. Subsurface storm flow shows up in the stream following overland flow, as stream flow declines back toward base flow conditions.

Base flow consists of water that infiltrates into the ground during and after a rain storm, sustaining streamflow during dry periods and between storm flows. The source of base flow is groundwater that flows through unsaturated and saturated soils and cracks or layers in bedrock or other impermeable layers adjacent to the stream. In this way, streams can sustain flow for weeks or months between precipitation events and through the winter when the ground surface and all precipitation is otherwise frozen. Stable-temperature groundwater inputs keep stream water warmer than the air in winter and cooler than the air in summer – this is what enables fish and other aquatic life to survive in streams year-round.

Hydrologists use a *hydrograph* of a stream, a graph showing amount or depth of flow over time, to analyze flow patterns and trends such as flood frequency or drought cycles. A *stream gage*, a device that primarily measures water level, is necessary to monitor stream discharge and develop a hydrograph. The United States Geological Survey (USGS) maintains a network of stream gages throughout the country, with a number of active gages on the Schoharie Creek and some of its tributaries (Figure 2.4.2).

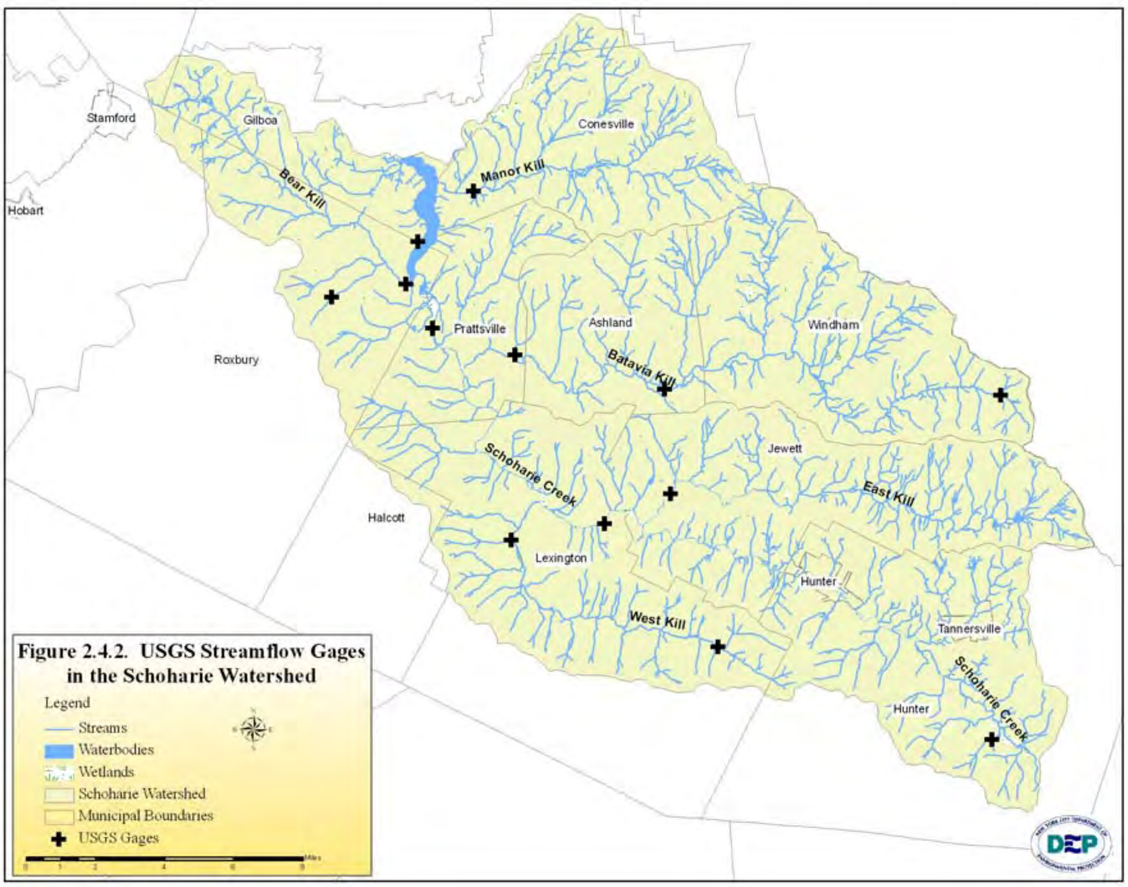

Figure 2.4.2. USGS Streamflow Gages in the Schoharie Watershed

The United States Geological Survey (USGS) maintains two continuously recording stream gages on the Schoharie Creek near Lexington (established 1999, drainage area 96.8 mi^2, USGS ID# 01349705) and Prattsville (established 1902, drainage area 237 mi^2, USGS ID# 01350000). Prior to 1996, a crest stage gage was maintained at Lexington starting in 1929. All gage information is available online at the USGS website: http://waterdata.usgs.gov/ny/nwis/uv/?site_no=01349705 (Lexington) and http://waterdata.usgs.gov/ny/nwis/uv/?site_no=01350000 (Prattsville).

These gages measure the *stage*, or height, of the water surface at a specific location, typically updating the measurement every 15 minutes. By knowing the stage we can calculate the magnitude of the *discharge* (flow), or volume of water flowing by that point, using a relationship developed by USGS called a *rating curve*. Using this rating curve, the magnitude of flow in the Schoharie at the gage location can be determined at any time just by knowing current stage. Flow can also be calculated for any other stage of interest. Additionally, we can use the historic record of constantly changing stage values to construct a picture of stream response to rain storms, snow melt or extended periods of drought, to analyze seasonal patterns or flood characteristics.

The Schoharie gages have a long enough period of record to prepare a hydrograph covering several years for the stream (Figure 2.4.3). Each spike on the Prattsville gage graph represents a peak in stream flow (and stage) in response to rain storms. Stream level rises (called the “rising limb” of the hydrograph) and falls as the flood recedes (called the “falling (or receding) limb” of the hydrograph). We can analyze long time periods to see seasonal trends or long-term averages for the entire length (period) of gage record. We can see the hydrograph for the gage shows higher flows in fall (hurricane season) compared to winter (water held in ice and snow), and higher flows in spring (snow and ice melt, with rain-on-snow events) compared to summer (drought conditions with vegetation using a lot of water). The highest flows of the year are generally associated with the hurricane season in the fall, followed by winter and spring snowmelt or rain-on-snow events. Overland flow accounts for most of water that causes the sharp peaks in the hydrograph.

Streamflow always rises and peaks following the height of a precipitation event because it takes time for water to hit the ground and run off to the stream (this is known as lag time). Knowing storm timing, we could also calculate *lag time* for Schoharie Creek at the gage location for particular storms or types of storms, and determine how the stream responds to storms both in timing and flood magnitude and recession. Through analysis of the long-term flow and flood records provided by the USGS, the town, its residents and resource managers can begin to better understand the cause/effect of various precipitation amounts on flooding.

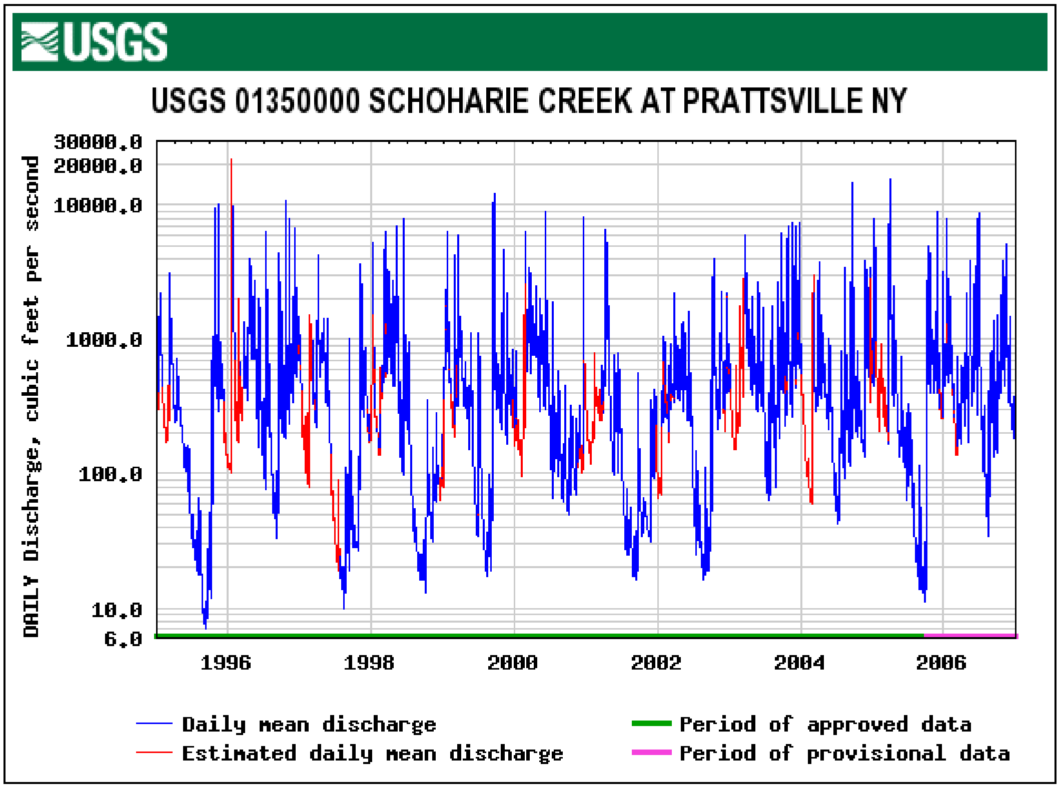

Figure 2.4.3. This hydrograph represents the daily average flow from 12/95 through 12/06.

The hydrograph of April, 2005 illustrates the effects of a spring storm on top of snow (Figure 2.4.4). The Schoharie rose quickly from the precipitation from a daily average of 411 CFS to 2,290 CFS in 24-hours. The recession took longer than a large summer storm due to the vegetation still being dormant, or just emerging, and the snow pack.

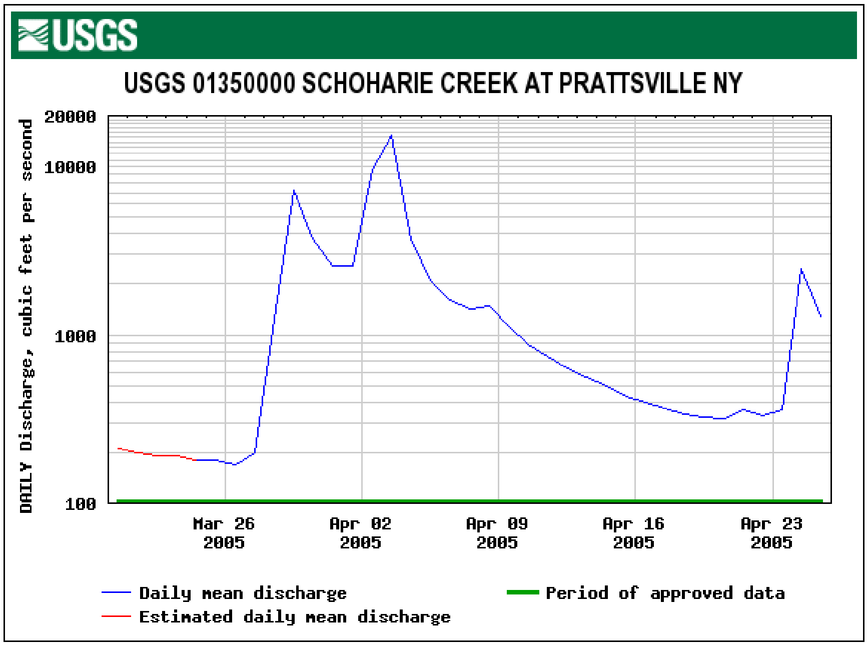

Figure 2.4.4. This hydrograph represents the daily average flow for April, 2005, including a large rain on snow precipitation event.

Schoharie Creek Flood History

As a mountain stream the Schoharie rises quickly as precipitation falls. If enough precipitation falls, the creek will rise to "flood stage". Flood stage for the Schoharie Creek at Prattsville is considered by the National Weather Service to be at 12 feet on the gage, which corresponds to approximately 18,000 cubic feet per second (cfs) (Figure 2.4.5; Table 2.4.1, also available through the USGS website for the Schoharie Creek at Prattsville Gage, referenced above). At 14 feet (roughly 26,000 cfs), the creek begins to overflow onto Main Street (Rte. 23), and by 18 feet (over 45,500 cfs) is considered severe flooding. Flooding in April of 1987, referenced below, peaked at 47,600cfs.

Between 1904 and 2006, the Schoharie Creek at Prattsville has exceeded flood stage 34 times (Figure 2.4.5), or about once in every 3 years. This does not mean that the Creek will exceed flood stage exactly once in 3 years – on the contrary, the record shows that often there will be several years in a row the Creek will flood, and other periods during which the peak flow does not exceed flood stage for several years. Flood cycles tend to follow larger weather patterns such that very wet periods will be high flooding years, and droughty times will see lower flows.

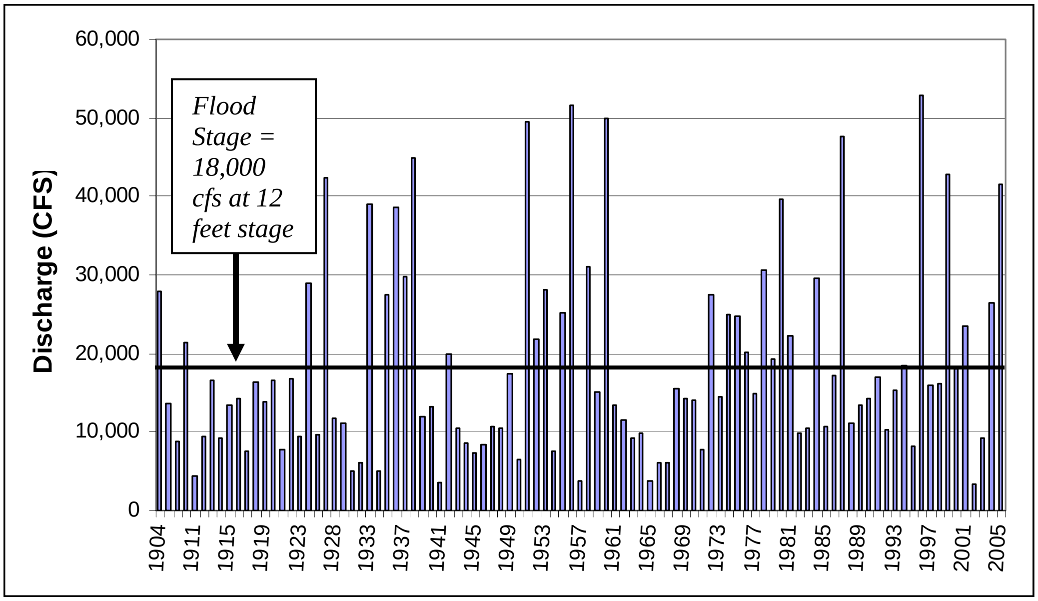

Figure 2.4.5. Annual peak flows for the period 1904 through 2006.

Table 2.4.1. Flood stage descriptions for USGS Gage Schoharie Creek at Prattsville, NY, as provided by the National Weather Service.

01350000
Schoharie Creek At Prattsville, NY
Datum of gage is 1,131.57 feet above mean sea level (NGVD of 1929)

(Flood-description information provided by the National Weather Service)

Elevation, Feet above mean sea level	Feet above datum	
1,151.07	19.5	Disastrous flooding Jan 1978 and Mar 1979 ice jams lower portion of village inundated with 3 ft of water.
1,149.57	18	Severe flooding (Apr 1987) with about two to three feet of water on properties in the village alongside the creek.
1,147.57	16	Water begins to overflow onto Greene Co. Route 7 north of Route 23 bridge downstream.
1,145.57	14	Begins to overflow onto Main Street (NYS Route 23)
1,143.57	12	**FLOOD STAGE…**Overflows into lowlands bankfull.
1,134.57	3	Normal low water.

The peak flow in any given year is not necessarily a significant/damaging storm event, but could represent a dramatic increase in flow, particularly if following drought. To put this in perspective, the flood of record (the highest flood ever documented since beginning to record floods at the gage in 1904) in1996 pushed the Schoharie Creek to its highest stage at 19.4' (peak flow of 52,800 cfs) reaching its 100 year flood stage and representing "disastrous" flooding from Table 2.4.1. The flood of 1996 was caused by unusually warm weather events during the winter which melted large amounts of snow very rapidly. North facing slopes of the Schoharie valley receive little sun exposure compared to south facing slopes. As a result, half of the valley retains a snow pack well into the spring when rain on snow events can cause dramatic spring flooding. Tropical storms and hurricanes in the late summer and early fall also trigger flooding in the valley. Prior to the flood of 1996, the Creek hadn't reached flood stage since November, 1993, when it just topped flood stage at 18,400 cfs, and before that the Creek hadn't reached flood stage since severe flooding in April 1987 (see Table above).

After the flood of 1996 $15.2 million of federal and state funding was distributed amongst 377 municipalities to help repair damage. The Federal Emergency Management Agency (FEMA) estimated that approximately $102 million worth of damage had occurred state wide during the flood (New York State, 1996). The 1996 flood also inspired the town of Gilboa to embark on a 1.5 million dollar project to purchase and demolish several homes which were located in the floodplain and to relocate Stryker Road. The flooding in 2000 was much less than 1996 (stage height 12.1'/18,000 cfs, just at flood stage), but still brought comparable damage statewide, with $12.7 million being released to 206 municipalities across NY, with Greene County receiving $176,596.23.

Another way to look at flooding magnitudes and patterns is through analysis of flood frequency distributions. This shows flood magnitude for various degrees of probability or likelihood, or in other words, how likely each size flood is likely to occur in any one year, or over a period of years. So for example, each year it is possible but not likely we will see a large flood and almost a certainty we will see a small one. This value is actually calculated as a percent likelihood, but is most often converted to a number of years as above in discussing the event of January, 1996, as the "100 year flood". This number of years is called the "recurrence interval" (RI) or "return period" of an event of certain size. For example, the flood with 20% chance of occurring or being exceeded in any single year corresponds to what is commonly referred to as a "5-year flood" (each of these values is the inverse of the other - just divide 1 by % probability to get RI in years, or divide 1 by RI in years to get % probability). This simply means that on average, for the period of record (the very long term), this magnitude flood will occur about once every 5 years. This probability is purely statistical; probability remains the same year to year over time for a particular size flood to occur, though the actual distribution of flood events in time is not regular; many years may go by without a certain magnitude flood, or it may occur several times in a single year. As another interesting characteristic of flood frequency distributions, the 5-year flood may not occur the "right" number of times in a certain period of record. For example, we might expect to see about 2 "5-year floods" for every 10 years of record, but any particular 10 year period may contain greater or fewer of this size flood.

The length of gaging records in New York is typically short, on the order of less than 30 years, compared to long-term history. 200-300 years might give a better picture of how often the range of floods may occur. Therefore, its somewhat difficult to assign probability to the floods we do see, particularly if we are in a particularly wet or dry period. A lot of research has gone into the actual distribution of flood events over time, so we can take as little as 10 years of record and generalize out to much longer periods, 100 or 200 years or longer.

Floods recorded at the Schoharie Creek gage that exceed a 5-year recurrence interval provide an example of distribution of medium to large floods over a longer time period, particularly if compared with two gages in a nearby watershed (Table 2.4.2).

Table 2.4.2. Flood Flows at Three Gages that Exceed Five Year Recurrence Intervals (Flood frequency statistics based on recorded peak flows through 1997. Esopus Creek at Allaben, NY: 5 yr RI flood:~6,500 cfs 10 yr RI flood: ~9,500 cfs Bushnellsville Creek at Shandaken, NY 5 yr RI flood:~800 cfs 10 yr RI flood: ~1,000 cfs Schoharie Creek at Prattsville, NY: 5 yr RI flood: ~24,000 cfs, 10 yr RI flood: ~33,000 cfs.).

Esopus Creek at Allaben, NY	
Date	***Flood Discharge (cfs)***
3/30/51	*20,000*
7/28/69	*7,870*
3/21/80	*15,900*
2/20/81	*6,540*
4/5/84	*8,470*
4/4/87	*16,100*

1/19/96	*15,000*
9/18/04	*6,700*
4/02/05	*20,400*
Bushnellsville Creek at Shandaken, NY	
Date	***Flood Discharge (cfs)***
11/25/50	*1,350*
10/15/55	*1,830*
3/21/80	*845*
4/5/84	*896*
4/4/87	*1,000*
1/19/96	*996*
9/18/04	*No data available*
4/02/05	*No data available*
Schoharie Creek at Prattsville, NY	
Date	***Flood Discharge (cfs)***
Sep. 30, 1924	*29,000*
Nov. 16, 1926	*42,300*
Aug. 24, 1933	*39,000*
Mar. 03, 1934	*50,002*
Jul. 08, 1935	*27,400*
Mar. 18, 1936	*38,500*
Feb. 22, 1937	*29,800*
Sep. 21, 1938	*45,000*
Nov. 25, 1950	*49,500*
Dec. 11, 1952	*28,200*
Aug. 13, 1955	*25,100*
Oct. 16, 1955	*51,600*
Dec. 21, 1957	*31,000*
Sep. 12, 1960	*49,900*
Jun. 22, 1972	*27,400*
Dec. 21, 1973	*24,900*
Dec. 08, 1974	*24,800*
Jan. 09, 1978	*30,600*
Mar. 21, 1980	*39,600*
Apr. 05, 1984	*29,500*
Apr. 04, 1987	*47,600*
Jan. 19, 1996	*52,800*
Sep. 16, 1999	*42,800*
Sep. 18, 2004	*26,500*
Apr. 2, 2005	*42,500*

However, recurrence interval can be misleading – it is a common misperception that a five year flood should occur exactly once every five years. But we know this isn't true – for example, on the Schoharie Creek in the 1930s, there were significant floods six years in a row, with two greater than the 25-year event – the size flood for which most NYS and county bridges are designed. By contrast, there were no such events during the entire decade of the 1940s.

Flooding occurs in response to excessive runoff associated with spring snowmelt, summer thunderstorms, fall hurricanes, and winter rain-on-snow events. Five of the seven major floods recorded at the Esopus Creek at Allaben station occurred in late winter/early spring and are presumably associated with major snowmelt events from either spring thaw or rain-on-snow events. The largest recorded flood is a spring runoff event. A summer flood in 1969 and the flood of January 1996 are the two other large floods recorded at the gage. Three of the six major floods recorded at the Bushnellsville gage occurred during the spring and are coincident with three of the Esopus events, showing some comparison can be made between nearby streams. Conversely, weather in the Catskills can produce localized historically significant flood events such that a peak event may not be recorded at each gage for the same time period or storm event. Significantly, we can see that 10 of 25 events at Schoharie Creek occurred during hurricane season (late summer to late fall), 13 occurred during winter and spring, and only 2 occurred during summer. The January 1996 flood was approximately a 10-year recurrence interval flood on the Bushnellsville Creek, less than a 40 year event at Esopus Creek, and the “flood of record” at the Schoharie Creek. This shows that between-stream comparisons are not always perfect. This is especially so with summer thunderstorms, where highly localized storm cells can produce 10 or more inches of rain in one watershed, and only a few inches in an adjacent watershed for the same storm. Summer peaks shown in Table 2.4.2 do not overlap between any of the three sites.

From review of available data we can generalize that most bankfull (low-level flooding) and greater events will occur in late winter/spring as the result of thaws and major rain-on-snow events. This is in large part due to landscape storage of available water as snow and ice, reduced infiltration capacity if the ground is still frozen (or partially so), and minimal evapotranspiration from vegetation, which would otherwise route moisture back into the atmosphere. Other major floods can be expected during hurricane and tropical storm season in the late summer and fall, particularly as vegetation enters the dormant season and demand for water in the landscape drops off.

The 1990s were generally a time of moderate flood events in the vicinity of the Schoharie, with the exception of the winter flood of January 19, 1996, which was similar in scale to April 1987. Tropical Storm Floyd flooding (September 1999) was typical of tropical storm events and the sometimes uneven distribution of precipitation associated with those storms. While flooding in Esopus drainages was typically less than a 5-year event, several drainages in bordering Schoharie system had over a foot of precipitation in 24 hours with flooding that exceeded the 10-year event discharge.

The years 2000 – 2002 were characterized by droughty conditions with intervening wet conditions. High water events were typically limited to bankfull (or smaller) events. 2003 was an unusually wet year, with several larger than bankfull events occurring during the summer. Predicting precisely when the next 5-year (or greater) flood will occur in the Schoharie is impossible – the probability for a large flood, or a flood of any particular size, is the same each year – though weather and storm patterns can be used to anticipate conditions for a few months out, and seasonal patterns are generally reliable. The last really large flood was in April, 2005, but the probability is high that, when the next flood occurs, late winter/early spring during snowmelt/rainy season will be prime time.

Implications of Schoharie Creek Flooding

The unique hydrology of the Schoharie Creek has consequences for how the stream corridor should be managed. Flood history and dynamics play a large role in determining the shape, or morphology, of stream channels and the hazards associated with land uses on the banks and in the floodplain. For example, applications for stream disturbance permits (from NYS DEC) typically increase following floods as landowners and municipalities attempt to repair damage caused by flooding. If we want to minimize their impact on property, infrastructure and other damages or inconvenience, it is critical that we understand and plan for flooding behavior. Historically, this "planning" has emphasized attempts to constrain and control stream channels, rather than working with processes we can measure and, to some extent, predict. The results are often costly and sometimes catastrophic, such as when berms or levees fail or bridges wash out. These "control" approaches typically result in ongoing maintenance costs that can draw valuable community resources away from other projects. With a better understanding of stream and floodplain processes, we can reduce these costs.

2.5 Upper Schoharie Watershed Geology

(Note: this is an adaptation of the Upper Esopus Creek Management Plan geology section)

Introduction

Photo 2.5.1. Streambank erosion into glacial lodgement till along East Kill, tributary to Schoharie Creek.

Water flows across the landscape and sculpts the watershed. The geology (the earth material) of the watershed helps determine the nature of the streams, influences the stream's water quality and the way the landscape erodes (Photo 2.5.1). In the Catskill Mountains, geology is the primary influence on water quality. Jill Schneiderman, a professor of geology at Vassar College, notes in her book, *The Earth Around Us: Maintaining a Livable Planet,* that the bedrock and glacial sediments of the Catskills provide excellent filtration for maintaining high water quality (Schneiderman, 2003). However the geology also periodically degrades the water quality. Where the stream erodes into very fine-grained (silt and clay) glacial deposits the water will become brown with the suspended sediment. This Section presents basic background information on Catskill and Upper Schoharie watershed geology, and discusses some of the important implications of geology on stream management. The intent is to provide just enough information to describe the geologic setting and history of the Upper Schoharie watershed. Specific recommendations pertaining to further characterization are presented at the end of this Section. References are provided for the reader interested in obtaining more detail on the geology of this region.

Streams and glaciers sculpted these mountains out of a plateau of rock that formed from ancient rivers. That is essentially the geologic story of the Northeastern Catskill Mountains. These mountains and their river valleys are the ongoing result of water interacting with landscape geology under the force of gravity over millions of years.

Knowing the geology of the landscape and stream corridor helps stream managers understand important conditions that control the stream's work (moving water and sediment out of the watershed), as well as significantly influencing water quality.

The nature of the bedrock – its composition and structure – determines how the stream valleys form and what the sediment will be like. Upper Schoharie Creek and its tributaries drain much of the northeast Catskill Mountains. These mountains are composed of sedimentary rock. The broken bits of this rock, formed from layers of ancient river sediment, is the source of almost all of the stream sediment you see today - from clay to boulders. The layered reddish clays exposed in stream banks are the legacy of ancient lake sediments eroded from the red siltstones and shales that often form the mountain slopes and the cobbles and boulders eroded from the thick-bedded sandstones that form the mountain cliffs (Photo 2.5.2). Much of this sediment that the stream is currently conveying was deposited during the most recent ice ages of 12,000 – 25,000 years ago, when the Catskills were mostly occupied by ice or the melt-water streams and lakes that followed the ice's retreat. The Schoharie Creek and all the streams that feed it water and sediment have inherited this geologic framework.

Photo 2.5.2. Streambank/bed with alluvial and non-alluvial sediment

The geology of the Upper Schoharie Creek valley is typical of the complex geologic conditions that prevail in the tributaries as previously documented in the Batavia Kill (GCSWCD, 2003) and West Kill (GCSWCD, 2005) Stream Management Plans and in the adjacent Esopus Creek basin to the south, as documented in the Upper Esopus Creek Stream Management Plan (CCE, 2007). The bedrock geology is straightforward, while the glacial geology provides the complexity that makes these basins unique in the Catskills.

Bedrock Geology

The bedrock geology of the Catskill Mountains and Upper Schoharie watershed exerts considerable control on the character of its valley slopes and streams (Figure 2.5.1; Photo 2.5.3). The gently sloping sedimentary rock, primarily composed of alternating layers of sandstone and siltstone/shales, creates the characteristic Catskill stepped topography. The sandstones form the cliffs while the more easily erodible siltstones/shales tend to form the slopes. The mountain tops tend to be formed of conglomerate (a gravelly sandstone). The sediments that form the middle-to-late Devonian (390 to 360 million years ago) bedrock are interpreted to be deposits of a vast deltaic river system, often called the "Catskill Delta" deposits that drained the ancient high peaks of the Taconic mountain range (Isachsen et al., 2000). Titus (1998) compared it to the Bangladesh river complex draining the Himalayas. The sandstone and conglomerate are made up of river channel sand and gravel, while the siltstones and shales are overbank and shallow fresh water silts and clays.

Photo 2.5.3. Bedrock exposed along Schoharie Creek

The Catskill Delta deposits were buried beneath younger sediments, and then uplifted as a plateau. Prior to and during the uplift, intersecting sets of vertical fractures formed in the Catskill rock. The following eras eroded away the overlying rock, and streams incised multiple channels into the slowly rising plateau. The following two publications are recommended for further detail on the Catskill bedrock geology: Geology of New York: A simplified account (Isachsen, et al., 2000) and The Catskills: A Geological Guide (Titus, 1998).

Fisher, et al. (1970) mapped the bedrock of the area as part of the New York State Geological Survey Map and Chart Series. The mapped geologic formations that make up most of the watershed are the Oneonta and Walton formations comprising sandstones, shales, and mudstones (Photo 2.5.3). Around the Schoharie Reservoir a similar sequence of rocks comprise the Genesee Group and the Moscow formation. The Moscow formation is the rock that hosts the famous Gilboa forest fossils (VanAller Hernick, 1996).

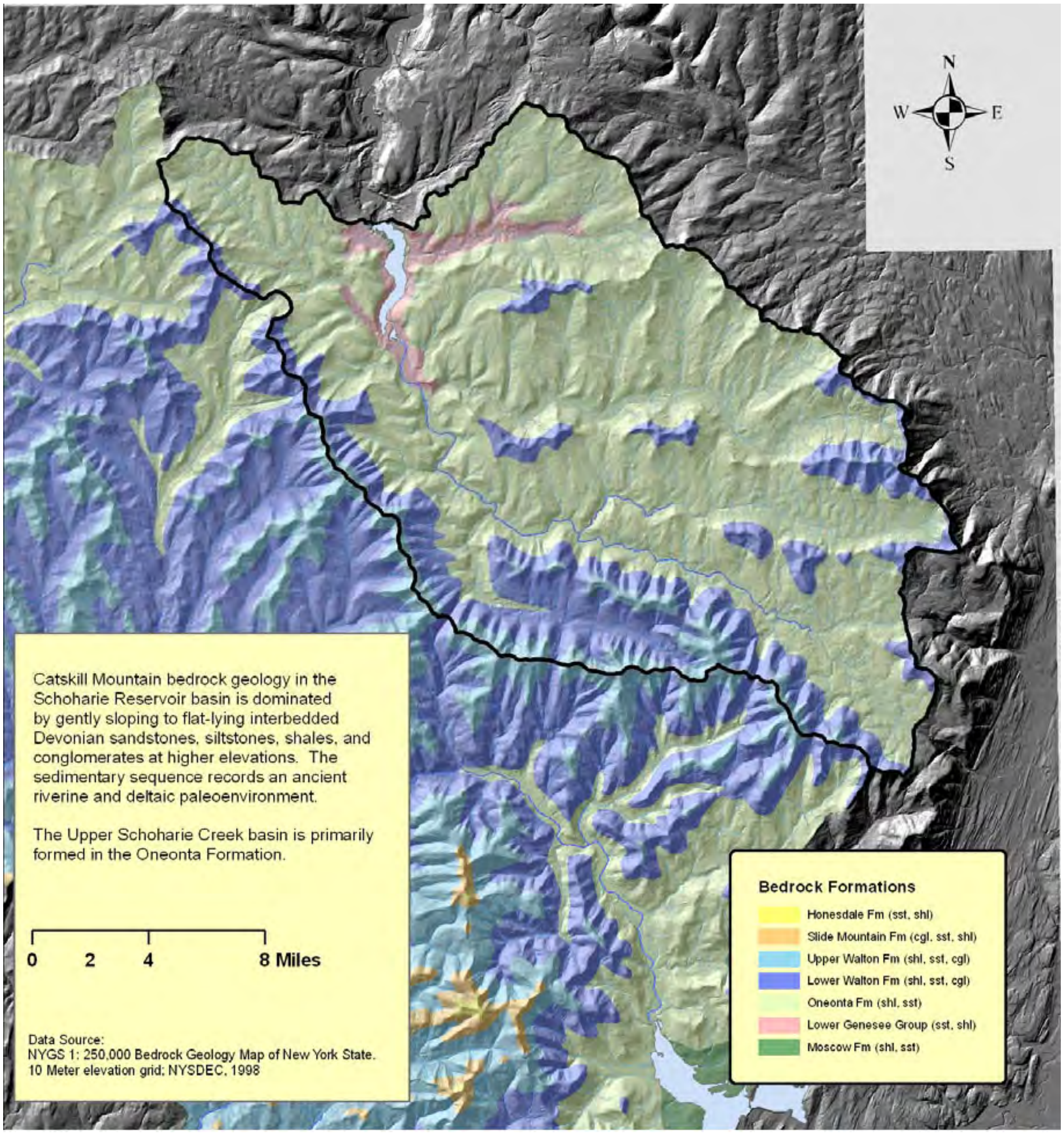

Figure 2.5.1. Bedrock geology of the Schoharie Basin.

The orientation of the stream valley is important, influencing the microclimate, average depth of snowpack and local hydrological regime in many ways. The Schoharie Creek watershed is uniquely oriented for Catskill drainage basins, with drainage to the west and north rather than to the southeast or southwest typical of the other principal watersheds.

Bedrock fracture orientations in the area are generally consistent with the overall trend of two sets for the central to northeastern Catskill Mountains. The dominant high-angle (near vertical) fracture sets are oriented NE and NW, influencing drainage pattern development.

Modern stream deposits in the Catskill Mountains are principally derived from erosion of the well-bedded sedimentary Catskill bedrock. As a result, stream clasts (sediment particles and classes) have a low spherocity ("roundness"), typically forming platy or disk-like particle shapes. This platy shape affects the stability of the streambed in a number of ways. First, it allows the particles to *imbricate*, or stack up at an angle, forming an overlapping pattern like fish scales or roof shingles (Photo 2.5.4). Imbricated streambeds are thus generally more stable or "locked up", and all other things being equal, generally require a larger flow to mobilize the bed material than nonimbricated beds. However this same platy shape can also, under the right conditions, act like an airplane wing and be lifted by the streamflow more readily than would a spherical particle of similar weight. Once this occurs for even a few particles, the imbrication is compromised and significant portions of the streambed become mobile.

Photo 2.5.4. Example of imbricated Catskill stream sediment

Surficial Geology

Surficial geology is concerned with the material covering the bedrock. In the Catskills this surface material is principally soils and glacial deposits. The focus here is on a brief introduction to the glacial geology of the Schoharie watershed and stream corridor. The Greene County Soil Survey is an excellent source for examining the soils of the Upper Schoharie Creek corridor (USDA, 1993).

The ice ages of the last 1.6 million years (Pleistocene Epoch) have left the latest mark on the Catskill landscape. Vast continental ice sheets and smaller local mountain glaciers scoured the mountains and left thick deposits of scoured sediment in the valleys. The last ice sheet (the "Laurentide Ice Sheet") reached maximum thickness over the Catskills about 22,000 years ago (Isachsen, et al., 2000) and had fully retreated by 12,000 years ago (Figure 2.5.2). As measured on the scale of geologic time this was a very recent event.

Figure 2.5.2. (a) Map of Laurentide ice sheet. (b) Photo of Greenland ice sheet in mountainous terrain.

The most recent ice ages – the time that spanned the last 30,000 years or so – had giant continental-sized ice sheets flowing across the northern landscape (Figure 2.5.2a). The ice sheet covering Greenland (Figure 2.5.2b) is a modern day analog to those Pleistocene conditions. The continental glaciers scoured and moved vast amounts of sediment across the landscape. Once the ice sheet started melting back into the Hudson-Mohawk River valleys to the north, smaller alpine glaciers formed in some of the higher mountains and further sculpted the landscape. The glaciers left a legacy that still profoundly influences hill slope and stream channel stability and water quality.

This was a period of accelerated erosion in the Catskills as the flowing ice sheet bulldozed sediment and "quarried" the bedrock. Glacial erosion broke the rock down into an entrained mixture of fragments ranging in size from boulders to clay. This mixture of saturated sediment was carried along by the ice and deposited as till (unsorted assemblage of glacial sediment) or as stratified "drift" if the sediment was subsequently sorted by melt-water streams. These glacial deposits filled in deep river ravines that once drained the landscape prior to the last glacier's advance over the mountains.

As the climate warmed and ice thinned, the landscape was deglaciated – lobes of the continental ice sheet melted back from the central Catskills in periodic stages (Dineen, 1986). As the ice sheet pulled back (and occasionally re-advanced as distinct "lobes" of flowing ice) alpine glaciers formed on some of the newly exposed peaks (e.g. Hunter Mountain). Meltwater from the decaying ice left a complex array of stream (outwash plain) and ice-contact (kame) sand and gravel deposits. Pro-glacial lakes formed where mountains, recessional moraines (deposits at former glacial margins) and ice impounded water and filled the valley floors with thick deposits of layered silt and clay (Figure 2.5.3). The extent of the pro-glacial lakes in the Catskills are inferred from elevations of "fossil" deltas from meltwater streams pouring into valley–filling. One long-standing lake during this time filled the ice-free parts of the Schoharie valley at an elevation up to 1600 ft (Rich, 1935) corresponding to the elevation of the notch at Grand Gorge. The notch was a spillway for Glacial Lake Grand Gorge, discharging water into the Delaware basin. The extent of the glacial lakes during the prolonged melting of stagnant continental ice exposed a large proportion of the catchment to the accumulation of layered fine sediment. As climate fluctuated during the period of deglaciation, temporary re-

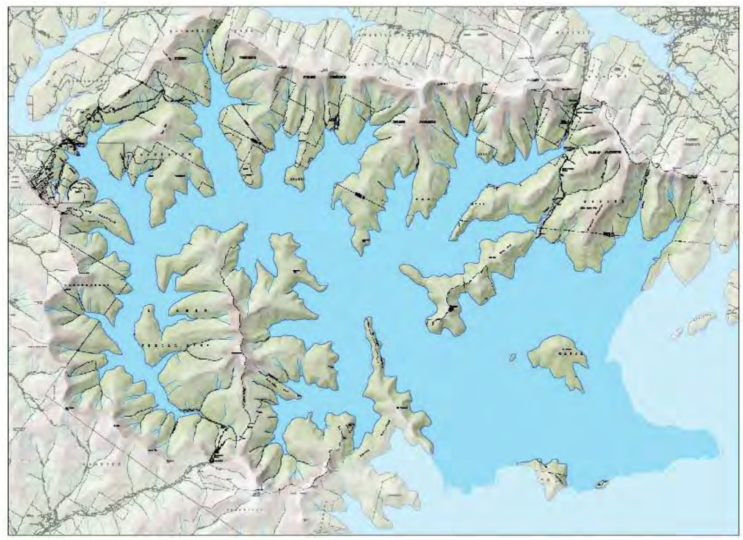

Figure 2.5.3. Example of extent of pro-glacial lake in adjacent Esopus Creek watershed

advances of ice from ice sheet lobes or alpine glaciers would leave till and other meltwater deposits on top of the earlier glacial material, resulting in the complex lateral and vertical distribution of glacial deposits observed today. After the ice fully retreated north, rainfall-runoff returned as the predominant sculptor of the landscape.

Glacial geology sets the geologic framework for most of the Upper Schoharie Creek stream system, controlling such characteristics as depth of *alluvium* (water worked sediments), presence of non-alluvial boundary conditions (till and glacial lake sediments), sediment supply and stream channel slope and geometry. For example, glacial depositional features that partially fill river valleys, such as recessional moraines or kame terraces along the valley wall, influence valley slope and cause valley constriction, both of which limit where the river channel can occur. Also, locally complex stratigraphy of glacial till, glacial lake deposits and unconsolidated *fluvial* deposits in the stream bank profile significantly influence erosional processes. Understanding detailed glacial geology can help identify causes of stream erosion and water quality problems as well as assist in prioritizing where future stream stabilization or restoration actions may be most useful.

For more detail on the glacial geology of the Catskills the reader is referred to Rich (1935), Cadwell (1986), Dineen (1986) and for a popularized account Titus (1996). Figure 2.5.4 presents a map of the surficial geology for the Schoharie basin as mapped by Cadwell (1987). It is safe to say that the actual geology is significantly more complicated than depicted on such a small scale map.

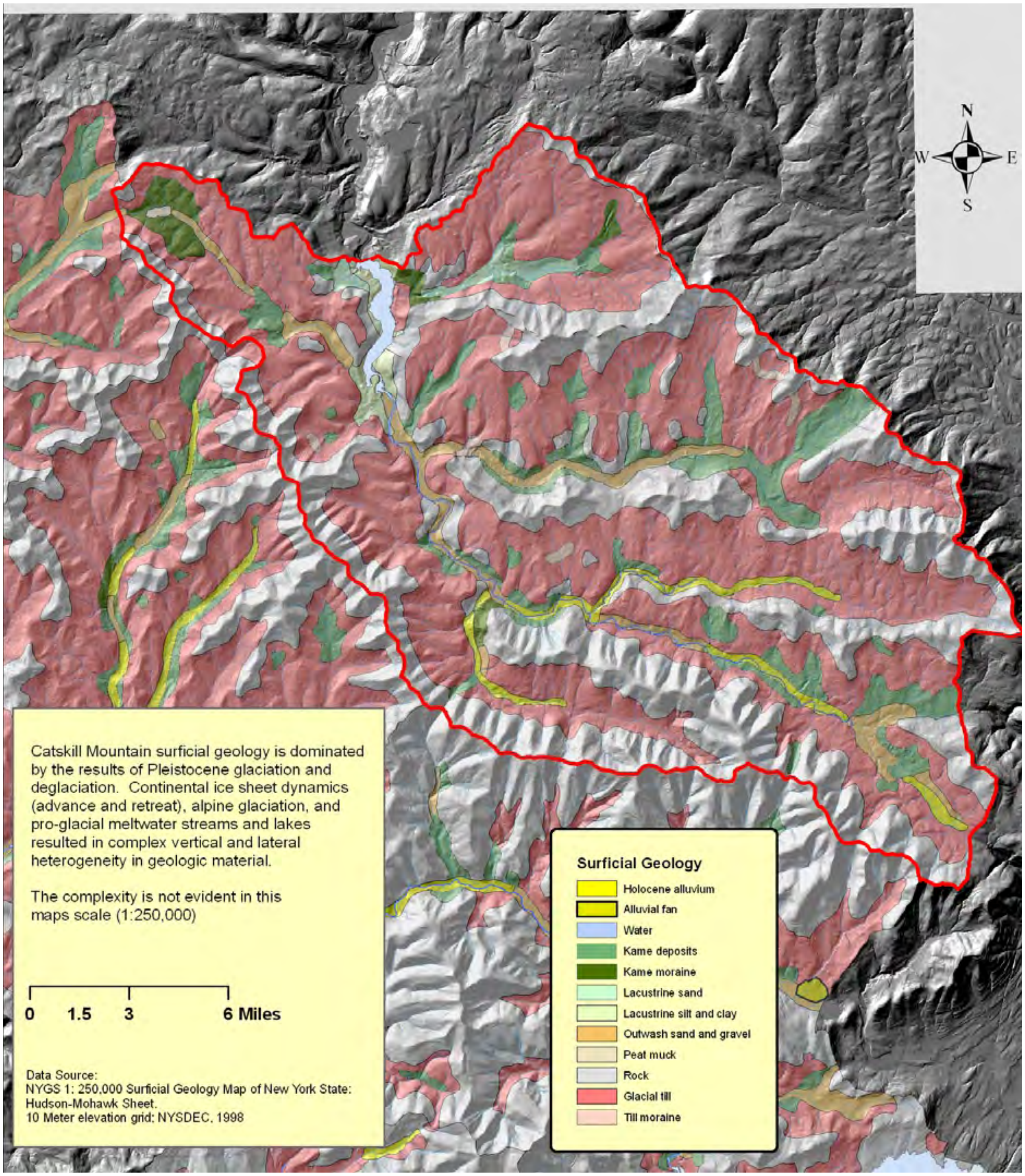

Figure 2.5.4. Surficial Geology of the Schoharie Creek Basin as mapped at 1:250,000

Hydrogeology

Though groundwater is not the subject of this Management Plan, its constructive role in maintaining base flow to the stream and cold water springs for thermal refugia, and its destructive role in hill slope failures should be addressed.

Given that much of the valley floor stratigraphy includes buried impermeable layers of glacial lake silt and clay and/or glacial till, groundwater circulating through the upper permeable coarse-grained alluvium is often perched and discharges as springs or base flow to the stream. Following periods of excess rainfall not only does the stream flow increase to or near flood stage, but the water table also increases and can flood basements. Much of the “flood” damage to basements in the Catskills is due to excess groundwater in these shallow groundwater systems and not directly from stream flooding.

Groundwater flow through the complex glacial stratigraphy on the hill slopes is a major factor in the massive hill slope failures that impact stream channel conditions and water quality (Photo 2.5.5). The combination of stream erosion at the toe of the hill slope, fluctuating groundwater levels, differential seepage from the slopes and saturated sediment can result in very long-lasting, deep-seated slope failures. Examples abound throughout the watershed. Every major rainfall-runoff event seems to generate new slope failures or reactivate older failures. Some of the chronic turbidity sources in the tributary streams are from these hill slope failures, such as in Batavia Kill and West Kill (GCSWCD, 2003; GCSWCD, 2005).

Photo 2.5.5. Hillskope failure in the Schoharie basin

Stream Channel Geology

Developing an effective stream corridor management plan that incorporates geologic boundary conditions requires an additional step beyond describing the geologic setting. Additional analysis is needed to characterize the surficial geology that forms the stream channel boundary by some of its sedimentologic conditions, specifically grain size distribution, cohesiveness, and consolidation.

Upper Schoharie Creek and its tributaries flow across a landscape characterized by sedimentological heterogeneity as a result of the complex distribution of glacial deposits and landforms. Stream channel stability and water quality vary in part as a function of this heterogeneity. By classifying the surficial geology along the stream corridor into mappable units that describe the potential for bed and bank erosion and entrainment of the stream channel material, recommendations for management of stream reaches can better reflect local geological considerations.

Rubin (1996) began this effort in the Stony Clove basin by classifying the glacial deposits into three sedimentologic units and mapping their distribution along the Stony Clove main stem and tributary channels (GCSWCD, 2004). The following are the three key sedimentologic units that influence water quality and stream stability. They were first proposed by Rubin (1996), and have been subsequently adapted for the development of stream management plans (GCSWCD, 2004; GCSWCD, 2005; CCE, 2007).

Unconsolidated Deposits

This general term is applied to all unconsolidated deposits regardless of whether they were deposited directly as post-glacial stream deposits, glacial outwash (proglacial fluvial sediments), reworked outwash, *kame terrace* deposits, melt-out till, *moraine* deposits or reworked lodgement till (Photo 2.5.6). The unit is composed of sand, gravel, cobbles, boulders and a small clay/silt fraction. The unconsolidated deposits are present in valley centers, typically ranging from four to twelve feet in thickness (Rubin, 1996). With the exception of a thin, weathered mantle often capping it, this is the uppermost geologic unit most commonly forming stream banks. Boulders specific to this geologic unit naturally drop out as stream banks are eroded, providing some aquatic habitat and diversity.

Photo 2.5.6. Coarse fluvial sediment comprises most of the Schoharie Creek and East Kill stream banks

Lacustrine silt/clay

Photo 2.5.7. Clay deposit along the Schoharie Creek

Reddish or pinkish brown, finely-layered, silty-clay deposits are present in significant portions of the Upper Schoharie Watershed (Photo 2.5.7). It was deposited *subaqueously* (from streams discharging into one or more glacial lakes) as a sediment blanket draped over underlying till or bedrock. Locally, it was also deposited in smaller impoundments associated with alpine glaciers and moraine dams. It is commonly exposed along the toe of the stream bank, sometimes in the channel bottom (often beneath a thin cover of coarse alluvium), and less frequently as long and/or large banks.

The fine, uniform grain size results in a very cohesive deposit that exhibits unique hydraulic and mechanical erosion characteristics. While the silts are easily entrained under high runoff events, many of the clay-rich deposits are resistant to hydraulic erosion. Susceptibility to erosion is largely dependent upon whether the layered silt/clay has been mechanically disturbed by geotechnical failures or human disturbance. The silt/clay unit tends to erode mechanically by slumping along rotational faults, subsequently losing its layered structure and cohesive strength (Figure 2.5.5). Within the silt and clay layers, strata of sand sometimes occur, creating the potential for piping and associated mechanical failures. When saturated, it tends to be extremely soft and in this physically- and chemically-weakened condition is susceptible to creep and erosion. Research in the Esopus Creek also demonstrated that erodibility was a function of the degree of disturbance of the exposure surface, and tended to diminish over time as the exposed surface smoothed through erosion Fischenich et al., 2007).

Glacial Lake Clays and Stream Bank Erosion

Stream banks formed in deep clay deposits tend to fail by rotational failure which occurs in cohesive materials when a block of disturbed bank material slides along a curved failure surface (fault). The block tends to rotate (appears to "slump") back toward the bank as it slides, in a rotational slip.

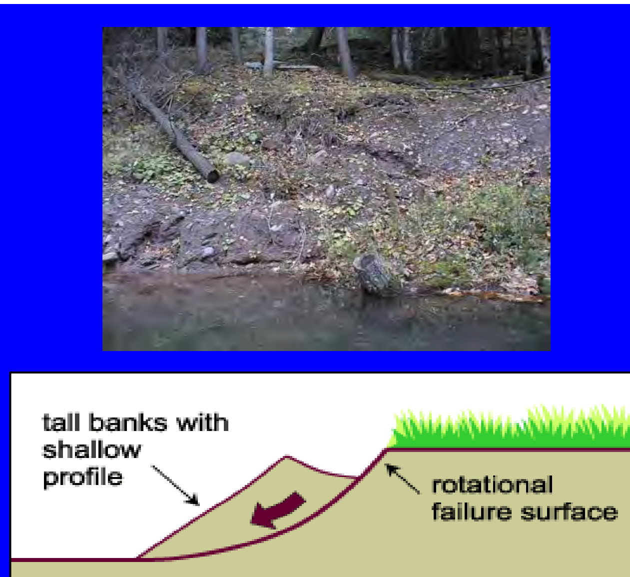

Figure 2.5.5. Glacial lake clays and stream bank erosion

Where vegetative cover is lost and large exposures of lacustrine silt/clays occur, revegetation is usually slow to due to the poor drainage and rooting characteristics of the soil. A metal probe or stick can often be sunk into this unit to depths of between three and five feet, thus enabling identification even when it is covered by a thin cobble layer. Elongate troughs, scour holes and even deep potholes reflect its entrainment potential during scouring flows. Clear stream water contacting lake clays often results in an entire stream becoming turbid within 50 feet. In the Upper Schoharie Creek watershed this lacustrine silt/clay, along with lodgement till, are the primary sources for suspended sediment and turbidity problems.

Lodgement Till

Lodgement till is an over-consolidated (very dense), clay-rich, reddish brown deposit that is prevalent in the Upper Schoharie Creek and East Kill watersheds (Photo 2.5.8). This hard-packed silty clay with embedded pebbles, cobbles and boulders forms a number of steep banks in the drainage

Photo 2.5.8. Lodgement till in the East Kill

basin. Its dense, consolidated character is distinguished from the looser assemblage of mixed sediment sizes (silty sand-boulder) that comprises melt-out till found in moraines and along mountain sides. Lodgement till is typically exposed in stream channels where overlying lake clay deposits have been removed by erosion, where streams have scoured into valley wall deposits or where they have breached morainal ridges.

Its relatively competent nature, especially compared to disturbed lacustrine sediment, make it significantly more resistant to hydraulic erosion. It is however, susceptible to mechanical erosion by mass failure of fracture bound blocks during saturation/desaturation and freeze/thaw cycles. This failed material is subsequently eroded by streamflows. Under conditions of high stream velocities and discharges, lodgement till is a contributor of sediment. However, where the stream (particularly in tributary valleys) is against the valley wall and the hill slope composed of lodgment till is saturated, long-lasting exposures can be chronic sources of suspended sediment into the stream well-after a storm event. Reaches in many of the Schoharie tributaries are subjected to this phenomenon. Rain water and overland runoff contacting exposed banks can also readily entrain sediment from these units. For field mapping, a metal probe or stick can rarely be pushed into this unit more than 0.2 feet.

Bedrock Control

The presence of bedrock sills and banks is an additional geologic unit equally important in characterizing geology for stream corridor management. These hydraulic controls can represent natural limits to changes in the stream channel system caused by incision or lateral migration. Examples include the falls in the headwater reaches, and occasional bedrock stream banks and sills along the Upper Schoharie Creek/East Kill (Photo 2.5.9).

Photo 2.5.9. Lateral bedrock control in the East Kill

In summary, the variable character of the Upper Schoharie watershed is largely a reflection of the geologic bedrock control and complex glacial history of the valley. These geologic influences are evident in the sedimentological variation characterizing the topography and geomorphology of the stream channel boundary. The nature of these deposits makes them variably susceptible to stream erosion. In particular, the lacustrine and till sediments are sensitive to natural or man made disturbances which can have a long lasting negative effect on channel stability, water quality and stream ecology.

Stream Management Implications

The inclusion of geology in stream management consideration for Upper Schoharie Creek and East Kill generally falls into four categories: fluvial erosion, hill slope erosion, water quality, and sediment supply.

Fluvial erosion

There are different types or "styles" of stream bank erosion associated with the different geologic units the stream encounters. The prediction, prevention and/or treatment of the eroding stream bank must factor in the stream bank material composition and the underlying mechanism of failure. Observations made during this planning process and previous similar projects throughout the watershed indicate the following:

- Pro-glacial lake sediment erodes easily during storm events once exposed; however, if the "soft" silt and clay unit is overlain by coarser fluvial sediment (sand-boulder sized material) it is typically a short-lived exposure and the stream bank tends to get armored by the draping of the coarser sediment.
- Pro-glacial lake deposits that are undisturbed are much more resistant to erosion than those that have had their physical and chemical bonds weakened by mechanical action (including abrasion and displacement from hill slope failures).
- Glacial till tends to erode either as (a) mass slumping from saturated conditions or (b) translational fracture-bound failures forming high steep banks.

- Coarse-grained, non-cohesive fluvial sediment will erode easily if not protected by dense roots or revetment.

Hill slope erosion

The mass wasting, or geotechnical failure of the valley hill sides when proximal to stream channels can result in chronic and excess fine and coarse sediment supply. This is a relatively common problem in the tributary valleys. Sediment entrainment occurs as a result of exposed glacial till or disturbed lake deposits to flood flows. In extreme situations, debris flows from these failures may block or cause the stream channel to adjust its planform. If the adjacent hill slope erosion is from a geotechnical failure in glacial till or pro-glacial lake sediment and the stream is actively eroding into the toe of the hill slope the problem is perpetuated by constantly activating the failure. Stream restoration or road construction/repair in these settings must first address whether the geotechnical failure can be resolved before dealing with the stream channel stabilization. Future construction or development activities in the Schoharie Creek tributary valleys should include geotechnical investigations and slope stability analyses to ensure that the proposed actions do not contribute to new slope failures or exacerbate existing failures.

Water quality

The "muddy" or turbid water that follows a storm event carries the fine silt and clay particles initially deposited as glacial till or pro-glacial lake sediment (Photo 2.5.10). Fluvial and hill slope erosion of these fine sediment sources, along with re-suspension of fine sediment deposited in the stream bed are the primary cause of the turbid water conditions. The fact that the glacial till and glacial lake sediment is widely distributed throughout most of the watershed suggests that effective removal of the stream from contacting this material

Photo 2.5.10. Turbid tributary entering the Schoharie Creek during a summer storm.

is impractical to consider. High levels of suspended sediment and associated turbidity have been and will be an ongoing water quality condition in the Upper Creek watershed.

Sediment supply

The mantle of glacial deposits over the landscape is the primary source material for all the coarse and fine sediment that the stream system conveys. At any given time along any given reach of stream most of the sediment observed has been in the stream system for a "long time". However, it is important to determine where sediment recruitment takes place. Unanswered questions remain: Which tributary streams deliver a proportionally larger amount of bed load material that Schoharie Creek has to process? Are there localized sources in the watershed that lead to localized aggradation?

Recommendations

The following recommendations are presented as an initial scope for further investigation and development of products to improve the Upper Schoharie Creek.

- Work with research and/or academic institutions to better characterize the lateral and vertical distribution of glacial deposits that influence stream channel condition and water quality. Encourage academic interest in addressing this applied geology issue.
- Continue to monitor previously mapped fine sediment sources along Upper Schoharie Creek and East Kill, and implement a program to identify "new" exposures. The aim of this effort is to better characterize the temporal nature of fine sediment exposures and their contribution to water quality problems in the basin.
- Using (1) georeferenced data obtained during the geomorphic investigation, (2) available soils map and (3) further reconnaissance mapping develop a stream channel geologic map for Upper Schoharie Creek and East Kill.
- Extend stream channel geologic and fine sediment source mapping into all tributary valleys not previously assessed, and develop a sediment budget to include more detail on the tributaries so that the relative contribution of

sediments from these sources can be determined and the potential benefits of management actions in the tributaries better elucidated.

- Support an investigation of the geotechnical and hydrogeologic processes controlling coupled hill slope and stream bank erosion in order to evaluate management feasibility.
- Develop a document that informs stream managers how to use this information when designing and implementing stream stabilization projects in the region.

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2.6 Wetlands & Floodplains

Wetlands are areas where the soil is inundated by surface or ground water often enough that the prevalent vegetation community is adapted for life in saturated soils. The term “wetlands” covers a diverse set of conditions, including swamps, marshes, bogs and fens. The timing and duration of soil saturation largely determines how the soil develops and the particular community of plants and animals living in and on the soil. The prolonged presence of water creates conditions that favor the growth of specially adapted plants (hydrophytes) and promote the development of characteristic wetland (hydric) soils (USEPA, 2006).

Wetlands are recognized as important features in the landscape that provide numerous beneficial functions, include protecting and improving water quality, providing fish and wildlife habitats, storing floodwaters, and maintaining surface water flow during dry periods. These valuable services are the result of the inherent and unique natural characteristics of wetlands (USEPA, 2001).

It has long been accepted that the presence and position of wetlands play a key role in the filtration of dissolved inorganic nutrients and suspended materials from water (Johnston et al. 1990; Welsh et al., 1995; Hammer, 1997). The wetland filtration function buffers our streams, ponds, and lakes from receiving excess nutrients and suspended materials. The addition of excessive amounts of nitrogen and phosphorous to marine and freshwater systems, where nitrogen and phosphorous, respectively, are generally limiting to plant growth, can lead to accelerated eutrophication (USEPA Office of Water, 1997).

Nitrate, the most mobile form of nitrogen, can either be absorbed by vegetation, leach into groundwater or surface water, or be converted to nitrogen gas in the process of denitrification (Welsh et al., 1995). Sediment and phosphorous retention is also an important function of wetland systems, with excess phosphorous tending to be associated with sediment. Wetland trapping and storage of sediment will also trap and store excess phosphorous. However, sediment attached phosphorous is subject to resuspension and movement when wetland sediments are disturbed (Welsh et al., 1995). Fecal coliform bacteria are often associated with suspended materials as well. Many of the organisms associated with fecal coliform bacteria cannot survive for long periods of time outside of their host organism. Therefore, the wetland function of retaining suspended material promotes the die-off of the fecal coliform bacteria (Johnston et al., 1990). This function is threatened with increasing storm water runoff and loss of wetlands. As of the mid 1980's, New York State had lost 60% of its original wetlands (Mitsch, 1993).

Fertilizer application, septic systems, and sewage treatment plant discharges directly affect nutrient exports (Caraco and Cole, 1999; Vitousek et al., 1997). Clearing of land for building lots and agriculture is often associated with a decrease in wetland acreage. The loss of wetlands removes a significant sink for fixed nitrogen leading to an increase in the mobility of nitrogen to streams, rivers, and lakes (Vitousek et al., 1997). Wetland restoration may be the most cost-effective method of decreasing nitrogen pollution (Carpenter et al., 1998). Removal of wetland systems has similar effects on sediment and phosphorous exports.

Federally Designated Wetlands

The National Wetlands Inventory (NWI) of the U.S. Fish & Wildlife Service produces information on the characteristics, extent, and status of the Nation's wetlands and deepwater habitats (USFWS, 2006). According to NWI maps there are 451 federally designated wetlands totaling 2,164 acres, including open water in the Schoharie Creek Watershed. These wetlands are 53.5% Lacustrine, 36% Palustrine, 10.2% Riverine, and 0.3% Upland.

The Lacustrine System includes wetlands and deep water habitats situated in a topographic depression or a dammed river channel, lacking trees, shrubs, persistent emergents, emergent mosses or lichens with greater than 30% areal coverage, a total area exceeding 8 hectares (20 acres). The Palustrine System includes all nontidal wetlands dominated by trees, shrubs, emergents, mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean derived salts is below 0.5 ppt. Wetlands lacking such vegetation are also included if they exhibit all of the following characteristics: are less than 8 hectares (20 acres); do not have an active wave-formed or bedrock shoreline feature; have at low water a depth less than 2 meters (6.6 feet) in the deepest part of the basin; and have a salinity due to ocean-derived salts of less than 0.5 ppt. The Riverine System includes all wetlands and deep water habitats contained in natural or artificial channels periodically or continuously containing flowing water or which forms a connecting link between the two bodies of standing water. Upland islands or Palustrine wetlands may occur in the channel, but they are not part of the Riverine System. Upland systems includes all areas not defined as wetland or deep water habitats. ($USFWS_1$, 2006).

In 2003, the dominant wetland type in the Schoharie Creek Watershed was Lacustrine, limnetic unconsolidated bottom wetlands (53%) (Table 2.6.1). These wetlands consist of deep-water habitats (>6.6 feet deep), lacking vegetation over 30% of its area, and must exceed 20 acres in size. These relatively large, deep water habitats have bottoms with more than 25% of their particles smaller than stones (< 6-7cm) ($USFWS_1$, 2006). In the Schoharie Watershed this wetland type includes the Schoharie Creek mainstem and the Schoharie Reservoir. The remaining half of wetlands in the watershed consist of four major types: Palustrine forested (12.8%), Riverine lower perennial (10%), Palustrine unconsolidated bottom (9.6%), and Palustrine emergent (8.1%) (Table 2.6.1). These wetlands are scattered throughout the watershed.

Table 2.6.1 National Wetland Inventory of Schoharie Creek Watershed

NWI Code	NWI Wetland Classification	Acres	%
L1	Lacustrine, Limnetic, Unconsolidated Bottom	1154.8552	53.4
L2	Lacustrine, Littoral	2.8170	0.1
PEM	Palustrine, Emergent	174.8615	8.1
PFO	Palustrine, Forested	277.7922	12.8
PSS	Palustrine, Scrub-Shrub	116.0764	5.4
PUB	Palustrine, Unconsolidated Bottom	207.9089	9.6
PUS	Palustrine, Unconsolidated Shore	1.2294	0.1
R2	Riverine, Lower Perennial	216.2176	10.0
R3	Riverine, Upper Perennial	4.2823	0.2
U	Upland	7.4617	0.3

Palustrine wetlands are vegetated wetlands including the small, shallow, permanent or intermittent water bodies often called ponds. Palustrine wetlands may be situated shoreward of lakes, river channels, or estuaries; on river floodplains; in isolated catchments; or on slopes. They may also occur as islands in lakes or rivers. Palustrine forested wetlands are characterized by woody vegetation that is 6 m tall or taller. Palustrine emergent wetlands are characterized by erect, rooted, herbaceous hydrophytes, excluding mosses and lichens. This vegetation is present for most of the growing season in most years. These wetlands are usually dominated by perennial plants. Palustrine unconsolidated bottom wetlands includes all wetlands and deep water habitats with at least 25% cover of particles smaller than stones (less than 6-7 cm), and a vegetative cover less than 30%. Riverine wetlands are confined within a channel and lack persistent emergent or woody vegetation. Riverine lower perennial wetlands have low velocity flows and fine substrates ($USFWS_1$, 2006).

Federally designated wetlands are protected under the Clean Water Act, a 1977 amendment to the Federal Water Pollution Control Act of 1972, which set the basic structure for regulating discharges of pollutants to waters of the United States ($USEPA_1$, 2003). Section 404 of the Clean Water Act established a program to regulate the discharge of dredged and fill materials into waters of the United States, including wetlands. Activities in waters of the United States that are regulated under this program include fills for development, water resource projects (such as dams and levees), infrastructure development (such as highways and airports), and conversion of wetlands to uplands for farming and forestry (USEPA, 2003).

New York State Designated Wetlands

The Freshwater Wetlands Act (FWA), Article 24 of the Environmental Conservation Law, provides NYS DEC and the Adirondack Park Agency (APA) with the authority to regulate freshwater wetlands in the state. The NYS Legislature passed the Freshwater Wetlands Act in 1975 in response to uncontrolled losses of wetlands and problems resulting from those losses, such as increased flooding. The FWA contains the following Declaration of Policy:

"It is declared to be the public policy of the state to preserve, protect and conserve freshwater wetlands and the benefits derived therefrom, to prevent the despoliation and destruction of freshwater wetlands, and to regulate use and development of such wetlands to secure the natural benefits of freshwater wetland, consistent with the general welfare and beneficial economic, social, and agricultural development of the state (ECL Article 24-0103)."

The FWA protects those wetlands larger than 12.4 acres (5 hectares) in size, and certain smaller wetlands of unusual local importance. The law requires DEC and APA to map those wetlands that are protected by the FWA. In addition, the law requires DEC and APA to classify wetlands. Outside the Adirondack Park, DEC classifies wetlands according to 6NYCRR Part 664, Wetlands Mapping and Classification Regulations from Class 1, wetlands which provide the most benefits, to Class IV, wetlands which provide the fewest benefits. Around every regulated wetland is a regulated adjacent area of 100 ft., which serves as a buffer area for the wetland (NYS DEC, 2003).

According to DEC maps, there are 16 NYS DEC designated wetlands totaling 468 acres, within the Schoharie Creek mainstem watershed. Of these wetlands, 22% are Class 1 and 78% are Class 2. The majority of these wetlands are located in the Schoharie Creek headwaters in the Town of Hunter. However, the Class 1 wetlands are located at the confluence of Johnson Hollow Brook and the Schoharie Creek.

Both Federal and NYS Designated Wetlands maps are available at County Soil & Water Conservation District Offices. Streamside wetlands are mapped and described for each management unit in Section 4 Management Unit Summary & Recommendations.

It must be cautioned that these maps should only be used as guidance of wetland locations and boundaries. It is the responsibility of property owners to determine if wetland areas will be disturbed by proposed projects. Smaller wetlands which meet federal criteria may not have been mapped but are still protected by federal regulations. The NYS DEC offers wetland delineation services to landowners when they need more precise information, such as when they are planning to conduct work near a NYSDEC designated wetland area.

Schoharie Creek Mainstem Watershed Wetlands Totals by Town

Within the Schoharie watershed the greatest acreage of wetlands are in the Town of Gilboa with Hunter a close second (Table 2.6.2). The majority of wetland acreage in the

Town of Gilboa is due to the Schoharie reservoir being classified as a deep water wetland. On average, due to the steepness of the slopes in the watershed the majority of wetlands lie adjacent to the streams, with smaller wetlands scattered throughout the forest near groundwater seeps. These forested wetlands and vernal pools may be underrepresented in table 2.6.2 since aerial photography was used for the NWI study. Within the NWI inventory analysis, wetlands down to an acre in size were identified well with wetlands as small as .005 acres detected. However, wetlands below one acre in size were under detected (Dahl, 2006). These smaller wetlands provide important habitat and water retention within Catskill forests.

Table 2.6.1 Schoharie Creek Mainstem Watershed wetland acreage by Town. (Many of the mapped DEC and NWI wetlands overlap. In most cases the NWI coverage is most comprehensive.)

Town	Acres of DEC wetlands	Acres of NWI wetland
Conesville	0	228
Gilboa	0	572
Hunter	309	430
Jewett	0	151
Lexington	58	201
Prattsville	101	263
Roxbury	0	319

Floodplains

A floodplain is streamside land that gets periodically inundated by floodwaters. Floodplains are important because they temporarily store floodwaters, improve water quality, and provide important habitat for wildlife. Natural floodplains help reduce the heights of floods. During periods of high water, floodplains serve as natural sponges, storing and slowly releasing floodwaters. The floodplain provides additional "storage," reducing the velocity of the river and increasing the capacity of the river channel to move floodwaters downstream. Natural floodplains also help improve water quality. As water courses through the floodplain, plants serve as natural filters, trapping sediments and capturing pollutants (American Rivers, 2003).

One of the largest problems facing floodplain management is the disconnection of a stream from its floodplain. Management practices such as channelization, straightening, development, and loss of riparian vegetation may lead to stream channel *incision* or down-cutting. As the stream incises it will lower the streambed elevation, no longer allowing floodwaters to spill out into the floodplain. As a result flood velocity will increase causing streambank *degradation* until a new floodplain in created at the lower streambed elevation. Building homes within the floodplain is incompatible with proper floodplain function. Many people want to live by streams but as they develop the floodplain, they often increase stream degradation by undertaking stream management activities to protect their property from flooding.

The Federal Emergency Management Agency (FEMA) performs hydrologic and hydraulic studies to produce Flood Insurance Rate Maps (FIRM), which identify flood-prone areas (FEMA, 2003). These studies analyze the data from local streamflow gages to predict how frequently different floods will occur, and to determine the magnitude of the benchmark "100-year flood". This is the flow that has a statistical probability of recurring once every 100 years, but because it is a statistical prediction, based on historical record, "100-year floods" could be seen more or less frequently than every hundred years, especially if changes in climate or land use occur. An engineering model is then used to map the predicted boundaries of the 100-year flood on the floodplain. Towns then use these maps to help determine areas where the risk of flooding is high enough to warrant special precautions or review of land development. Towns are required to pass a floodplain protection ordinance that sets certain limits on building in the 100-year floodplain in order to participate in the National Flood Insurance Program.

Some towns develop other ordinances that help focus review of development on lands that could affect stream and floodplain function. One example of an innovative model in effect locally is the ordinance that was adopted by the Town of Woodstock. The text of this ordinance can be found at http://www.woodstockny.org/Laws/WWLAW9.pdf

Digital Flood Mapping Project

The NYSDEC Bureau of Program Resources and Flood Protection has developed new digitized floodplain maps, using topographic information derived from an airborne laser imaging technology called LIDAR (Light Detection and Ranging). LIDAR data, together with updated computer HEC models and digital aerial photography, enable engineers to produce extremely detailed and accurate maps. Modeling with this new data allows for flood contour lines indicating various depths of water under 100-year and other flood conditions.

FEMA's new hardcopy Flood Insurance Rate Maps (FIRMs) are a vast improvement over their predecessors. One of the most obvious improvements is the inclusion of base map imagery utilizing the 2004 orthoimagery from New York's statewide orthoimagery program. A New York State Floodplain Management Map (NYSFMM) series has also been developed to provide floodplain managers, municipal planners, and other professionals with a tool for mitigation and planning. In addition to the information found on a FIRM, the NYSFMMs also contain department-set survey reference marks and flood depth contours (NYS DEC, 2006).

The new FIRM hardcopy maps are available for viewing at County Soil & Water Conservation District Offices and most town halls. Using GIS mapping software, Greene County Soil & Water Conservation District (GCSWCD) is able to overlay tax parcel boundaries with digital floodplain boundaries to asses if a property falls within a flood zone. This service is available to all interested. Floodplain maps of each management unit can be found in Section 4 Management Unit Summary & Recommendations.

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2.7 Riparian Vegetation Issues in Stream Management

General Concepts of Riparian Vegetation Ecology and Management

The Role of Vegetation in Maintaining a Healthy Stream

Although people value trees and plants along a stream for their contribution to the beauty of the streamside landscape, the vegetation in a watershed, especially in the *riparian* area, plays a critical role in providing for a healthy stream system. The riparian, or streamside, plant community serves to maintain the riverine landscape and moderate conditions within the aquatic ecosystem.

As rainfall runs off the landscape, riparian vegetation:

- Slows the rate of runoff
- Captures excess nutrients carried from the land
- Protects stream banks and floodplain from the erosive force of water
- Regulates water temperature changes

It also:

- Provides food and cover to terrestrial and aquatic fauna
- Conserves soil moisture, ground water and atmospheric humidity.

Vegetation's Erosion and Pollution Prevention Capabilities

Riparian vegetation serves as a buffer for the stream against activities on upland areas. Most human activities whether agriculture, development, or even recreation, can result in a disturbance or *discharge* which can negatively impact the unprotected stream. Riparian vegetation captures and stores pollutants in overland flow from upland sources such as salts from roadways and excess fertilizer from lawns and cropland. The width, density, and structure of the riparian vegetation community are important characteristics of the buffer that can be used to define the level of its functionality.

On bare soils, high stream flows can result in bank erosion and overbank flow can cause soil erosion and scour on the floodplain. The roots of vegetation along the bank hold the soil and shield against erosive flows. On the floodplain, vegetation slows flood flows, reducing the energy of water. This reduction in energy will decrease the ability of water to cause erosion and scour. Furthermore, as vegetation slows the water, the soil suspended in the water is deposited on the floodplain.

Vegetation's Hydrologic Influences

Vegetation intercepts rainfall and slows runoff. This delay increases the amount of precipitation that infiltrates the soil and reduces overland runoff. A reduction and delay in runoff decreases the occurrence of destructive flash floods, lowers the height of flood waters, and extends the duration of the runoff event. These benefits are generally most readily observed in forested watersheds, like the Schoharie, as opposed to watersheds where urban development is the chief land use (Figure 2.7.1). The reduction in flood stage and duration typically means fewer disturbances to stream banks and floodplains.

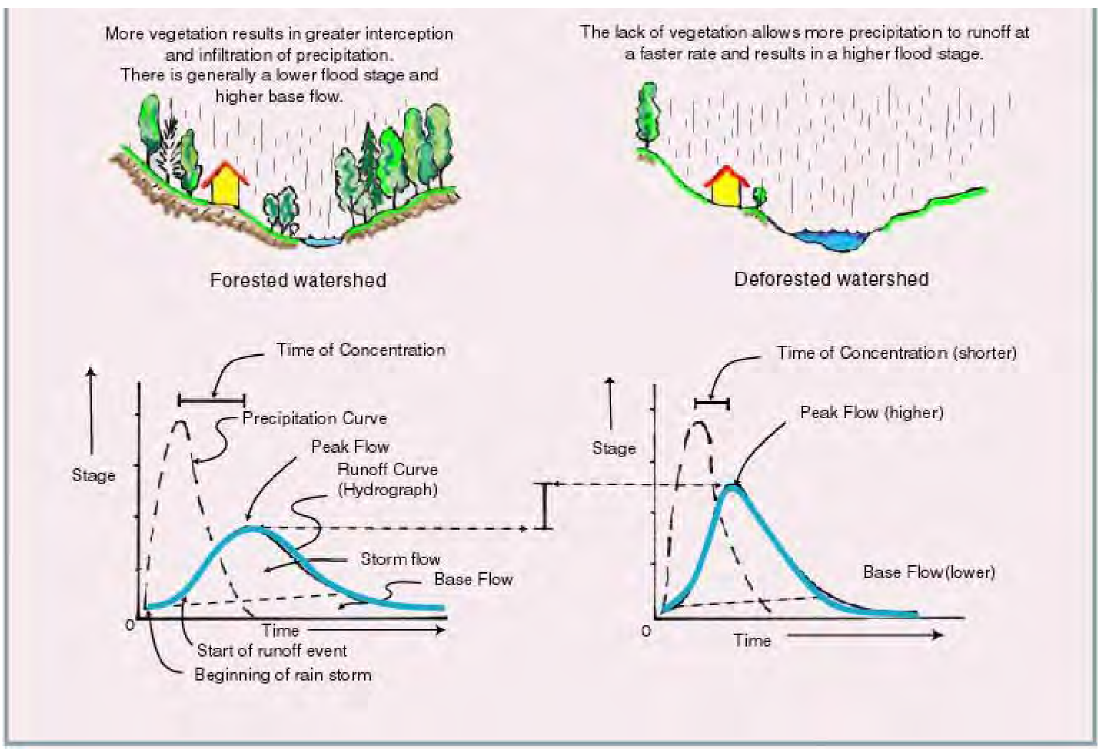


Figure 2.7.1. Comparison of Runoff on a Forested Watershed Versus a Deforested Watershed. Illustration by P. Eskeli 2002, from Watershed Hydrology, P.E. Black, 1991, Prentice Hall, page 202, 214.

Ecological Importance of Vegetation in the Riparian Zone

Vegetation along a stream also functions to provide the climate, habitat, and nutrients necessary for aquatic and terrestrial wildlife. Trees shading a stream help maintain cool water temperatures needed by native fish populations. Low hanging tree branches and roots on undercut banks create cover for fish from predators such as birds and raccoons. Natural additions of organic leaf and woody material provide a food resource needed by terrestrial insects and aquatic macroinvertebrates (stoneflies, mayflies, etc.), the primary source of food for fish. Terrestrial wildlife depends upon vegetation for cover as they move from the upland community to the water's edge. A diverse plant community, one similar to the native vegetation of the Schoharie Creek, provides a wide range of conditions and materials needed to support a diverse community of wildlife. If the vegetation is continuous within the riparian zone along the length of a stream, a corridor is available for wildlife migration. Connectivity between the riparian and upland plant communities enhances the ability of upland and riparian plant and animal communities to thrive despite natural or human induced stress on either community.

Characteristics of a Healthy Riparian Plant Community

A healthy riparian plant community should be diverse. It should have a wide variety of plants including trees, shrubs, grasses or herbs (Figure 2.7.2). The age of the plants should be varied and there should be sufficient regeneration of new plants to ensure the future of the community. A diverse community provides a multitude of resources and the ability to resist or recover from disturbance. An important difference between an upland plant community and a riparian community is that the riparian community must be adapted to frequent disturbance from flooding. Consequently, many riparian plants, such as willow, alder, or poplar can regrow from stump sprouts or can reestablish their root system if up ended. Furthermore, the seed of these trees may have a greater ability to germinate and establish in depositional areas, such as gravel bars and lower flood benches.

Diverse Plant Types
(trees, shrubs, grasses, herbs)
+
Diverse Plant Ages
(young and old)
+
Disturbance-adapted, Moisture-loving Plants
(accustomed to flooding & ice floes)

=

Healthy Riparian Buffers

Figure 2.7.2. A healthy riparian community is densely vegetated, has a diverse age structure and is composed of plants that can resist disturbance.

Riparian Vegetation in Schoharie Creek

Forest History and Composition in Schoharie Creek

Catskill mountain forests have evolved since the ice age reflecting the changes in climate, competition and human land use. The first of these changes was the result of the climatic warming that occurred after the ice age which enabled warm climate adapted plant communities to replace the cooler climate communities. Following the retreat of the glaciers, the forests of the Schoharie Watershed gradually re-established and evolved from the boreal spruce/fir dominated forests, (examples of which can presently be found in Canada) to the maple-beech-birch northern hardwood forests (typical of the Adirondacks and northern New England) with the final transition of the lower elevations of the watershed to a southern hardwood forest dominated by oaks, hickory and ash (typical of the northern Appalachians). Dr. Michael Kudish provides an excellent documentation of evolution and site requirements of the region's forests in his book, The Catskill Forest: A History (Kurdish, 2000).

More recently, human activities have affected the forest either through the manipulation of regeneration for the maintenance of desirable species, the exploitation of the forest for wood and wood products or through development. Native American land management practices included the use of prescribed burning as a means of enabling the nut bearing oaks and hickories to remain dominant in the forest. European settlers contributing to the rising industrial economy in the 18th and 19th century greatly altered the landscape and forest cover through land clearing for agriculture, forest harvesting for construction materials, and hemlock bark harvesting for the extraction of tannin. The land cover in Schoharie Creek began to revert to forest with the local collapse of these economies in the 20th century and the acquisition of much of the land by the state for the Catskill Forest Preserve (Kudish, 2000). Please refer to individual Management Unit descriptions in for more detailed information about past activities that affected the streamside and floodplain vegetation.

Previous land uses have had a significant role in determining the type of vegetation found along the stream. Due to the steepness of the sides of the valley, the most intensive development activities were confined to the valley floor along the stream. Pastures and fields were created from cleared, forested floodplains. After abandonment, these old fields have experienced a consistent pattern of recovery, with species dominating the initial regrowth including sumac, dogwoods, aspens, hawthorns, and white pine. These species are succeeded by other light loving hardwood tree species such as ash, basswood and elm or in lower parts of the watershed, hickories, butternut, and oak. Hemlocks are largely confined to the steeper stream banks and slopes where cultivation or harvesting of hemlocks for bark was impossible. More recent housing construction has re-intensified activity along the stream and been accompanied by the introduction of non-native vegetation typical of household lawns and gardens. Today, the Schoharie Creek watershed and riparian areas are largely forested, although the continuity of the forest is frequently interrupted by infrastructure, utility lines, residential land use and abandoned agricultural lands.

The Riparian Forest

Typically, a riparian forest community is composed of those plant species that thrive in a wet or moist location and have the ability to resist or recover from disturbance. Generally, the riparian forest community is more extensive where a floodplain or wetland exists and the side slopes to the valley are more gently sloping. The plant associations found in forested floodplain communities may be exclusive to riparian areas. Where the valley side slopes are steeper, the riparian community may occupy only a narrow corridor along the stream and then quickly transition to an upland forest community. From a vegetation assessment in a nearby watershed, it was found that northern hardwood communities on steep slopes adjacent to the stream contained a mix of ash, poplar, elm, beech, yellow birch and some maple, whereas in upland northern hardwood communities, the yellow birch and maple became the dominant species. Soils, ground water and solar aspect may create conditions that allow the riparian forest species to occupy steeper slopes along the stream, as in the case where hemlock inhabits the steep, north-facing slopes along the watercourse.

Natural Disturbance and its Effects on the Riparian Vegetation

Riparian vegetation is disturbed by the forces of nature and development activities of those who live near the stream. Sources of natural disturbance include damage due to floods, ice floes, and to a lesser extent, high winds, pest and disease epidemics, drought and fire. Deer herds can also alter the composition and structure of the vegetation due to their specific browse preferences.

The 1996 flood created and reopened numerous high flow channels on Schoharie Creek, reworked point bars, scoured floodplains and eroded formerly vegetated stream banks. Immediately following the flood, the channel and floodplains were scattered with woody debris and downed live trees. In the years since this event, much of the vegetation has recovered. Trees and shrubs flattened by the force of floodwaters have re-established their form. Gravel bars and sites disturbed in previous flood events became the seedbed for herbs and grasses. This type of natural regeneration is possible where the stream is stable and major flood events occur with sufficient interval to allow establishment. The effect of flood disturbance on vegetation along stable stream reaches is short-term, and the recovery/disturbance regime can be cyclical. If the disturbance of floods and ice are too frequent, large trees will not have the opportunity to establish. Typically, the limit that trees can encroach upon the channel is defined by the area disturbed by the runoff event that achieves bankfull flow (expected to occur on average every 1.3 years). While shrubs like willow and alder or herbaceous plants like sedges, which reestablish themselves quickly after disturbance, can grow in the bankfull channel, it is unadvisable to plant trees in this channel area.

Local geology and stream *geomorphology* may complicate the recovery process. A number of sites were found in the Schoharie Creek where vegetation has not been able to reestablish itself on the high, steep bank failures created during recent flood events. On these sites it will be necessary to understand the cause of the failure before deciding on whether to attempt planting vegetation to aid in site recovery. In these instances, the hydraulics of the flowing water, the morphological evolution of the stream channel, the geology of the stream bank, and the requirements and capabilities of the vegetation must be considered before attempting restoration. Since the geologic setting on these sites is partially responsible for the disturbance, the period required for natural recovery of the site would be expected to be significantly longer unless facilitated by restoration efforts.

The ice break up in the spring, like floods, can damage the established vegetation along the stream banks and increase mortality of the young tree and shrub regeneration. Furthermore, ice floes can cause channel blockages which result in erosion and scour associated with high flow channels and overbank flow. Typically this type of disturbance also has a short recovery period.

Pests and diseases that attack vegetation can also affect changes in the ecology of the riparian area and could be considered a disturbance. The hemlock woolly adelgid (*Adelges tsugae*) is an insect, which feeds on the sap of hemlocks (*Tsuga spp*.) at the base of the needles causing them to desiccate and the tree to take on a greyish color. Stress caused by this feeding can kill the tree in as little as 4 years or take up to 10 years where conditions enable the tree to tolerate the attack (McClure, 2001). This native insect of Japan was first found in the U.S. in Virginia in 1951 and has spread northward into the Catskills (Adams, 2002).

Hemlock woolly adelgid on the underside of a branch.

In the eastern United States, the adelgid attacks eastern hemlock (*Tsuga canadensis*) and Carolina hemlock (*Tsuga carolinianna* Engelman) and can affect entire stands of hemlock. Once a tree is infested, population trends for the insect are typified by a fluctuating density of the insect with some hemlock regrowth occurring in periods when insect population densities are lower. This regrowth is stunted and later attacked as the adelgid population increases. With each successive attack, tree reserves become depleted and eventually regrowth does not occur. The native predators of hemlock woolly adelgid have not offered a sufficient biological control, but recent efforts to combat the insect include experimentation with an Asian lady beetle (*Pseudoscymnus tsugae* Sasaji) which is known to feed on the adelgid. Initial experimental results have been positive, but large-scale control has yet to be attempted. The US Forest Service provides extensive information about this pest at its Morgantown office "forest health protection" webpage: www.fs.fed.us/na/morgantown/.

With respect to stream management, the loss of hemlocks along the banks of Schoharie Creek poses a threat to bank stability and the aquatic habitat of the stream. Wildlife, such as deer and birds, find the dense hemlock cover to be an excellent shelter from weather extremes. Finally, dark green hemlock groves along the stream are quiet, peaceful places that are greatly valued by the people who live along the Schoharie Creek. The Olive Natural Heritage Society, Inc. is monitoring the advance of the hemlock woolly adelgid in the Catskills and is working in cooperation with NYS DEC on testing releases of *Pseudosymnus tsugae.* Initial results of the monitoring suggested a possible link between the presence of hemlock woolly adelgid on a site and the degree to which people use or access the site. Due to the widespread nature of the infestation, the use of chemical pest control options such as dormant oil would most likely provide little more than temporary, localized, control. The use of pesticides to control adelgid is not recommended in the riparian area due to potential impacts on water quality and aquatic life.

Without a major intervention (as yet unplanned), it is likely that the process of gradual infestation and demise of local hemlock stands by woolly adelgid will follow the patterns observed in areas already affected to the south. Reports from Southern Connecticut describe the re-colonization of hemlock sites by black birch, red maple and oak (Orwig, 2001). This transition from a dark, cool, sheltered coniferous stand to open hardwood cover is likely to raise soil temperatures and reduce soil moisture for sites where hemlocks currently dominate vegetative cover. Likewise, in the streams, water temperatures are likely to increase and the presence of thermal refuge for cool water loving fish such as trout are likely to diminish. Alternatives for maintaining coniferous cover on hemlock sites include the planting of adelgid resistant conifers such as white pine as the hemlock dies out in the stand (Ward, 2001).

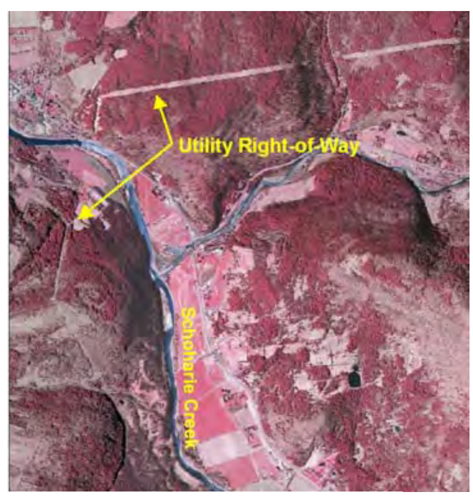
Human Disturbance and its Effects on the Riparian Vegetation

Although natural events disrupt growth and succession of riparian vegetation, human activities frequently transform the environment and, as a result, can have a long-lasting impact on the capability of vegetation to survive and function. Presently, the most significant sources of human disturbance on riparian vegetation in the Schoharie watershed includes the construction and maintenance of roadway infrastructure, the maintenance of utility lines and the development of homes and gardens near the stream and its floodplain.

Roadway and Utility Line Influences on Riparian Vegetation

Due to the narrow valley and steepness of the valley walls, the alignments of NYS Route 23A, county and local roads along Schoharie Creek closely follow the stream alignment. Use and maintenance of the road right-of-way impacts the vigor of riparian vegetation. The narrow buffer of land between the creek and the road receives the runoff of salt, gravel, and chemicals from the road that stunt vegetation growth or increase its mortality. Road maintenance activities also regularly disturb the soil along the shoulder and on the road cut banks. This disturbance fosters the establishment of undesirable invasive plants. The linear gap in the canopy created by the roadway separates the riparian vegetation from the upland plant communities. This opening also allows light into the vegetative understory which may preclude the establishment of shade loving plants such as black cherry and hemlock.

Utility lines parallel the roadway and cross the stream at various points requiring the utility company to cut swaths through the riparian vegetation at each crossing, further fragmenting essential beltways for animal movement from streamside to upland areas. Although the road right-of-way and utility line sometimes overlap, at several locations along the stream, the right-of-way crosses through the riparian area separate from the road. This further reduces the vigor of riparian



Utility right-of-way.

vegetation and prevents the vegetation from achieving the later stages of natural succession, typified by climax species such as sugar maple, beech and hemlock.

Residential Development Influence

Residential land use and development of new homes can have a great impact on the watershed and the ecology of the riparian area. Houses require access roads and utility lines that frequently have to cross the stream. Homeowners, who love the stream and want to be close to it, may clear trees and shrubs to provide access and views of the stream. Following this clearing, the stream bank begins to erode, the channel over-widens and shallows. The wide, shallow condition results in greater bedload deposition and increases stress on the unprotected bank. Eventually stream alignment may change and begin to cause erosion on the property of downstream landowners. Catskill stream banks require a mix of vegetation such as grasses and herbs that have a shallower rooting depth, shrubs with a medium root depth, and trees with deep roots. Grasses alone are insufficient to maintain bank stability in steeply sloping streams such as the Schoharie Creek.

Streamside development and mowing to the edge of the stream leads to bank failure. This bank has been reinforced with riprap and concrete.

Many people live close to the stream and maintain access to the water without destabilizing the bank. By carefully selecting a route from the house to the water's edge and locating access points where the force of the water on the bank under high flow is lower, landowners can minimize disturbance to riparian vegetation and stream banks. Restricting access to foot traffic, minimizing disturbance in the flood prone area, and promoting a dense natural buffer provide property protection and a serene place that people and wildlife can enjoy. Additional information on concepts of streamside gardening and riparian buffers can be found at the following web site produced by the Connecticut River Joint Commission, Inc: http://www.crjc.org/riparianbuffers.htm and Catskillstreams.org. A list of native trees and shrubs, "Native Trees for Riparian Buffers in the Upper Connecticut River Valley of New

Hampshire and Vermont" developed by this group is provided in Appendix A.   A list of native vegetation for the Catskill Mountain Region has been compiled using several sources, see Appendix A for this list or contact GCSWCD for more information.

Japanese Knotweed and Riparian Vegetation

Sometimes the attempt to beautify a home with new and different plants introduces a plant that spreads out of control and "invades" the native plant community. Invasive plants present a threat when they alter the ecology of the native plant community. This impact may extend to an alteration of the landscape should the invasive plant destabilize the geomorphology of the watershed (Malanson, 2002). The spread of Japanese knotweed (*Polygonum cuspidatum*), an exotic, invasive plant gaining a foothold in Schoharie Creek, is an example of a plant capable of causing such a disruption. As its common name implies, Japanese knotweed's origins are in Asia, and it was brought to this county as an ornamental garden plant.

Japanese knotweed is quite recognizable throughout the year. The series of photographs in Figure 2.7.3 illustrate different stages of Japanese knotweed's growth throughout each season. This herbaceous, or non-woody, perennial goes through these cycles every year. In the spring (generally late April, early May), new red, asparagus-like shoots sprout from last year's crown or from underground roots (*rhizomes*). By July, individual stems may reach 11 feet tall. Many thick, hollow stems are based at a crown. The upper areas of the stems form a few branches that reach out like an umbrella from the crown. Each main stem and branch holds several large, nearly-triangular leaves. In August knotweed dons abundant clusters of small, white flowers that attract several pollinators, such as bees, wasps and Japanese beetles.

Figure 2.7.3. Stages of Japanese knotweed's growth throughout the growing season.


Knotweed seeds.

The numerous flowers turn into buckwheat-like seeds by late September/early October. Although some seeds may create small seedlings (Forman & Kesseli 2003), knotweed spreads more by their *rhizomes*.


Knotweed following a frost.

Cold weather halts the growth of knotweed; once frost covers the land, knotweed drops its leaves and turns an auburn hue. These dead stems often remain standing for one or two years and then cover the ground, decaying slowly.


Knotweed's leaf pattern.


Dense stand of knotweed.

The above ground portion of Japanese knotweed dies back each fall and re-grows to a height of 6-11 feet tall each spring. The canopy of the dense stands of bamboo-like stalks, covered by large heart shaped leaves, provides cover that prevents most of the sunlight from reaching the soil, thereby shading out other plants and leaving the soil bare.

Japanese knotweed spreads primarily by vegetative means. Often, earthmoving contractors, highway department crews or gardeners transfer small portions of the roots in fill or soil that gets dumped on or near a streambank. These roots then grow into a new plant that soon becomes a colony. Japanese knotweed is able to spread rapidly on disturbed sites and prefers the moist, open conditions of the stream edge and bank for colonization. Once knotweed has established itself in the riparian area, it is able to spread downstream after disturbances caused by beaver activity or by high flows scouring the streambank. Such disturbances often cause stems and rhizomes to break off and float downstream where fragments may establish themselves on streambanks that were previously unaffected by knotweed. Exposed streamside areas such as sediment deposits or disturbed banks with eroded soils lacking vegetation are particularly vulnerable to invasion by knotweed.

Although the impact of a Japanese knotweed invasion on the ecology of the riparian area is not fully understood, the traits of Japanese knotweed pose several concerns. Some of these concerns include:

- Knotweed appears to be less effective at stabilizing streambanks than deeper-rooted shrubs and trees, possibly resulting in more rapid bank erosion.
- The shade of its broad leaves and the cover by its dead litter limit the growth of native plants that provide food and shelter for associated native animals.
- Knotweed branches do not lean out over stream channels, providing little cooling from shade.
- Dead knotweed leaves (*detritus*) may alter food webs and impact the food supply for terrestrial and aquatic life.
- Large stands of knotweed impede access to waterways for fishing and streamside hiking.
- The presence of knotweed could reduce property value.
- Knotweed may alter the chemical make-up of the soil, altering soil microfauna and soil properties.

Japanese knotweed colony along Schoharie Creek.

Japanese knotweed is very difficult to control. The broad use of herbicides, while potentially effective following a protocol of repeated treatments by a professional certified applicator, does present risks due to the threat the chemicals pose to water quality and the fragile aquatic ecosystem. Mechanical control, by cutting or pulling, is labor intensive and requires regular attention to remove any re-growth. Biological controls are untested. The first step for residents and those who manage land and infrastructure in Schoharie Creek is to familiarize themselves with the appearance and habits of knotweed. Next, it is important for landowners and land managers to monitor its spread. Landowners should avoid practices that would destabilize the streambanks or weaken the natural riparian vegetation that can prevent its spread. Any fill material introduced to the riparian area should be tested for the presence of Japanese knotweed. Any Japanese knotweed roots pulled or dug up from your property should be disposed of in a manner that will prevent it from spreading or re-establishing itself.

During the 2006 stream feature inventory and assessment, the project team mapped the distribution of Japanese knotweed along the Schoharie Creek. During these mapping efforts, the size of a colony was estimated, however the map does not show the area covered by each colony, only the presence of a colony. As is evident from the map, Japanese knotweed has colonized many sites along the Schoharie Creek mainstem (Figure 2.7.4). In 2006, there were 630 occurrences of Japanese knotweed, affecting approximately 36,663 feet of stream banks. Without control and prevention efforts it is likely to continue to spread and fill in along the banks within a matter of a few years. For more information about the specific quality and composition of a particular riparian area, please refer to individual Management Unit descriptions.

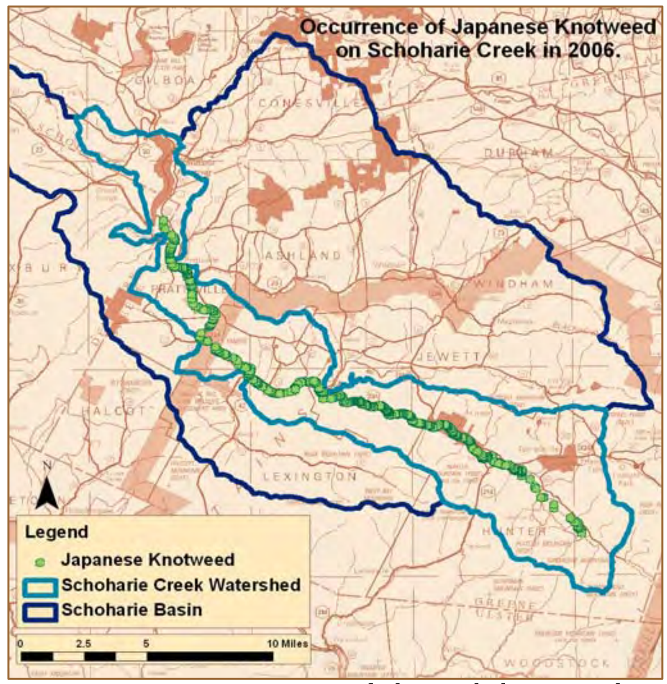


Figure 2.7.4. Japanese Knotweed along Schoharie Creek.

For several years, NYCDEP, GCSWCD and Hudsonia have been collaborating on research efforts to gain a greater understanding of Japanese knotweed. In 2003, Hudsonia submitted a final draft of their report *Japanese Knotweed and Water Quality on the Batavia Kill in Greene County, New York: Background Information and Literature Review*. This report provided a review of available information on Japanese knotweed including, the biology, ecology, history of its invasive spread, and methods of management (Talmage and Kiviat, 2003). The NYCDEP, GCSWCD and Hudsonia are currently working together on a project, along the Batavia Kill, to determine an effective treatment method for Japanese knotweed. Three experimental treatment methods are being tested for their effectiveness at managing stands of knotweed; these methods include, 1)frequent mowing, 2) limited excavation with planting of native species and a weed barrier around the trees, and 3) herbicide injection. This research is part of an effort to develop management recommendations for its future control. For more information on Japanese knotweed and for a link to Hudsonia's report, visit our website http://www.gcswcd.com/stream/knotweed/ and/or Catskillstreams.org.

Japanese knotweed has established colonies along the Schoharie Creek and many of its' tributaries. Management of knotweed is a difficult task and careful consideration must be taken before determining how to manage individual knotweed stands or colonies on streamside properties. Besides understanding key characteristics about knotweed (e.g. how it spreads, what environments it prefers), it is also essential to recognize a few key concepts that actually apply to most invasive species. First and foremost, prevention is the best policy. Preventing the spread of knotweed is the most cost-effective and time-efficient approach to take, and may be achieved by: telling others about knotweed and warning them of its associated problems; keeping streambanks stable by allowing native trees and shrubs to grow and mature; and checking transported soil for any knotweed fragments.

It is critical to recognize that knotweed grows under diverse conditions and in varying locations, so there are different ways to approach its control. Before simply mowing down all the knotweed or spraying herbicides everywhere, one should first ask:

- How large is the stand of knotweed?
- Is it located near a waterway?
- What native plants exist nearby?

With answers to the questions above a customized approach may be taken, saving time and money by applying the most appropriate techniques.

Finally, someone wanting to control knotweed should understand that:

- **A disposal plan for all knotweed material is a must**; otherwise a new colony will just sprout somewhere else. This might include burning the material, burying it more than 6 ft. deep or letting it completely dry out before disposal of the material.
- **Most treatments require multiple applications**. A one-time cutting or mowing of knotweed will not do anything besides stunt it temporarily and cause the rhizomes to extend underground faster towards more nutrients, possibly causing a higher rate of spread.
- **Revegetation with native species after treatment is necessary.** Leaving bare ground only promotes the reinvasion of knotweed. Rapid-growing, native trees and shrubs must be planted soon after removing knotweed in order to affect the most beneficial change.

Below are various treatment prescriptions depending on size of the knotweed stand, its proximity to a waterway and amount of surrounding vegetation. Please note that where bare ground exists after removing knotweed stems and roots, it is essential to revegetate the area with competitive (fast-growing) native trees and shrubs. This is especially critical if surrounding vegetation is limited or nonexistent. Otherwise reestablishment of knotweed is likely and control efforts are futile.

For *small* stands (less than $3ft^2$):

  - Cover with dark plastic.
  - Frequent cutting, grubbing or pulling with safe disposal of knotweed stems.
  - Herbicide injection of stems. PLEASE READ HERBICIDE CAUTION BELOW.

For *medium* stands ($3ft^2$ to $25ft^2$):

  - Frequent mowing (do not allow cut material to leave site).

For *large* stands ($25ft^2$+):

In some cases, the extent of a knotweed colony is so extensive that more harm (e.g. damage to soils) would be done in trying to eliminate the entire stand. For this reason control of expansion is the appropriate action.

  - Frequent mowing around edges of stand (do not allow cut material to leave site).

- Herbicide injection of stems in edges of stand. PLEASE READ HERBICIDE CAUTION BELOW.

Herbicide Caution: Glyphosate (e.g. Rodeo, Roundup, Aquamaster) is the recommended active agent. When used with care and according to product labels, this herbicide does NOT negatively affect *un*touched plants and animals. Using an injection method is the highest recommendation, because knotweed material is not cut therefore requiring no disposal. Also this method eliminates drift and targets only injected stems. Only certain herbicides, such as Rodeo and Aquamaster, should be used near a waterway. Please take care to wear appropriate protective equipment. Check with Cornell Cooperative Extension of Greene County at 518-622-9820 for information about the proper, safe and legal use of herbicides.

Assessment of the Current Condition of Riparian Vegetation

As part of the stream management planning process, physiognomic classes (e.g., deciduous open tree canopy, shrubland, herbaceous) were mapped and the riparian vegetation assessed for the Schoharie Creek watershed (methodology available in Appendix B). The purpose of this exercise was to provide the planning team with baseline information about communities present in the watershed, a description of the condition of vegetation in the riparian area, and to aid in the development of recommendations related to the management of riparian vegetation along the stream.

Mapping of Physiognomic Classes

Mapping of physiognomic classes was loosely based on the Vegetation Classification Standard produced by The Federal Geographic Data Committee. The mapping was based upon 2001 digital-ortho photos and confined to the riparian and near adjoining upland areas within 300 ft. of the mainstem of the Schoharie Creek. This classification was selected because it allows identification of those locations, such as herbaceous or cobble deposits, where the

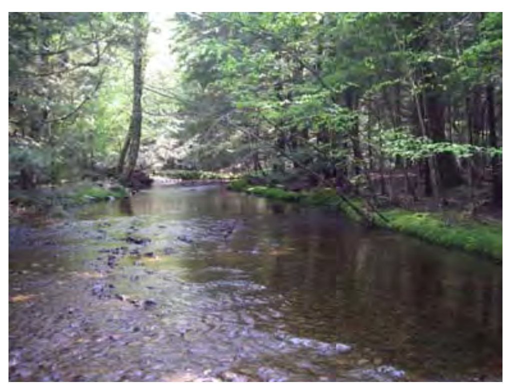


Figure 13 Riparian vegetation (closed deciduous), protects stream banks and water quality, and provides habitat and food sources for fish and wildlife.

combination of channel morphology and riparian vegetation would indicate the greatest cost-benefit from riparian buffer plantings and bio-engineered bank stabilizations.

The mapping exercise included the approximate delineation of the classes through the photo interpretation of 2001 infra-red digital orthophotography acquired by New York State. A physiognomic class GIS data layer was created using heads-up digitizing techniques with ESRI's Arcview software. The photo interpretation was field checked with class boundaries, and classifications were amended based upon field observations. The vegetation map resulting from this process is folded and included in the back of this management plan.

Summary of Findings

According to this riparian vegetation assessment, herbaceous (approximately 599 acres) and deciduous closed tree canopy (approximately 468 acres) were the largest physiognomic classes within the 300 ft. buffer, while evergreen closed tree canopy and mixed closed tree canopy occupied approximately 308 acres and 265 acres respectively. This predominance of closed forest cover helped to provide a high degree of stability to the watershed. Forest cover slows storm runoff and the stream banks in much of the watershed have some woody vegetation to protect against bank erosion. Protection of the forest communities near the stream will help ensure long-term stream stability, but the effectiveness of stream protection provided by vegetative communities, differs based on their width, plant density, vegetation type and the stream's geomorphic characteristics.

Although forested land covered a large portion of the watershed's riparian area, the extent of herbaceous cover is a concern. While herbaceous cover is better than no cover at all, plants with a variety of rooting depths (herbs, shrubs and trees) provide more extensive stream bank protection. Approximately 698 acres, or 30% of land area was considered to have inadequate vegetative cover; this included areas of herbaceous vegetation, bare soil and revetment. A streamside planting program is recommended to address these areas of inadequate vegetation.

Table 2.7.1 provides the results of the GIS vegetation assessment of the Schoharie Creek, including the area and percentage of each land cover type. Classes listed in italics contribute to the total area of inadequate vegetation.

Table 2.7.1. Summary of Physiognomic Vegetation Classification		
Vegetation Classification	**Area (acres)**	**Percent**
Bare Soil	83.18	3.61%
Deciduous Closed Tree Canopy	467.81	20.32%
Deciduous Open Tree Canopy	123.20	5.35%
Evergreen Closed Tree Canopy	308.10	13.39%
Evergreen Open Tree Canopy	11.00	0.48%
Herbaceous Vegetation	599.42	26.04%
Impervious Surface	129.84	5.64%
Mixed Closed Tree Canopy	264.80	11.50%
Mixed Open Tree Canopy	29.03	1.26%
Revetment	15.43	0.67%
Shrubland	216.60	9.41%
Unpaved Road	23.18	1.01%
Water	30.15	1.31%
Total Area	2301.75	
Inadequate Vegetation	698.04	30.33%

Riparian ecosystems are an important component of watershed protection and resource conservation. Therefore, it is important to maintain and improve the riparian vegetation along the Schoharie Creek and its' tributaries.

Schoharie Creek Streamside Planting

A streamside planting program is recommended for the Schoharie Creek. The findings from the mapping of physiognomic classes can be used to identify candidate stream reaches for inclusion in future streamside planting programs. There are three main steps to establish this type of program.

1. *Identify priority sites* using information gathered during riparian vegetation characterization analyses to identify potential planting sites where improvement of the riparian vegetation is likely to be both effective and successful.
2. *Develop treatment designs* for participating prioritized sites using primarily native plants that address landowner aesthetics, ecological enhancement and water quality improvement or protection.
3. *Install the designs* and document the planting process and results for program replication and general education/outreach.

To effectively carry out riparian planting projects, it is necessary to develop objective physical criteria for identifying and prioritizing eroding banks that may be stabilized with riparian vegetation plantings. It is also important to coordinate with streamside landowners by canvassing riparian landowners whose properties meet these objective criteria for their interest in participating in a project, and establishing a partnership with interested landowners. Technical assistance may then be provided to landowners to reestablish the riparian buffer on their property with native vegetation. GCSWCD and NYCDEP will be piloting such a project in 2007.

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2.8 Land Cover/Land Use

Land use and land cover of a watershed have a great influence on water quality and stream stability. The watershed's land cover directly impacts stream hydrology by influencing the amount of stormwater runoff. Forests, natural meadows and wetlands naturally absorb rainwater, allowing a portion of it to percolate back into the ground. However, impervious surfaces such as pavement, parking lots, driveways, hard-packed dirt roads and rooftops increase the amount of rainfall that flows over land and reduces the amount of rainfall that percolates into the soil to recharge groundwater wells and streams.

Impervious cover is a major influence on streams and stream life due to the way it changes the amount and duration of stormwater that gets to the stream. Generally, the more impervious surface there is in a watershed, the less groundwater recharge (which supplies summer low flows), and the greater the magnitude of storm flows (and related erosion in streambeds). In addition to degrading streams, watersheds with a high percentage of impervious surfaces are prone to larger and more frequent floods, which cause property damage through inundation, as well as ecological harm resulting from lower base stream flows.

The literature has documented the deleterious effects impervious surfaces have on biota (Limburg and Schmidt, 1990; May et al., 2000; Wang et al., 2001; Roy et al., 2005), stream stability (Booth, 1990; CWP, 1998; White and Greer, 2005; Wohl, 2005) and in-stream water quality (Groffman et al., 2004 and Deacon et al., 2005). For example, impervious surfaces can raise the temperature of stormwater runoff, which in turn reduces the waters ability to hold dissolved oxygen and harms some game fish populations, while promoting excess algal growth. Field observation, research and hydrologic modeling suggest a threshold of 10% impervious surface in a watershed, after which there is marked transition to degraded stream conditions (CWP, 1998 and Booth, 2000).

Certain types of pollution problems are often associated with particular land uses, such as sedimentation from construction activities. There has been a vast array of research demonstrating that as land uses become more urbanized (built), biotic communities decline in health (Limburg and Schmidt, 1990; Schueler and Holland, 2000; May et al., 2000; Wang et al., 2001 and Potter et al. 2005). Concentrations of selected chemical constituents, including nitrate, in stream base-flow were strongly affected by the predominant land use in a large Hudson Valley study (Heisig, 2000). The decline of watershed forest cover below 65% percent marked a transition to degraded water quality (Booth, 2000). Based upon these results, land use/cover appear to be attractive attributes for long-term trend tracking. These results can then be correlated with in-stream water quality data and then used to focus best management practices towards the land uses with the greatest impact on water quality.

In this section, land cover and land use data were analyzed for both the Schoharie Creek Main Stem Watershed and the Schoharie Creek Basin (Figure 2.8.1). As defined by the U.S. Geological Survey, a *drainage basin* is the land area where precipitation runs off into, and is drained by, a river, stream, lake or reservoir. Large drainage basins, such as the Schoharie Creek Basin, contain multiple smaller drainage basins also known as *watersheds*. Within the Schoharie Creek Basin, there are several watersheds including the Schoharie Creek Main Stem Watershed.

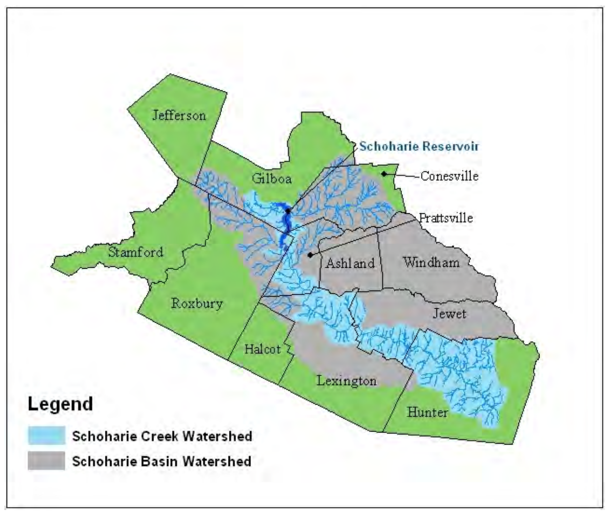

Figure 2.8.1. Schoharie Creek Main Stem Watershed (blue) and the Schoharie Basin Watershed (gray)

Land cover of the Schoharie Creek Main Stem Watershed and overall Schoharie Creek Basin was analyzed using the LANDSAT ETM 2001 geographic information system (GIS) coverage created by the New York City Department of Environmental Protection (DEP) (Figure 2.8.1). The categories are comprised of 47 different classification descriptions. To simplify the categories, land cover classifications have been grouped together and re-classified to convey the general land cover category that each classification falls under. For example, the classification descriptions of central business district, residential, and industrial, among others, have been combined and re-classified as development. Approximately 85% of the Schoharie Creek main stem watershed (Table 2.8.1; Figure 2.8.2) and 86% of the Schoharie Creek Basin (Table 2.8.2; Figure 2.8.3) was covered by coniferous, deciduous, or mixed forest, while development covered approximately 3.5% and 3.0% respectively. Proper land use planning to direct development into priority areas while preserving sensitive areas should be utilized to limit the impact of future development and subsequent increases in impervious surfaces.

Table 2.8.1. 2001 Land Cover of Schoharie Creek Main Stem Watershed		
Land Cover Category	**Acres**	**Percent Cover**
Agriculture	840.91	1.41%
Development	2075.54	3.47%
Dumps	23.85	0.04%
Exposed Soil	1.00	0.00%
Forest	50584.37	84.64%
Herbaceous	944.16	1.58%
Managed Herbaceous	888.19	1.48%
Mined Lands	35.58	0.06%
Shrubland	1865.86	3.12%
Water	1340.89	2.24%
Wetland	1163.81	1.95%
Total	59,764.16	100%

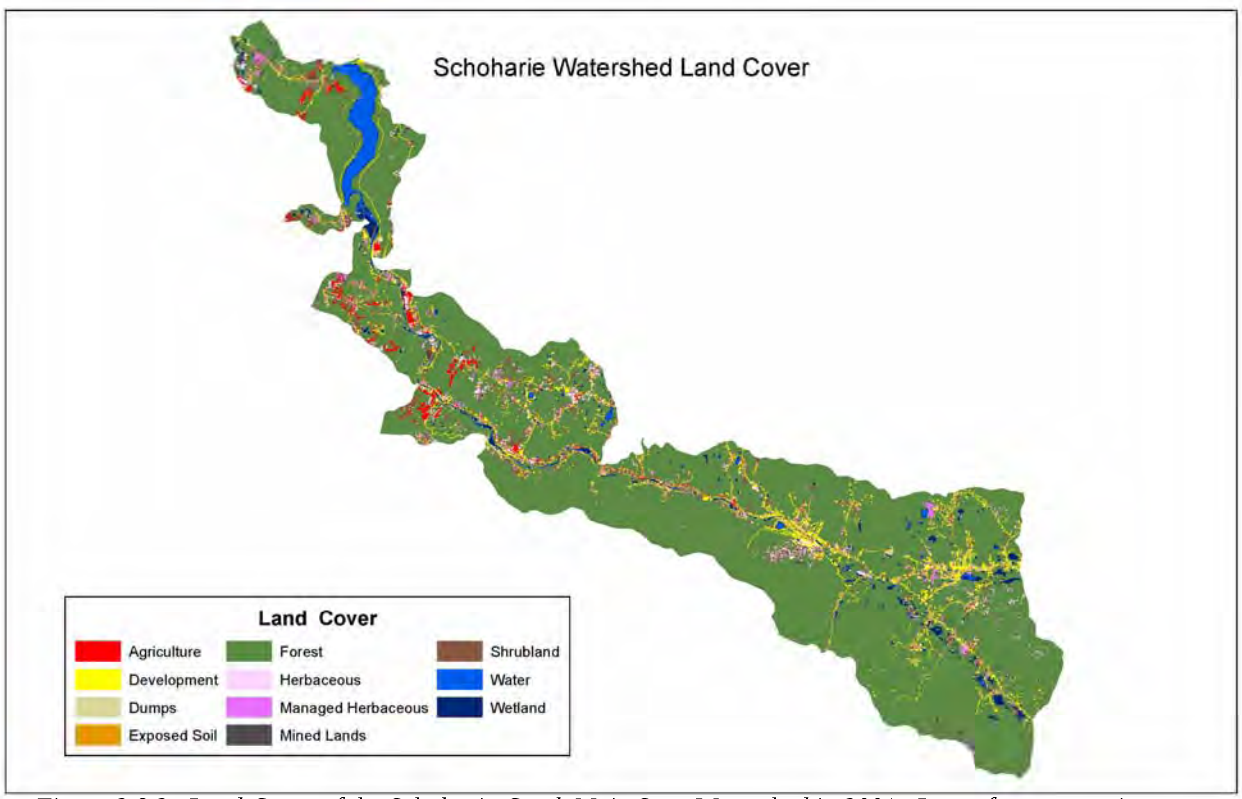

Figure 2.8.2. Land Cover of the Schoharie Creek Main Stem Watershed in 2001. Large format map is available in the back pocket of this plan.

Table 2.8.2. 2001 Land Cover of Schoharie Creek Basin		
Land Cover Category	**Acres**	**Percent Cover**
Agriculture	4432.24	2.20%
Development	5947.97	2.94%
Dumps	39.49	0.02%
Exposed Soil	38.87	0.02%
Forest	172079.21	85.57%
Herbaceous	4160.20	2.07%
Managed Herbaceous	3417.75	1.70%
Mined Lands	53.62	0.03%
Shrubland	6920.65	3.44%
Water	1658.79	0.83%
Wetland	3294.82	1.64%
Total	202,043.61	100%

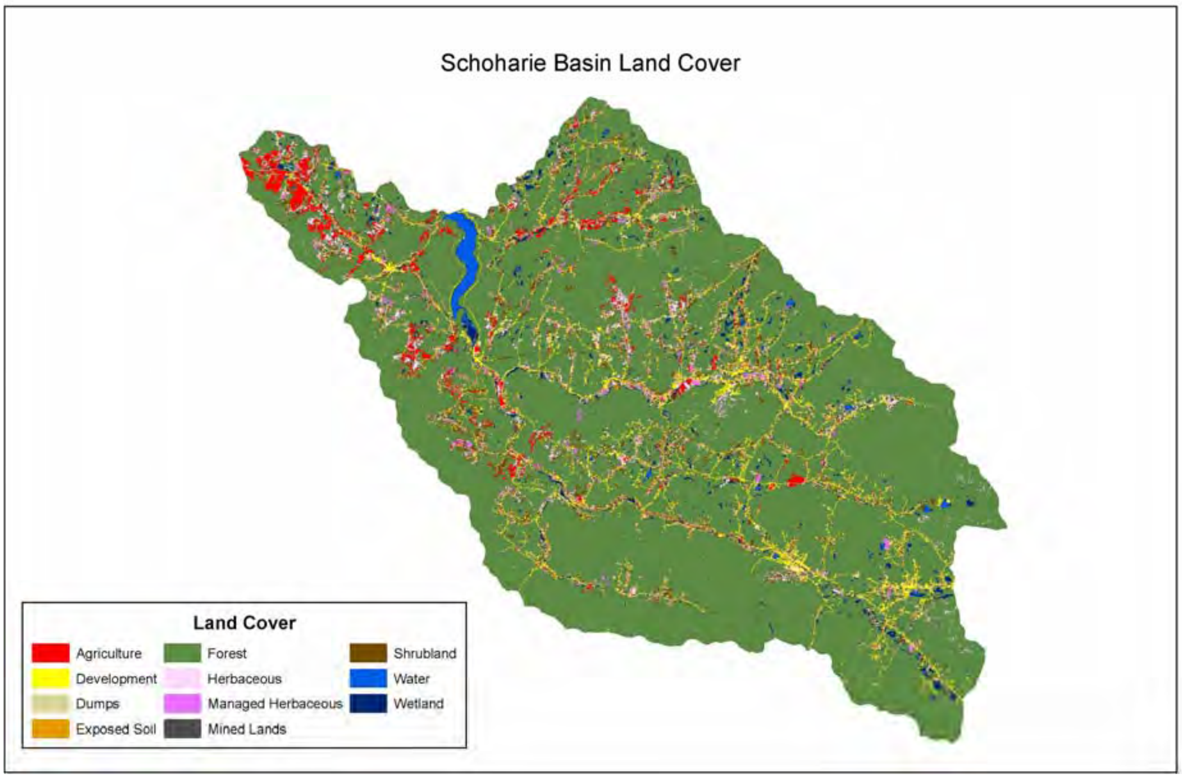

Figure 2.8.3. Land Cover of the Schoharie Creek Basin in 2001. Large format map is available in the back pocket of this plan.

Protected Lands

To determine the percentage of parcels within the Schoharie basin that were protected as Wild, Forested, Conservation Lands & Public Parks, the ownership and property use classifications as documented on records of the Greene, Schoharie and Delaware County

Real Property Tax Service Departments, were analyzed. In 2006, approximately 27% of the Schoharie Creek Main Stem Watershed lands and 24% of the Schoharie Creek Basin lands were protected as Wild, Forested, Conservation Lands & Public Parks. The primary owner of the protected lands was New York State with 57% of protected land at the Main-stem watershed scale and 74% at the basin-scale. Under current State laws, these lands owned by the State will remain undeveloped. In 2006, approximately 4.8% of land within the Watershed and Schoharie Basin was owned by New York City (Table 2.8.3).

Table 2.8.3. Acreage and percentage of protected lands within the Schoharie Creek Main Stem Watershed and Schoharie Creek Basin.

Property Use Class	**Schoharie Creek Main Stem Watershed**		**Schoharie Basin Watershed**	
	Acres	Percent	Acres	Percent
Wild, Forested, Conservation Lands & Public Parks	15,588	27%	49,557	24%
NYC Owned Land	2,829	4.83%	9,469	4.77%

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2.9 Wildlife and Fisheries

A very young fawn crosses the Schoharie Creek, summer 2006.

The Schoharie watershed is literally crawling with life. An amazing variety of habitats, people, plants, and animals are all interconnected in a fragile web of life, often called biodiversity. Every member is essential to keeping this web in balance. For example, the list of species required for the life cycle of a single tree may be in the hundreds or thousands. Moreover, the list of animals that will utilize a single fallen tree is in the thousands, but a few of the more well known creatures include squirrels, woodpeckers, grouse, bears, foxes, skunks, beavers, otters, mice, and shrews as well as worms, salamanders, beetles, ants, centipedes, sowbugs, and other insect larvae. There are twice as many species of beetles that live on dead and dying wood as there are species of mammals, birds, reptiles, and amphibians in the entire world (Kyker-Snowman, 2003). The fallen tree also provides critical habitat, steady moisture, and food for a multitude of mosses, fungi, trees, and vascular plants. If our fallen tree had been removed either during land use changes or during "clean up" efforts after falling, the ramifications would reverberate throughout the web. Certainly, this doesn't preclude us from taking a few trees for firewood, but if enough fallen trees are removed, the structure of the overall community would likely change.

The fallen tree example was meant to demonstrate the complexity of the web of life, and how eliminating one organism or habitat will ultimately affect many. It is very difficult to predict the consequences of removing individual strands from the web of life. Therefore, as an integral piece of the web, humans should work toward protection and preservation of the functions necessary for our survival. There are many ecosystem functions we receive from nature including cleaner air through vegetation respiration, cleaner water through soil and wetland filtration, soil formation from forests, pollination of food crops from our native insects, natural flood water retention/groundwater recharge, and pest control from our native bats, birds, and insects (e.g. dragonflies/damselflies). For example, bees pollinate about a trillion apple blossoms each year in New York State, micro-organisms biodegrade much of our garbage as well as fallen leaves, sticks and other dead animal and plant matter, soil bacteria turn nitrogen into nitrate fertilizer and plants use up carbon dioxide and produce oxygen, thereby slowing global climate change. One example that affects us locally is the maintenance of healthy biodiversity and community structure, which if done properly can reduce the incidence of Lyme disease (LoGiudice et al., 2003); and forest fragmentation which can increase white-footed mouse populations, that in turn increases the human risk of exposure to Lyme disease (Allan et al. 2003). Therefore, the benefits of a healthy and diverse ecosystem extend far beyond clean air and water and into the fabric of human health and quality of life.

In the United States the economic services provided by a vibrant/healthy biological web of life (biodiversity) contribute an estimated $319 billion per year, or 5% of the gross domestic product (Pimentel et al., 1997). The worldwide benefits are estimated to be $2,928 billion per year, or approximately 11% of the world economy (Pimentel et al., 1997). Closer to home, the economic impact of the Schoharie hasn't been calculated, but anecdotally considering it's uses for recreation, water supply and aesthetics the economic value is most likely high. Clearly, our economic vitality depends on maintaining healthy biodiversity, which in turn indicates clean water and a good quality of life.

The plants and animals that inhabit the Schoharie watershed are suited to the habitats provided by our temperate climate. The other major factor is human alteration of the landscape. Pre-European colonization the watershed was predominantly forested with some small areas cleared by Native Americans for hunting. Early European settlers attempted to farm the land, but abandoned it soon after due to a short growing season, steep slopes and rocky and shallow soils. Between 1800 and the early 1900s gristmills, woolen mills, sawmills, the tanning industry, quarrying for bluestone, logging, furniture making, railroads and resorts cleared the Catskills of its forest cover. Since the early 1900s these industries have declined and areas that were previously cleared have grown back into forest, with approximately 85% of the Schoharie-basin's land cover being classified as forest in a 2001 NYCDEP analysis. The reaction of wildlife has varied to the changing land uses. A few, such as the timber wolf, eastern cougar, New England cottontail and passenger pigeon have been extirpated from the region (passenger pigeon is extinct worldwide); and some such as

Small wood turtle (Clemmys insculpta) spotted along the Schoharie Creek, summer 2006. The wood turtle is a species of special concern in New York State

tiger beetle and timber rattlesnake are disappearing from the Catskills. Beaver, pileated woodpeckers, and bald eagles were once gone from this region due to over hunting, habitat loss, and pesticide poisoning respectively, but have since returned with reduced hunting pressure, an increase in second-growth forests, and a ban on DDT. Some species, such as the bobcat, black bear, river otter and osprey are less common than they were prior to European colonization. However, other common species, such as the white tailed deer, raccoon, skunk, red fox, robin, and painted turtle have thrived.

We often focus on human-induced land use changes as the dominant factor in habitat and natural landscape changes. However, many wildlife and plant species also influence the landscape. Heavy deer browsing of seeds, seedlings, and saplings can dramatically alter the composition of a forest to encourage the growth of species that deer find less palatable (Curtis, 2004). Species imported from other areas that thrive in our region, often called invasive species, can also have dramatic effects on the landscape. For example, Japanese knotweed (*Polygonum cuspidatum*) is native to Asia, but has run rampant in the Schoharie basin choking out native species, diminishing recreation opportunities and possibly making soil more susceptible to erosion (more info in section 2.6). The wooly adelgid (*Adelges tsugae*), a small aphid-like insect pest native to China and Japan, is threatening to decimate our eastern hemlock (*Tsuga canadensis*) populations. Once infested, hemlock mortality rates range between 50%-99% (Orwig, 2002). The plant species most likely to replace hemlocks are hardwood tree species and possibly other invasive species. Ultimately, this will have a dramatic effect on the structure of these communities. For example, the distribution and abundance of brook trout and diversity of aquatic insects will likely decline

Tent caterpillars along the Schoharie Creek, summer 2006.

with the hemlock forests (Evans, 2002). Hemlock forests maintain stable, lower water temperatures and more stable hydrologic regimes (i.e. they don't dry up as much) than the hardwood forests that will likely replace them (Snyder et al., 2002). These are just a few examples of how, in a global society, careless actions that import and release invasive species can cause drastic changes in our ecological communities.

Tent caterpillar damage within the Schoharie Watershed, summer, 2006. Favorable climatic conditions were good, so many of these trees probably grew a second growth of leaves after the caterpillar population dwindled in late June.

Native pests often have native predators that control their populations. For example, the forest tent caterpillar (*Malacosoma disstria*) can cause a large amount of damage to Catskill forests. However, their population tends to be controlled by a natural predator fly (*Sarcophaga aldrichi*) whose population explodes following the explosion of the caterpillar's population and help bring the caterpillar populations back under control. A bacterial disease, known as "wilt" and cold, wet, weather conditions in early spring also help to control the caterpillar population. This demonstrates the checks-and-balances of native versus non-native pests. Native pests often have a naturally-evolved control measure that eventually bring the populations under control, but non-native species do not.

The upper Schoharie, and many of its tributaries, are primarily cold water streams, meaning they provide suitable water temperatures for organisms, such as brook trout and sculpins, which require cold water (less than 72˚ F (22˚C). The Schoharie main stem is stocked annually with 19,250 brown trout from the Prattsville fish barrier dam to the mouth of the Roaring Kill. Below the Prattsville fish barrier the primary sport fish species are smallmouth bass (*Micropterous dolomieu*) and walleye (*Stizostedion vitreum*). The fish barrier dam was constructed in 1939 to restrict the movement of bass upstream, and seemed to have some effect, but in the 1960s smallmouth bass were still the most abundant sport fish downstream of the Schoharie/East Kill confluence (Keller and Fieldhouse, 1993). Smallmouth bass in the Schoharie tended to grow very slow and were much smaller than other streams in the region (Keller and Fieldhouse, 1993). Trout were the most abundant species above the East Kill/Schoharie Creek confluence. Gooseberry Creek, a Schoharie tributary near Tannersville, was stocked exclusively with brook trout and may provide sanctuary for these native trout. The upgrading of sewer treatment plants in the Schoharie basin, including the Tannersville STP on the Gooseberry Creek, should improve the fishery. Species collected since 1954 during NYSDEC fishery surveys upstream of the Prattsville fish barrier are available in Table 2.9.1. Interestingly, researchers found that over a relatively short period of time (3 years), modified-natural channel design restorations that incorporated fish habitats increased fish biomass, including trout biomass and numbers (Baldigo et al., 2006).

Table 2.9.1. Fish species collected since 1954 during NYSDEC fishery surveys upstream of the Prattsville fish barrier.

Common Name	**Scientific Name**
Creek chub	*Semotilus atromaculatus*
Common shiner	*Luxilus cornutus*
Pumpkinseed	*Lepomis gibbosus*
Golden shiner	*Notemigonus crysoleucas*
White sucker	*Catostomus commersoni*
Stone roller	*Campostoma anomalum*
Cutlips minnow	*Exoglossum maxillingua*
Marginated madtom	*Noturus insignis*
Brown trout	*Salmo trutta*
Brook trout	*Salvelinus fontinalis*
Rainbow trout	*Oncorhynchus mykiss*
Blacknose dace	*Rhinichthys atratulus*
Longnose dace	*Rhinichthys cataractae*
Tesselated darter	*Etheostoma olmstedi*
Largemouth bass	*Micropterus salmoides*
Slimy sculpin	*Cottus cognatus*
Stone cat	*Noturus flavus*
Bluntnose minnow	*Pimephales notatus*
Fallfish	*Semotilus corporalis*
Northern hog sucker	*Hypentelium nigricans*
Brown bullhead	*Ameirus nebulosus*
Banded killifish	*Fundulus diaphanous*
Smallmouth bass	*Micropterus dolomieu*
Yellow perch	*Perca flavescens*

It should be noted that a high-predatory warm-water species was sited often during the 2006 assessment in areas that would typically support a cold water fishery. These largemouth bass were stocked or escaped into the stream from adjacent ponds and could compete with trout for resources. However, they may also migrate to more suitable habitat conditions and/or suffer high mortality rates during the cold winter months.

Largemouth bass in the East Kill, summer 2006.

Wildlife of Stream Corridors and Conservation Recommendations for the Upper Schoharie Watershed, Greene County, March, 2007

The Upper Schoharie Watershed contains a high degree of biological diversity with a species assemblage that is unusual within the Hudson River Valley. Forests with features such as talus slopes, cliffs, and mature stands are habitat for plants and animals adapted to these conditions. The large, unfragmented nature of the forests creates favorable habitat for wide-ranging animals (such as black bear and bobcat) and wildlife that prefer forest interiors (such as black-throated blue warbler). It is likely that forests of the Upper Schoharie watershed are important breeding areas for raptors such as broad-winged hawk, Northern goshawk, and sharp-shinned hawk.

Forests that occur adjacent to the stream create habitat for a wide range of small mammals, including rarely seen moles, voles, and shrews, and fox, weasel, mink, beaver, and muskrat. The change in elevation from stream valley floor to Catskill peaks, and the presence of both evergreen and deciduous forests contribute to the watershed's biodiversity. High-altitude coniferous forests are habitat for the rare Bicknell's thrush and blackpoll warbler.

In the Upper Schoharie watershed, abundant streams with cobble beds, undercut banks, and streamside wetlands and forests are habitat for damselflies, dragonflies, stream salamanders, turtles, and frogs. The wood turtle lives almost exclusively in and near streams, while spotted turtles might be found in streamside wetlands. Riparian forests are particularly important breeding habitat for birds such as the Lousiana waterthrush and yellow-throated vireo. Stream corridors are the preferred foraging habitat for the many bat species that are likely to occur in the watershed.

Grassy fields, open woods, and shrubby patches make important contributions to biodiversity of the watershed. These open and scrubby areas can provide nesting habitat for the wood turtle and shrubland bird species that are declining in New York State as old farms revert to forests. Young forests are habitat for Canada warbler, American woodcock, and ruffed grouse, while open shrublands and dense thickets are preferred by brown thrasher.

Many species, like American woodcock and wood turtle, require a complex of different habitats to complete breeding, foraging, overwintering, and migration portions of their life cycles. As a result, maintaining connectivity between the stream and the adjacent uplands is very important for biodiversity conservation. NYSDEC Species of Greatest Conservation Need (SGCN), included in the State Wildlife Plan, and Hudson Valley regionally rare species that may use the Schoharie basin are listed in Table 2.9.2. A complete list of potential species and an occurrence map is provided in Appendix C, and a map of rare species and significant ecosystems is provided in Figure 2.9.1.

Management Recommendations

Stream managers should consider the following general recommendations to maintain and protect important stream corridor habitats:

- Limit disturbance and protect both small and large stream corridor wetlands that provide significant habitat for amphibians, reptiles, and breeding birds in the watershed;
- Most shrubland breeding birds are relatively tolerant of human development if appropriate habitats exist, and unlike some grassland birds, do not require large habitat patches for breeding. While open lands should not be created at the expense of mature, unfragmented forests, agricultural and suburban landowners who maintain shrubby thickets in the uplands adjacent to stream corridors can support shrubland birds;
- Where possible, plant native species appropriate to the pre-existing or predicted ecological community for a site;

- Stream managers are encouraged to learn to recognize the Appalachian tiger beetle and other declining and threatened species and report observations to the NY Natural Heritage Program.

Riparian buffer widths can be established to conserve habitat function, in addition to water quality, hydrologic, and geomorphic functions. It is particularly important to maintain habitat connectivity needed by wildlife to complete their life cycles. To evaluate connectivity, consider the needs of indicator species, or species of conservation concern in the watershed.

- The forest area within 300 ft of the forest edge is considered “edge” habitat. Edge habitats support increased densities of deer and invasive plants, and are avenues for nest predators to enter forests. A minimum 300 ft forested stream buffer will protect forest health and provide better breeding habitat for forest wildlife;
- Riparian forests at least 50 acres in size with an average total width of at least 300 ft can provide forest interior habitat and should be highly valued. Breeding bird diversity increases substantially between 300 and 1,500 ft from the stream’s edge;
- Most of the amphibian and reptile observations in this watershed are within or near stream corridors. Seek to create a minimum 500 ft forested buffer around stream corridor wetlands to provide terrestrial habitat required by stream- and vernal pool-breeding amphibians to complete their life cycles, and to protect wetlands from adjacent land uses;
- Stream buffers up to 1,000 ft will encompass most wood turtle nesting sites and summer habitats (wood turtles are on land during the spring and summer and over-winter in rivers).   These buffers should be maintained along one or more miles of stream length to accommodate the yearly movements of wood turtles up and down the stream channel;
- Buffer widths of 30-100 ft should be maintained for riparian forest canopies to provide enough shading and cooling of streams to maintain trout populations. These buffers need to be nearly continuous. Some studies suggest 80% of banks

along a stream supporting trout populations must have forests at least 30 ft wide to provide sufficient shade for trout;

- Minimum buffers of 50-100 ft are often recommended to protect aquatic communities. Large woody debris deposited into streams provides important shelter for fish, and in particular for trout. At a minimum, a 50 ft buffer appears necessary to maintain sufficient woody debris inputs to streams. Riparian vegetation provides leaves and other forms of litter that feed macroinvertebrates. In turn, aquatic macroinvertebrates are the major food source for most freshwater fish. A minimum 100 ft buffer is recommended to protect aquatic macroinvertebrate and fish abundance.

Typically, the locations of wood turtle nesting sites are not known. However, stream managers can use the following information to identify possible nesting areas near the stream and maintain adequate buffer widths to protect nesting wood turtles:

- Wood turtles typically nest in sandy, bare areas well exposed to sunlight and close to water, but elevated. Usually, nesting areas are within 200 ft of the stream channel, but wood turtles will travel up to 2,000 ft from the stream to reach suitable nesting areas. Nesting sites are often exposed stream banks, but can include cultural features such as nearby railroad tracks, abandoned sand and gravel mines, utility right-of-ways, and meadows/fields with gravelly soils. Wood turtles will nest in corn fields and other recently disturbed areas. If possible, identify potential wood turtle nesting sites near streams and protect them. Buffers between the stream and suitable nesting areas should be used lightly or not at all, particularly during nesting season (May to July, peak in June);
- Where the wood turtle is likely to occur, maintain stream geomorphology with naturally elevated banks and gravel deposits (used for winter hibernation, basking, and nesting).

A number of stream corridor species depend on natural channel processes to provide habitat during parts of their life cycles:

- Stream salamanders are generally sensitive to siltation, scouring, nutrient enrichment, channelization, and diversion of water. Maintain natural stream processes and riparian buffers to protect salamander habitats. Spring salamander is probably the most sensitive species and is found in relatively unpolluted headwater streams of the Catskills;

- There is one known remaining occurrence of Appalachian tiger beetle in this watershed. There are only 10 rivers in NYS with populations of this species. The Appalachian tiger beetle (right) is typically found on riverside sand and cobble bars at the edges of forested streams. Stream management practices should maintain natural stream processes, including natural flooding regimes that prevent dense plant growth on cobble bars. Gravel mining and off-road vehicle use of sand and gravel bars can destroy beetle larvae.

Table 2.9.2. NYSDEC Species of Greatest Conservation Need and other species of conservation concern that may occur in the Upper Schoharie watershed (a complete list of species and NYNHP classification descriptions are available in appendix C) (Prepared by the NYSDEC Hudson River Estuary Program, Feb. 2007).

Predicted Terrestrial Vertebrate Species (source: Hudson River Valley GAP)

Terrestrial, vertebrate species that are predicted to occur within the watershed based upon presumed associations of species with habitats. See the HRV-Gap Analysis Project report to view predicted species distribution maps.

Key: TNC Status: For State and Global Rank explanations see www.nynhp.org; Legal Status: FE = Federal Endangered, FT = Federal Threatened, SE = State Endangered, ST = State Threatened, G = Game species, SC = State Special Concern; NYNHP Species: Rare species tracked by the NY Natural Heritage Program; NYSDEC SGCN: Species of Greatest Conservation Need included in State Wildlife Plan; Hudsonia Regional: Hudson Valley regional status: R = regionally rare, Rm = regionally rare migrant, S = regionally scarce, D = declining, V = vulnerable

Mammals		**TNC Status**	**Legal Status**	**NYNHP Species**	**NYSDEC SGCN**	**Regional**
Eastern Pipistrelle	Pipistrellus subflavus	G5, S3				R
Eastern Red Bat	Lasiurus borealis	G5, S5B, SZN			X	R
Hoary Bat	Lasiurus cinereus	G5, S4B, SZN			X	R
Indiana Myotis	Myotis sodalis	G2, S1	FE, SE	X	X	
Silver-haired Bat	Lasionycteris noctivagans	G5, S4B, SZN	SC		X	Rm
Woodland Jumping Mouse	Napaeozapus insignis	G5, S5				R
Long-tailed Shrew	Sorex dispar	G4, S4				R
Southern Bog Lemming	Synaptomys cooperi	G5, S4				R
Porcupine	Erethizon dorsatum	G5, S5				R
Black Bear	Ursus americanus	G5, S5	G			S

Fisher	Martes pennanti	G4G5, S4	G			S
Bobcat	Lynx rufus	G5, S4	G			V
Eastern Cougar	Felis concolor cougar	G5TH, SX	FE, SE		X	
River Otter	Lutra canadensis	G5, S5	G		X	S
Amphibians		**TNC Status**	**Legal Status**	**NYNHP Species**	**NYSDEC SGCN**	**Regional**
Jefferson Salamander	Ambystoma jeffersonianum	G5, S4	SC		X	
Jefferson Salamander Complex	Ambystoma jeffersonianum x laterale	G4, S3	SC		X	
Spotted Salamander	Ambystoma maculatum	G5, S5				V
Northern Dusky Salamander	Desmognathus fuscus	G5, S5				D, V
Longtail Salamander	Eurycea longicauda longicauda	G5, S2S3	SC	X	X	
Four-toed Salamander	Hemidactylium scutatum	G5			X	
Common Mudpuppy	Necturus maculosus	G5, S4			X	
Northern Red Salamander	Pseudotriton ruber ruber	G5, S3S4			X	
Northern Leopard Frog	Rana pipiens	G5, S5	G			R
Wood Frog	Rana sylvatica	G5, S5	G			V
Reptiles		**TNC Status**	**Legal Status**	**NYNHP Species**	**NYSDEC SGCN**	**Regional**
Wood Turtle	Clemmys insculpta	G4, S3	SC, G		X	
Timber Rattlesnake	Crotalus horridus	G5, S3	ST		X	
Smooth Greensnake	Opheodrys vernalis	G5, S4			X	D
Eastern Box Turtle	Terrapene c. carolina	G5, S3	SC		X	

Observed Breeding Birds (source: 1980-1985 Breeding Bird Atlas)
Breeding bird species known or suspected to be breeding within the watershed. The species list is derived from reports of observed breeding bird activity within Breeding Bird Atlas Blocks that overlap the watershed. Parties using these data for environmental review purposes do so at their own risk.

Key: TNC Status: For State and Global Rank explanations see www.natureserve.com; Legal Status: FE = Federal Endangered; FT = Federal Threatened; SE = State Endangered; ST = State Threatened; G = Game species; SC = State Special Concern; NYNHP Species: Rare species tracked by the NY Natural Heritage Program; NYSDEC SGCN: Species of Greatest Conservation Need included in State Wildlife Plan; Other Ranking: Listed Partners in Flight WatchLIst

Birds		**TNC Status**	**Legal Status**	**NYNHP Species**	**NYSDEC SGCN**	**Other Ranking**	**# Blocks (35 total)**
American Black Duck	Anas rubripes	S4, G4	G		X	WL, PIF	3
American Woodcock	Scolopax minor	S5,G5	G		X	WL, PIF	9
Bicknell’s Thrush	Catharus bicknelli	S2S3B, G4	SC	X	X	WL, PIF	5
Black-billed Cuckoo	Coccyzus erythropthalmus	S5, G5			X		2
Black-throated Blue Warbler	Dendroica caerulescens	NR, G5			X		23
Blue-winged Warbler	Vermivora pinus	S5, G5			X	WL, PIF	3
Bobolink	Dolichonyx oryzivorus	S5, G5			X	PIF	15
Brown Thrasher	Toxostoma rufum	S5, G5			X		21
Canada Warbler	Wilsonia Canadensis	S5, G5			X		13
Cooper’s Hawk	Accipiter cooperii	S4, G5	SC		X		5
Eastern Meadowlark	Sturnella magna	S5, G5			X		14
Golden-winged Warbler	Vermivora chrysoptera	S4, G4	SC		X	WL, PIF	1
Louisiana Waterthrush	Seiurus motacilla	NR, G5			X		18
Northern Bobwhite	Colinus virginianus	S4, G5	G		X		1
Northern Goshawk	Accipiter gentiles	S4B, S3N, G4	SC		X		7
Olive-sided Flycatcher	Contopus cooperi	S5, G5			X	WL, PIF	3

Prairie Warbler	Dendroica discolor	S5, G5			X		12
Red-headed Woodpecker	Melanerpes erythrocephalus	S4, G5	SC		X	WL, PIF	1
Ruffed Grouse	Bonasa umbellus	NR, G5	G		X		20
Scarlet Tanager	Piranga olivacea	NR, G5			X		34
Sharp-shinned Hawk	Accipiter striatus	S4, G5	SC		X		9
Vesper Sparrow	Pooecetes gramineus	S5, G5	SC		X		3
Whip-poor-will	Caprimulgus vociferous	S4, G5	SC		X	PIF	2
Willow Flycatcher	Empidonax traillii	S5, G5			X	WL, PIF	5
Wood Thrush	Hylocichla mustelina	S5, G5			X	WL, PIF	30
Worm-eating Warbler	Helmitheros vermivorus	S4, G5			X		1

Observed Rare Species and Significant Ecological Communities (source: NY Natural Heritage Program)
Rare plant and animals species with known populations within the watershed and documented examples of rare and high quality ecosystems within the watershed. Information regarding the locations of rare species is considered sensitive. The distribution of information which identifies the locations of rare species or their habitats may lead to the collection or disturbance of the animals and plants at those locations.

Key: TNC Status: For State and Global Rank explanations see www.natureserve.com; Legal Status: FE = Federal Endangered; FT = Federal Threatened; SE = State Endangered; ST = State Threatened; G = Game species; SC = State Special Concern; NYNHP Species: Rare species tracked by the NY Natural Heritage Program; NYSDEC SGCN: Species of Greatest Conservation Need included in State Wildlife Plan; Other Ranking: Listed Partners in Flight WatchLIst

Rare Birds		**TNC Status**	**Legal Status**	**NYNHP Species**	**NYSDEC SGCN**
Bald eagle	Haliaeetus leucocephalus	S2S3B, S2N, G5	ST, FT	X	X
Bicknell's Thrush	Catharus bicknelli	S2S3B, G4	SC	X	X
Rare Plants		**TNC Status**	**Legal Status**	**NYNHP Species**	**NYSDEC SGCN**
Blunt-lobe Grape Fern	Botrychium oneidense	S2S3, G4Q	SE	X	
Climbing Fern	Lygodium palmatum	S1, G4	SE	X	
Musk Root	Adoxa moschatellina	S1, G5	SE	X	
Rough Avens	Geum virginianum	S2, G5	SE	X	
Whorled Mountain-mint	Pycnanthemum verticillatum var. verticillatum	S1S2, G5T5	ST	X	
Rare Invertebrates		**TNC Status**	**Legal Status**	**NYNHP Species**	**NYSDEC SGCN**
Appalachian Tiger Beetle	Cicindela ancocisconensis	S1, G3	U	X	X
Natural Communities		**TNC Status**	**Legal Status**	**NYNHP**	**NYSDEC SGCN**
Hemlock-northern hardwood forest		S4, G4G5		X	
Beech-Maple Mesic Forest		S4, G4		X	
Spruce-Northern Hardwood Forest		S3S4, G3G4		X	
Mountain fir forest		S2, G3		X	
Mountain Spruce-Fir Forest		S2S3, G3		X	

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NY Natural Heritage Program Conservation Guides
Online at: http://www.acris.nynhp.org/

NYS Amphibian and Reptile Atlas

Online at: http://www.dec.state.ny.us/website/dfwmr/wildlife/herp/

NYS Breeding Bird Atlas

Online at: http://www.dec.state.ny.us/website/dfwmr/wildlife/bba/index.html

NYS Comprehensive Wildlife Conservation Strategy

Online at: http://www.dec.state.ny.us/website/dfwmr/swg/cwcsmainpg.html

NYS Threatened, Endangered & Special Concern Species List

Online at: http://www.dec.state.ny.us/website/dfwmr/wildlife/endspec/

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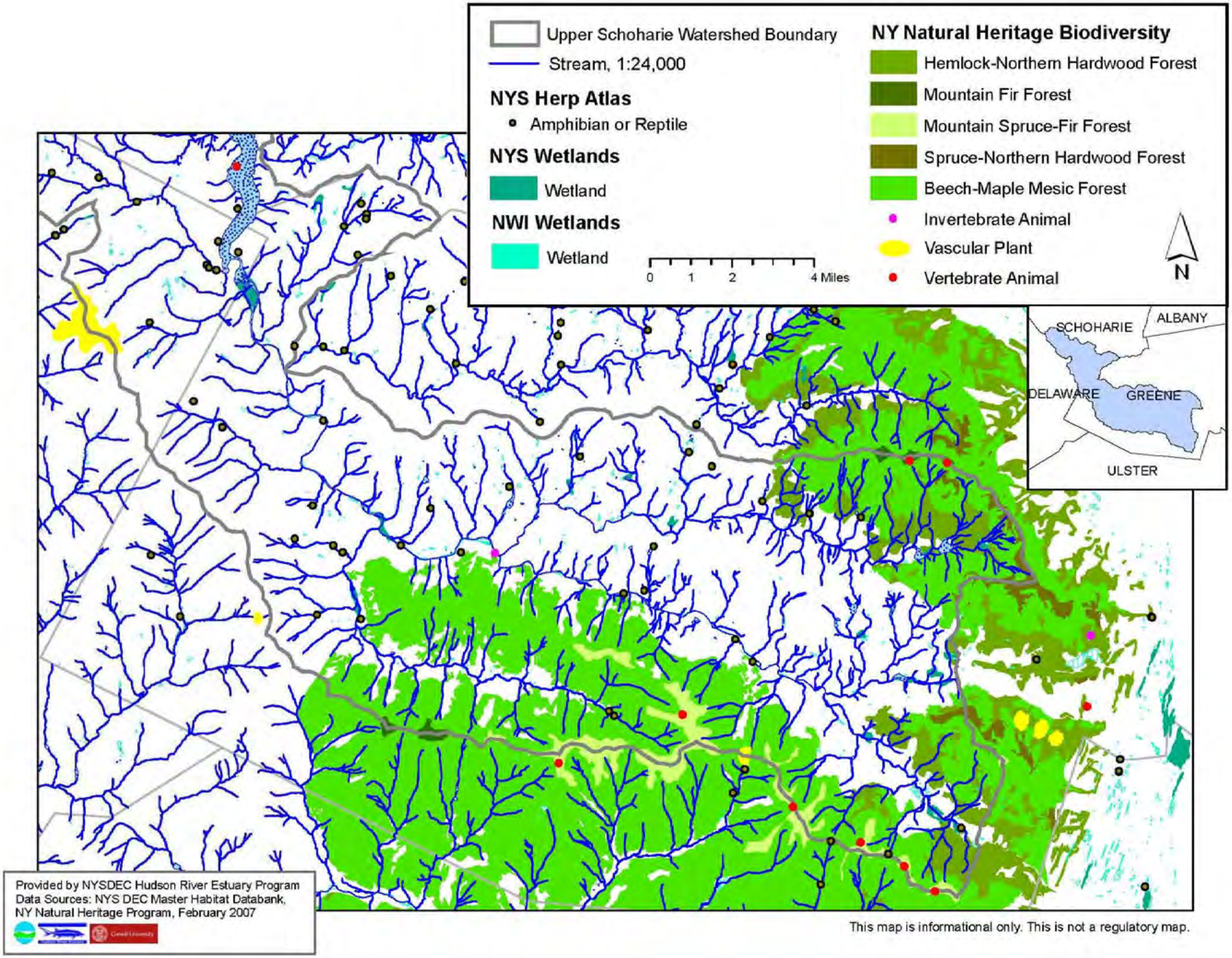


Figure 2.9.1. Known examples of plants, animals, and significant ecosystems in the Schoharie Basin. Other significant wildlife habitats exist, but have not been mapped.

2.10 Recreational Opportunities

The Catskill Park is a mountainous region of public and private lands in Ulster, Greene, Delaware, and Sullivan counties. The natural and cultural heritage of the Catskill region is inextricably linked to the unique high quality streams that course through its mountains and valleys and play a defining role in the character of its landscape. Recreation in and around these Catskill streams provides residents and visitors with a myriad of opportunities to reconnect with the natural world.

Catskill Forest Preserve

Fifty-three percent of the Schoharie Creek watershed is located within the Catskill Park "blue line" (Figure 2.10.1). Only 18% of the watershed is actually protected within the Catskill Park's forest preserves and other state owned parks. A 100 ft. riparian corridor along the Schoharie Creek mainstem lies almost entirely outside any protected preserves.

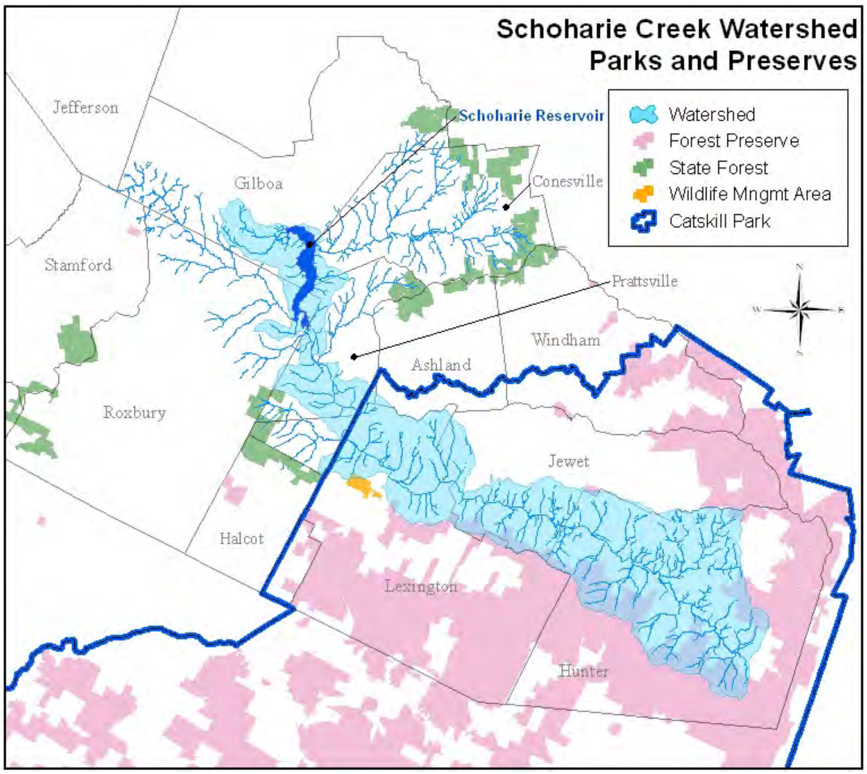


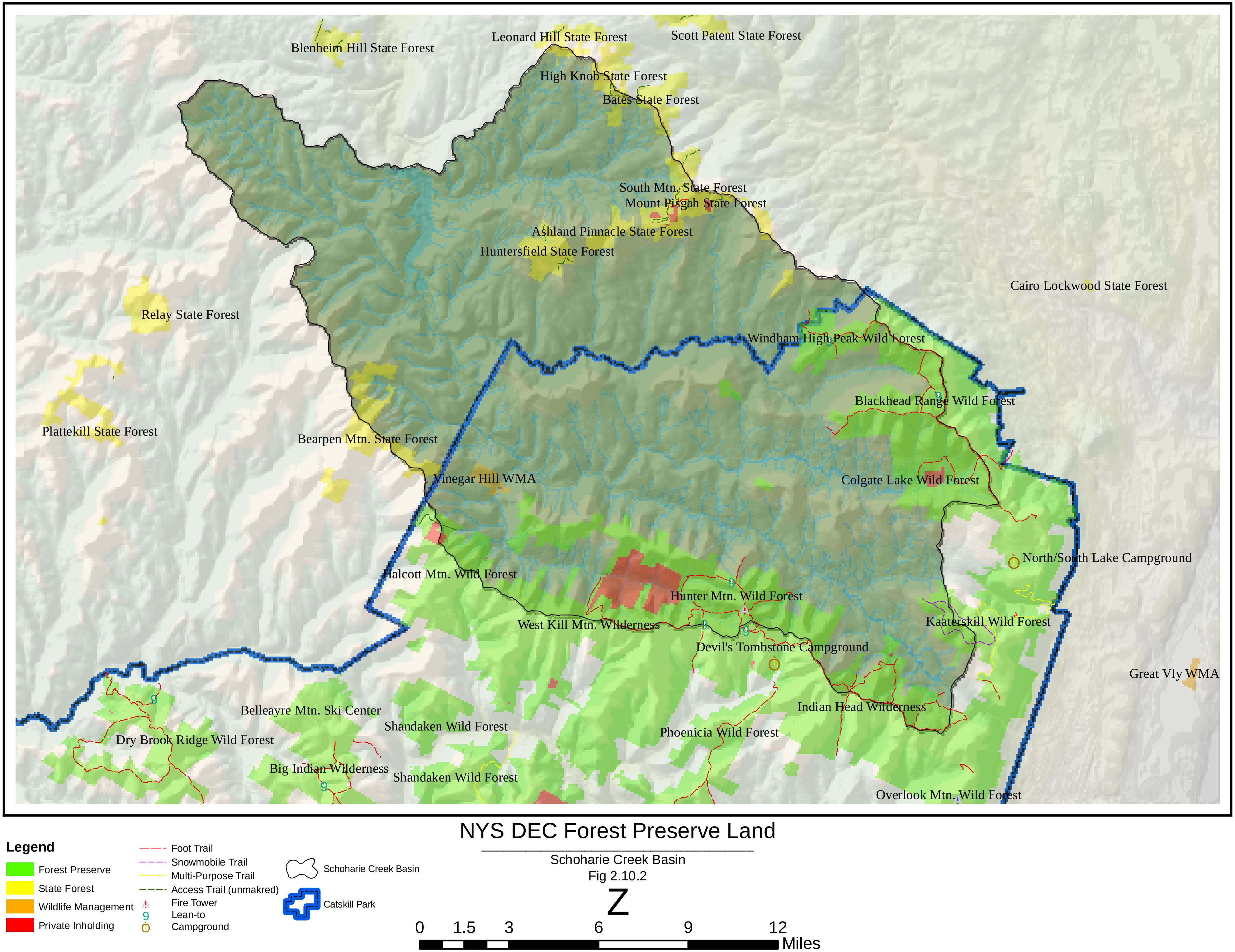
Fig 2.10.1 Schoharie Creek Watershed Parks and Preserves

The New York State Department of Environmental Conservation (DEC) manages lands in the forest preserve according to its classification in the Catskill Park State Land Master Plan (NYSDEC, 1985). Management recommendations are based on specific land characteristics and its capacity to withstand certain uses. These public uses include Wild Forest, Wilderness, Intensive Use and Administrative Use. DEC's *Catskill Forest Preserve Map and Guide* graphically depicts the locations of these different management areas and provides general background information about the Catskill Park and Preserve. This information can be obtained at DEC's regional offices. Locations of their offices are listed on DEC's website: http://www.dec.state.ny.us/website/about/abtrull3.html. There is also an interactive map on DEC's website called Environmental Navigator. This map shows the entire state of New York and can be magnified to specific locations, showing recreational attributes such as trails and parking facilities. This map service can be accessed through the following web address: http://www.dec.state.ny.us/cfmx/extapps/statelands/index.cfm.

The Schoharie Creek watershed encompasses many regional parks and preserves (Figure 2.10.2). Surrounding its headwaters on the southwest side is Hunter Mountain Wild Forest and Indian Head Wilderness. Hunter Mountain is a popular hiking destination. At the summit is a fire tower offering an excellent view, used in the past to keep an eye out for fires. In the winter Hunter Mountain is famous for its ski slopes, with Hunter Mountain Ski Bowl attracting many skiers each year. South of Hunter Mountain summit (outside the Schoharie Creek watershed,) is Devils Tombstone State Campground. Several other preserves are located just south of the Schoharie Creek watershed, in some cases lying partially within the watershed basin or sharing borders with the watershed preserves. Such preserves include Halcott Mountain Wild Forest, Phoenicia Wild Forest, Westkill Mountain Wilderness, Shandaken Wild Forest, and Overlook Mountain Wild Forest.

Hunter Mountain Fire Tower

On the northeast side of the Schoharie Creek's headwater region is Kaaterskill Wild Forest. This preserve lies only partially within the Schoharie Creek basin. It contains North/South Lake Campground, a popular destination for hiking, boating, fishing, swimming and camping. Continuing north is Colgate Lake Wild Forest and Blackhead Range Wild Forest, followed by Windham High Peak Wild Forest. Windham Mountain is another popular ski resort.


Blenheim Hill State Forest
Leonard Hill State Forest
Scott Patent State Forest
High Knob State Forest
Bates State Forest
South Mtn. State Forest
Mount Pisgah State Forest
Ashland Pinnacle State Forest
Huntersfield State Forest
Cairo Lockwood State Forest
Relay State Forest
Windham High Peak Wild Forest
Blackhead Range Wild Forest
Plattekill State Forest
Bearpen Mtn. State Forest
Vinegar Hill WMA
Colgate Lake Wild Forest
North/South Lake Campground
Halcott Mtn. Wild Forest
Hunter Mtn. Wild Forest
West Kill Mtn. Wilderness
Kaaterskill Wild Forest
Devil's Tombstone Campground
Great Vly WMA
Belleayre Mtn. Ski Center
Shandaken Wild Forest
Indian Head Wilderness
Dry Brook Ridge Wild Forest
Phoenicia Wild Forest
Big Indian Wilderness
Shandaken Wild Forest
Overlook Mtn. Wild Forest
Legend
Forest Preserve
State Forest
Wildlife Management
Private Inholding
Foot Trail
Snowmobile Trail
Multi-Purpose Trail
Access Trail (unmakred)
Fire Tower
Lean-to
Campground
Schoharie Creek Basin
Catskill Park
NYS DEC Forest Preserve Land
Schoharie Creek Basin
Fig 2.10.2
Z
0
1.5
3
6
9
12
Miles

There are several smaller preserves located near the bottom of the Schoharie Creek where it flows into the Schoharie Reservoir. On the west side of this region there is Bearpen Mountain State Forest. Further west there is Plattekill State Forest and Relay State Forest. On the east side of this region, where tributaries flow directly into the Schoharie Reservoir, there are a cluster of State Preserves. These include Huntersfield, Ashland Pinnacle, Manorkill, Mount Pisgah, Bates, and High Knob State Forests. Leonard Hill State Forest, a non-DEC preserve, is also located in this region.

All the preserves mentioned in this lower region are located outside the Catskill Park. Table 2.10.1 displays the different types of NYS preserves and trails (both DEC and non-DEC) located within the Schoharie Creek watershed and the area they encompass.

Preserve Type	Area/Distance
Forest Preserve	8934.9 acres
State Preserve	9.8 acres
Wildlife Management Area	50.1 acres
Foot Trail	15.7 miles
Snowmobile Trail	0.6 miles

Table 2.10.1 NYS preserves and trails in the Schoharie Creek watershed.

There is ample lodging and restaurants in and around many of these locations as they are some of the most frequently visited destinations in the Catskill Park. Hiking is permitted on all lands held by NYS. A good website for information on various hikes is www.localhikes.com. Hunting is allowed subject to required NYS licenses and regulations.

The Long Path

A trail called the Long Path passes through the Schoharie Creek watershed. The Long Path is a 326 mile hiking trail that stretches from the George Washington Bridge in New Jersey to White Face Mountain in the Adirondacks. On its way through the Schoharie Creek watershed it passes through both New York State and New York City owned land. It enters the Schoharie Creek watershed in the Blackhead Range Wild Forest, meanders through such preserves as Windham High Peak Wild Forest, before reaching a northeastern piece of the Schoharie Reservoir and exiting the watershed. Roughly 35 miles of the Long Path lie within the Schoharie Creek basin. The Catskill Trails Committee manages sections of the trail within the Catskill Park, and the Long Path North Committee manages those which are north of the park. The Long Path North Committee is currently trying to bypass road paths, taking the trail into more wooded areas in hopes of sparking greater interest and use of the trail. They wish to do this in the small State Preserves located in the northeastern region of the Schoharie Creek watershed, namely Huntersfield State Forest. For more information on the Long Path visit: http://www.nynjtc.org/trails/longpath/.

NYCDEP Recreation Land

The New York City Department of Environmental Protection (NYCDEP) manages land within the Schoharie Creek watershed basin. This is part of an effort to protect and improve the quality of NYC drinking water through natural filtration. As of August 2006, DEP owned approximately 8,920 acres within the Schoharie Creek basin, 5,811 acres of which is available for public recreation. The types of recreation that are permitted on these lands include hunting, fishing, and hiking. All three of these recreational activities have specific guidelines and designated areas at which they can be pursued.

In general, areas with signs that state "Public Area" can be accessed without a permit. In order to access most city lands, DEP requires that an Access Permit is obtained. Permits are free of charge and are valid for 5 years, at which point they can be updated for free. These permits can be applied for online at the following web address: http://www.nyc.gov/html/dep/watershed/html/wsrecreation.html#here.
Table 2.10.2 shows a list of city-owned recreational areas within the Schoharie Creek basin where hunting is allowed and what types of other activities are permitted. In order to hunt on city lands a Hunt Tag must be obtained from DEP in addition to an Access Permit. Hunt Tag application forms can be downloaded at the following web address: http://www.nyc.gov/html/dep/watershed/html/wsrechunt.html#hunttag. For the 2006-2007 season a pilot program for hunting small game, turkey and bear has been launched. This is the first time this type of hunting will be allowed on city land. The program restricts this particular hunting to specified areas (Table 2.10.2). Hunters must also have a valid NYS hunting license and follow all other NYS hunting laws and regulations while hunting on city land. Further information pertaining to specially designated hunting areas and specific rules and regulations can be found at the following web address:
http://www.nyc.gov/html/dep/watershed/html/wsrechunt.html

As of August 2006, approximately 5,661 of city land in the Schoharie basin was open for hiking. Hiking is not permitted on all recreational areas, only at designated areas (Table

2.10.2) and "Public Areas." Hiking includes skiing, snowshoeing, bird watching, nature observation and photography. Hiking is not permitted on or around any NYC reservoirs. More information can be found through DEPs "Rules for the Recreational Use of Water Supply Lands and Waters" which can be accessed at the following web address: http://www.nyc.gov/html/dep/watershed/html/wsrecrules.html. Maps of the individual recreational areas can be downloaded at the following web address: http://www.nyc.gov/html/dep/watershed/html/wsrecmaps.html. Only those possessing an Access Permit can view these maps. Many common questions about accessing city lands are answered on the FAQ page: http://www.nyc.gov/html/dep/watershed/html/accessfaq.html.

Management Unit	Location (Road(s), Town)	Hunting	Small Game, Turkey, Bear	Fishing	Hiking
McGregor Mountain	Charcoal Rd. and Rt. 23, Roxbury and Gilboa	X			X
West Schoharie	William Lutz Rd, Roxbury	X			X
Road Seven	NYC Rd 7, Gilboa	X			
Bull Hill	Bull Hill Rd, Conesville	X		X	X
Hubbard Hill South	East Conesville Rd, Conesville	X	X		X
Bearkill	Bearkill Rd, Conesville	X			X
Manorkill	Potter Mountain Rd, Conesville	X			X
West Conesville	Bull Hill Rd, Conesville	X	X		X
Macumber Road	Macumber Rd, Conesville and Prattsville	X			X
Bluebird Road	South Mountain and Bluebird Rd, Conesville	X	X		X
Huntersfield Creek	Cty Rt 10 and Stanley Slater Rd, Prattsville	X		X	X
West Ashland	West Settlement Rd, Ashland	X			X
West Hollow	Sutton Hollow Rd, Ashland	X	X		X
Mount Hayden	Bagley and Narvoo Rd, Windham	X	X		X
Maplecrest	Rt 40, Windham	X			X
Beech Ridge	Beech Ridge Rd, Lexington	X			X
Westkill	Rt 42, Lexington	X		X	X
Balsam Mountain	Spruceton Rd, Lexington	X	X	X	X
Roundtop Mountain	Gillespie Rd, Hunter	X			
Patterson Ridge	Route 23, Ashland			X	X
Spruceton	Route 42, Lexington			X	X
McGregor Mountain North	Route 23, Gilboa			X	X

Table 2.10.2 NYCDEP recreation lands; permitted activities with an Access Permit

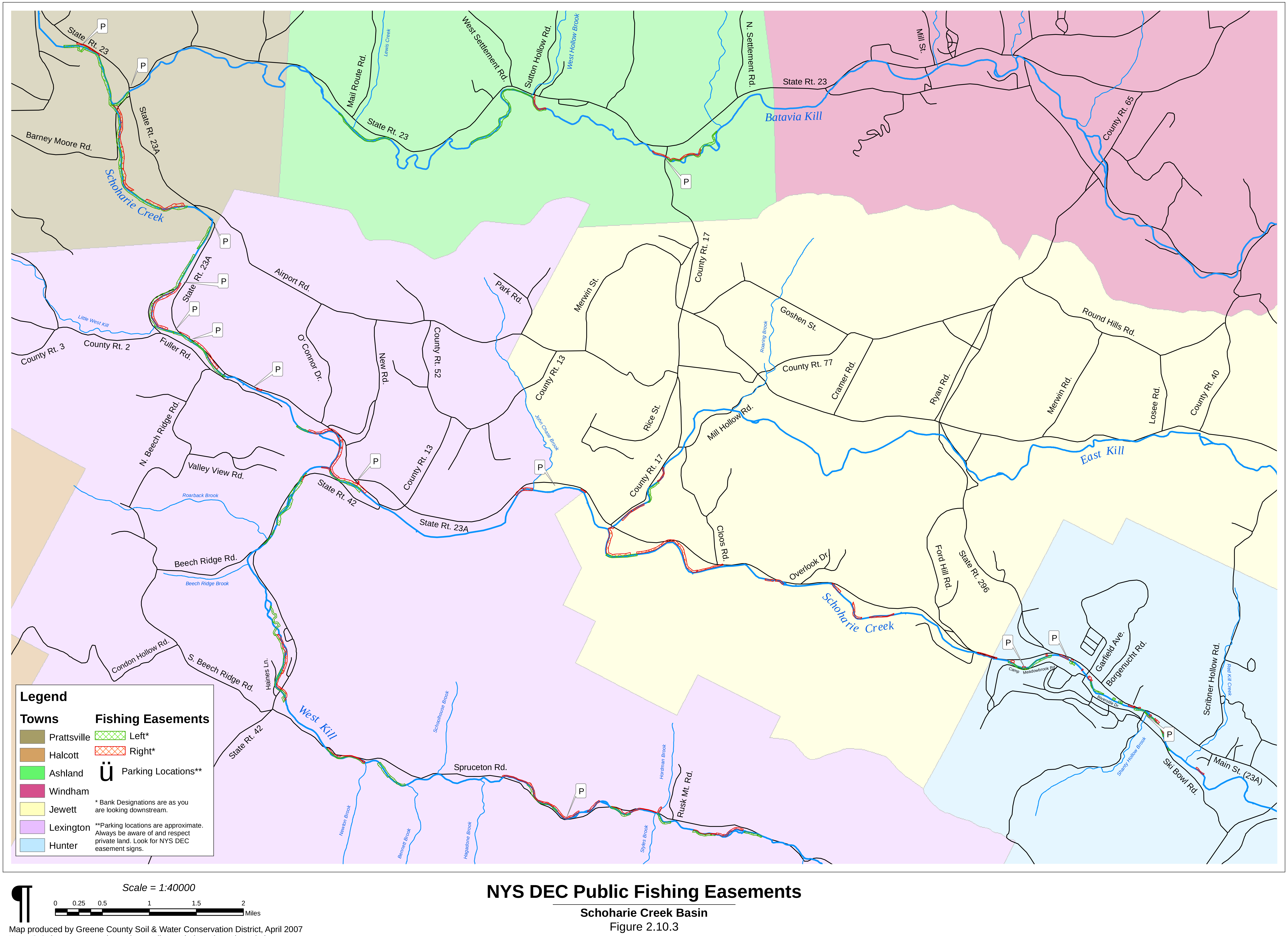
Fishing

The Schoharie Creek and its tributaries are renowned for their fishing, especially trout fishing. Locations between Prattsville and the Schoharie Reservoir (as well as locations below the reservoir) are also notorious for largemouth, smallmouth, and rock bass. Numerous public access fishing sites have been created along these creeks by DEC (Figure 2.10.3). The Schoharie Reservoir is also accessible for fishing for mostly warm-water species such as largemouth bass. The Schoharie Creek and several of its tributaries are stocked with trout by DEC. Trout fishing season in New York is open from April 1 through October 15, and bass season is open from the 3rd Saturday in June to November 30th. To view more information on the fishing season for these and other species of fish in New York State, see the Freshwater Fishing Guide at http://www.dec.state.ny.us/website/dfwmr/fish/fishregs/fishregsguide0608.pdf. Persons over the age of 16 must obtain a fishing license to fish the freshwaters of New York State.

Fishing is permitted on all NYC reservoirs, including the Schoharie Reservoir, providing the person has obtained an Access Permit. Row boats are allowed for fishing on the reservoir. Boats must be registered with a Boat Tag, steam cleaned by DEP, and stored in designated areas on the reservoir, all of which is free of charge. However, ice fishing is not permitted on the Schoharie Reservoir. To view locations where ice fishing is allowed, go to http://www.nyc.gov/html/dep/watershed/html/wsrecrules.html. All NYS laws also apply when fishing on city lands. For further information go to http://www.nyc.gov/html/dep/watershed/html/wsrecfish.html or call the Schoharie Reservoir Land Management Office at (607) 588-6231. Fishing is also allowed on all ponds within hiking areas.

References

NYSDEC. 1985. Catskill Park State Land Master Plan. New York State Department of Environmental Conservation (DEC), Albany, NY.



NYS DEC Public Fishing Easements

Schoharie Creek Basin

Figure 2.10.3

Map produced by Greene County Soil & Water Conservation District, April 2007
Note: GIS data are approximated according to their scale and resolution.
They may be subject to error and are not a substitute for on-site inspection or survey.

2.11 Stakeholders

Schoharie Creek/East Kill Informational meeting, June 3, 2006.

Saturday, June 3, 2006, marked the official start to the stakeholder involvement portion of the Schoharie Creek and East Kill Stream Management Planning Projects. Greene County Soil and Water Conservation District (GCSWCD) and New York City Department of Environmental Protection (DEP) representatives presented information on the two agency's water resource programs and the various components of the stream management plans to the 100 participants. Presentations were followed by a question and answer session that included passionate stream management discussions that should lead to active participation in the planning process.

Results from the June 3rd session reinforced that a critical component of the stream management planning process is public support and input for the project. To this end, the Schoharie project team, and a professional consultant from the Consensus Building Institute, completed a survey of potential Project Advisory Committee (PAC) members to start gathering input for the management planning process (full results and recommendations below). Most interviewees described the stream as picturesque and aesthetically pleasing, historic and of great potential value. At the same time, it was also described as "out of control", in need of attention, and unstable.

The survey information was further expanded upon at a facilitated workshop at which the following priority considerations for forming a project advisory committee to assist in the development and implementation of the stream management plans were decided upon: 1) representation of all key stakeholder groups; 2) manageable size (30 is probably about the biggest manageable group for full group discussions) 3) balance among stakeholder interests; 4) PAC membership should stay open through the planning process, so that new players can be added if appropriate. The group also decided the primary goals of the PAC should include: 1) building consensus among the key stakeholders on the goals, process and expected outcomes of the SMP process, based on broad public input; 2) engaging key stakeholders in reviewing information about the current conditions of the Schoharie Creek and East Kill and its management, and gathering new information if necessary; 3) facilitating joint development of options for improving management, especially options that can contribute to multiple goals (environmental, economic, recreational and social); 4) prioritizing and integrating those options into a balanced management plan that says how resources will be allocated, who will do what and by when, and how to implement the preferred options; 5) mobilizing key stakeholders and the public to work together to generate the resources needed to implement the plan. Following the workshop a PAC was initiated that met several times prior to completion of this stream management plan. In should be noted that "completion" is a relative term. The stream management plans are designed to be updated with new assessments, knowledge or recommendations. Additionally, the PAC will develop annual action plans to prioritize recommendations. Therefore, the management planning process is not a stagnant process that concludes with the development of this stream management plan, but rather begins.

Occurring simultaneously with the Schoharie watershed planning process was the Schoharie Turbidity Task Force. This project was designed to develop a turbidity reduction strategy for the Schoharie basin. The project included the surveying of stakeholder interests to better understand the challenges that turbidity poses to various interest groups (i.e. local residents, fishermen, water supply, local officials, highway crews, etc.). In addition, the hosting of a "turbidity summit" to present turbidity concerns within the Schoharie basin, possible best management practices to reduce turbidity and to gather input from ~ 100 attendees. Final turbidity reduction recommendations are scheduled to be completed in late 2007/early 2008.

Schoharie Turbidity summit break-out session (1 of 3), January 27, 2007.

All of the stakeholders listed in Table 2.11.1 have an interest in maintaining the Schoharie as a well-functioning natural resource, and many of them have direct management influence over it. With the completion of the plan, the next phase will include review of the plan's recommendations by the community, stakeholders and the Project Advisory Committee. The plan will then be revised to ensure that it adequately reflect stakeholders' concerns, and then presented to the various municipalities and agencies for formal adoption and implementation.

Table 2.11.1. Stakeholder groups within the Schoharie basin.

Landowners	Federal Emergency Management Agency
Watershed Towns and Villages	Community Organizations
Greene County Soil and Water Conservation District	NYS Department of Environmental Conservation
Greene County Highway Department	USEPA
Army Corps of Engineers	Private utility companies
NYC Department of Environmental Protection	NYS Department of Transportation, including Region
NY State Emergency Management Office	Local Businesses

Schoharie/East Kill Summary of Stakeholder Interests and Concerns

Final Report and Recommendations from the Consensus Building Institute

Overview

The Consensus Building Institute (CBI) was asked by the DEP Stream Management Program, in cooperation with the GCSWCD, to help develop a Project Advisory Committee to provide public input and decision-making for the Schoharie/East Kill Stream Management Plans.

DEP and GCSWCD believe that in order to provide for maximum protection by multiple entities, developing a stream management plan must be a collaborative process among DEP, the local Soil and Water Conservation District(s), local governments, local nongovernmental agencies, watershed residents, and local business representatives. To promote collaboration, DEP and GCSWCD will create a Project Advisory Committee (PAC) of key stakeholders to help develop, and eventually implement, the Schoharie Stream Management Plan.

In order to develop an effective community engagement process that might result in diverse constituencies with ownership in the final plan, CBI was asked to conduct an impartial assessment of the interests and concerns of a broad range of stakeholders regarding the Schoharie and East Kill Watersheds. This assessment was presented at, and supplemented by, a focus group meeting of stakeholders on November 1, 2006.

The Consensus Building Institute is a not-for-profit [501 c(3)] organization based in Cambridge, Massachusetts. CBI provides facilitation and mediation services to help public, private, and non-governmental organizations throughout the United States and internationally reach agreement on complex public policy matters.

Background

In response to damage of private property and public infrastructure caused by flood events, as well as ongoing water quality and fish habitat concerns, the GCSWCD, in cooperation with the DEP Stream Management Program, initiated the development of stream management plans for the Schoharie Creek and the East Kill.

The Schoharie–East Kill Watershed project is a continuation of a 10-year collaborative effort between the GCSWCD and DEP to promote sound stream management in the Catskills. The project involves conducting a thorough assessment of both streams, followed by the development of a detailed stream management plan for both waterways. While the project involves a significant number of activities, there are three main objectives: Complete a detailed assessment of the stream corridor to develop a reasonable, science based, understanding of the status and condition of the stream systems, including identification of stability problems; use data collected, in conjunction with watershed stakeholder discussions, to develop a detailed stream management plan for the watershed; conduct a demonstration project that will present a “hands-on” opportunity to restore stability at a selected site. Once completed, the Stream Management Plans (SMP) will provide an effective tool for government, citizens and other interested parties to manage the streams in a manner that will protect water quality, private & public property as well as the fisheries resource.

The Schoharie Creek main stem watershed drains large sections of Prattsville, Lexington, Jewett, Hunter, and the Villages of Hunter and Tannersville, and smaller sections of Ashland in Greene County. The East Kill watershed drains primarily the town of Jewett. Both the Schoharie Creek and East Kill are very “active” streams, noted for their tendency to quickly change from gentle waterways to raging streams under flood conditions. Damage from floods has been a way of life along these waterways for as long as humans have inhabited the watershed.

Methodology

The Consensus Building Institute conducted confidential, voluntary interviews with 9 individuals between August and October, 2006. In the interviews, CBI asked stakeholders questions about: perceptions and uses of Schoharie Creek and East Kill; interests, needs, and concerns associated with the Stream Management Plan, and; how and in what ways they would like to be involved in the watershed planning process. Interviews were done with individuals who fit into key stakeholder categories, including local government officials, local administrators, landowners, recreation groups, and federal agencies.

CBI staff used an established interview protocol as a general guide for conducting the interviews. The interviewer followed the general structure of the protocol, while allowing each conversation to follow the interests and comments of each interviewee. This summary is based on the views and opinions of interviewees. In addition, draft findings from these interviews were shared at a focus group meeting on November 1, 2006, with 25 attendees. Participants were asked to respond and add to these findings – these responses and additions are integrated into this summary.

Please note that the CBI's role is to provide accurate, impartial analysis of the situation in order to assist the DEP and GCSWCD in making recommendations on how to best proceed with a process able to engage the community in appropriate participation in the Stream Management Plan process and implementation. We are not an advocate for any particular outcomes or interests and are bound to conduct our work in a fair, deliberate, and non-partisan fashion. CBI staff is bound by the Association for Conflict Resolution (ACR) Code of Ethics: "The neutral must maintain impartiality toward all parties, maintain freedom from favoritism or bias either by word or by action, and commit to serve all parties as opposed to a single party". Please also note that the assessment is not a legal document, technical report or planning study, nor an exhaustive study of all the concerns of individuals and organizations with a stake in the Schoharie/East Kill Stream Management Plan. This final report is limited by the information gathered in the interviews and focus groups conducted and our interpretation of that information. Any errors or omissions are the sole responsibility of CBI.

Findings

Perceptions and Uses of Schoharie/East Kill Creek

Most interviewees described the stream as picturesque and aesthetically pleasing, historic and of great potential value. At the same time, it was also described as out of control, in need of attention, and unstable. They told stories of historic uses for the creek including swimming, boating, tubing, and fishing, but most said that these activities are quite curtailed in current times, due to the shallowness of the water. Others raised questions about the accuracy of the memory of a historically deeper stream, and questioned whether kayaking or tubing were ever popular on the stream. It was referred to as a great fishing stream, with consistent fishing and good retention of the stocked fish. It was also mentioned that there has been a reduction in insect and minnow life over the years. In addition to its beauty, the creek's value was described as an economic resource, an aquatic habitat, a source of water for the local ski area, conveyance for regulated water discharge from treatment plants, and a site for fishing.

Interests, Needs, and Concerns associated with the Stream Management Plan

Interviewees named a number of concerns they had about the stream. These included flooding, erosion, turbidity, backfill, invasive plants, storm water overflow, impacts of rapid development (especially potential future development), public access, landowner stewardship, and aquatic preservation.

Some comments from stakeholders include:

- Single biggest concern is that it needs to be controlled within its banks
- Flooding is getting worse. Extensive damage to town roads and personal property
- Within the town of Hunter, the community could use enhanced access
- Concerned about the potential impacts of new development, especially unplanned
- Need to enhance landowner stewardship and local commitment
- Additional development –especially unplanned – could increase storm water run off, sediment and turbidity
- Erosion has to be curtailed where clay banks are becoming exposed

- Turbidity exists, but the stream is one of the quickest in the area to clear up after rain events

In speaking about their interests for the stream, stakeholders mentioned stream bank stabilization, studies of the stream beyond turbidity, including aquatics, restrictions on development, greater investment in structural improvements and preservation efforts, and a desire to see it restored back to a depth that would be useful for fishing, kayaking, tubing and swimming. There was also a call to avoid channelization of the stream, plan for and document the more-than-occasional flooding, and to identify and implement aquatic habitat improvement projects. Conversation arose about the history of gravel mining in the stream by local landowners, which is now prohibited, and is seen by many to have caused longer term instability. The group raised the question of how to meet objectives of flood mitigation & fish habitat improvement without gravel mining.

Interviewees had some ideas about how to bring about improvements in the stream, which could be included as part of the Stream Management Plan recommendations. These included requests to dig out the stream, eradicate non-native plants and educate people not to plant them, protect the natural features that help confine the flooding, and allow landowners to do work in the stream. Interviewees were also interested in strategies to prevent filling of banks, erosion, and flooding, improving the shading of the stream to reduce high August water temperatures that harm aquatic life, and a desire for new construction of berms and bridges to redirect the flow when it gets high. There were suggestions that the plan ensure that all initiatives were first the work of the local users, and that it raise awareness and interest of stakeholders, making the creek something important to them that they want to improve. This could be done through an offer of incentives and resources to towns and/or landowners to improve the stream. The idea was also raised of setting up volunteer opportunities – cleaning up streams, plantings, monitoring, pulling out Japanese Knotweed – for groups that might be willing/able to participate.

A focus group participant also mentioned that it would be wise to reduce the acreage requirement for disturbances that require stormwater management plans from the current requirement of over 1 acre because smaller disturbances may still impact water quality. Another attendee offered that reducing this limit would be too cumbersome on landowners and mentioned landowners could sue the water quality/quantity offender instead.

Recommendations for Local Involvement in the SMP process

Based on input from interviews and the focus group, as well as interests from DEP and GCSWCD in ensuring collective buy-in and ownership of the SMP recommendations, convening parties should establish a Project Advisory Committee. The most important considerations in deciding PAC membership should be 1) representation of all key stakeholder groups; 2) manageable size (30 is probably about the biggest manageable group for full group discussions); 3) balance among stakeholder interests (e.g. if there are 8 people from the Town of Hunter who want to participate, but only 1-2 people from other affected areas, the Hunter group should probably be asked to talk together to figure out which 2 or 3 can best represent their shared interests at any given meeting). PAC membership should stay open through the planning process, so that new players can be added if appropriate.

Given this, PAC members should include:

- Representatives of all Towns/Villages in these watersheds including: town supervisors, planning board members, highway superintendents and code enforcement officers;
- Any and all interested streamside landowners, with special efforts made to reach out to non-resident landowners because they do not elect Town officials and may not be represented by them;
- Any and all interested local businesses with a stake in the streams;
- Representatives from state and federal government agencies;
- Representatives from non-governmental organizations and recreation groups.

The primary goals and tasks for the group should include:

- Building consensus among the key stakeholders on the goals, process and expected outcomes of the SMP process, based on broad public input;
- Engaging key stakeholders in reviewing information about the current conditions of the Schoharie Creek and East Kill and its management, and gathering new information if necessary;
- Facilitating joint development of options for improving the management of the Schoharie and East Kill, especially options that can contribute to multiple goals

(environmental, economic, recreational and social);

- Prioritizing and integrating those options into a balanced management plan which says how resources will be allocated, who will do what, by when and how to implement the preferred management options;
- Mobilizing key stakeholders and the public to work together to generate the resources needed to implement the plan.

The PAC should ensure inclusion, participation, and a real voice of members in decision making, and should seek to hold participants accountable for collecting and offering perspectives from those they represent. Given time constraints, the PAC should meet at least 2-3 times before April, 2007, and should then commit to working together to adopt and implement the recommendations of the SMP.

The PAC meetings should include a 2-way exchange of information. They are an opportunity for the project team to share their progress and current thinking about the SMP and its recommendations, to explore outstanding questions or disagreements among the group (such as "how deep is the stream? How deep did it used to be?") and also for the PAC members to build consensus on SMP recommendations and priorities for funding.

In addition to the PAC, GCSWCD should offer other opportunities for the participation of the public at large. Those opportunities might include:

- Hosting 1-2 public meetings together with the PAC, to share information about progress so far and draft ideas on recommendations and priorities, to provide an opportunity for community input;
- Creating a website and/or regular electronic and print updates which the public can use to follow the progress of the SMP;
- Involving them in data gathering activities, e.g. putting monitoring devices on their property or responding to questionnaires;
- Providing input to members of the PAC, and/or attending meetings of the PAC as observers.

By creating opportunities like these, NYC DEP and GCSWCD can broaden and deepen stakeholder engagement in the SMP process.

2.12 Agency Contacts and Program Resources

Technical Assistance

A wealth of information and assistance is available to local municipalities, landowners, and businesses in the Catskill/Delaware watershed. Services are wide ranging through a variety of programs. Although funding and grant opportunities may not always be a possibility, the organizations listed below offer a variety of solutions for water quality, infrastructure, and property protection. Please do not hesitate to contact these resources with questions and requests. Many of these organizations also offer grant and other funding opportunities. Please see the grant resources list at the end of this section for more information on monetary support (Table 2.12.1).

<u>Soil & Water Conservation Districts (SWCD)</u>

With a conservation district in each county, these local entities provide a variety of services to its local constituency. Most districts focus on offering agricultural assistance with best management practices (BMPs) through design, installation, and oversight. These BMPs include water management such as diversions, barnyard management systems, manure storages, grazing systems, and animal water systems. Other services include riverfront revitalization, plant materials supply, environmental education, permit assistance, flood mitigation, and stream restoration. The SWCDs are often a good starting place for information and assistance. If they cannot help you, they can most likely point you in the right direction.

Greene:	Executive Director	*Schoharie:*	Executive Director
	(518) 622-3620		(518) 234-4092
Delaware:	Executive Director		
	(607) 865-7161/7090		

<u>New York City Department of Environmental Protection (NYC DEP)</u>

http://www.nyc.gov/html/dep/html/watersup.html

The Bureau of Water Supply works closely with landowners to achieve goals in an environmentally sensitive manner. NYC DEP has a variety of programs that assist landowners with the management of their property and streams. Please see below for a brief description of the various programs.

Land Acquisition: In 1997, the DEC issued a permit that allowed the DEP to acquire land for the purpose of watershed protection. The acquisition of land is one of the best ways to ensure the ongoing prevention of pollution and to prevent future water quality problems from occurring as a result of adverse development close to critical natural features and reservoir intakes. Purchase of land at fair market value or placement in an easement is negotiated only from willing sellers Interested parties should contact the Land Acquisition Program @ 1-800-575-LAND or (845) 340-7540.

Stream Management: DEP's Stream Management Program was established in 1992, and formalized in 1996, as one of the watershed community partnership programs included in the 1996 Watershed Memorandum of Agreement. Its mission is to establish long-term stewardship of streams through a watershed-scale, community-based, geomorphic approach, and the development of Stream Management Plans for priority sub-basins in the NYC Water Supply West-of-Hudson (WOH) watersheds. Essential to achieving this goal is the provision of technical assistance to local municipalities, landowners, and businesses within the watershed. Staff members also offer training and educational programs regarding these topics. Concerns or requests for service, should be made to the Stream Management Program at (845) 340-7628.

Land Management: The Land Management Program develops land resource management plans for DEP properties, conducts a recreational review, and develops basin plans, incorporating specific property by property uses and stewardship. In addition, the DEP implemented a public access program that of august, 2006 had made 65% of acquired lands in the Schoharie basin available for recreational purposes like hiking, hunting, and fishing. For additional information call (845) 340-7541.

The DEP also oversees a number of other programs like the watershed agricultural and watershed forestry programs, sewer and septic maintenance, economic development, and watershed education through the Catskill Watershed Corporation (CWC). Please see the CWC description below for more details.

New York State Department of Environmental Conservation (NYS DEC)

www.dec.state.ny.us

Many water related programs are offered by the NYS DEC. The agency has various divisions, which handle watershed assessment and management, environmental education, fisheries, and flood protection. Information about the DEC stocking schedule, fishing licensing, and access points is available at http://www.dec.state.ny.us/website/dfwmr/fish/index.html or by calling (607) 652-7366 for Region 4.

To receive information regarding any flooding issues and the National Flood Insurance Program, see http://www.dec.state.ny.us/website/dow/bfp/gisfpm/index.htm or call (518) 402-8141 about flood control projects or (518) 402-8146 about flood plain management.

In addition to the above services, the DEC is also the regulatory agency for the state of New York's waterways. Having classified Catskill streams, the DEC requires a Protection of Waters Permit for disturbing the bed or banks of a stream. Please contact the following for direction and advice.

Greene/Delaware/Schoharie Bureau of Habitat
65561 St Hwy 10
Stamford, NY 12167
(607) 652-2645

U.S. Army Corps of Engineers (ACOE) New York District

www.nan.usace.army.mil/index.htm

The Army Corps of Engineers has a variety of duties related to stream management. If a municipality or landowner wishes to install a water-related structure, dredge or fill a stream, or affect a wetland area, ACOE will often assign a field technician to visit the sight in order to evaluate the need for a federal permit. ACOE also offers engineering designs and other technical expertise. In addition, they are available for planning, designing, and constructing flood control projects. For a field technician contact the appropriate office listed below:

Delaware/Greene/Schoharie: (518) 273-7420

<u>Catskill Watershed Corporation (CWC)</u>

www.cwconline.org

The CWC is a not-for-profit corporation with a dual goal: to protect the water resources of the New York City Watershed west of the Hudson River, while preserving and strengthening communities located in the region. Although the CWC is mainly a source of funding (see grant information section), they can also provide technical assistance. Pertinent programs for Catskill/Delaware stream stakeholders include the Stormwater Controls for New Construction, Stormwater Retrofit, Septic System Rehabilitation and Replacement, and Alternate Design Septic Program. For more information call (845) 586-1400.

The Septic Rehab and Replacement program, administered by The Catskill Watershed Corporation (CWC) reimburses permanent residents 100 percent of eligible costs of repairing or replacing a failed septic system. Non-primary residents are reimbursed 60 percent of eligible costs. Eligible systems must be a one or two family residence or home-business combination using less than 1,000 gallons per day, and be located in the NYC Watershed in Delaware, Greene, Schoharie, Sullivan or Ulster Counties. The septic system must be located within 150-feet of a watercourse or within 500 feet of a reservoir or reservoir stem in the West-of-Hudson (WOH) Watershed. This program does not pay for new septic systems serving newly constructed home; or for new or repaired systems intended for commercial or institutional use (CWC, 2006).

The Septic Maintenance program is intended to extend the life of septic systems serving one and two family households in the West-of-Hudson Watershed. This program is open to homeowners anywhere in the NYC WOH watershed, who have had a new, or replacement septic system installed after January 21, 1997, and at least three years ago. This program reimbursed homeowners for up to 50% of the eligible cost for septic system inspections and pump-outs.

Watershed Agricultural Council (WAC)

www.nycwatershed.org

WAC offers the Watershed Agricultural Program and the Watershed Forestry Program. WAC subcontracts with local, state, and federal agricultural assistance agencies, Cornell University, and the private sector to provide planning, education, training, engineering, scientific, and administrative support.

Watershed Agricultural Program (WAP)

WAP strives to protect the high water quality from agricultural nonpoint source pollution through the planning and implementation of Best Management Practices (BMPs) on farms. Using traditional and non-traditional BMPs, WAP strives to offer a variety of alternatives to farmers that promote the health of their land and the stream. Some specific programs are Whole Farm Planning, the Conservation Reserve Enhancement Program, Nutrient Management Planning, and Small Farm Program. Call (607) 865-7790 or email info@nycwatershed.org with questions or requests.

Conservation Reserve Enhancement Program (CREP)

This program is available to current agricultural landowners or landowners who may not currently farm land, but whose property has a history of agricultural use. CREP is a program for promoting the health of streamside vegetation by providing rental payments for buffer lands that are taken out of production, as well as 100% funding for tree/shrub planting. This program also helps landowners implement stream fencing and livestock watering facilities and other BMPs.

Watershed Forestry Program (WFP)

The Watershed Forestry Program is a voluntary partnership between New York City and the upstate forestry community that maintains well-managed forests as a preferred land use for watershed protection. In 2001, forests covered approximately 85% of the Schoharie basin land area, and a majority of this forest land is privately owned and managed by thousands of individual landowners. To promote forest stewardship and encourage long-term investment in private forestry, the Forestry Program offers cost-sharing to landowners for developing 10-year forest management plans written by qualified professional foresters.

Participating landowners must own at least 10-acres of forest land in the watershed. The Forestry Program also offers a variety of cost-sharing, technical assistance and other incentive programs to both loggers and landowners for implementing certain forestry practices that protect water quality, such as properly installing new timber harvest roads and stream crossings or remediation of existing forest roads that have documented erosion problems. Owning a watershed forest management plan is actually a prerequisite for many of these programs. Forest landowners may also attend a variety of educational workshops and other training events that are periodically sponsored throughout the watershed. For more information, call (607) 865-7790 or email forest@catskill.net.

National Rural Water Association

www.nrwa.org

The National Rural Water Association is a non-profit federation of State Rural Water Associations. Their mission is to provide support services to State Associations who have more than 22,000 water and wastewater systems as members. See description below for New York state contact information.

New York Rural Water Association

http://www.nyruralwater.org/technical_assistance/technical.cfm

New York Rural Water Association (NYRWA) is a not-for-profit group organized in 1979 with the goal of promoting the development, improvement, and sound operation of rural drinking water and wastewater systems throughout New York State. New York Rural Water Association recently expanded its scope to offer training, technical, and administrative assistance to rural communities on solid waste management matters as well. Contact (518) 828-3155, or visit nyruralwater.org.

Federal Emergency Management Agency (FEMA)

http://www.fema.gov/ www.msc.fema.gov

FEMA is the federal government agency responsible for administering emergency and disaster relief, recovery, planning and preparedness programs across the United States and territories. While FEMA's most apparent role is emergency response and recovery, its role in risk reduction through the establishment of building codes and administration of insurance programs, like the national flood insurance program, provide protection against losses of life and property in the case of an emergency or natural disaster. Based in Washington, FEMA operates regional offices across the United States including the Region II office in New York City, covering New York State. FEMA works in cooperation with other federal agencies and State and local emergency response entities such as the State Emergency Management Office (NYS SEMO) and county Emergency Management officials (please see below). FEMA provides training to state and local officials on most aspects of their work including emergency response, disaster response planning, hazard mitigation planning, code interpretation and enforcement. Following a Presidentially declared disaster, FEMA's assistance can be available to state and local government, private individuals, and businesses.

Floods are the most common disaster that would require FEMA involvement with Catskill watershed communities. To protect against flood damages and the loss of life associated with flood events, FEMA provides the following types of assistance:

- Administration of the National Flood Insurance Program (NFIP). Through this program FEMA prepares flood insurance rate maps (FIRMs) that define where floodwaters are likely to cause damage to property. These maps provide communities with a tool to prevent losses through the limitation of building and flood plain modification within these flood zones (Maps provided at FEMA's Map Service Center where you can access the most current FIRM maps: www.msc.fema.gov).
- Management of hazard mitigation programs that help communities identify and modify situations and places at risk during flood events. This would include the development of hazard mitigation plans prepared by communities to help the community reduce or avoid threats to life or property during flood events.
- Following flood events that are declared by the President to be a disaster for a specific county, FEMA typically provides assistance for temporary housing, clean-up, repairs to private structures and repairs to public infrastructure. The availability of this assistance depends on the magnitude of the disaster and the types of losses incurred by the county and its residents. The Small Business Administration also can provide assistance with low interest loans to private business. FEMA programs are

modified frequently and therefore the type and level of assistance will vary from event to event.

- FEMA plays its most important role as a coordinator of response and information in times of a disaster.

To contact the FEMA Region II office, please call (212) 680-3600.

New York State Emergency Management Office (NYS SEMO)

www.semo.state.ny.us

As stated above, the New York State Emergency Management Office is the state entity for pre- and post disaster assistance. Like FEMA, the state office provides planning and resources through cooperation with local governments, volunteer organizations like Red Cross, and the private sector. Where FEMA is primarily involved immediately after a disaster event, SEMO provides long-term recovery solutions. The state agency is more involved in the day to day planning and preparation for disaster response. Below are summaries of some of SEMO's major programs.

Mitigation: This may be one of SEMO's most influential programs by providing preventative assistance to communities within the Catskills. Mitigation efforts intend to reduce negative impacts of floods and other major disasters by preparing pre-disaster planning. This program also aims to identify potential threats and repeatedly damaged structures and to offer positive solutions to reduce future losses and protect against the loss of life and property. It is the intention that preventative efforts will greatly reduce the cost of recovery and will also reduce the loss of property. SEMO manages a Hazard Mitigation Grant program available to communities that prepare hazard mitigation plans. Communities preparing the plan are eligible for grant program funds to implement hazard mitigation projects following Presidentially declared disasters within New York State. Individuals living in communities with plans may benefit from the program through the reduction in flood insurance rates.

Disaster Recovery Assistance: Recognizing that not all disasters can be prevented, this program aims to provide local assistance for faster recovery by coordinating public assistance funds, disaster housing assistance, individual family grants, and small business administration assistance.

Other Emergency Assistance: SEMO also provides a variety of services during times of emergency. These services include state of the art communications, information dissemination, and emergency operation coordination. Call the Emergency Coordination Center at (518) 929-2200 with questions or requests.

Cornell Cooperative Extension (CCE)

www.cce.cornell.edu

Cooperative Extension builds partnerships and coalitions with individuals, communities, organizations, government agencies, and businesses around issues of mutual concern; develops local leaders who use CCE knowledge to inform decisions; promotes youth development through 4-H clubs and other experiences; strives to help participants make informed choices using the best knowledge available; connects learners with educational resources found in locations throughout the world; consults with individuals and groups on multiple topics; provides resources via technologies such as the World Wide Web, satellite, and compressed video.

Greene:	(518) 622-9820	*Schoharie*:	(518) 234-4303
	greene@cornell.edu	schoharie@cornell.edu	
Delaware:	(607) 865-6531		
	delaware@cornell.edu		

The Greene County CCE Agroforestry Resource Center

http://arc.cce.cornell.edu/

The Agroforestry Resource Center provides educational programs, supports research, and promotes collaboration among organizations concerned with sustaining the forest dominated landscape of the Catskill Mountain/Hudson Valley Region. Agroforestry is the art and science of integrating timber production with other crops and forest related income opportunities. The goal is to promote sustainable practices that will provide economic benefits to landowners and communities while preserving forested areas so they continue to provide ecological, economic and public health benefits to the surrounding human population.

Natural Resources Conservation Service (NRCS)

www.nrcs.usda.gov

NRCS puts nearly 70 years of experience to work in assisting owners of America's private land with conserving their soil, water, and other natural resources. Local, state and federal agencies and policymakers also rely on their expertise. They deliver technical assistance based on sound science and suited to a customer's specific needs. Cost shares and financial incentives are available in some cases. Most work is done with local partners. NRCS's partnership with local conservation districts serves almost every county in the nation, and the Caribbean and Pacific Basin. Participation in our programs is voluntary. Please see below for local contact information.

Greene:	Ghent Service Center (518) 828-4385	*Schoharie*:	Cobleskill Service Center (518) 234-4377
Delaware:	Walton Service Center (607) 865-4005		

United States Geological Survey (USGS)

ny.water.usgs.gov

The USGS provides the Nation with reliable information about the Earth to minimize the loss of lives and property from natural disasters, to manage biological, water, mineral, and energy resources, to enhance and protect the quality of life, and to contribute to wise economic and physical development. The USGS provides a variety of assistance related to the four main categories of biology, geography, geology, and water. The water division is broken down into ground water, surface water, and water quality. Individuals can find a multitude of data throughout the website, search various resource databases, and view a number of maps. For more information call the Troy office at (518) 285-5600.

Catskill Forest Association (CFA)

www.catskillforest.org

The Catskill Forest Association is a non- profit organization dedicated to enhancing all aspects of the forest in New York's Catskill region. CFA offers educational programs at all levels, from one-on-one site visits at landowner properties to group woods-walks, workshops and seminars. School-based activities include classroom visits and teacher training such as the Watershed Forestry Institute. CFA is also active in advocating for proper forest management, as well as promoting the economic development of viable markets for a variety of forest products. For more information, email cfa@catskill.net or call (845) 586-3054.

Catskill Center for Conservation and Development (CCCD)

www.catskillcenter.org

The Catskill Center is a non-profit organization working to protect the cultural, historic, and natural resources of the Catskill Mountains. The CCCD has a few integrated program areas:

Land Conservation & Natural Resource Protection: This program identifies, monitors, and engages in effective actions to protect and preserve sensitive, ecologically significant, aesthetically, or recreationally critical lands and waters.

Community Outreach and Planning Assistance: This program provides technical support to rural communities in the Catskills on grant-writing, planning, land use, zoning, subdivision, community empowerment, main street revitalization, regional forums, conferences and workshops, producing reports and publications, and public policy development.

Education: This program consists of a curriculum entitled The Catskills: A Sense of Place, which is a series of five modules on the water resources, geography and geology, ecosystems, human history, and culture and arts of the Catskills. A Sense of Place is designed to give children a better awareness, understanding, and appreciation of the distinctive features of our area. In addition, The Center has partnered with Hudson Basin River Watch to support advanced water quality monitoring efforts by adult volunteer groups. Lastly, they host a hike, lecture, and recreation series for our membership and the general public throughout the year. Visit their website at catskillcenter.org or call (845) 586-2611.

Trout Unlimited (TU)

www.tu.org

Trout Unlimited's mission is to conserve, protect and restore North America's trout and salmon fisheries and their watersheds. TU accomplishes this mission on local, state and national levels with an extensive and dedicated volunteer network. Local TU members have been active in many aspects of stream management planning throughout the Catskill/ Delaware watershed. Not only do they participate in public meetings, legislative activities, and volunteer events, but TU has also funded research projects such as the "Economic Impact Assessment of the Beaverkill-Willowemoc Trout Fishery" to promote improved trout habitats and stream health. Please contact the following local chapters for further information:

Ashokan-Pepacton 559: (845) 657-2312

Catskill Mountain 028: (845) 334-9323

Columbia Greene RVW 569: (518) 851-9442

Greene Land Trust

http://www.greenelandtrust.org/

Recognizing the need for an organizational structure that would insure long-term protection and management of critical habitat lands, the Greene County Soil & Water Conservation District and Greene County Industrial Development Agency funded the establishment of the Upper Hudson—Northern Catskill Natural Resource Trust, which later filed with the NYS Dept of State to operate under the assumed name of Greene Land Trust. While the GLT was founded to assist the habitat protection efforts, it is an autonomous organization that continues to grow and address a range of local natural resource issues in the Greene County area. Contact Rene Vanschaack at (518) 622-3620 or info@greenelandtrust.org.

ESRI Environmental Conservation Program (CSP)

www.conservationgis.org/aaesrigrants.html

This program provides donations and discounts of GIS software, data, books, and training. It offers free on-line live workshops. The overall goal of the ECP is to support conservation groups in acquiring, learning, and using GIS tools and methods. ECP has a particular focus on appropriate levels of technology for locally sustainable programs. Its goal is not to throw out one-off donations into a vacuum with no forethought, but to build permanent, locally based support structures that provide ongoing evolutionary growth in GIS skills. Email ecp@esri.com for detailed information.

Table 2.12.1. Funding Sources and Agency Contacts

Name	Focus	Due Date	Contact	Award Example	Notes/Priority	on-the-	research	planning	< $20K	$20K to	> $100K	Range
Natural Resources Conservation Service												
Conservation on Private Lands http://www.nfwf.org/AM/Template.cfm?Section=Browse_All_Programs&CONTENTID=3971&TEMPLATE=/CM/ContentDisplay.cfm	Projects that engage private landowners, primarily farmer and ranchers, on the ground project.		Eastern Partnership Office, Director, Peter Stangel 404-679-7099		Partnership with NRCS or local conservation districts, priority given to landscape, watershed scale projects integrating agriculture, forestry, and ranching that benefit fish and wildlife.	X			X	X	X	10K-150K
Emergency Watershed Protection http://www.nrcs.usda.gov/programs/ewp/factsheet.html	Projects support such work as clearing debris from clogged waterways, restoring vegetation, and stabilizing river banks.	on-going	Highland Service Center 845-883-7162		The measures that are taken must be environmentally and economically sound and generally benefit more than one property owner.	X						
National Oceanic and Atmospheric Administration												
Community-based Restoration http://www.nmfs.noaa.gov/habitat/restoration/projects_programs/crp/index.html	Provides funds for small-scale locally driven habitat restoration projects that foster natural resources stewardship within communities.		Robin Bruckner robin.bruckner@noaa.gov 301-713-0174	Provides funding to implement on-the-ground habitat restoration projects to benefit marine, estuarine and riparian habitats.		X			X	X	X	14K-8 mil.
Federal Emergency Management Agency												
Flood Mitigation Assistance http://cfpub.epa.gov/fedfund/list1.cfm?prog_num=31	Program helps states and communities identify and implement measures to reduce or eliminate the long-term risk of flood damage to homes and other structures.	established by states	Public Assistance Branch, Recovery Division FEMA,DHS 500 C Street, SW Washington, DC 20472 202-646-4262		Two types offered: planning and project grants for National Flood Insurance Program (NFIP) participating communities.	X		X				
U.S. Fish and Wildlife Service												
North American Wetlands Conservation Act Grants http://www.fws.gov/birdhabitat/Grants/index.shtm	Standard and small grants programs help deliver funding to on-the-ground projects through the protection, restoration, or enhancement of an array of wetland habitats.		Standard–David Buie 703-358-2266 Small-Keith Morehouse 703-358-1888	See award examples at: http:/birdhabitat.fws.gov/nawca/grants.htm				X	X	X	X	small=<75 K standard= 75K-36.2mil.
Partners for Fish and Wildlife http://ecos.fws.gov/partners/viewContent.do?viewPage=home	Restoring former and degraded wetlands, native grasslands, stream and riparian areas, and other habitats to conditions as natural as feasible.	on-going	Carl Schwartz 607-753-9699	The program has partnered landowners to restore wetlands, prairie grassland, and in-stream aquatic and riparian habitat.	Provides technical and financial assistance to landowners interested in voluntarily restoring or otherwise improving native fish & wildlife habitat on their lands.	X			X	X		<25K

Table 2.12.1. Funding Sources and Agency Contacts, Continued

Name	Focus	Due Date	Contact	Award Example	Notes/Priority	on-the-ground	research	planning	< $20K	$20K to	> $100K	Range
Cooperative State Research, Education, and Extension Service												
National Integrated Water Quality http://www.usawaterquality.org/integrated	Supports integrated research, education, and extension projects, as well as, extension/education projects to address water quality issues at the watershed scale.		Mike O'Neill National Program Leader, Water Quality 202-205-5952 moneill@csrees.usda.gov	See award examples at: http:/www.usawaterquality.org/projects	Grant awards to be made to four-year degree granting institutions.		X			X	X	85K-1.3 mil.
State Emergency Management Office												
http://www.semo.state.ny.us	Provides leadership, planning, education, and resources to protect lives, property and the environment.	on-going	State Emergency Coordination Center 518-292-2200 postmaster@semo.state.ny.us			X		X	X	X	X	
Catskill Watershed Corporation												
Catskill Fund for the Future http://www.cwconline.org/programs/econ_dev/econ_dev.html	Funds will be used to make loans and rants to businesses and organizations proposing environmentally responsible projects.	rolling basis	Michael Triolo, Economic Development Director, triolo@cwconline.org Phil Sireci, sireci@cwconline.org	Delhi received money for establishment of Riverwalk Community Park (purchase of riparian property and development of a village riverfront area with canoe access.	This fund program includes a variety of grant and loan programs.	X		X	X	X	X	
Septic System Rehabilitation and Replacement http://www.cwconline.org/programs/septic/rehab.html	This program reimburses homeowners for repairing or replacing damaged septic tanks.		Leo LaBuda labuda@cwconline.org John Jacobson jjacobson@cwconline.org 845-586-1400		Limited to properties in the five-county West-of-Hudson Watershed whose septic systems or property centroids lie within 100 feet of a watercourse. 60% and 100% of eligible costs for non-primary and primary landowners, respectively.	X			X			60%-100% of costs

Table 2.12.1. Funding Sources and Agency Contacts, Continued

Name	Focus	Due Date	Contact	Award Example	Notes/Priority	on-the-ground	research	planning	< $20K	$20K to	> $100K	Range
Catskill Watershed Corporation continued												
Stormwater Controls for New Construction http://www.cwconline.org/programs/strm_wtr/strm_wtr.html	Program to design and construct runoff and erosion control measures.		Thomas De John Professional Engineer tdejohn@cwconline.org	One project will improve stormwater collection and treatment on Railroad Ave., a project intended to decrease pollution and nutrient loading and reduce flow to the village's wastewater treatment plant.		X					X	
Stormwater Retrofit http://www.cwconline.org/programs/strm_wtr/strm_wtr.html	Program to provide funds for stormwater management needed to correct or reduce existing erosion, polluted runoff or other problems associated with stormwater.		Thomas De John Professional Engineer tdejohn@cwconline.org		Projects to implement stormwater BMPs that reduce erosion and/or pollutant loading associate with conditions existing on/or before January 21, 1997 are eligible to apply.	X						
Public Education http://www.cwconline.org/programs/pub_edu/pe.html	Projects that would increase awareness of the region's environment, its natural beauty, and human history.		Diane Galusha galusha@cwconline.org	Tri-Valley Central School, Grahamsville, water monitoring equipment to expand the agricultural and environmental studies programs to include water quality examinations; Ernest Myer School, to bring Streamwatch.		X			X			$750 to $10K
Local Technical Assistance Program http://www.cwconline.org/programs/tech/tech.html	Program addresses projects that enhance pollution prevention management plans or regulations intended to reduce existing /potential erosion and/or pollutant loading or improve the vitality of watershed communities		Thomas De John Professional Engineer tdejohn@cwconline.org	New Program	Preference given to projects that involve municipalities with commitment to adopting management plans, local law, or study recommendations.			X	X	X		<$50K

2.12.1. Funding Sources and Agency Contacts, Continued

Name	Focus	Due Date	Contact	Award Example	Notes/Priority	on-the-ground	research	planning	< $20K	$20K to	> $100K	Range
National Fish & Wildlife Foundation												
Bring Back the Natives http://www.nfwf.org/AM/Template.cfm?Section=Browse_All_Programs&TEMPLATE=/CM/ContentDisplay.cfm&CONTENTID=4095	Funds on-the-ground efforts to restore native aquatic species to their historic range. Can involve riparian habitat restoration, moving streams toward stability and supporting native aquatic communities.	two-decision cycles/year	Corey Grace 415-778-0999 corey.grace@nfwf.org		Projects involving sensitive or listed aquatic species. Does not fund basic research or monitoring.	X				X	X	
Native Plant Conservation Initiative http://www.nfwf.org/AM/Template.cfm?Section=Stewardship&TEMPLATE=/CM/ContentDisplay.cfm&CONTENTID=3966	Projects that protect and enhance, and/or restore native plant communities on public and private land, including protection and restoration, information and education, and inventory and assessment.	two-decision cycles/year	Ellen Gabel 202-857-0166 ellen.gabel@nfwf.org		There is a strong preference for "on-the-ground" projects that involve local communities and citizen volunteers in the restoration of native plant communities. Projects that include a pollinator conservation component are also encouraged.	X	X					10K-50K
Five-Star Restoration Matching Grants Program http://www.nfwf.org/AM/Template.cfm?Section=Browse_All_Programs&TEMPLATE=/CM/ContentDisplay.cfm&CONTENTID=4502	Supports community-based wetland, riparian, and coastal habitat restoration projects that build diverse partnerships and foster local natural resource stewardship through education, outreach and training activities.		Amanda Bassow 202-857-0166 amanda.bassow@nfwf.org	The Mahopac High School will create a half-mile of wetlands along SEAC Creek in front of Mahopac High School by re-contouring the stream corridor and planting native trees and shrubs. The project will serve as a local example of ecological restoration and will be designed as an outdoor classroom for student educational use.	Preference will be given to projects that: Are part of a larger watershed or community stewardship effort; include specific provisions for long-term management, monitoring, and protection; and demonstrate the value of innovative, collaborative approaches to restoring the nation's waters.	X						5K-20K
Watershed Agricultural Council												
NYC Watershed Forestry Program http://www.nycwatershed.org/	Provides cost-sharing incentives and technical assistance to watershed forest landowners to promote forest management planning and to help establish streamside buffers.	rolling assistance	Watershed Forestry Program 607-865-7790 1-800-662-1220 info@nycwatershed.org		Assistance from this program could be used to establish additional grants from matching programs that require existing challenge funds and partnerships.			X	X			

Table 2.12.1. Funding Sources and Agency Contacts, Continued

Name	Focus	Due Date	Contact	Award Example	Notes/Priority	on-the-ground	research	planning	< $20K	$20K to	> $100K	Range
The Conservation Fund												
Kodak American Greenways Award http://www.conservationfund.org/?article=2372	Small grants to stimulate the planning and design of greenways in communities throughout America.	03-01 to 06-01 each year	American Greenways Program 703-525-6300 postmaster@conservationfund.org	North American Water Trails received grant money for its development, enjoyment and stewardship or recreational water trails.	Grants used for appropriate expenses needed to complete greenway project including planning, technical assistance, legal and other costs.			X	X			
ESRI Conservation Program												
Software/Training Donations	Provides donations and discounts of basic GIS software and books.	on-going	grant@esri.com		Does not provide hardware or cash.							
Conservation Program http://www.conservationgis.org/aaesrigrants.html Resource Conservation District Grant Programs http://www.esri.com/grants/esri/conservation.html	Provides donations and discounts of GIS software, data, books, and training.	on-going	ecp@esri.com rcdgrant@esri.com.		Does not provide hardware or cash.							
Tech Grants												
http://www.techfoundation.org	TechFoundation is committed to bringing financial resources, technology solutions and management expertise to non-profits to strengthen the social sector.		techgrants@techfoundation.org 617-354-7500	Colorado Environmental Coalition www.ourcolorado.org	Awardees selected for focus on projects that will bring quality technology resources.	X		X	X			
Earthwatch Institute												
Research Program http://www.earthwatch.org/research	Supports field research worldwide in biological, physical, social, and cultural sciences.	on-going	Earthwatch Institute 1-800-776-0188 info@earthwatch.org	Monitor water quality. Inventory, monitoring, or restoration of watershed environments.	Grants cover cost of maintaining volunteers and research field staff not PI salaries, capital equipment, or overhead.				X	X	X	
Toshiba America Foundation												
www.toshiba.com/taf/apply.html	Contribute to projects designed by classroom teachers to improve science and math education.	on-going	212-596-0620 foundation@tai.toshiba.com	MS received grant for earth science students to conduct a water quality study in their area.		X			X	X		

2.13 Stream-related Activities and Permit Requirements

NYS DEC Permit Requirements

Certain kinds of human activities can have a detrimental impact on water resources. The policy of New York State is to preserve and protect lakes, ponds, rivers and streams, as set forth in the Environmental Conservation Law (ECL) Title 5 of Article 15. To implement this policy, the New York State Department of Environmental Conservation created the Protection of Waters Regulatory Program.

All waters of the State have a classification and standard designation based on existing or expected best usage of each water or waterway segment. The classification AA or A is assigned to waters used as a source of drinking water. Classification B indicates a best usage for swimming and other contact recreation. Classification C is for waters supporting fisheries and suitable for non-contact activities. Classification D, the lowest classification standard, reflects a best usage for fishing.

Waters with classifications, A, B, and C may also have a standard of (t), indicating that it is able to support a trout population, or (ts) indicating that it supports trout spawning. Special requirements apply to sustain these waters that support these valuable and sensitive fisheries resources. The Schoharie Creek and most of its tributaries have a classification and standard of C(t) or higher, and as such are subject to the stream protection provision of the Protection of Waters regulation.

A Protection of Waters Permit is required for disturbing the bed or banks of a stream with a classification and standard of C(t) or higher. For example, 1) the construction of a bridge or placement of a culvert to allow access across a stream; 2) any type of stream bank protection, e.g. placement of rip-rap, or other revetment; 3) lowering stream banks to establish a stream crossing (i.e. creation of a ford); 4) using equipment to remove debris in a stream, all require a permit.

Some examples of activities which are exempt from the requirement to obtain a Protection of Waters permit would be: 1) agricultural activities involving the crossing and recrossing of a stream by livestock or rubber tired farm equipment at an established crossing; or 2) removal of fallen tree limbs or trunks where material can be cabled and pulled from the stream without disruption of the stream bed or banks, using equipment placed on or above the stream bank. There are occasions when permits from other state or local agencies are required; county or town permits, flood plain permits or other approvals may be necessary. The appropriate offices should be consulted. There is no charge for the Protection of Waters Permit. For permit applications and any questions regarding the permit process contact:

NYSDEC Region 4
Bureau of Habitat
65561 St Hwy 10
Stamford, NY 12167
(607) 652-7741
http://www.dec.state.ny.us/website/reg4/index.html

Living Streamside in the Schoharie:

Frequently Asked Questions about Working In/Near the Stream

Everyone wants their stream to look and be healthy. Stream health can be measured ecologically by the plants and animals that live in it, but also by its riparian (streamside) buffer area and the stability of its bed and banks. A stable stream is one that does not undergo accelerated erosion. This means the stream does not move laterally (the banks remain stable) or vertically (the stream bed does not build up or cut down) over short periods of time. Streams are very sensitive to anthropogenic (man-made) disturbances, and if stream related projects do not take the necessary precautions, a stable stream can quickly become unstable. Experience has shown that many stream related projects (such as flood control or stream bank stabilization) that have been performed in the past have done far more harm than good to the nation's waterways. Studies that have focused on some of these projects have contributed to the development of new technology to better work with the natural ability of streams to remain stable over time.

Following are answers to some of the questions most commonly asked by homeowners about activities they are considering undertaking that may impact the health and stability of streams. Where you may need more information, contacts are provided. Please contact your local Soil and Water Conservation District office for site-specific information.

We have also noted those activities that may not be beneficial to overall stream health. This information constitutes some of the best professional guidance available today.

If you seek to:

1) Construct a private bridge for vehicles or foot-traffic over the stream, or install a culvert under a driveway or along a stream

Resource Guidance: Efforts should be made to avoid widening or narrowing the stream beyond its naturally stable width. Often, you can observe stable conditions in a reach nearby. Each stream has a stable set of dimensions (width, depth and cross sectional area), which are necessary to maintain effective sediment and water transport. Widening or narrowing can lead to stream instability that could also eventually undermine the bridge. To minimize the potential for erosion or other problems, try to locate a bridge at a narrow and straight reach, and not on a bend. A bridge functions much better than a culvert as a stream crossing, so bridges are preferable to culverts wherever possible. A bridge should span the entire stream to reduce potential erosion damages and prevent debris from catching on the bridge in a flood. If a culvert is absolutely necessary, the size and placement are critical to maintaining stream stability and ensuring the culvert stays in place and minimizes impact on fish passage. DEC's Habitat Unit staff can advise you on size and placement. Multiple culverts (two or more) are rarely permitted.

Permits: Depending on the specific conditions of a stream crossing (bridge or culvert) project, permits are required from the Army Corps of Engineers (ACOE), the New York State Department of Environmental Conservation (DEC) and the New York City Department of Environmental Protection (DEP). An ACOE permit is required when more than 25 cubic yards of fill material will be used below the "ordinary high water mark" (the approximate yearly flood level). Because the streambed or banks will be disturbed, stream crossing construction requires an Article 15 Stream Disturbance Permit from the DEC. Depending upon whether or not there are any drainage features (streams or wetlands) on the property that will be involved as a result of the project, it may require a Crossing, Piping and Diversion Permit (DEP). Also, if the bridge is part of new construction that involves disturbance of more than 1 acre, it must be reviewed under the DEC stormwater State

Pollution Discharge Elimination System (SPDES) program. If the project will disturb more than 2 acres, it may need a Stormwater Pollution Prevention Permit (SPPP) from DEP.

Contacts: Start by contacting the DEC Habitat Unit staff to determine which state permits are needed. In Region 4 (Greene, Schoharie and Delaware Counties), contact Jerry Fraine at 607-652-7366. For DEC Stormwater permits in Region 4 contact Peter Freehafer at 518-357-2381 and at DEP, contact Brenda Drake at 845-340-7633.

2) Divert water from a stream

Resource Guidance: Any diversion of water from a stream, especially during warmer summer months, can negatively impact downstream ecology by reducing the amount of cool water available to aquatic life. This condition can be especially urgent when streamflows are naturally at their lowest levels and trout are in survival-mode. Improper installation of pumps or waterlines can also disturb the streambed or banks, and potentially initiate erosion problems that can worsen over time and move up and downstream to neighboring properties. Finally, water taken from the stream for use nearby will eventually return to the stream, often warmer or containing substances (i.e., lawn chemicals, salts, oils or soap from cars or driveways) that may further stress fish and other aquatic life, or reduce water quality for downstream users.

Permits: Any diversion must be reviewed by DEC.

Contacts: Contact the DEC Habitat Unit. In Region 4 (Greene, Schoharie and Delaware Counties), contact Jerry Fraine at 607-652-7366.

3) Pave or repave a driveway near a stream

Resource Guidance: By not allowing water to slow down and percolate into the ground, impervious surfaces (i.e., pavement and buildings) and associated land drainage improvements that occur from development can accelerate rain runoff into streams, changing the amount and timing of water they receive and in effect delivering it all in one big "gush". Generally, by the time a watershed exceeds approximately 10% impervious land cover, the streams that capture the runoff are already impaired. A particular concern is localized streambed or bank erosion that a poorly drained impervious surface can encourage. Localized scour and erosion problems can, quickly or slowly, move upstream or downstream and cause your property or a neighbor's property to erode. Designing "stream friendly" drainage for existing or new impervious surfaces can reduce stream damages from stormwater runoff.

Permits: A DEC Article 15 stream disturbance permit may be required. Seek DEC guidance if the impervious surface is within 50 feet of the stream. If the disturbance is more than 1 acre, it must be reviewed under the DEC stormwater State Pollution Discharge Elimination System (SPDES) program as well. If the project will disturb more than 2 acres, it may need a Stormwater Pollution Prevention Permit (SPPP) from DEP. New driveways being paved for the first time will be required to have a setback from the stream under DEP's regulations.

Contacts: Start by contacting the DEC Habitat Unit to determine what state permits are needed. In Region 4 (Greene, Schoharie and Delaware Counties), contact Jerry Fraine at 607-652-7366. For DEC Stormwater permits, in Region 4, contact Peter Freehafer at 518-357-2381, and at DEP, contact Brenda Drake at 845-340-7633.

4) Cut or trim streamside (riparian) vegetation on the streambank

Resource Guidance: Stable streambanks in the Catskills usually require woody vegetation. Shrub and tree roots provide holding power for streambank soils that cannot be achieved solely by grasses or herbs. For a more thorough discussion on the role of vegetation in stabilizing streambanks, see Section 2.7. To maximize stream bank stability as well as ecological and aesthetic benefits of riparian vegetation, discontinue mowing and allow a buffer of vegetation to grow, or plant woody vegetation.

If you are removing a log jam (a pile of trees that have fallen into the stream and are trapping more trees and stream sediment): this requires technical assistance to ensure that the removal process does not initiate new erosion areas upstream or downstream. These jams can cause considerable property damage. While biologically they may actually be beneficial to the stream, resource management agencies understand the property damage they can cause, and will work with you towards the most beneficial solution. If you are removing individual trees, they must be cut up into smaller pieces and removed from the stream so they will not get caught further downstream and cause or worsen another log or debris jam. If the log jam or falling trees are not on your property, but are causing damage to your property, you must coordinate with your neighbor.

Permits: The DEC will require an Article 15 Stream Disturbance Permit if the project will disturb the bed or banks of the stream.

Contacts: Seek technical assistance from the DEC Habitat Unit. In Region 4 (Greene, Schoharie and Delaware Counties), contact Jerry Fraine at 607-652-7366. DEP Stream Management Program staff can provide assistance, contact Beth Reichheld at 845-340-7512, or contact your local Soil and Water Conservation District: Greene County SWCD, Rene Van Schaack at 518-622-3620.

5) Stabilize an eroding streambank

Resource Guidance: Streambank stabilization is a common need in the Schoharie valley. As the management plan has revealed, there are eroding streambanks that threaten water quality, private property and public and private infrastructure (i.e., bridges, culverts and roads). Care should be taken in designing stabilization work to ensure that you don't over-widen, narrow, or encroach upon the stream. Borrowing fill material from nearby gravel bars in the stream should be avoided (see FAQ #7). Seek technical assistance to identify the set of causes of your streambank instability problem so the solution can addresses these causes, and seek a solution that does not transfer the erosion problem up or downstream. The agencies referenced below can advise you on streambank stabilization projects. Neighboring properties may need to be involved to properly address the erosion concern.

Permits: Streambank stabilization will require a DEC Article 15 Stream Disturbance Permit. An ACOE permit is required when more than 25 cubic yards of fill material will be used below the "ordinary high water mark" (the approximate yearly flood level); the DEC can advise you about determining these limits.

Contacts: Seek technical assistance from the DEC Habitat Unit. In Region 4 (Greene, Schoharie and Delaware Counties), contact Jerry Fraine at 607-652-7366. DEP Stream Management Program staff can provide assistance, contact Beth Reichheld at 845-

340-7512, or contact your local Soil and Water Conservation District: Greene County SWCD, Rene Van Schaack at 518-622-3620.

6) Build a house or other structure

Resource Guidance: Siting a new home near a stream can define your enjoyment of that stream and relationship to it. Proper location for homes and facilities must consider stream flooding behavior, no matter how high above or far back from the stream the location may appear during low flows. Because some areas on the FEMA floodplain maps may contain errors due to stream channel migration or infrastructure changes over time, technical assistance is necessary to identify approximate floodplain boundaries, and design your site in as "stream friendly" a manner as possible. Give the stream area to flood, and to move (because a slow rate of erosion is a natural stream adjustment process), so you'll be able to enjoy living streamside, as well as reducing home maintenance costs from streambank erosion or flood inundation.

Permits: Of course, many permits are needed for new construction, and listing them is beyond the scope of this guidance document. If the house or structure is within 50 ft of a streambank, contact DEC to determine if an Article 15 stream disturbance permit is needed. If the house or driveway will be within 100 ft. of a perennial (flows all year round) stream, you'll need an Individual Stormwater Permit (DEP). If your project is to construct a single family residence and it will disturb more than 1 acre of land, you must submit a notice of intent to work and an erosion control plan to the DEC under their Stormwater State Pollution Discharge Elimination System (SPDES) program. If your project will disturb more than 2 acres, you'll need a Stormwater Pollution Prevention Permit (DEP). You will also need to follow State and local regulations, and should contact your Town code enforcement officer. In many communities, the building inspector serves in this capacity.

Contacts: For DEC Article 15 permits: In Region 4 (Greene, Schoharie and Delaware Counties), contact Jerry Fraine at 607-652-7366. For DEC Stormwater permits, in Region 4, contact Peter Freehafer at 518-357-2381, and for DEP permits: Brenda Drake, 845-340-7633. Contact your Town clerk for the number of the local code enforcement officer, and/or building inspector

7) Extract gravel from the stream

Resource Guidance: There is a common belief that cleaning gravel from streams is necessary to improve flood conveyance capacity and reduce flooding. Others wish to use skimmed stream gravel for construction-related projects. Proponents of gravel mining should reflect on stream processes including the concept that a stream must effectively be able to move both water and sediment delivered from its watershed to maintain its shape and provide optimum water quality and aquatic habitat. Therefore, any stream channel alterations should consider the impact not only on moving water, but also on sediment (the gravel) transport, to ensure these qualities of a functioning stream are preserved. Excavating gravel usually disturbs the sensitive balance the stream maintains between its slope (steepness) and the amount and size of sediment it can move. Gravel mining reduces the amount of bed material available in the stream system, as a result the stream begins to erode its bed and banks in efforts to bring its sediment load back into balance with its slope and the amount of water in the stream. Gravel mining typically results in accelerated erosion and deposition processes that harm fish habitat. If you are removing gravel to increase flood conveyance capacity, please bear in mind that this has been found to be a damaging practice. If you are excavating gravel for construction-related projects, a non-stream source should be considered.

Permits: DEC rarely permits gravel removal. Any removal will require a DEC Article 15 Stream Disturbance Permit. An ACOE permit is required when more than 25 cubic yards of fill material will be used below the “ordinary high water mark” (the approximate yearly flood level). The DEC can advise you about the need for an ACOE permit.

Contacts: Start by contacting the DEC Habitat Unit to determine what state permits are needed. In Region 4 (Greene, Schoharie and Delaware Counties), contact Jerry Fraine at 607-652-7366. You can also seek technical assistance from the DEP and/or your local Soil and Water Conservation District: Greene County SWCD, Rene Van Schaack at 518-622-3620 and the DEP Stream Management Program, contact Beth Reichheld at 845-340-7512.

Additional Frequently Asked Questions

From: A Guide to Living in Harmony with Streams by the Chemung County SWCD, http://www.chemungcountyswcd.com/Tire%20Page.htm

Who owns the streambed?

New York State is the sovereign owner of the beds of "navigable waters" in the state. This ownership gives the state the right to control the bed and to ensure that navigable waterways shall forever remain public highways. A stream and any contiguous wetlands may be classified as "navigable" if it is large enough for operation of a canoe or larger boat. For information about state ownership of a waterway and the activities for which state approval is required, contact the Lands Underwater program of the NYS Office of General Services (http://www.ogs.state.ny.us/realEstate/permits/luwfaq.html). As a general rule, the ownership and therefore control of the bed of non-navigable streams or other non-navigable bodies of water is vested in the proprietors of the adjoining uplands, unless their deed provides otherwise. In other words, if you own the bank of a non-navigable stream, you probably own the streambed and are referred to as a riparian owner. Regardless of who owns a stream, various government entities retain police power over activities that may impact navigation, public safety, the environment, or the rights of other property owners. Owning a stream does not give you the right to do whatever you please with it.

Who owns the water in a stream?

In New York State, water in a stream is not "owned" by anyone. The relevant question is: Who has the right to use water in a stream? Water rights and water laws vary from state to state. New York follows the riparian rights doctrine developed under common law. Common law means that the rules were not enacted by the legislature, but were developed by the courts through the decisions they hand down. Riparian rights doctrine allows the owners of land bordering on a watercourse to withdraw a "reasonable" amount of water. The courts have generally held that domestic use or use on the land is "reasonable," while removal of water from the riparian property is "unreasonable." Because all landowners along a stream have "riparian rights," none can use the water so as to deprive the others of their rights. If a water use interferes with the "reasonable" use of another riparian owner, the aggrieved party must go to court to protect his/her rights.

Who is responsible for the stream?

Restoration of stream problems is generally the responsibility of the private landowner. Although various government agencies have regulatory jurisdiction over how a stream is managed, it is not their job to come and "fix" your stream. Government highway departments generally limit their stream work to that needed for protection of roads, bridges, and culverts. Other government resources are more likely to be available to assist with a project that restores a degraded stream system, rather than one designed for localized protection of private property. For information about stream maintenance and restoration assistance, contact the Greene County Soil and Water Conservation District (518-622-3620). Responsibility for a stream does not give you the right to do whatever you consider necessary to "fix" its problems. Assume that every stream is regulated unless you determine otherwise.

LIABILITY

Common Law is that body of law developed from judicial decisions, based on custom and precedent. As such, it is constantly changing by extension or by interpretation. The central point of common law is damage. The owner of a bridge, hydraulic structure, or other stream project has a legal obligation to protect adjacent landowners from damages due to changes in natural drainage that result from that project. Anyone claiming such damage may file suit in court.

If flooding occurs or gets worse after a stream has been modified (by diverting flow, modifying the channel, constructing a bridge, etc.), is the person who made the modification liable for damages?

Yes, quite possibly. Courts have, according to common law, followed the adage "use your own property in such a manner as not to injure that of another." This means that no landowner, public or private, has a right to use his/her land in a way that substantially increases flood or erosion damages on adjacent lands. A municipality or property owner may thus be liable for construction, improvements, or modifications that they should reasonably have anticipated to cause property damage to adjacent property. The lack of proper planning, design, and execution thereof, may be considered a clear indication of the lack of good faith and hence negligence with regard to damages that subsequently occurred.

May someone be held liable for failing to remedy a natural hazard that damages adjacent property?

Sometimes. Courts have generally not held governmental units and private individuals responsible for naturally occurring hazards such as stream flooding or bank erosion that damage adjacent lands. In keeping with this principle, a municipality would not be liable for failure to restrain waters between banks of a stream or failure to keep a channel free from obstruction that it did not cause. However, a small number of courts have held that government entities may need to remedy hazards on public lands that threaten adjacent lands. In addition, land owners and governments are liable if they take actions that increase the hazards.

Can liability arise from failure to reasonably operate and maintain a bridge, drainage structure, dam, or flood control structure?

Possibly. The owner of a dam or other water control structure is responsible for inspecting and maintaining it. Where there is a duty to act and the risk of not acting is reasonably perceived, then failure to take appropriate actions may be considered negligent conduct.

May a regulatory agency be liable for issuing a regulatory permit for an activity that damages other private property?

Yes, quite possibly. In fact a careful analysis of hundreds of cases in which the lawsuit involved permitting indicates that a municipality is vastly more likely to be sued for issuing a permit for development that causes harm than for denying a permit based on hazard prevention regulations. The likelihood of a successful lawsuit against a municipality for issuing a permit increases if the permitted activity results in substantial flood, erosion or physical damage to other private property owners.

How safe is safe enough? Municipalities regularly issue permits for activities that are in compliance with existing laws, but might still be at risk of damage.

For example, floodplain development regulations generally apply only to areas mapped as the 100-year floodplain. Yet significant flooding and erosion damages can and do occur outside of these regulated flood-prone areas. Some municipalities address this additional risk by attaching conditions to their approvals for those projects with identified risks. These conditions can clearly state that the municipality is not obligated to fix personal property in the event of damage. One Town granted approval for a driveway bridge that met all applicable standards, but attached material clearly warning the applicant about the hazards of driving through floodwaters, the risk that emergency vehicles may be unable to reach the house during floods, the potentially high maintenance costs, and the potential liability for the owner if the project results in damage to other property.

May governmental units be held liable for refusing to issue permits in floodways or high-risk erosion areas because the proposed activities could damage other lands?

No. In general, landowners have no right to make a "nuisance" of themselves. Courts have broadly and consistently upheld regulations that prevent one landowner from causing a nuisance or threatening public safety.

What precautions can be taken to avoid liability?

Be "reasonable." The overall issue, in most instances, is the "reasonableness" of an action by the community or property owner. Due to advances in technology and products, there is an increasingly high standard of care for "reasonable conduct." The "act of God" defense is seldom successful because even rare flood events are now predictable. As a precaution, technical assistance from stream professionals should be obtained prior to implementing any stream project. Because a well-designed project is less likely to damage other lands, this reduces the potential basis for legal action. And if you are sued, the best defense is a well-documented record showing "due diligence." That is, that you have done sufficient analysis and design to demonstrate the adequacy of the project with "a reasonable degree of certainty."