The Sawkill Creek & Vandermark Creek Watershed:

A Rivers Conservation Plan

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INTRODUCTION

The Sawkill and Vandermark Creeks flow through the scenic Pocono Mountains region of northeastern Pennsylvania, ultimately draining to the Delaware River at Milford Borough. The combined drainage areas of the two streams, collectively known as the "Sawkill-Vandermark Creeks Watershed", span 30 square miles and 5 municipalities in Pike County (Milford Borough and Dingman, Milford, Shohola and Westfall Townships). The watershed is a mosaic of forest, fields, parks and natural areas, and residential and commercial development. The creeks, their tributary streams, and the surrounding watershed are characterized by exceptional water quality, adequate water supply, and diverse and healthy biological communities, including several rare or threatened plant and wildlife species. Moreover, the watershed's surface water resources have been afforded strong protection under Pennsylvania state law as either High Quality - Cold Water Fishery (HQ-CWF) streams or the more stringent Exceptional Value (EV) streams. These designations ensure that the water quality and the biological communities native to these waterways are maintained through the state's anti-degradation requirements.

Given these conditions, it is not surprising that the watershed has long attracted people to its many opportunities for nature appreciation, recreation and other outdoor activities. From its early history as a largely agricultural region, this rapidly growing area has become a popular destination for tourism and a prime location for both year-round and vacation homes. Since the late 1800s, visitors and new residents alike have been drawn to this picturesque, semi-rural oasis just outside the urban centers of New York and northern New Jersey. The watershed's rolling hills, scenic views, clear trout streams and spectacular waterfalls have become a magnet for people seeking a peaceful place to live, work and play.

Despite these generally favorable conditions, however, the Sawkill-Vandermark Creeks Watershed faces several environmental and ecological threats. Ironically, the appeal that its abundant natural resources hold for so many also threatens their long-term protection and management. This is directly a function of the attraction of the area and its proximity to major population and business centers. The quality of interstate roadways increases the area's accessibility and promotes development and expansion of the watershed's existing urban centers. It is thus no surprise that the Sawkill-Vandermark Creeks Watershed is part of the fastest-growing county in Pennsylvania and has experienced dramatic increases in both population and residential and commercial development over the last half-century. Although these trends have meant good news overall for the recreation-based economy, the environmental and aesthetic impacts associated with more houses and traffic, fragmented forests, and increased water, soil and air pollution are less desirable. The impacts attributable to watershed development may include an increase in polluted stormwater runoff, which can degrade the quality of streams and rivers; the elimination of wildlife habitat; the loss of scenic views and hiking trails; increases in noise and air pollution; and an overall reduction in the open space and natural areas that attracted people to the watershed in the first place. Without a comprehensive plan to manage and protect these resources, it is likely that the current environmental quality and special features of the watershed will be degraded and to some extent lost in the future.

The Sawkill-Vandermark Creeks Watershed presents planners and state and municipal decision makers with a special set of challenges as they seek to find the right balance between natural resource protection and the ever-growing demand for increased recreational opportunities. For example, watershed boundaries do not follow political boundaries, making cross-jurisdictional cooperation a critical element of any watershed management effort. The links between stream water quality and pollutant sources (particularly nonpoint pollutant sources, which may be as small and numerous as storm drains and widely scattered throughout the watershed) are not always easy to identify. In addition, the new homes and businesses that bring revenue to the local economy may also be responsible for degrading local waterways, reducing wildlife habitat and obstructing scenic views.

This plan was created to address these challenges and provide the watershed community and local decision makers with information, management recommendations and tools to protect the Sawkill and Vandermark Creeks and their associated ecological, recreational and aesthetic amenities. This effort is particularly timely because, as discussed in detail throughout this plan, the watershed abounds with high-quality streams, lakes, woodlands and other natural areas. In fact, the primary goals of this plan, developed by Pike County and its watershed partners, focus on enhancing public access to and enjoyment of these existing amenities - and ensuring that future generations may also benefit from them for many years to come. These goals include:

- **Reconnect Milford Borough and its immediate environs to the Sawkill Creek, Vandermark Creek and the Delaware River** - Achieving this goal will promote public understanding of the natural resources surrounding them, enhance public enjoyment of those resources, and complement existing recreation- and tourism-based businesses in the area.

- **Establish a trail system within the Sawkill-Vandermark Creeks Watershed and the adjoining watersheds** - Achieving this goal will connect public lands and improve recreational hiking opportunities throughout the watershed.

- **Enhance outdoor recreation opportunities and create conservation educational opportunities for Pike County residents and visitor**s - Achieving this goal will complement and expand upon the previous goals.

- **Provide educational/interpretive opportunities relating to riparian buffer systems along the trail network** - Achieving this goal will promote public understanding of the value of stream water quality and the importance of riparian buffers to protect that water quality. It will also enhance the recreational experience of hikers and people enjoying the trail system.

This plan includes site-specific recommendations for accomplishing each of these goals, as well as making improvements in water quality, recreation, and the aesthetic value of the

watershed, while allowing continued economic growth and prosperity for the region. But this plan should not be viewed as the end of the watershed planning process. Instead, it represents the initial phase of a multiphase process leading to the development of a sound resource management plan with specific implementation projects that will bring these streams up to their fullest potential as streams eligible for the Pennsylvania Rivers Conservation Registry. To accomplish this, the long-term commitment of watershed residents, decision makers and educators is essential.

Project Background

In March of 1999, Pike County was awarded a grant from the Pennsylvania Department of Conservation and Natural Resources (PADCNR) to develop a comprehensive management plan for the Sawkill-Vandermark Creeks Watershed. The purpose of the grant is to work with local residents to develop a "Rivers Conservation / Watershed Management Plan" by identifying significant natural, recreational and cultural resources; determining the issues, concerns and threats to river/watershed resources and values; and recommending methods to conserve, enhance and restore the watershed's streams and rivers.

Regional planning is not a new concept in Pike County. In the late 1990's, the public, elected officials, businesses, academics, and government agencies were involved in a "visioning" effort as a way to address the pressures that rapid population growth was beginning to have on the county's environment, infrastructure and communities. The visioning process focused on how to prepare for and adapt to the changes expected in the next twenty years. Two principles were critical to the success of the visioning effort: that there is a strong link between a healthy environment and a sustainable economy, and that a diverse mix of government bodies must work together to respond to growth and change in the county. Using these principles as a foundation for their work, five task forces held meetings throughout the county to solicit public input on a variety of issues, including economic development, environment, government, infrastructure, land use and quality of life (e.g., arts, education and youth, health, housing and senior issues). Their efforts helped to form the foundation of the recommendations of this plan (discussed in more detail in Section 7).

In 2000, Pike County selected Princeton Hydro, LLC, an environmental consulting firm, to coordinate the watershed planning process and prepare the Sawkill-Vandermark Creeks Watershed Management Plan. Consistent with PADCNR guidance for the Rivers Conservation Planning process as a participatory public process, watershed partners and stakeholders were identified as a first step. These include:

- The municipalities of the Sawkill-Vandermark Creeks Watershed: Dingman Township, Milford Borough, Milford Township, Shohola Township and Westfall Township
- Pennsylvania Department of Conservation and Natural Resources (PADCNR)
- Pike County Planning and Human Development
- Pike County Chamber of Commerce
- Delaware River Basin Commission

- Pennsylvania Bureau of Forestry
- Delaware Water Gap National Park Service
- Delaware Valley High School

These stakeholders were later invited to participate in a "kick-off" meeting for the watershed planning process, where their input was used to develop more detailed goals and objectives for the plan. These are discussed in detail in Section 2. A Steering Committee and five issue-oriented subcommittees were also created to manage the process and gather information to characterize the watershed and assess its current conditions and health. This information is discussed in detail in Sections 1, 3, 4, 5 and 6. These groups also worked together with the public to develop recommendations for achieving the plan's goals. These are discussed throughout the plan and in detail in Section 7.

As noted above, this plan is neither meant to conclude the watershed planning process, nor to gather dust on a shelf. It has been created as the first step toward implementing projects that will improve the streams of the Sawkill-Vandermark Watershed for the ecological and human communities that depend on them. This plan does not have any regulatory force. To implement its recommendations, the people who live and work in the watershed—many of whom were involved in developing this plan—must continue to work together to ensure that these potential projects actually become reality. To do this, the long-term involvement of watershed residents and decision makers is critical.

The decision to participate in this long-term watershed implementation process rests entirely with the municipalities and individuals that enjoy and care for this watershed. In the future, if a municipality chooses to undertake one of the projects recommended in this plan for improving the watershed, that municipality will still be required to comply with state and federal permitting regulations. Likewise, if a municipality chooses to adopt an ordinance to protect watershed resources or direct development in a way that enhances stream water quality, that municipality will still go through its usual decision-making and approval process.

The benefits to local decision makers for participating in the watershed planning process are many, including improved recreational opportunities, enhanced scenic views, and better protection for valuable local water resources and increased revenue for the local recreation- and tourism-based economy. The partners involved in developing this plan hope that the municipalities, organizations and individuals that enjoy and depend on the Sawkill-Vandermark Creeks watershed will continue to work together to ensure its long-term health.

Section 1. Project Area Characteristics: An Overview

The following section is intended to provide a broad overview of the Sawkill-Vandermark Creeks Watershed project area. More detailed information regarding biological and cultural resources and land use will be presented in subsequent sections of this watershed plan.

Located in the heart of Pike County along Pennsylvania's borders with New Jersey and New York, the Sawkill-Vandermark Creeks Watershed has historically been influenced by its proximity to the metropolitan centers of New York City, northern New Jersey and Long Island, NY (see Figure 1). However, it is primarily known for its bucolic natural setting, historic village character and many recreational amenities. The watershed is also located within the Delaware River Heritage Corridor, a federally designated region of environmental, historic and cultural significance.

1.1 Watershed Location, Size and Major Tributaries

The headwaters of Sawkill Creek and Vandermark Creek originate north and west of Milford Township, with both streams eventually discharging into the Delaware River (see Figure 1). Together, the Sawkill Creek and Vandermark Creeks watersheds span approximately 30 square miles across 5 municipalities (Milford Borough and Dingman, Milford, Shohola and Westfall Townships) in Pike County, Pennsylvania. The combined area (referred to here as the "Sawkill-Vandermark Creeks Watershed") is recognized locally and regionally for its important natural, recreational and economic resources. Its varied landscapes include state and federal recreational land, habitat for threatened and endangered plant and animal species and several National Historic Landmarks. A significant portion of the watershed still contains untouched groundwater recharge areas. In addition, the lower reaches of the watershed have been designated as "Outstanding Basin Waters."[1]

[1] "Outstanding Basin Waters" are interstate waters contained within the established boundaries of national parks; national wild, scenic and recreational rivers systems; and/or national wildlife refuges that are classified by the Delaware River Basin Commission as having exceptionally high scenic, recreational, and ecological values that require special protection. Delaware River Basin Commission. 1996. Administrative Manual — Part III: Water Quality Regulations. www.state.nj.us/drbc/regs/wq-regs.pdf

Figure 1. BASE MAP

1.2 Topography

The Sawkill-Vandermark Creeks Watershed lies within the Low Plateau Section of the Allegheny Plateau Province. To the east, along the Delaware River, the Mardin-Manlius-Arnot and Manlius-Arnot-Rock outcrop soil associations are underlain by gray to dark gray fine- to medium-grained sandstones, olive and dark gray siltstones and shale's of the Trimmers Rock, Mahantango and Marcellus formations of Upper and Lower Devonian age. The area has steep ridges and hilly valleys, ranging in elevation from 500 to over 1400 feet (see Figure 2 & Figure 3). A thin layer of glacial till or outwash covers the bedrock. The Mardin-Manlius-Arnot formation covers ten percent of the total land area of Pike County and the Manlius-Arnot-Rock Outcrop covers about six percent.

The Sawkill Creek headwaters originate in the Towamensing (Catskill Formation) geological area in Shohola Township. After meandering through this moderately steep, northwest-dipping, dark-gray siltstone and shale, the tributaries join the Sawkill Creek in Milford Township and flow in a southeasterly direction through the Millrift Formation and Sloat Brook Formation (siltstone, silt shale and sandstone).

The Vandermark Creek headwaters flow through the Mahantango Formation (glacial or alluvial gravel, sand and clay deposits) in Westfall Township. Much of the area lies in undulating upland topography developed mainly on resistant, gray, flaggy sand stone and local areas of glacial till. Sand and gravel occur along streams and some valley sides. Drainage is poor, with numerous peat bogs.

1.3 Geohydrology

The unconsolidated glacial deposits that overlie bedrock in the Delaware River valley form an unconfined aquifer. These glacial deposits are recharged by precipitation, the adjacent underlying bedrock and stream flow. The amount of recharge to the groundwater system in an unconfined aquifer depends upon climatic and hydrologic conditions as well as the permeability of the aquifer materials. Most recharge of the glacial aquifer is discharged to the Delaware River or withdrawn throughout the watershed via water supply wells (potable and otherwise) developed within the water yielding formation. However, some groundwater may flow parallel to the river and discharge into the river downstream of the project area.

As with any watershed, recharge of groundwater supplies and alteration in local and regional geohydrological conditions can be significantly altered as a result of development. An increase in impervious cover will decrease the opportunity for the percolation of precipitation through the upper soil horizons and down into the underlying formation. This can have deleterious effects not only on the availability of potable water, but can impact base flow of streams and compromise the hydrology of wetland systems. The potential impacts caused by increased impervious cover can be magnified in fractured rock aquifers when development occurs over major fractures or fracture nodes that enable and facilitate infiltration and recharge.

FIGURE 2. The Sawkill -Vandermark Creeks Watershed - Topography Map

FIGURE 3. SHADED RELIEF / TOPOGRAPHY OF WATERSHED

1.4 Land Use and Zoning

The total drainage area for the Sawkill Creek, Vandermark Creek and their tributaries spans approximately 30 square miles. Land use within the watershed was initially evaluated using municipal Comprehensive Plans and zoning ordinances. GIS land use coverage's were also obtained from the Pike County Conservation District. The GIS coverage's were used to develop a land use/land cover map (see Figure 4) and to calculate the percentage of land area associated with each land use within in the Sawkill-Vandermark Creeks Watershed (see Table 1).

Municipal zoning influences the future development patterns that can be projected for the study area. Zoning in the study area include areas that allow limited commercial development along US Route 6, however, the vast majority of the study area entails areas of 1 to 2 acre minimum residential zoning. As the county's population continues to grow, new residential pressures will cause the land cover to slowly change into a more urbanized environment. The commercial zones in the proximity of the intersection of US Route 6/ Rt84 pose the largest threat to the fragile water source serving the Borough of Milford. Future development possibilities in this area need to be closely monitored. Municipal land development review and approval procedures need to consider impacts on water quantity and quality as a major priority.

The Pike County Visioning effort as well as the Pike County Comprehensive Plan and its current update recognize zoning and municipal land use decisions as an important component of smart growth and environmental protection. A multi-municipal task force dealing with Zoning and Land Use should be considered for municipalities that share a commercial corridor as their municipal border.

Table 1. Land Use, Sawkill-Vandermark Creeks Watershed

LAND USE	ACRES	SQ. MILES	% OF TOTAL
Deciduous Forest	11,015.38	17.21	57.31%
Mixed Forest	2,967.73	4.64	15.44%
Coniferous Forest	2,322.40	3.63	12.08%
Transitional	734.70	1.15	3.82%
Row Crops	672.98	1.05	3.50
Woody Wetland	434.05	0.68	2.26%
High Density Urban	316.67	0.49	1.65%
Low Density Urban	256.08	0.40	1.33%
Water	228.16	0.36	1.19%
Emergent Wetland	208.50	0.33	1.08%
Hay Pasture	64.95	0.10	0.34%
TOTALS	**19,221.60**	**30.03**	**100%**

FIGURE 4. Land Use / Land Cover Map

1.5 Social/Economic Profile

1.5.1 Population

Over the past several decades, the five Pike County municipalities located in the Sawkill-Vandermark Creeks Watershed have experienced relatively rapid population growth. In fact, Pike County has been the fastest-growing county in Pennsylvania for over 30 years (The Scranton Tribune 2004). Its growth has been fueled largely by its popularity as a resort area and its proximity to the major metropolitan employment centers of Philadelphia and New York City, which have attracted tourists and new residents alike since the late 1800s. In 1880, the population of Pike County was 9,663, but that number had dropped to 7,452 by 1940. By 1960, however, the upward trend in population had become firmly established, with the population at 9,158 and continuing to rise. By 1990, the county's population had jumped to 27,966, an increase of more than 300% compared to the 1960 population level. By 2000, Pike County was home to 46,302 people (US Census Bureau, 2000).

In addition to the dramatic resident population increase, seasonal fluctuations in the local population have also become more pronounced in recent decades. Outdoor recreational opportunities have enticed growing numbers of people to invest in second homes throughout Pike County, while the hotel and tourism industry continues to thrive. This trend poses unique challenges for county and municipal planners, who must ensure that transportation networks, community facilities and local services have the capacity to handle the large influx of warm-weather inhabitants.

Concurrent with these changing patterns of seasonal residency, Pike County increased its housing stock by 74% from 1980 to 1990 (from 17,727 to 30,852 units). Not surprisingly, given the upward trend in second home ownership within the county, the total number of housing units in 1990 surpassed the permanent population and increased at a faster rate (74% versus 53%) than population growth between 1980 and 1990. However, by 2000 the rate of housing growth had slowed, increasing by only 12% from 1990 to 2000 (from 30,852 to 34,681 units).

Population growth in any watershed typically results in significant land use changes, such as increased residential and commercial development and their associated environmental impacts (e.g., increased impervious surfaces lead to increased stormwater runoff and nonpoint source pollution). These impacts underscore the importance of incorporating watershed protections into current and future land use planning activities throughout the watershed. Clearly, the additional increases in population predicted for the watersheds principal municipalities (see Table 2) would affect both the quantity and quality of surface and groundwater resources within the Sawkill-Vandermark Creeks watershed.

Table 2. Population Projections for Municipalities in the Watershed

Municipality	1990 Census	2000 Census	2010 (Middle)
Milford Borough	1,064	**1,104**	1,117
Westfall Township	2,106	**2,430**	3,333
Shohola Township	1,586	**2,088**	3,624
Dingman Township	4,591	**8,788**	11,752
Milford Township	1,013	**1,292**	1,746
TOTAL FOR ALL MUNICIPALITIES	**10,360**	**15,702**	**21,572**

1.5.2 Transportation Facilities and Designated Scenic Roadways

As noted above, the Sawkill-Vandermark Creeks Watershed draws many tourists and seasonal residents from the nearby metropolitan areas of New York City (75 miles away) and Philadelphia (125 miles away). To facilitate travel among these population centers, major arterial roads in the watershed include Interstate 84, Routes 209/206 and Route 6 (see Figure 1). Interstate 84 (I-84) bisects Pike County east to west and is responsible for carrying much of its local traffic as well as commuters and commercial transportation. In 2001, the most recent year for which data is available, average annual daily traffic (AADT) on I-84 ranged from 18,000 vehicles between Exit 20/Greentown and 26/Promised Land to 25,000 vehicles between Exit 53/Matamoras and the New York State line. Truck traffic represents approximately thirty percent of the total (Pike County 1992).

A major non-commercial arterial route between eastern/southeastern Pennsylvania and New York and New England, Route 209 parallels the Delaware River through the Delaware River Water Gap National Recreation Area. Route 209 intersects Route 206 just south of Milford Borough and joins Route 6 in the Borough. Most traffic destined for New York and New England and the traffic heading for Route 6 west merge at this point and are funneled through Milford. The National Park Service owns and maintains Route 209 in the Recreation Area, where all commercial vehicles are prohibited except for local deliveries.

Route 6 connects the Milford/Matamoras area (Pike County's principal commercial and activity center) to residential areas in Dingman, Milford, Shohola, Delaware and Westfall Townships. The greatest traffic volumes on Route 6—or on any other route in Pike County, with the exception of I-84—occur along the corridor between Milford Borough and Matamoras Borough. The 2001 AADT on Route 6 at the traffic light in Milford Borough at approximately 15,000 vehicles.

The Old Milford-Bushkill Road, commonly referred to as SR 2001, is the key collector along the upland corridor between Bushkill and Milford. SR 2001 carries traffic from numerous residential subdivisions in Lehman, Delaware and Dingman Townships to the connecting arterials of Route 6, Route 209 and Route 739. PennDOT data indicate that residents and visitors in Dingman Township travel primarily north to Milford and Route 6, where AADT on SR 2001 reaches almost 6,500 vehicles after increasing steadily from 1,900 vehicles at the Dingman/Delaware Township line.

Table 3 lists AADT in 1990 and 2001 for the major arterial roads crossing the Sawkill-Vandermark Creeks Watershed.

Table 3. Average Annual Daily Traffic (AADT) for Major Arterial Roads

YEAR	ROUTE 6	ROUTE 209	MILFORD-MONTAGUE BRIDGE / DRJTBC
1990	2170	3640	6580
2001	7600	5500	7300

Source: *Transportation Issues, Pike County Comprehensive Plan*, April 1992, Table IV-II
PennDOT 2001 Traffic Volume Map

1.5.3 Employment Sources

With their abundant recreational, cultural and historic resources (discussed in more detail in Section 6), the economy of Pike County and the Sawkill-Vandermark Creeks Watershed depends heavily on recreation, tourism and construction associated with second home development. As a result, county unemployment rates tend to fluctuate from summer lows to winter highs (although since 1982, the average annual employment rate in Pike County has been lower than the State average).

Many full-time residents commute to employment outside the state where jobs are more plentiful but housing is less affordable. According to the 2000 census, of the 19,302 employed residents of Pike County, only 5,464 (28%) work in the County; 4,636 (24%) work outside of Pike County but in the state of Pennsylvania; but most alarming is the 9,202 (48%) workers that work outside the state of Pennsylvania…predominately in New York and New Jersey.

Between 1990 and 2000, the county's labor force increased at a rate higher than the population increase (59% versus 50%). According to the 2000 Census, approximately 15 percent of Pike County residents are employed in the "operators, fabricators and laborers" category, which includes employees of Altec Lansing Technologies, Worthington Industries, Hazard Communication and the few other industrial/manufacturing firms in the County. This represents a decrease of 3 percent from the 1990 Census. Conversely, the "Technical Sales and

Administrative Support" occupational category increased by almost 3 percent. Table 4 provides an employment profile for the five municipalities in the Sawkill-Vandermark Creeks Watershed.

Table 4. Municipal Employment Profile

Employment by Sector	Dingman Township		Milford Borough		Milford Township		Shohola Township		Westfall Township	
Census Year	**1990**	**2000**	**1990**	**2000**	**1990**	**2000**	**1990**	**2000**	**1990**	**2000**
# Persons employed 16 years old & older	2206	4056	487	504	523	628	704	894	959	1120
Employed in Ag, Forestry, & Mining	61	9	10	2	15	11	28	10	16	8
Employed in Construction	249	288	38	38	58	42	133	105	81	65
Employed in Manufacturing	276	303	56	42	52	67	106	94	207	130
Employed in Communications, Utilities & Transportation	178	275	28	32	37	54	49	83	86	112
Employed in Wholesale & Retail Trade	468	753	94	95	125	86	137	153	163	226
Employed in Finance, Insurance & Real Estate	242	374	32	37	57	53	49	47	80	79
Employed in Education, Health, and Social Services	442	930	160	103	107	141	115	159	187	246
Employed in Public Administration	96	196	34	29	14	44	44	75	40	57
Employed in Professional	492	1366	141	178	134	256	154	262	227	336
Employed in Sales	654	1027	155	129	165	160	213	208	301	316
Employed in Service	291	679	94	91	59	82	77	132	120	159
Employed Blue Collar	769	984	97	106	165	130	231	292	311	309

Source: US Census Bureau. 1990 and 2000 Census.

1.5.4 Income

Pike County's income levels have increased steadily from 1969 through 1990. According to US Census Bureau data, between 1969 and 1979, aggregate income increased by almost 263 percent. Per capita, average household, and median household income during the same period all increased at rates over 100 percent. Between 1979 and 1990, the rate of increase slowed somewhat for per capita income, but median household income increased at a faster rate. The tremendous increases between 1969 and 1979 can be attributed to the rapid growth and development in the County and the higher incomes of new commuting residents, as well as high inflation.

The Pike County household income ranges that experienced the greatest gain between 1979 and 1990 were the $35,000 to $49,000 and $50,000 to $74,999 income groups, moving from 8 percent of the total to 35 percent. The median household income continues to rise showing the past trends continuing. The median household income increased from $30,314 in 1990 to $44,608 in the year 2000. This likely reflects the influx of higher income families economically linked to employers outside of Pike County, resulting in the disparity of income between recent immigrants and residents who depend on the local economy for their income. This tends to support the "suburbanization" trend, which suggests that Pike County continues to evolve into a bedroom community of families with members who commute to higher paying jobs in nearby metropolitan areas.

1.6 Outstanding or Unique Features

1.6.1 Plants and Animals

The principal vegetative cover in the Sawkill-Vandermark Creeks Watershed is forest, including deciduous and coniferous stands of varying maturity, density and canopy cover. In the late 1800s, lumbering altered much of the watershed's natural vegetation. This, combined with a slow tree growth rate, repeated fires and frequent gypsy moth infestations, has left the watershed's woodlands in relatively poor condition, with many stands of second and third growth trees. A variety of oak species predominates, with scattered hickory, birch, poplar, maple, hemlock and pine. The understory includes rhododendron, mountain laurel and huckleberry. Along the Delaware River, sycamore, soft maples, basswood, ash and a variety of maples are abundant. These woodlands are generally of little commercial value except for firewood. From an ecological perspective, however, they are extremely valuable. They provide habitat, maintain soils, contribute to the hydrologic balance of the region and define, to a large extent, the aesthetic and recreational attributes of the watershed and region. As such, these forests are integral components of the overall ecological character of the Sawkill-Vandermark Creeks Watershed.

Several rare and endangered plant species are known to occur in or near the watershed. Northern Yellow-Eyed Grass (*Xyris Montana)*, Soft-leaved Sedge (*Carex disperma*), and Bog Rosemary (*Andromeda polifolia*) are all designated "rare" in Pennsylvania and are found within the watershed. Roseroot Stonecrop (*Sedum rosea*), Fogg's Goosefoot (*Chenopodium foggii*) and

Hemlock Parsley (*Coniosulinum Chinese*) are all designated "endangered" in Pennsylvania and are found in nearby watersheds.

The watershed and its environs serve as a wintering area for Bald Eagles and summer habitat for Ospreys. In addition, a wide array of passerine songbirds, wading birds and waterfowl take advantage of the unique forest, wetland and aquatic habitats occurring within the watershed. Many of these species are sensitive to disturbance and the habitat fragmentation that often occurs as a result of watershed development and road construction.

Populations of native brook trout and wild brown trout inhabit Sawkill Creek, Vandermark Creek, and their tributaries. In addition, the streams of the Sawkill-Vandermark watershed maintain outstanding diversity of stream invertebrates that are characteristic of cold, clean streams. Additional information on significant habitat and species of statewide and local importance is discussed in Section 5.

1.6.2 Exceptional Water Quality

A stream classified as a High Quality Water (HQ) or Exceptional Value Water (EV) affords the stream special protection under PADEP's regulations (PA Code, Title 25, Chapter 93). This protection includes a requirement for a more stringent planning and permitting process before a discharge is permitted to the stream. An HQ designation indicates that the stream has excellent water quality, which "exceeds levels necessary to support propagation of fish, shellfish, and wildlife and recreation in and on the water" and environmental or other features that require special water quality protection. An EV designation indicates that the stream constitutes an outstanding national, state, regional or local resource. These include: waters of national, state or county parks or forests; waters which are used as a source of unfiltered potable water supply; waters of wildlife refuges or state game lands; waters which have been characterized by the Pennsylvania Fish Commission as "Wilderness Trout Streams"; and other waters of substantial recreational or ecological significance.

All streams in the Sawkill-Vandermark Creeks Watershed have been designated either HQ or EV. Table 5 provides a list of watershed streams and their designated uses. Unlike these tributaries, the Delaware River is classified as a Warm Water Fishery and Migratory Fishery and does not possess special protection status under Pennsylvania's Chapter 93 regulations. However, the Delaware River Basin Commission (DRBC) protects the portion of the Delaware River just below Matamoras to well south of the watershed area. Under the DRBC's Anti-Degradation Program, which is also coordinated with PADEP, the Delaware River is protected from discharges that would degrade existing water quality.

The Pennsylvania Natural Diversity Inventory (PANDI) classifies both the Sawkill Creek and Vandermark Creek as High Gradient Clearwater Creek communities (NC 517).

Table 5. Streams within the Sawkill-Vandermark Watershed and Their Designated Uses

STREAM	DESIGNATED USE*
Vandermark Creek	HQ-CWF
Laurel Swamp Brook	HQ-CWF
Deep Brook	EV
Sawkill Creek	EV
Sloat Brook	EV
Vantine Brook	HQ-CWF
Dimmick Meadow Brook	EV
Pinchot Brook	EV
Craft Brook	EV
Savantine Creek	EV
Gum Brook	EV

* Designated Use identifies the standards for the ecological community and the water quality of a given stream, and the extent of environmental protections afforded that stream.

Section 2. Identification of Regional Public Issues, Concerns, Constraints and Opportunities

2.1 Public Participation Process

2.1.1 Introduction

The early stages of a watershed-planning project can be the most challenging, but may also pave the way for the plan's ultimate success. Introducing the planning effort to watershed stakeholders—including local residents—is a critical first step in initiating a public participation process that considers the needs and interests of everyone involved. In fact, the PA Department of Conservation and Natural Resources (PADCNR) has found that "involving residents in the beginning of a project assists with decreasing opposition and increasing volunteer participation …substantial public involvement at the planning stage increases the likelihood that projects will go beyond the planning stage to implementation" (PADCNR, Public Participation Guide, 2000).

As required by PADCNR, the initial steps of developing a Rivers Conservation Plan include determining public interest, gathering information on local issues and concerns, and organizing an advisory Steering Committee. The following sections describe how these steps were accomplished in the Sawkill-Vandermark Creeks Watershed planning process to identify and integrate the needs and interests of people living, recreating and working in the watershed.

2.1.2 The Pike County Visioning Project

Prior to the Sawkill-Vandermark Creeks Watershed project, Pike County spearheaded another participatory planning venture for the region. In the late 1990's, the public, elected officials, businesses, academics, and government agencies were involved in an outreach and planning effort culminating in the publication of a report entitled *Pike County Visioning (1998-2020) A Final Report* (Pike County, 1999). The catalyst for this "visioning" process was the need for a plan to address the pressures that rapid population growth was beginning to have on the county's environment, infrastructure, municipal and county services, employment, housing and public safety (Pike County, 1999). Approximately 130 county residents participated in the effort, providing input on how to prepare for and adapt to the changes expected in the next twenty years.

Pike County Commissioners recognized that two principles were critical to the success of the visioning effort: that there is a strong link between a healthy environment and a sustainable economy, and that a diverse mix of government bodies must work together to respond to growth and change in the county. Using these principles as a foundation for their work, five task forces held meetings throughout the county to solicit public input on a variety of issues, including economic development, environment, government, infrastructure, land use and quality of life (e.g., arts, education and youth, health, housing and senior issues). Their efforts helped to form the foundation of the recommendations of this plan (discussed in more detail in Section 7). As described below, many of these include an environmental conservation component.

- **Environmental Task Force:** Task force members focused their discussions on seven topics: public land management, water quality, sewage treatment, outdoor recreation, wildlife and habitat, private land holdings and development of an environmental ethic. Building on previous outreach efforts, including a 1994 survey of 500 Pike County residents, the group's final recommendations included promoting the economic viability of the natural environment, offering quality environmental education opportunities to residents and visitors, promoting intergovernmental coordination of environmental issues, using the County Geographical Information System (GIS) to inventory and map natural resources, and planning regional development to preserve natural resources and promote a sustainable economy.

- **The Economic Development Task Force:** This task force explored ways to promote economic development while avoiding negative impacts on the environment. To further this goal, the group recommended using planned development and innovative land use/zoning strategies designed to stimulate business growth while protecting natural amenities, creating a "Pocono Center for Historical Culture and Eco-Science," promoting a highly visible "nature preserve" identity and sustainable tourism, developing a local trail system, and establishing a partnership with the Delaware Water Gap National Recreation Area and the Upper Delaware River Council.

- **Land Use Task Force:** Recognizing that Pike County had experienced a 135% population increase between 1970 and 1990, and was facing a projected increase of 50% by 2010, this group recommended a coordinated, municipal-level land use planning and implementation effort to protect the county's rural character and natural beauty. This would include inter-municipal planning and innovative land use design (e.g., conservation subdivision design, municipal greenways), development and easy access to GIS data layers needed for land use planning, and maintenance of a Central Planning Resource Center focused on land use issues.

- **Government and Infrastructure Task Force:** This group made several recommendations relevant to the rivers conservation planning process, including strengthening regional partnerships, achieving a recycling rate of 25% by 2002 and 35% by 2010, completing regional water and sewage studies and preserving historic buildings.

- **Quality of Life Task Force:** This task force made several recommendations for providing the County with quality youth, education and senior services, including improving water and sewer infrastructure and developing a support system for all youth and educational volunteer programs.

The Sawkill-Vandermark Creeks Watershed Rivers Conservation Plan Steering Committee (described below) used these goals and recommendations as a starting point for planning their public outreach efforts.

2.1.3 Steering Committee

PADCNR's guidelines for watershed planning specify the creation of a steering committee, an idea strongly supported by the Pike County Office of Community Planning and Human Development. In fact, when the county initially decided to apply to PADCNR for a Rivers Conservation Planning grant, a stakeholders committee was formed to complete the application and to actively participate if it was successful. To show their support, each of the seven stakeholder organizations pledged to donate both a portion of the $36,000.00 contribution specified in the grant proposal and a significant amount of time (in-kind donations). This precursor to the Steering Committee included:

- Pike County Department of Community Planning and Human Development
- Pike County Conservation District
- Pike County Geographic Information System and Tax Administration Department
- National Park Service
- United States Forest Service (Grey Towers)
- Yale School of Forestry
- Milford Square Enhancement Committee

Once funding was granted and an environmental consultant (Princeton Hydro, LLC) was hired, representatives from the following entities joined the project Steering Committee:

- Penn State Cooperative Extension
- Pocono Environmental Education Center (PEEC)
- Milford Borough Water Authority
- Dingman Township
- Delaware River Basin Commission
- Delaware Valley High School Environmental Club (Student Member)

From the beginning, the Steering Committee stressed the need for shared responsibility among the participants in the planning process (i.e., Pike County, Princeton Hydro and the Steering Committee). Work sessions took place monthly for the first six months, until subcommittees were formed to research and address specific issues (watershed education, water quantity and quality, recreational trails and forest and wildlife corridors).

2.2 Outreach Approach

2.2.1 Monthly Steering Committee Working Sessions

Each meeting was open to the public, had a formal agenda, was well-attended, included "give-and-take" discussion and involved shared responsibility from the county, the consultant and members of each subcommittee.

2.2.2 Municipal Outreach

The Steering Committee agreed that the municipalities must be involved in the project before the first public meeting in light of local anxiety that the Rivers Conservation Plan would result in additional regulations much like those promulgated under the PA Stormwater Management Act (Act 167). To allay this fear and explain the benefits of participating in the project, the committee developed an informational brochure targeted at municipal officials. PADCNR also agreed to write a letter to each municipality assuring that the plan was intended to build partnerships and would focus on non-regulatory implementation projects (e.g., education, trails, stream bank restoration, etc.), while the Pike County Office of Planning & Human Development made presentations at municipal meetings. Throughout the planning process, the municipalities were provided with progress reports and invitations to scheduled events.

2.2.3 Steering Committee Involvement and Subcommittees

Each Steering Committee member participated in one of five issue-oriented subcommittees:

- Education
- Water Quantity and Water Quality
- Corridor Assessment / Impervious Surface Study
- Trails
- Wildlife Corridors

These subcommittees were charged with identifying existing needs and resources in the watershed and providing regular updates on their progress to the Steering Committee and the public. Each subcommittee ultimately drafted goals, objectives and recommended activities for their specific area of focus. These have been incorporated into the plan under the appropriate section headings; recommendations are discussed in more detail in Section 7.

Steering Committee participation in the subcommittees required active involvement in the formulation of goals, objectives and specific recommendations; research and data acquisition; technical writing; and periodic updates and presentations at public meetings and other events.

2.2.4 First Public Meeting

Sixteen people attended the first public meeting on June 27, 2001, which included an overview of the project area, the planning process and the subcommittee responsibilities. The majority of the meeting time was reserved for public participation and comment. Attendees were asked to answer the following questions:

- What is important to you about the Sawkill and Vandermark Creek Watershed?
- Are there any problems or threats to the future of this area that concern you?
- Are there issues that you feel are not being addressed?
- What area values would you particularly like to see preserved?

- What approaches do you feel should be used to preserve those values?

A series of public issues and regional concerns, summarized below, were identified during the first public meeting. These formed a preliminary basis for the goals, objectives and recommendations included in this plan (discussed in more detail in Section 7).

- **Identified Significant Resources**
  - High Quality and Exceptional Value streams
  - Scenic areas (including ridgelines)
  - Clean water increases value of real estate

- **Area Concerns**
  - Lack of public access to scenic/recreational resources, particularly streams; additional trails needed
  - Natural resources need protection because of the region's reliance on tourism
  - Protection of water quality
  - Noise/traffic pollution (I-84)

- **Preservation Issues**
  - Consider protecting ridgelines from development because of their high visibility (Pocono Escarpment south of Milford is protected as part of the Delaware Water Gap National Recreation Area, but much of the escarpment between Milford and Matamoras is private land)

- **Identified Tools to Preserve Values**
  - Conservation zoning
  - Public-private partnerships for land protection
  - Increased education and outreach efforts (e.g., use of Milford Water Authority's mailings to provide watershed information)
  - Additional funding to implement recommendations
  - Citizen-based watershed association

2.2.5 Active Volunteer Involvement in Field Assessment

Based on Steering Committee members' extensive education and outreach experience, the decision was made to assess streams, tributaries and watershed land primarily as a public education exercise (although data collected was summarized for potential use in other scientific studies). The Committee developed "user-friendly" field sheets (see Appendix B) to allow volunteers to note significant natural features and cultural/historic/scenic areas and pinpoint any observed problem areas within the watershed.

Section 3. Land Resources

3.1 Soil Characteristics and Limitations

The soil series in Pike County reflect either the bedrock beneath the soils or the glacial material that was deposited over the landscape. The soil types and their properties influence, and may even dictate, the vegetation, development and land use patterns within Pike County.

Several features of soil influence their suitability for residential and commercial development, recreation and other land uses. These include: depth of soil over bedrock, degree of slope, permeability, incidence of flooding, depth to seasonal high water table, soil texture and degree of stoniness (USDA, 1969). These properties influence the selection of development sites, the designs of the structures, construction practices and maintenance (SSURGO database, accessed January 2005). For example, commercial buildings should be constructed on level ground with little flooding, while basements are typically unsuitable for areas with a seasonal high water table that is very close to the surface. Similarly, slope, depth to bedrock, depth to seasonal high water and soil fertility affect the suitability of a site for agricultural and silvacultural activities. These same soils characteristics can either limit or promote the utility of a site for recreational uses, which in turn may influence decision making with respect to open space acquisitions and land preservation.

Information about soils characteristics and development suitability are contained in the Pike County Soil Survey and the USDA - Natural Resources Conservation Service (NRCS) Soil Survey Geographic (SSURGO) Database (available online at http://mcdc.cas.psu.edu). Within the SSURGO database, the suitability of various soils for different types of development is rated by the NRCS as not limited, somewhat limited or very limited. Soil rated as “not limited” for a specific land use or development type is relatively free of any limitations, or has limitations that can be readily mitigated with respect to the proposed use of the site. Higher degrees of limitation may involve limitations that can be mitigated, addressed or overcome but will require more creative planning, somewhat advanced engineering design, and proper construction techniques. Limited soils may also require the implementation of advanced erosion control measures to prevent or reduce the opportunity for acute and chronic soil erosion. Finally, soils with the highest degree of limitation may be impossible or impractical to use for a particular type of development. However, in some cases it may be possible to overcome the inherent limitations of native soils through implementation of special planning, engineering design, environmental impact mitigation and construction measures.

A soil series is a group of soils that share similar characteristics, but differ in the texture of their surface layer. Soils are broken into separate groups according to such differences in texture, and are known as soil types. A list of all the soils located within the watershed is provided below, followed by descriptions of the dominant soil series within the watershed (see Figure 5 for locations of these soils series within the watershed). The soil descriptions include their limitations for various land uses. By correlating this information to the location of the soils throughout the Sawkill-Vandermark watershed as depicted in Figure 5, it is possible to determine where the potential for certain types of land development is limited by naturally-occurring soil

conditions. Where such constraints exist, municipalities should integrate restrictions on development into their zoning and development ordinances. Conversely, where these development-restrictive areas coincide with areas of significant natural resource qualities or recreational potential, long-term planning initiatives may focus on the acquisition, preservation or conservation of these areas.

Soil Series Occurring within the Sawkill-Vandermark Watershed

The following list is based upon data obtained from the USDA - NRCS SSURGO Database:

Arnot
Barbour
Braceville
Chenango
Craigsville-Wyoming
Delaware
Edgemere
Edgemere-Shohola
Freetown
Gleneyre-Kimbles
Lordstown
Lordstown-Swartswood
Manlius
Manlius-Arnot
Mardin
Morris
Oquaga
Oquaga-Arnot
Paupack
Philo
Shohola-Edgemere
Suncook
Swartswood
Wurtsboro
Wyalusing
Wyoming
Wyoming-Chenango

Figure 5. SOILS MAP

Soil Series Descriptions and Potential Limitations*

* Based upon USDA Natural Resources Conservation Service SSURGO soils data.

Arnot Series

The Arnot series formed in glacial till and typically have a very dark, grayish-brown silt loam surface six inches thick. The series consists of shallow, somewhat excessively to moderately well-drained soils on uplands, with bedrock at 10 to 20 inches and slopes ranging from 0 to 70%. These soils have moderate permeability and low available water capacity, with a water table deeper than six feet. Their major limitations for development are slope and a shallow depth to bedrock. Arnot soils tend to occur in the eastern portion of the Sawkill-Vandermark Creeks watershed (see Figure 5, Soils Map).

Estimated Degree of Limitation for Selected Land Uses
Arnot Soil Series

Map Symbol and Description	Dwellings - no basements	Dwellings with basements	Small commercial buildings	Local roads & streets	Lawns & landscaping
402C - very channery loam, 3-15% slopes, very rocky	Very limited (depth to hard bedrock, slope)	Very limited (depth to hard bedrock, slope)	Very limited (depth to hard bedrock, slope)	Very limited (depth to hard bedrock, frost action, slope)	Very limited (depth to bedrock, droughty, gravel content, large stones, slope)
402E - very channery loam, 15-35% slopes, very rocky	Very limited (slope, depth to hard bedrock)	Very limited (slope, depth to hard bedrock)	Very limited (slope, depth to hard bedrock)	Very limited (depth to hard bedrock, slope, frost action)	Very limited (depth to bedrock, slope, droughty, gravel content, large stones)

Barbour Series

Soils of the Barbour Series formed in alluvial deposits from reddish sandstone, siltstone and shale. They are very deep, well-drained soils occurring on floodplains, alluvial fans and low terraces. They have a six-inch loam surface layer that is dark reddish brown in color. Their major limitation for development is flooding. Barbour soils occur in the central portion of the watershed, in Milford Township.

Estimated Degree of Limitation for Selected Land Uses
Barbour Soil Series

Map Symbol and Description	Dwellings - no basements	Dwellings with basements	Small commercial buildings	Local roads & streets	Lawns & landscaping
27 - fine sandy loam	Very limited (flooding)	Very limited (flooding, depth to saturated zn)	Very limited (flooding)	Very limited (flooding, frost)	Somewhat limited (flooding)

Braceville Series

The Braceville Series consists of very deep, somewhat poorly and moderately well-drained soils which formed in glacial outwashes of sands, silts and gravel. The fine sandy loam surface layer is generally 11 inches thick, with a very dark grayish-brown appearance. Their major limitation

for development is a high water table. Braceville soils occur along the border of Milford Township and Milford Borough.

Estimated Degree of Limitation for Selected Land Uses Braceville Soil Series					
Map Symbol and Description	**Dwellings - no basements**	**Dwellings with basements**	**Small commercial buildings**	**Local roads & streets**	**Lawns & landscaping**
14 - fine sandy loam	Somewhat limited (depth to saturated zone)	Very limited (depth to saturated zone)	Somewhat limited (depth to saturated zone)	Somewhat limited (frost, depth to saturated zone)	Somewhat limited (depth to cemented pan, depth to saturated zone)

Chenango Series

Chenango soils were formed in grayish glacial outwash and are well drained, deep, gravelly and/or cobbly. These soils are found mostly in major stream valleys, on nearly level or gently sloping areas on outwash terraces. Since they are well drained, Chenango soils have low to moderate available moisture capacity. They have rapid permeability and are underlain by gravel. Their major limitation for development is slope. Chenango soils occur throughout the watershed, with broad swaths in the eastern portion of Milford Township and the southeastern part of Dingman Township.

Estimated Degree of Limitation for Selected Land Uses Chenango Soil Series					
Map Symbol and Description	**Dwellings - no basements**	**Dwellings with basements**	**Small commercial buildings**	**Local roads & streets**	**Lawns & landscaping**
89B - gravelly fine sandy loam, 0-8% slopes	Not limited	Not limited	Not limited	Somewhat limited (frost action)	Somewhat limited (gravel content, droughty)
89C - gravelly fine sandy loam, 8-15% slopes	Somewhat limited (slope)	Somewhat limited (slope)	Very limited (slope)	Somewhat limited (slope, frost action)	Somewhat limited (slope, gravel content, droughty)
89D - gravelly fine sandy loam, 15-25% slopes	Very limited (slope)	Very limited (slope)	Very limited (slope)	Very limited (slope, frost action)	Very limited (slope, gravel content, droughty)

Craigsville Series

Craigsville soils are very deep and well-drained. They formed in coarse-textured alluvial material and occur in floodplains. Their major limitations for development are flooding and a high content of large stones, which makes excavation and construction difficult. Craigsville-Wyoming soils occur in the eastern portion of Milford Township.

Estimated Degree of Limitation for Selected Land Uses Craigsville Soil Series					
Map Symbol and Description	**Dwellings - no basements**	**Dwellings with basements**	**Small commercial buildings**	**Local roads & streets**	**Lawns & landscaping**
9B - Craigsville-Wyoming complex, 0-8% slopes, extremely stony	Not limited to very limited (flooding, lg stones)	Not limited to very limited (flooding, lg stones)	Not limited to very limited (flooding, lg stones)	Not limited to very limited (flooding, lg stones, frost)	Somewhat limited to very limited (lg stones, flooding, droughty, gravel)

Delaware Series

The deep, well-drained soils of the Delaware series formed in old alluvial material. They are found on low terraces. Since they are well drained, these soils have low to moderate available moisture capacity. They have moderately rapid permeability but are prone to flooding, which limits their potential for development. Delaware soils occur to a limited extent in the watershed, most notably in the southeast portion of Milford Township near the border with Dingman Township.

Estimated Degree of Limitation for Selected Land Uses Delaware Soil Series					
Map Symbol and Description	**Dwellings - no basements**	**Dwellings with basements**	**Small commercial buildings**	**Local roads & streets**	**Lawns & landscaping**
24A - fine sandy loam, 0-3% slopes	Very limited (flooding)	Very limited (flooding)	Very limited (flooding)	Somewhat limited (frost, flooding)	Not limited
24B - fine sandy loam, 3-8% slopes	Very limited (flooding)	Very limited (flooding)	Very limited (flooding)	Somewhat limited (frost, flooding)	Not limited
24C - fine sandy loam, 8-20% slopes	Very limited (flooding, slope)	Very limited (flooding, slope)	Very limited (slope, flooding)	Somewhat limited (slope, frost, flooding)	Somewhat limited (slope)

Edgemere Series

Edgemere soils are primarily located in depressions. They are very poorly drained and have a low permeability rate. Thus, these soils are susceptible to high runoff rates. Available water capacity is low, as well as the shrink/swell potential. Their major limitations for development are high water table, ponding and high content of large stones. Edgemere soils occur throughout the watershed, with concentrations in the western portion of Dingman Township and the northeast part of the watershed in Westfall Township. Edgemere-Shohola soils occur throughout the watershed.

Estimated Degree of Limitation for Selected Land Uses Edgemere Soil Series					
Map Symbol and Description	**Dwellings - no basements**	**Dwellings with basements**	**Sm commercial buildings**	**Local roads & streets**	**Lawns & landscaping**
11A - extremely stony loam, 0-3% slopes, very rubbly	Very limited (depth to saturated zone, ponding, lg stones)	Very limited (depth to saturated zone, ponding, lg stones)	Very limited (depth to saturated zone, ponding, lg stones)	Very limited (depth to saturated zone, frost, ponding, lg stones)	Not rated
111B - Edgemere-Shohola complex, 3-15% slopes, very rubbly	Very limited (depth to saturated zone, ponding, slope)	Very limited (depth to saturated zone, ponding, slope)	Very limited (depth to saturated zone, ponding, slope)	Very limited (depth to saturated zone, frost, ponding, slope)	Very limited (depth to saturated zone, lg stones, depth to cementd pan, droughty, slope)

Freetown Series

Freetown soils are largely found in swampy areas. They are very poorly drained and have a high runoff potential. Their available water capacity is very high. While these soils are usually not flooded, ponding can frequently occur due to the high water table. This limits their potential for development. Freetown soils occur throughout the watershed, with the exception of the southeastern portion of Dingman Township.

Estimated Degree of Limitation for Selected Land Uses Freetown Soil Series					
Map Symbol and Description	**Dwellings - no basements**	**Dwellings with basements**	**Sm commercial buildings**	**Local roads & streets**	**Lawns & landscaping**
20 - mucky peat	Very limited (ponding, depth to saturated zone)	Very limited (ponding, depth to saturated zone)	Very limited (ponding, depth to saturated zone)	Very limited (ponding, depth to saturated zone, frost)	Not rated

Gleneyre Series

The Gleneyre series consists of very deep, very poorly drained soils on fluvio-lacustrine deposits. They formed in sandy and silty lake bed sediments that have been redeposited by stream action. Because they are poorly drained, they are prone to flooding and ponding, which restricts their potential for development. Gleneyre-Kimbles soils occur mainly in Shohola Township and western Milford Township.

Estimated Degree of Limitation for Selected Land Uses Gleneyre Soil Series					
Map Symbol and Description	**Dwellings - no basements**	**Dwellings with basements**	**Small commercial buildings**	**Local roads & streets**	**Lawns & landscaping**
12 - Gleneyre-Kimbles complex, 0-2% slopes	Very limited (ponding, flooding, depth to saturated zone)	Very limited (ponding, flooding, depth to saturated zone)	Very limited (ponding, flooding, depth to saturated zone)	Very limited (ponding, depth to saturated zone, frost, flooding)	Very limited (ponding, flooding, depth to saturated zone)

Lordstown Series

Lordstown soils are very well drained with a low runoff potential. They have low rates of permeability, and are very close to bedrock (generally 20 to 40 inches). Flooding and/or ponding usually do not occur on these soils. Lordstown soils have a low shrink/swell rate. Lordstown-Swartswood soils occur mainly in the southwest portion of the watershed (Shohola Township) and throughout the central and north-central portions of the watershed (Milford Township).

Estimated Degree of Limitation for Selected Land Uses
Lordstown Soil Series

Map Symbol and Description	Dwellings - no basements	Dwellings with basements	Sm commercial buildings	Local roads & streets	Lawns & landscaping
897B - Lordstown-Swartswood complex, 0-8% slopes, extremely stony	Not limited to somewhat limited (slope, depth to hard bedrock)	Very limited (depth to hard bedrock, depth to saturated zone)	Not limited to somewhat limited (depth to hard bedrock)	Somewhat limited (frost, depth to hard bedrock)	Somewhat to very limited (lg stones, depth to bedrock, droughty, depth to cemented pan, gravel)
897C - Lordstown-Swartswood complex, 8-15% slopes, extremely stony	Somewhat limited (slope, depth to hard bedrock)	Very limited (depth to hard bedrock, depth to saturated zone, slope)	Very limited (slope, depth to hard bedrock)	Somewhat limited (slope, frost, depth to hard bedrock)	Somewhat to very limited (lg stones, slope, depth to bedrock, droughty, depth to cemented pan, gravel)
897D - Lordstown-Swartswood complex, 15-30% slopes, extremely stony	Very limited (slope, depth to hard bedrock)	Very limited (slope, depth to hard bedrock, depth to saturated zone)	Very limited (slope, depth to hard bedrock)	Very limited (slope, frost, depth to hard bedrock)	Very limited (slope, lg stones, depth to bedrock, droughty, depth to cemented pan, gravel)

Manlius Series

Manlius soils consist of moderately deep, well-drained, shale soils. These very acidic soils are gently sloping to very steep, very rocky or rocky soils on ridge tops and steep escarpments. They have moderately rapid permeability, and thus low available moisture capacity. These soils are often very dry and are limited for farming, even on the gentle slopes. The rocks and steep slopes can also be severe limitations for building sites. Manlius-Arnot soils occur mainly throughout the southeast portion of the watershed in Milford and Dingman Townships.

Estimated Degree of Limitation for Selected Land Uses
Manlius Soil Series

Map Symbol and Description	Dwellings - no basements	Dwellings with basements	Sm commercial buildings	Local roads & streets	Lawns & landscaping
121D - Manlius-Arnot-rock outcrop complex, 15-30% slopes, rubbly	Very limited (slope, depth to hard bedrock, lg stones)	Very limited (slope, depth to hard bedrock, lg stones)	Very limited (slope, depth to hard bedrock, lg stones)	Very limited (slope, depth to hard bedrock, frost, lg stones)	Very limited (slope, depth to bedrock, lg stones, droughty, gravel)
121F - Manlius-Arnot-rock outcrop complex, 30-80% slopes, rubbly	Very limited (slope, depth to hard bedrock, lg stones)	Very limited (slope, depth to hard bedrock, lg stones)	Very limited (slope, depth to hard bedrock, lg stones)	Very limited (slope, depth to hard bedrock, frost, lg stones)	Very limited (slope, depth to bedrock, lg stones, droughty, gravel)

Mardin Series

Mardin soils are found mostly in uplands, in the eastern section of the county, where gray rocks are predominant. They are deep, moderately well drained soils. They are gently sloping to moderately steep. These acidic soils have a well-developed fragipan that begins nearly 20 inches below the surface. (A fragipan is a natural subsurface horizon having a higher bulk density than the solum above, seemingly cemented when dry, but showing moderate to weak brittleness when moist. The layer is low in organic matter, mottled, and slowly or very slowly permeable to water; it usually has some polygon-shaped bleached cracks). The growth of roots and the flow of water through the soil are impeded by the fragipan. Mardin soils occur mainly throughout the southeast portion of the watershed in Milford and Dingman Townships.

Estimated Degree of Limitation for Selected Land Uses
Mardin Soil Series

Map Symbol and Description	Dwellings - no basements	Dwellings with basements	Sm commercial buildings	Local roads & streets	Lawns & landscaping
60B - channery silt loam, 0-8% slopes, stony	Somewhat limited (depth to saturated zone)	Very limited (depth to saturated zone)	Somewhat limited (depth to saturated zone)	Somewhat limited (frost, depth to saturated zone)	Somewhat limited (depth to cemented pan, droughty, depth to saturated zone, lg stones, gravel)
60C - channery silt loam, 8-15% slopes, stony	Somewhat limited (depth to saturated zone, slope)	Very limited (depth to saturated zone, slope)	Very limited (slope, depth to saturated zone)	Somewhat limited (slope, frost, depth to saturated zone)	Somewhat limited (depth to cemented pan, droughty, slope, depth to saturated zone, lg stones)
61B - stony loam, 0-8% slopes, extremely stony	Somewhat limited (depth to saturated zone)	Very limited (depth to saturated zone)	Somewhat limited (depth to saturated zone)	Somewhat limited (frost, depth to saturated zone)	Somewhat limited (depth to cemented pan, lg stones, droughty, depth to saturated zone, gravel)
61C - stony loam, 8-15% slopes, extremely stony	Somewhat limited (depth to saturated zone, slope)	Very limited (depth to saturated zone, slope)	Very limited (slope, depth to saturated zone)	Somewhat limited (slope, frost, depth to saturated zone)	Somewhat limited (depth to cemented pan, slope, droughty, depth to saturated zone, gravel)

Morris Series

Morris soils are loamy soils that were formed in glacial till derived from a mixture of red and gray, acid sandstone and shale. Though these very acidic soils are found in uplands, they are somewhat poorly drained to poorly drained due to a firm fragipan about 15 inches below the surface. An elevated seasonal high water table makes Morris soils poorly suited for agriculture or development. Morris soils occur to a limited extent in the watershed, mainly in Milford and Shohola Townships.

Estimated Degree of Limitation for Selected Land Uses Morris Soil Series					
Map Symbol and Description	**Dwellings - no basements**	**Dwellings with basements**	**Sm commercial buildings**	**Local roads & streets**	**Lawns & landscaping**
19B - very channery loam, 0-8% slopes, very stony	Very limited (depth to saturated zone)	Very limited (depth to saturated zone)	Very limited (depth to saturated zone)	Very limited (frost, depth to saturated zone)	Very limited (depth to cemented pan, depth to saturated zone, droughty, lg stones, gravel)

Oquaga Series

Oquaga soils occur on uplands and are moderately deep. Because they are well drained to excessively drained with moderate permeability, they have low runoff potential and are not prone to flooding or ponding. However, they may have steep slopes and large stones which restrict development. Oquaga soils and Oquaga-Arnot soils occur mainly throughout the central portion of the watershed.

Estimated Degree of Limitation for Selected Land Uses Oquaga Soil Series					
Map Symbol and Description	**Dwellings - no basements**	**Dwellings with basements**	**Small commercial buildings**	**Local roads & streets**	**Lawns & landscaping**
239B - very stony loam, 0-8% slopes, extremely bouldery	Somewhat limited (depth to hard bedrock, lg stones)	Very limited (depth to hard bedrock, lg stones)	Somewhat limited (depth to hard bedrock, lg stones)	Somewhat limited (frost, depth to hard bedrock, lg stones)	Somewhat limited (droughty, lg stones, depth to bedrock)
239C - very stony loam, 8-15% slopes, extremely bouldery	Somewhat limited (slope, depth to hard bedrock, lg stones)	Very limited (depth to hard bedrock, slope, lg stones)	Very limited (slope, depth to hard bedrock, lg stones)	Somewhat limited (slope, frost, depth to hard bedrock, lg stones)	Somewhat limited (droughty, slope, lg stones, depth to bedrock, gravel)
239D - very stony loam, 15-30% slopes, extremely bouldery	Very limited (slope, depth to hard bedrock, lg stones)	Very limited (slope, depth to hard bedrock, lg stones)	Very limited (slope, depth to hard bedrock, lg stones)	Very limited (slope, frost, depth to hard bedrock, lg stones)	Very limited (slope, droughty, lg stones, depth to bedrock, gravel)
240F - Oquaga-Arnot-rock outcrop complex, 20-60% slopes, very rubbly	Very limited (slope, depth to hard bedrock, lg stones)	Very limited (slope, depth to hard bedrock, lg stones)	Very limited (slope, depth to hard bedrock, lg stones)	Very limited (slope, frost, depth to hard bedrock, lg stones)	Very limited (slope, lg stones, droughty, depth to bedrock, gravel)

Paupack Series

Paupack soils consist of moderately deep to mineral material. They are very poorly drained, with high runoff potential and a tendency to pond or flood. This limits their development potential and may create subsidence conditions. “Pockets” of Paupack soils occur throughout the watershed, mainly in Westfall and Milford Townships.

Estimated Degree of Limitation for Selected Land Uses Paupack Soil Series					
Map Symbol and Description	**Dwellings - no basements**	**Dwellings with basements**	**Small commercial buildings**	**Local roads & streets**	**Lawns & landscaping**
18 - mucky peat	Very limited (ponding, subsidence, depth to saturated zone)	Very limited (ponding, subsidence, depth to saturated zone)	Very limited (ponding, subsidence, depth to saturated zone)	Very limited (ponding, depth to saturated zone, subsidence, frost)	Not rated

Philo Series

Philo soils formed in recent alluvial material and occur on floodplains. They are moderately permeable and have a water table that rises to within 1½ to 3 feet of the surface when wetness is at its peak, so they are prone to flooding. The available moisture capacity is moderate. These soils are strongly to extremely acidic. Development on Philo soils is restricted due to flooding and excessive wetness. Philo soils occur mainly in the eastern portion of the watershed, in Milford Township near the border with Milford Borough.

Estimated Degree of Limitation for Selected Land Uses Philo Soil Series					
Map Symbol and Description	**Dwellings - no basements**	**Dwellings with basements**	**Small commercial buildings**	**Local roads & streets**	**Lawns & landscaping**
26 - loam	Very limited (flooding, depth to saturated zone)	Very limited (flooding, depth to saturated zone)	Very limited (flooding, depth to saturated zone)	Very limited (flooding, frost, depth to saturated zone)	Very limited (flooding, depth to saturated zone)

Shohola Series

Shohola soils are very deep and somewhat poorly drained. They formed in glacial till and occur on uplands. Their tendency to flood and high proportion of large stones limits their potential for development. Shohola-Edgemere soils occur in relatively narrow bands throughout the watershed.

Estimated Degree of Limitation for Selected Land Uses Shohola Soil Series					
Map Symbol and Description	**Dwellings - no basements**	**Dwellings with basements**	**Small commercial buildings**	**Local roads & streets**	**Lawns & landscaping**
7B - Shohola-Edgemere complex, 0-8% slopes, very rubbly	Very limited (depth to saturated zone, ponding, lg stones)	Very limited (depth to saturated zone, ponding, lg stones)	Very limited (depth to saturated zone, ponding, lg stones)	Very limited (depth to saturated zone, frost, ponding, lg stones)	Very limited (depth to saturated zone, lg stones, depth to cementd pan, droughty)
7C - Shohola-Edgemere complex, 8-15% slopes, very rubbly	Very limited (depth to saturated zone, ponding, slope, lg stones)	Very limited (depth to saturated zone, ponding, slope, lg stones)	Very limited (depth to saturated zone, ponding, slope, lg stones)	Very limited (depth to saturated zone, frost, ponding, slope, lg stones)	Very limited (depth to saturated zone, lg stones, depth to cementd pan, slope, droughty)

Suncook Series

Suncook soils formed in alluvium derived from granite, gneiss, schist and quartzite and occur on floodplains. They are very deep and excessively drained, with low runoff potential and rapid or very rapid permeability. However, they are subject to common flooding for brief durations. Their major limitations for development are flooding and droughtiness. Suncook soils occur in very limited "pockets" in the watershed.

Estimated Degree of Limitation for Selected Land Uses
Suncook Soil Series

Map Symbol and Description	Dwellings - no basements	Dwellings with basements	Small commercial buildings	Local roads & streets	Lawns & landscaping
5B - loamy sand, 0-8% slopes	Very limited (flooding)	Very limited (flooding)	Very limited (flooding)	Very limited (flooding)	Somewhat limited (droughty, flooding)

Swartswood Series

Swartswood soils were formed in glacial till derived from gray sandstone and siltstone. These soils are well drained with a moderately coarse texture. These strongly acidic soils have moderate permeability and moderate available moisture capacity. Swartswood soils are gently sloping to moderately steep, and most are stony. Swartswood soils occur in broad swaths throughout the northern and central areas of the watershed.

Estimated Degree of Limitation for Selected Land Uses
Swartswood Soil Series

Map Symbol and Description	Dwellings - no basements	Dwellings with basements	Sm commercial buildings	Local roads & streets	Lawns & landscaping
38B - stony fine sandy loam, 0-8% slopes, extremely stony	Not limited	Very limited (depth to saturated zone)	Not limited	Somewhat limited (frost)	Somewhat limited (lg stones, droughty, depth to cementd pan)
38C - stony fine sandy loam, 8-15% slopes, extremely stony	Somewhat limited (slope)	Very limited (depth to saturated zone, slope)	Very limited (slope)	Somewhat limited (slope, frost)	Somewhat limited (lg stones, slope, droughty, depth to cementd pan)
38D - stony fine sandy loam, 15-30% slopes, extremely stony	Very limited (slope)	Very limited (slope, depth to saturated zone)	Very limited (slope)	Very limited (slope, frost)	Very limited (slope, lg stones, droughty, depth to cementd pan)

Wurtsboro Series

Wurtsboro soils were formed in glacial till derived from acid, gray sandstone and siltstone. These deep, moderately well drained, sandy soils are found mainly in the eastern part of Pike County. They are gently sloping to moderately steep, and have a moderate available moisture capacity and slow permeability due to the fragipan that begins about 20 inches below the surface. Wurtsboro soils are very strongly acidic and so stony that they have severe limitations for agriculture. Broad swaths of Wurtsboro soils occur in Dingman, Milford and Westfall Townships.

Estimated Degree of Limitation for Selected Land Uses Wurtsboro Soil Series					
Map Symbol and Description	**Dwellings - no basements**	**Dwellings with basements**	**Sm commercial buildings**	**Local roads & streets**	**Lawns & landscaping**
30B - stony fine sandy loam, 0-8% slopes, extremely stony	Somewhat limited (depth to saturated zone)	Very limited (depth to saturated zone)	Somewhat limited (depth to saturated zone)	Somewhat limited (frost, depth to saturated zone)	Somewhat limited (depth to cemented pan, droughty, lg stones, depth to saturated zone)
30C - stony fine sandy loam, 8-15% slopes, extremely stony	Somewhat limited (slope, depth to saturated zone)	Very limited (depth to saturated zone, slope)	Very limited (slope, depth to saturated zone)	Somewhat limited (slope, frost, depth to saturated zone)	Somewhat limited (depth to cemented pan, droughty, slope, lg stones, depth to saturated zone)

Wyalusing Series

Wyalusing soils formed in alluvial deposits and occur on floodplains. They are typically subject to flooding and support wetland-type vegetation. Their major limitations for development are flooding and high water table. Small "pockets" of Wyalusing soils occur throughout the watershed, concentrated just outside of Milford Borough.

Estimated Degree of Limitation for Selected Land Uses Wyalusing Soil Series					
Map Symbol and Description	**Dwellings - no basements**	**Dwellings with basements**	**Small commercial buildings**	**Local roads & streets**	**Lawns & landscaping**
143 - fine sandy loam	Very limited (flooding, depth to saturated zone)	Very limited (flooding, depth to saturated zone)	Very limited (flooding, depth to saturated zone)	Very limited (depth to saturated zone, frost, flooding)	Very limited (flooding, depth to saturated zone)

Wyoming Series

Wyoming soils formed in water-sorted sand and gravel derived from red and gray sandstone. They typically occur on terraces and moraines. These soils are somewhat excessively drained. They tend to have steep slopes and a high content of large stones, which limits their development potential. Wyoming soils occur mainly in Milford and Dingman Townships near their mutual border, as well as other scattered "pockets" throughout the watershed.

Estimated Degree of Limitation for Selected Land Uses Wyoming Soil Series					
Map Symbol and Description	**Dwellings - no basements**	**Dwellings with basements**	**Small commercial buildings**	**Local roads & streets**	**Lawns & landscaping**
442B - very cobbly sandy loam, 3-8% slopes	Somewhat limited (lg stones)	Somewhat limited (lg stones)	Somewhat limited (lg stones, slope)	Somewhat limited (lg stones)	Very limited (lg stones, droughty, gravel)
442C - very cobbly sandy loam, 8-15% slopes	Somewhat limited (slope)	Somewhat limited (slope)	Somewhat limited (slope)	Somewhat limited (slope)	Very limited (lg stones, slope, droughty, gravel)
442D - very cobbly sandy loam, 15-30% slopes	Very limited (slope, lg stones)	Very limited (slope, lg stones)	Very limited (slope, lg stones)	Very limited (slope, lg stones)	Very limited (slope, lg stones, droughty, gravel)

3.2 Prime Agricultural Soils

The Comprehensive Plans for the five watershed municipalities note that the most fertile agricultural soils (prime agricultural soils) in the area are located in the floodplains along the Delaware River (see Figure 6). As of 1992, 1,770 acres of land in the County were reported to be in farm use, representing less than 1 percent of the County's total land area. Always a limited land use in Pike County, agriculture has declined since 1950; by 1979, only five farms were operating commercially in the county, with 1.05 square miles used for cropland and 0.10 square miles used for pasture.

Most of the prime agricultural land in Pike County lies along the Delaware River and is now owned by the National Park Service as part of the Delaware Water Gap National Recreation Area. The National Park Service does lease the river bottomlands for crop production, with a total of 872 acres of the Recreation Area under tillage in the county, used primarily for corn production. The balance of the county's agricultural land, approximately 900 acres, is used largely for pasture or fodder crops associated with a few dairy, beef, llama, sheep and goat operations. The county's agricultural lands act to protect ground and surface water yields by providing large areas of pervious soils, which readily absorb precipitation and help recharge groundwater supplies, reduce flooding and decrease polluted stormwater runoff.

The following is a list of the soil types described by the USDA - Natural Resource Conservation Service - as "all areas are prime farmland" or "Farmland of Statewide Importance":

Barbour fine sandy loam
Braceville fine sandy loam
Chenango gravelly fine sandy loam, 0-8% slopes
Chenango gravelly fine sandy loam, 8-15% slopes
Delaware fine sandy loam, 0-3% slopes
Delaware fine sandy loam, 3-8% slopes
Mardin channery silt loam, 0-8% slopes
Mardin channery silt loam, 8-15% slopes
Suncook loamy sand, 0-8% slopes
Wurtsboro channery fine sandy loam, 0-8% slopes
Wurtsboro channery fine sandy loam, 8-15% slopes

Figure 6. PRIME AGRICULTURAL SOILS MAP

3.3 Geology

The Sawkill Creek Watershed lies completely in the Glaciated Low Plateaus section of the Appalachian Plateaus physiographic province, while the Vandermark Creek Watershed lies in between the Glaciated Low Plateaus Mountain section of the Appalachian Plateaus physiographic province and the Appalachian Mountain section of the Valley and Ridge physiographic province. Topography of both watersheds can be generalized as flat-topped hills lying on top of fairly steep slopes. In the southeastern section of the watershed, an escarpment (a steep slope or long cliff that results from erosion or faulting and separates two relatively level areas of differing elevations) dominates the topography. This escarpment (known locally as The Bluff) lies in a northeast-southwest fashion. The steepest slopes of The Bluff occur on the southeast side while the gentle slopes are located on the northwest side.

The underlying geology of the entire watershed is comprised of four different formations (see Figure 7):

- ***Long Run and Walcksville Members of Catskill Formation, undivided*** **(Dclw).** Includes, in descending order, the Long Run (Dclr) and Walcksville (Dcw) Members of the Catskill Formation. Long Run consists of gray and grayish-red sandstone and grayish-red siltstone and mudstone in fining-upward cycles. The Walcksville formation consists of Greenish-gray sandstone and red siltstone and mudstone in fining-upward cycles.

- ***Towamensing Member of Catskill Formation*** **(Dct).** Dominantly gray sandstone and some siltstone and shale; freshwater fossils.

- ***Mahantango Formation*** **(Dmh).** Gray, brown, and olive shale and siltstone; marine fossils. Includes the following members, in descending order: Tully—argillaceous limestone; Sherman Ridge, Montebello (sandstone), Fisher Ridge, Dalmatia, and Turkey Ridge. In south-central Pennsylvania, includes Clearville, Frame, Chaneysville, and Gander Run Members. Characterized by coarsening-upward cycles.

- ***Trimmers Rock Formation*** **(Dtr).** Olive-gray siltstone and shale, characterized by graded bedding; marine fossils; some very fine grained sandstone in northeast; black shale of Harrell Formation at base in Susquehanna Valley.

Figure 7. GEOLOGY

3.4 Land Use / Land Cover

"Land Use" refers to the present manner in which land is being utilized in an area. "Land Cover" pertains to the type of vegetation (if any) in a particular area. Land Use/ Land Cover is an important watershed feature, as it shows the types of activity taking place throughout the watershed and is an indicator of the location and amount of impervious surfaces (which contribute to stormwater runoff and nonpoint source pollution) and other potential pollutant sources (e.g., industrial facilities, agricultural lands, mining operations) in the watershed.

The Sawkill-Vandermark Creeks Watershed is dominated by natural habitat (forest and wetlands). Deciduous forest is the dominant land cover within the watershed and is found mainly in the northern section, where changes in elevation are prevalent (see Figure 3). Due to the constraints of steep slopes and the preservation of much of this area in protected lands, these areas are relatively undeveloped and contain large contiguous tracts of deciduous forest.

Table 6. Public/Private Lands Comparison

	Total Public Lands	Total Private Lands	Total Acres
Sawkill Watershed	4,920 acres	10,971 acres	15,891 acres
Vandermark Watershed	285 acres	3,061 acres	3,346 acres
Total	5,205 acres	14,032 acres	19,237 acres

Row crops comprise a small portion of the total land cover within the watershed. These smaller tracts of land are scattered about the southern half of the watershed, and with good reason. Figure 5 (Soils) shows that the locations of the row crops correlate to the location of the prime farmland soils within the watershed. A majority of the development that has taken place has occurred in the flat, lower-lying valleys. The High/Low Density Urban areas are centered on Interstate 84 corridor and the Borough of Milford. Secondary population centers consist of the much less densely populated rural developed areas located south of Interstate 84, in the southwestern half of the watershed.

3.5 Landfills and Sinkholes

According to Pennsylvania DEP records, there are currently no landfills or known sinkholes located within the Sawkill-Vandermark Creeks Watershed.

3.6 Potential Hazard Areas

One method of determining natural resource vulnerability and potential pollution is to determine the location of Superfund sites, state hazardous waste sites, regulated storage tanks, and other regulated facilities. The following information was obtained from PADEP and is provided to present a sense of where these facilities are located throughout the watershed study area:

- **Superfund (CERCLA & SARA) Sites** – In 1980, Congress enacted the Comprehensive Environmental response, Compensation and Liability Act (CERCLA), commonly known as the Superfund, in response to the dangers of uncontrolled or abandoned contaminated sites. The Superfund Amendments and Re-authorization Act (SARA) amended CERCLA in 1986. CERCLA and SARA require that a National Priorities List of sites throughout the United States be maintained and revised at least annually. *There are no federal Superfund Sites located in the Sawkill-Vandermark Creeks Watershed.*

- **Hazardous Waste Generators** – The federal Resource Conservation and Recovery Act (RCRA) was enacted in 1976 as a response to growing public awareness of serious problems related to disposal of hazardous waste. The hazardous waste provision of RCRA requires that entities generating, transporting, or disposing of hazardous waste obtain a permit. The PADEP database notes that there are six registered hazardous waste generators, transporters, and/or disposers of hazardous waste in the municipalities involved in this study. They include: *Mil Fab, Inc, Milford; Milford Compressor Station, Milford; Milford Dry Cleaners, Milford; Oil Energy Recover, Inc., Shohola; S&M Management, Inc., Milford; and S&M Waste Oil, Inc., Milford.*

- **State Hazardous Waste Contamination Sites** – The Known Contaminated Sites in Pennsylvania is a list of sites in the state where contamination of soil or groundwater is confirmed and remediation is either underway or pending. There are 11 such sites within the municipalities involved in this study. They include: *Camp Speers-Eljabar, Dingman Township; Clean Treatment Sewage Company, Dingman Township; Delaware Valley School District, Milford Borough; Delaware Valley Utilities, Inc., Westfall Township; Mr. Bruce N. Harding, Shohola Township; Jersey Federation of YMHA & HW, Dingman Township; Lake Adventure Community Association, Dingman Township; Milford Borough Municipal Authority, Milford Township; Pike County Environmental, Inc., Westfall Township; Mr. Timothy & Marcia Shields, Dingman Township; and Shohola Falls Trails End P.O.A., Shohola Township.*

- **Quarries/Mining Operations – Active and Inactive** – The Pennsylvania Department of Environmental Protection maintains a list of active and inactive quarries/mining operations. Active and inactive sites in the study area include: *Eureka Stone Quarry, Dingman Township, active; FAW Associates Quarry, Milford Township, active; Myers Quarry, Milford Township, inactive.*

Section 4. Water Resources

The following section includes a detailed discussion about the surface and groundwater resources in the Sawkill-Vandermark Creeks Watershed (see Figure 8). It is significant to note that the municipalities' zoning ordinances and associated land development regulations recognize the importance and value of these resources.

4.1 Major Tributaries

4.1.1. Vandermark Creek

The Vandermark Creek watershed is relatively small (5.2 square miles or 3347 acres), and two tributaries (Laurel Swamp Brook, Deep Brook) comprise a large proportion of this watershed area (see Table 7, Figure 8, Figure 9). Laurel Swamp Brook flows in a southwesterly direction from Westfall Township towards Milford Township and drains an area of 0.8 square miles (499 acres). It passes through a large forested swamp in Milford Township just south of Westfall Township prior to its confluence with Vandermark Creek. Deep Brook's headwaters also originate in Westfall Township and the stream flows primarily in a southerly direction through a deep canyon before it meets with Vandermark Creek to the north of Milford Borough. The area drained by Deep Brook is 2.0 square miles (1261 acres), approximately 38% of the total Vandermark Creek watershed.

Vandermark Creek and most of its tributaries are recognized by the State of Pennsylvania as High Quality - Cold Water Fishery (HQ-CWF) streams (see Table 6). Deep Brook, however, has a more stringent designated use as an Exceptional Value (EV) stream. With the main stem and all tributaries designated either HQ-CWF or EV, Vandermark Creek is protected for the "maintenance or propagation, or both, of fish species including the family Salmonidae and additional flora and fauna which are indigenous to a cold water habitat" (25 Pa. Code § 93.3). Furthermore, as HQ and EV streams, Vandermark Creek and its tributaries are protected by the anti-degradation requirements set forth in the Pennsylvania Code (25 Pa. Code § 93.4a) that require the maintenance both of the designated uses (a broader category related how the stream is valued by humans) and of the existing water quality of these streams. It is important to note that Vandermark Creek and it tributaries not only have special protection designations but that they also attain their designated uses based on the 2004 Integrated List (the 2004 Pennsylvania Integrated Water Quality Monitoring and Assessment Report). This attainment of their designated uses (HQ-CWF, EV) establishes that the streams in the Vandermark Creek watershed currently exist in a relatively pristine condition with no substantial impacts to water quality or ecological condition (see Water Quality below).

4.1.2. Sawkill Creek

In addition to the main stem of the Sawkill Creek, seven tributaries make up the Sawkill Creek Watershed. They include Savantine Creek, Gum Brook, Dimmick Meadow Brook, Pinchot Brook, Craft Brook, Vantine Brook and Sloat Brook (see Figure 9, Figure 9). Two of these tributaries (Sloat Brook, Vantine Brook) drain lower elevation areas below the significant

barrier of Pinchot Falls (aka, Sawkill Falls) and join Sawkill Creek in or near Milford. The remaining five tributaries drain higher elevation headwater areas of the watershed and have variable watershed areas and lengths, with Savantine Creek draining a large area of the northwestern headwaters (4.9 sq. mile or 3142 acres) and the other streams draining smaller headwater areas (see Table 7). In total, the watershed for Sawkill Creek drains and area of 24.8 square miles (15,890 acres).

Sawkill Creek's headwaters are in and immediately above Mud Pond in Dingman Township. Sawkill Creek then runs in an easterly direction passing through several additional ponds, Pinchot Falls in Milford Township, and a number of quarries before joining the Delaware River in Milford Borough. Savantine Creek has its headwaters in Shohola Township just east of the Twin Lakes watershed. It flows in a southeasterly direction until meeting up with Sawkill Creek in Milford Township. Craft Brook is the next tributary downstream running in a southerly direction; it passes through Lily Pond in Milford Township until it meets the Sawkill Creek. Pinchot Brook, another small tributary, merges a short distance below the confluence between Craft Brook and Sawkill Creek. Pinchot Brook originates in Westfall Township from an unnamed pond and flows in a southwesterly direction until it meets with Sawkill Creek. Dimmick Meadow Brook is the forth tributary to merge with Sawkill Creek. Dimmick Meadow Brook also originates in Westfall Township within Delaware State Forest lands. It flows southeasterly through steep terrain in Milford Township, merging with Sawkill Creek northwest of I-84. Vantine Brook is the last tributary of the Sawkill Creek watershed that enters Sawkill Creek from the north. Its headwaters start in a series of unnamed ponds in Milford Township, flows under both I-84 and Route 6, and past Milford Reservoir before it merges with Sawkill Creek. Finally, Sloat Brook is a small tributary to the south of Sawkill Creek that originates in Dingman Township and flows in an easterly direction to merge with Sawkill Creek just west of Milford Borough.

Sawkill Creek and its tributaries are all designated and protected as either EV or HQ-CWF streams (see Table 7). Specifically, Vantine Brook is designated HQ-CWF, while all sections of the main stem Sawkill Creek and the remaining tributaries to Sawkill Creek from its headwaters down to the Delaware River have received EV designation. Like Vandermark Creek and its tributaries, the EV and HQ designations protect both the existing uses of cold-water organisms as well as the existing water quality of these streams in the Sawkill Creek watershed. And like Vandermark Creek, all streams that have been assessed in the Sawkill Creek basin have attained their designated use. Together, then, the streams of the Vandermark Creek and Sawkill Creek watershed are well-protected by Pennsylvania state law and should continue to maintain their high water quality through the proper application of the Water Quality Standards.

4.2 Wetlands

Wetlands are an important component of an ecologically balanced ecosystem. Wetlands, especially riparian wetlands, help maintain the hydrologic and hydraulic stability streams and surface waters, protect water quality and provide valuable habitat for a variety of terrestrial, aquatic and amphibian organisms. More specifically, wetlands often function as natural catch basins detaining and/or retaining storm flows, which in turn are gradually released into the

ground or adjacent waterways. During the dry season, wetlands also release waters to ground and surface sources, thus helping to maintain base flows during dry or drought periods. In addition, wetland vegetation, through filtration, settling and flow dampening biotreat runoff, decreasing storm conveyed contaminants by filtering, assimilating and recycling pollutants.

Table 7. Summary of Sub-Basins and Streams within the Sawkill-Vandermark Watershed

STREAM	WATERSHED AREA		STREAM MILES		DESIGNATED USE[1]	INTEGRATED LIST STATUS[2]
	sq. miles	%	miles	%		
Vandermark Creek (entire watershed)	5.2	100%	11.4	100%	HQ-CWF	Attaining (Aquatic Life Use)
Laurel Swamp Brook	0.8	15%	2.5	22%	HQ-CWF	Attaining (Aquatic Life Use)
Deep Brook	2.0	38%	4.0	35%	EV	Attaining (Aquatic Life Use)
Sawkill Creek (entire watershed)	24.8	100%	60.1	100%	EV	Attaining (Aquatic Life Use)
Sloat Brook	2.7	11%	3.5	6%	EV	Attaining (Aquatic Life Use)
Vantine Brook	1.2	5%	3.2	5%	HQ-CWF	Attaining (Aquatic Life Use)
Dimmick Meadow Brook	2.7	11%	7.1	12%	EV	Attaining (Aquatic Life Use)
Pinchot Brook	1.8	7%	5.4	9%	EV	Attaining (Aquatic Life Use)
Craft Brook	1.7	7%	5.5	9%	EV	Attaining (Aquatic Life Use)
Savantine Creek	4.9	20%	14.3	24%	EV	Attaining (Aquatic Life Use)
Gum Brook	1.2	5%	3.3	5%	EV	Attaining (Aquatic Life Use)

[1] Designated Use identifies the standards for the ecological community and the water quality of a given stream, and the extent of environmental protections afforded that stream.
[2] Integrated List Status is based on the 2004 *Pennsylvania Integrated Water Quality Monitoring and Assessment Report* and includes whether the designated use is attained and what aspects have been assessed.

The Army Corps of Engineers (ACOE) and the EPA jointly define wetlands as "those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas" (U.S. Army Corps of Engineers Environmental Laboratory 1987). The National Wetlands Inventory, published by the US Fish and Wildlife Service, identifies the County's major wetlands. In addition, hydric soils identified in the Pike County Soil Survey provide a good indication of wetland locations in the County (see Figure 5).

The U.S. Fish and Wildlife Service divides wetlands into five broad categories. Within the Sawkill-Vandermark Creeks Watershed, the area's wetlands are defined as riverine, palustrine, or lacustrine. The majority of wetlands in the Sawkill-Vandermark Creeks Watershed are primarily classified as palustrine. This broad classification of wetlands includes wetland systems commonly referred to as swamps, marshes, bogs, fens, wet meadows, and seasonally wet woodlands as well as the smaller and shallower ponds not matching the lacustrine designation. These palustrine wetlands can be found throughout the watershed but are heavily concentrated in the headwaters of each stream catchment. In addition, Laurel Swamp Brook passes through a notably large forested wetland in the central part of its drainage basin. Across the combined Sawkill-Vandermark Creeks Watershed, all wetlands cover an area of 643 acres and comprise 3.3% of the watershed area (see Figure 7 and detailed description of lacustrine wetlands in Lakes and Ponds section below).

Within the Vandermark watershed, a single riverine wetland exists along the lower sections of Deep Brook below I-84. The Sawkill watershed contains no similar riverine wetlands. The remaining wetlands in the Vandermark watershed all lie north of I-84 in headwater areas and consist of either small ponds or vegetated wetlands (scrub-shrub, broadleaf deciduous, and needle-leaved evergreen). Although these various wetlands serve as local concentrations of biodiversity and provide outstanding ecosystem functions for the Vandermark watershed, none of these wetlands have been identified as outstanding natural features for Pennsylvania by the PADEP. However, this does not mean they do not require protection or are of ordinary value.

Figure 8. STREAMS, WETLANDS, FLOODPLAIN MAP

Figure 9. WATERSHED BASINS MAP

Relative to the Vandermark watershed, the Sawkill watershed contains more extensive areas of wetlands and a broader diversity of wetland types, although riverine wetlands are absent from the Sawkill watershed. These wetlands include lakes, pond, and various types of vegetated wetlands. The lakes and ponds are discussed below. The vegetated wetlands include forested wetlands (broad-leaved deciduous, needle-leaved evergreen, and mixed deciduous-evergreen), scrub/shrub wetlands, and emergent wetlands all with varying hydro-periods. In addition, a bog (scrub/shrub, broad evergreen wetland with acidic conditions) surrounds Mud Pond in the headwaters of the Sawkill. This bog is one of two extraordinary wetlands resources within the Sawkill watershed, with a good population of a state-rare shrub. In the headwaters of Savantine Creek, one of the upper tributaries to Sawmill Creek, a second outstanding wetland exists, Sagamore Swamp. This is a small coniferous swamp in excellent condition. However, this wetland ecosystem is threatened by development. Reportedly, there are plans to fully inundate this wetland through the construction of an impoundment.

Pennsylvania's waterways and wetlands protection program is recognized as one of the best in the nation. The program has recorded a net gain in wetland acreage and permitted wetland losses average fewer than 100 acres annually. Since 1990, 1,471 acres were required to be replaced to offset 885 acres impacted as a result of different development related activities (Housing, commercial, highway, etc.). There are also a variety of voluntary wetland restoration programs supported by the US Division of Fish and Wildlife, the Natural Resource Conservation Service, DEP, watershed groups and private landowners that have helped Pennsylvania to gain an additional 3,200 acres of wetlands during the past decade.

Those wetlands that are within floodplains are protected from fill and encroachment activities through municipal floodplain zoning. Filling or encroachment of wetlands located in non-floodplain areas cannot proceed without appropriate State and Federal permits. The Natural Resources and Conservation Service administers the voluntary Federal Wetland Reserve Program, which provided incentives for the permanent protection of wetlands on private lands. The Fish and Wildlife Service additionally works with landowners on a voluntary basis to restore wetland habitat through its Partners for Wildlife Program. Other wetland protection measures could be considered by the County and municipalities to direct development away from these important areas, or by requiring subdivision designs that do not entail wetland encroachment, disturbance or filling, or minimizes such impacts to the fullest extent practical.

4.3 Floodplains

Floodplains are valuable, naturally occurring areas adjoining streams, ponds or lakes that are subject to routine inundation during or immediately following a storm event. Besides flood and storm flow mitigation, floodplains provide numerous environmental benefits. They aid in groundwater recharge, decrease soil erosion and sedimentation, increase wildlife utilization and protect stream quality. Lush, naturally occurring vegetation in floodplain areas provide wildlife habitat and natural travel corridors (greenways) for a variety of birds, reptiles, amphibians and mammals.

However, floodplains are best recognized for their ability to decrease the dangers and damages associated with periodic flooding. The soils and vegetation in undisturbed floodplain areas store water by accommodating fluctuating stream volumes during heavy rains, thereby localizing flooding. When floodplains are maintained in an undisturbed state, expensive flood control structures are not needed. In response to disastrous flood events in the past, the Federal Emergency Management Agency (FEMA) and the National Flood Insurance Program (NFIP) have implemented measures to regulate development within floodplains. Maps produced by FEMA delineate floodways and flood fringe areas.

The *floodway* is the area regulated by Federal, state or local requirements to provide for the discharge of the base flood so the cumulative increase in water surface elevation is no more than a designated amount (not to exceed one foot as set by the NFIP) within the 100-year floodplain. The *flood fringe* is the portion of the 100-year floodplain outside of the floodway (Army Corps of Engineers, internet). The NFIP states that there shall be no new construction or substantial improvements in the floodway and that all new construction must be above the base flood elevation.

One hundred year floodplain and floodway run along Sawkill Creek and Vandermark Creek and their tributaries (see Figure 8). Because of the steep topography within the watershed, however, the floodplains tend to be narrow and comprise a small proportion of the total watershed. Where the stream gradients become gentler (i.e., the topography is less steep, the floodplains expands in width. The need for preservation of the floodplain, floodway and flood fringe is greater in these areas because of greater risk of wide scale flooding owing to the gentler slope of adjacent terrain. These expanded floodplain areas are shown on Figure 8. They are most obvious around Milford and upstream of Pinchot Falls along the main stem of Sawkill Creek. None of the five municipal zoning and subdivision ordinances allow intrusion into delineated floodplains. As an additional precaution, the zoning ordinances for the municipalities protect floodplain soils and limit intrusion into the flood fringe.

4.4 Lakes and Ponds

Three major named ponds exist within the Sawkill-Vandermark Creeks Watershed, with numerous smaller ponds adding to this total number. The primary ponds are Mud Pond, Sawkill Pond, and Lily Pond, all within the Sawkill Creek drainage. Mud Pond is a natural glacial pond situated in the headwaters of Sawkill Creek. It has a number of outstanding natural features and is important for the unique biological communities it supports (see Biological Resources in Section 5). Sawkill Pond and Lily Pond were formed by the construction of small dams on Sawkill Creek and Craft Brook, respectively. They are both valuable scenic and recreational resources. This is especially true of Lily Pond, which is located in the Pike County Park and surrounded by Delaware State Forest. It provides excellent public access for fishing, boating, and hiking in the surrounding forest. In total, the majority of the 228 acres of open water within the combined watershed lie within these three ponds. The remaining small ponds within the watershed occur on both public and private land. Their origins are mixed, resulting from small dams on streams, excavation and/or flooding of lowlands, and limited glacial depressions.

The majority of larger ponds within the watershed are impoundments of the part of the Sawkill and Vandermark Creek stream corridors. As such, they receive the same designated use under Pennsylvania Code, as do the streams that they impound. With the exception of the small reservoirs at the headwaters of Vantine Brook, all of the larger ponds within the watershed are EV designated use and are protected by the stringent anti-degradation protections associated with EV water bodies. For Vantine Brook, the HQ-CWF designation applies along with the strong anti-degradation protections associated with HQ water bodies.

4.5 Water Quality

The water resources of the Sawkill-Vandermark Creek Watersheds are comprised of two distinct types of water features, groundwater and surface water, which themselves are intricately interconnected in many important ways. Yet, because of the distinctions between them, the water quality features of groundwater and surface water are discussed separately in this section of the plan.

4.5.1 Groundwater

In the Sawkill Creek and Vandermark Creek Watersheds, the water quality from all aquifers is very good and the water is suitable for most uses. Only manganese and iron exceeded recommended limits in some wells. Elevated concentrations of manganese were found in some water samples from all aquifers, but iron concentrations in excess of 1 mg/L were found only in two water samples from the Catskill Formation.

The glacial aquifer that underlies the Route 6/209 corridor between Milford and Matamoras, PA, is one of the most productive in Pike County (Davis, 1989). Most businesses and residences along this narrow, 7-mile corridor rely on individual wells for water supply and septic systems for wastewater disposal. Much of the roadway and parking lot runoff is routed to swales, basins, and dry wells or areas at the edges of lots where the runoff infiltrates to the groundwater system. Groundwater quality in the glacial aquifer is threatened because of potential contamination by nutrients, bacteria and viruses from septic systems and salt from roadway runoff.

Historical water quality data from the Pike County Planning Commission and the Pike County Department of Health show the availability of consistently good drinking water, although volume varies with location. Generally the groundwater quality in Pike County is very good, and is suitable for potable uses. The water is typically soft to moderately hard and slightly acidic to slightly basic in pH. Section 3.3 gives a more accurate description of the Pike County geology and its affect upon the water.

The U.S. Geological Survey has been involved in groundwater monitoring along US Routes 209 and 6 between Milford and Matamoras Boroughs. A report issued in 1994 states that groundwater testing found nitrate, manganese and chloride concentrations in area wells, concluding that groundwater quality in this unconsolidated aquifer is threatened by contamination due to salts and nutrients from septic systems and salts in roadway runoff.

In November 1998, the *Pike County Water Supply Plan and Wellhead Protection Study* was completed, and a groundwater pollution vulnerability map was included (Gehringer-Roth Associates). The Catskill, Trimmer Rock and Mahntango/Mardcellus rock-types are major geologic formations in Pike County. Since groundwater is the main source of potable water in Pike County, each of these formations is considered to be a groundwater reservoir. The classification category was based upon the natural system of protection afforded bedrock aquifers. GIS overlay analysis was performed using physical features such as geology, soils, topography and hydrogeologic influences.

4.5.2 Surface Water

Surface waters within Pennsylvania (i.e., streams, lakes, rivers) are classified according to designated "uses" (Water Quality Standards, PA Code, Title 25, Chapter 93). These "uses" correspond to the types and quality of biological communities, water supplies, and recreation that exist or are expected to exist for a given stream or lake. In addition to designating a "use" for each surface water body, Pennsylvania then assesses whether the designated uses of a given water body are attained through detailed chemical and biological sampling from these streams and lakes. Thus, for surface water features in Pennsylvania, one can determine the value and quality of that stream or lake by first determining its designated use and then checking whether full or partial attainment of that designated use has been achieved.

All streams and lakes within the Sawkill-Vandermark watershed have received one of the Special Protection designations identified for Pennsylvania (see Table 7). These Special Protections are HQ (High Quality Waters) and EV (Exceptional Value Waters). The designation of all streams within the combined Sawkill-Vandermark Creeks watershed as either HQ or EV clearly demonstrates the outstanding status of the watershed and its surface water features. For those streams designated with the slightly less restrictive HQ designation, these surface water features have also received the added designation and protection of CWF (Cold Water Fishes). For both these HQ-CWF and the EV streams and lakes, the designated use of CWF protects these streams and requires the "Maintenance or propagation, or both, of fish species including the family Salmonidae and additional flora and fauna which are indigenous to a cold water habitat" (25 Pa. Code § 93.3). More specifically, the Anti-degradation Requirements mandate that the water quality for EV waters remain unchanged and that the water quality for HQ waters remain unchanged except under special exceptions following stringent review.

Given the stringent protections based on these designated uses, it is then important to evaluate whether the streams and other surface water features attain their designated uses or whether they have been degraded by human activities and fail to attain the high water quality conditions set forth under the HQ, CWF, and EV designated uses. The 2004 Integrated List for Pennsylvania, a single document incorporating both the Federal Clean Water Act 305(b) report and the 303(d) listing, lists all streams within the Sawkill-Vandermark watershed as Category 2 streams. The Category 2 designation indicates that the designated uses are attained for all uses that have been evaluated, but that some of the designated uses of these streams and lakes have not been formally evaluated. For the Sawkill-Vandermark watershed, the Aquatic Life Use has been evaluated for every stream, and all streams have attained their designated uses (EV, HQ,

and CWF; Human Health Use and Recreational Use have not been assessed for any stream in the watershed). Review of these Aquatic Life data from both stream invertebrate samples and stream fish samples reveals a broad diversity of cold-water organisms that are highly sensitive to environmental degradation. Among these groups are many groups of stoneflies, mayflies, and caddis flies among the stream insect fauna, and two species of trout (native brook trout and non-native brown trout). This information therefore demonstrates that the streams in the Sawkill-Vandermark watershed currently exist in a relatively pristine condition with no substantial impacts to water quality or ecological condition. The water quality is extremely high, and the biological communities present in the streams represent pristine or minimally impacted communities of the highest quality.

More specific water quality monitoring results are given in Appendix D (Special Protection Evaluation Reports). These monitoring results demonstrate the outstanding water quality as well as the extraordinary diversity of the freshwater fauna in the streams of the watershed.

4.6 Water Supply

A Water Resource Report prepared by the US Geological Survey indicated that large quantities of water probably flow through the Pike County groundwater reservoir. The County has a humid continental climate and has a long-term (1931-1981) average precipitation of 42 inches annually. Pike County is approximately 545 square miles in size, so approximately 20 million gallons of precipitation falls each day across the County, on average, and is available for groundwater recharge, surface water runoff and evapotranspiration.

Based on a comparison of historic and recent well yield data, it appears there has been no general decline in groundwater levels in Pike County. Even during the drought conditions of 1991, the groundwater supply was generally more than adequate. It is important to note, however, that some wells dropped 40-80 feet during this single year drought, a value far beyond typical well sustainability levels. During more sustained droughts or with greater daily withdrawal rates from the aquifers, the groundwater supply could be considerably strained.

In Pike County, the Boroughs of Milford and Matamoras are the only municipalities having public water systems. In Milford Borough, all of the water supply is derived from springs in the aquifer. The Milford Municipal Authority derives its water from 16 springs that flow into two reservoirs, each having a capacity of over 200,000 gallons. In Milford and Westfall Townships, most ground water that is pumped, is returned to the aquifer through discharge by septic systems. A general estimate of domestic consumptive use of ground water is about 10 percent of the volume withdrawn from the aquifer.

Section 5. Biological Resources

For many years, regional and local planning documents have noted the unique variety of biological resources in the Sawkill-Vandermark Creeks watershed region of Pike County. The biological variety stems both from the diversity of elevation, geology, and climate in the watershed as well as from the relatively undeveloped nature of the watershed with large tracts of undeveloped land. The following sections provide details on the specific biological communities present within the watershed, with particular emphasis placed on unique and/or threatened species and communities that deserve special consideration when prioritizing the preservation and sustainable development within the watershed.

5.1 Vegetation

Pike County is located in the Glaciated Section of the original Oak-Chestnut Forest Region. The Oak-Chestnut forest extended from southern New England to northern Georgia. Oaks, and formerly chestnuts, are the tree species that are used to characterize the forest of this region. Little to nothing remains of the original oak-chestnut forest because of both intensive timber harvesting and because the chestnut blight essentially eradicated the American chestnut from this region. As a result, the forest of this region is now called Mixed Oak Forest. Because of logging, much of the reproduction of oaks is as sprouts from the stumps; so that the forest is also know as “sprout hardwoods”. These forests have been logged in the past for lumber and fuel and most of the forest today consists of even-aged timber between 40 and 80 years old.

White, Red and Black oaks are the primary species of the forest. Although these species can occur together, each thrives in different moisture and nutrient conditions and they are often found in non-overlapping distributions. White oaks are typically found on moist soils while red oaks prefer drier, better drained soil conditions, and black oak are most common on the dry upland slopes. Common associates include red and sugar maple, black cherry, black gum, and white pine. Shrubs include blueberry, shadbush, viburnums and witch hazel. On ridge tops where conditions can be very harsh, chestnut oak is the dominant species. Soils are shallow, nutrients are usually scarce, and winds and weather can be severe. As a result, trees are stunted and contorted by these environmental extremes. Black gum, gray birch, huckleberries, and mountain laurel are common associates on these ridges.

One of the most striking features of any glaciated landscape is the abundance of wetlands. When the ice retreated it left ice blocks and shallow drainage channels behind. As the ice blocks melted and glacial debris accumulated around them, steep sided “kettle hole” lakes formed. Surface water from the glacier was trapped in those drainage channels that were blocked by debris and marshes and swamps eventually formed behind the blockage. In many of the kettle holes, bogs formed because there was very little contact with surface and ground water from the surrounding watershed. Nutrients and oxygen became scarce in such environments. Because of the lack of oxygen, organic matter did not decompose but slowly filled the lake. These peatlands often have developed a floating bog mat over the lake surface. The most common type is called a “level bog” and is the only kind known in Pennsylvania. In Pike County, these range in size from less than an acre to more than 40 acres. The classic bog has

concentric zones of vegetation surrounding a central pond. The first zone consists of low shrubs and sedges and is the floating mat overlying the pond, the second zone typically contains taller shrubs and is not as treacherous. The final zone is the bog forest, or boreal conifer swamp, that is dominated by black spruce and larch. Many of the plant species inhabiting bogs are more typical of peatlands much farther to the north and reach their southernmost limit in these bogs.

Marshes, wet meadows, and swamps have formed in shallow depressions and along streams and other water bodies. These wetlands receive water that is generally well aerated. The water accumulates in these wetlands and different plant species dominate. Red maple, hemlock, ash, black gum, and yellow birch are typical canopy species while blueberry and swamp azaleas are common shrub species. In the past ten years, however, an exotic pest of the eastern hemlock has invaded the region and has led to high mortality rates among the region's hemlock stands. The hemlock woolly adelgid (*Adelges tsugae*) is a small aphid-like insect that attaches near the base of the hemlock needles and inserts its feeding tube into the needle to extract plant juices from the hemlock. Intense infestations of the woolly adelgid can quickly kill individual trees, particularly those in marginal habitats or subject to insufficient water during droughts. Because hemlocks play a particularly important role in riparian forests of the region (e.g., stabilizing soils, maintaining cool water temperatures), the potential loss of these trees from the riparian corridor may lead to substantial degradation of the riparian buffers and thus the quality of the stream resources themselves. The excessive browsing pressure from the over-abundant deer population (see below) further prevents additional tree species from replacing hemlocks within the riparian corridor. Thus, the dual threat of abundant deer and the woolly adelgid may lead to important negative changes for the streams of the Sawkill-Vandermark watershed.

5.2 Wildlife

Much of the Sawkill Creek and Vandermark Creek watersheds are possible breeding grounds for a variety of birds of special concern. Specific locations generally are not known due to insufficient information, but birds of special concern that are possibly breeding in the area are here listed by quadrangle:

- Edgemere: Marsh Wren, Osprey, Bald Eagle, Northern Harrier, Red-shouldered Hawk, Whip-poor-will
- Milford: Osprey, Sharp-shinned Hawk, Cooper's Hawk, Northern Goshawk
- Pond Eddy: Bald Eagle, Sharp-shinned Hawk, Cooper's Hawk, Northern Goshawk
- Shohola: Hooded Merganser, Osprey, Bald Eagle, Northern Harrier, Cooper's Hawk

Game birds such as turkey, woodcock, and grouse also maintain strong populations within the Sawkill and Vandermark watersheds. Along with these game birds, a number of important mammal species continue to have sizable populations within one or both watersheds.

These include beaver, mink, black bear, and snowshoe hare. River otters were recently known to have populations within the Sawkill-Vandermark watersheds, but the most recent data from the Pennsylvania Natural Diversity Inventories does not currently list the populations of river otter within the combined watershed. River otters may still be present in the watershed, or populations may become re-established from neighboring watersheds where otters continue to exist. Overall, the extensive mix of relatively undisturbed and contiguous wetlands, forests, and stream corridors provides excellent habitat for these and other wildlife species. However, the lack of top predators in the system other than humans has permitted the whitetail deer population to increase to the point where the deer now are having both direct and indirect negative effects on the other plant and animal species within the watershed. Excessive deer browsing has eliminated much of the forest understory. Their foraging also has contributed to nominal regeneration and growth of young trees to replace and augment the existing forest types. Such impacts lead to reductions in habitat complexity, food availability, and structural diversity, all of which negatively effect many of the species of wildlife that inhabit these otherwise undisturbed areas. As such, the management of the deer population is an important consideration to maximizing the value of these undisturbed lands and to maintaining strong populations of a diverse wildlife assemblage within the Sawkill-Vandermark Watershed.

The fish and invertebrates inhabiting the surface waters of the Sawkill-Vandermark Creek Watershed are equally diverse and further demonstrate the extraordinary value of the watershed on a local and regional scale. Reproducing populations of both brook trout (a native species) and brown trout (an introduced species) are present in both the Sawkill Creek and the Vandermark Creek watersheds. At nearly all sampled sites in the watershed, a diverse aquatic insect community was extensively represented by the sensitive stoneflies, mayflies, and caddisflies dominates the streams' invertebrate fauna. Indeed, the extraordinary diversity of insects, along with the streams' ability to support and sustain trout, is among the prime reasons for the Special Protection Status (HQ, EV) given to all streams in these two watersheds.

5.2.1 PNDI Species

A number of species tracked through the Pennsylvania Natural Diversity Inventories (PNDI) database are found within the watershed boundaries of the Sawkill and Vandermark Creeks, including species categorized as Critically Imperiled (S1) within Pennsylvania (see Table 8). Two species of snakes are included in this list. The eastern hognose snake has no official protection status in Pennsylvania, but is listed as either Vulnerable (S3) or Secure (S4). The timber rattlesnake is currently given a status in Pennsylvania as a candidate species (PC) and has a proposed status of Candidate at Risk (CA), both of which indicate that this species is relatively abundant now but is at risk for becoming threatened or endangered in the future.

Table 8. Species and Ecological Communities Tracked in the PNDI Database that are found in the Sawkill-Vandermark Creeks Watershed

COMMON NAME	SCIENTIFIC NAME	GLOBAL RANK*	STATE RANK*	STATE STATUS*	PROPOSED STATE STATUS*
Reptiles					
Eastern Hognose Snake	*Heterodon platirhinos*	G5	S3S4		
Timber Rattlesnake	*Crotalus horridus*	G4	S3S4	PC	CA
Insects					
Cobblestone Tiger Beetle	*Cicindela marginipennis*	G2G3	SX		
Green-faced Clubtail Dragonfly	*Gomphus viridifrons*	G3	S1		
Abbreviated Clubtail Dragonfly	*Gomphus abbreviatus*	G3G4	S2		
Variable Dancer Damselfly	*Argia fumipennis*	G5	S?		
Persius Duskywing Butterfly	*Erynnis persius*	G4T2T3	S1S2		
Plants					
Northern Yellow-eyed Grass	*Xyris montana*	G4	S2	PR	PR
Soft-leaved Sedge	*Carex disperma*	G5	S3	PR	PR
Horned Bladderwort	*Utricularia cornuta*	G5	S2	N	PT
Bog Rosemary	*Andromeda polifolia*	G5	S3	PR	PR
Natural Communities					
Oligotrophic glacial kettlehole bog		G?	S3		
Waterfall and Plungepool		G?	S3S4		
Waterfalls and Rapids		G?	S?		
Ridgetop Dwarf-Tree Forest (*Quercus ilicifolia/ Kalmia latifolia/ Pinus rigida*)		G4	S3		

* Detailed descriptions of the Global and State Ranks and Status codes can be found at the PDNI website: www.dcnr.state.pa.us/forestry/pndi/rank.htm

Five species of insect are also included in the PNDI list for the Sawkill-Vandermark watershed, although none of these species is given any official status in Pennsylvania. One of these species, the cobblestone tiger beetle, is believed extirpated from the Commonwealth but at one time did occur in the watershed. One dragonfly (the green-faced clubtail) and one butterfly (the persius duskywing) have been found within the watershed and are Critically Imperiled (S1) or borderline Critically Imperiled-Imperiled (S1S2) within Pennsylvania. A similar dragonfly (the abbreviated clubtail) is also listed as Imperiled (S2) while a damselfly (the variable dancer) maintains an uncertain status within Pennsylvania. Among these five insect species, the global rank ranges from Stable (G5) to borderline Imperiled-Vulnerable (G2G3).

Among plants tracked through the PNDI database, four species have been found within the Sawkill-Vandermark watershed. All of these species are either aquatic plants or associated with aquatic environments and saturated soils. None of these species currently maintains any legal status in Pennsylvania other than Pennsylvania Rare (PR), although the northern yellow-eyed grass has been proposed for Threatened status (PT). The global rank for all four species ranges between Apparently Secure (G4) to Secure (G5), while the state rank ranges from Imperiled (S2) to Vulnerable (S3).

Finally, the northern river otter (*Lontra canadensis*) is a State Vulnerable (S3) species that has historically been found within the Sawkill-Vandermark Creeks Watershed. The most recent data from the PNDI database, however, does not indicate that populations currently are known from the joint watershed, perhaps indicating that the otter has been extirpated locally. Given the high quality streams, the extensive wetlands and forests, and the corridors to other relatively pristine areas within the region that may still maintain populations of river otter, it is possible that otters may still exist within the watershed or may re-colonize the watershed from nearby populations.

5.2.2 Important Habitats

Eight areas within and bordering the Sawkill Creek and Vandermark Creek watersheds are listed in the 1990 Pike County Natural Areas Inventory (updated 1995) as being significant for the protection of biological diversity (Table 9). These sites are shown on the Edgemere, Milford, Pond Eddy, and Shohola topographic quadrangles and are discussed below.

Four of these habitats are also listed and tracked within the PNDI database. These four communities are: Kettlehole Glacial Bog (Mud Pond); Waterfall and Plungepool (Pinchot Falls); Waterfall and Rapids (Sawkill Creek); and Ridgetop Dwarf-Tree Forest (Buckhorn Oak Barren). The abundance and diversity of such extraordinary and unique habitats within a relatively small area attests to the value of the Sawkill and Vandermark Creek watersheds and the need to maintain the high quality of the unique natural features within them. In addition, the contiguous forested areas across the Sawkill Creek, Vandermark Creek, Crawford Branch, Cummins Creek, and Little Bushkill watersheds provides an extraordinary example of relatively pristine lands within Pennsylvania. The Pennsylvania Chapter of the Nature Conservancy has recently recognized this fact when they designated this larger plot as one of the key roadless areas in Pennsylvania and deserving immediate attention and protection.

Table 9. Sites of Statewide Significance for the Protection of Biological Diversity in the Sawkill-Vandermark Creeks Watershed

Site Name	USGS Topographic Map	Natural Community, TNC Global & State Ranks, Importance, Recommendations
Mud Pond	Edgemere	Privately owned, Good Glacial Bog with 1 G5S3 plant; threats from upslope development; protect watershed with conservation easements.
Sagamore Swamp	Edgemere	Small conifer swamp worthy of protection as a natural area. Wetland area in headwaters of Savantine Creek, tributary to Sawkill Creek.
Buckhorn Oak Barren	Pond Eddy, Milford	Fair example of a Pitch Pine-Scrub Oak Barren community. Habitat also supports a good population of an animal of special concern.
Sawkill Creek	Milford	Contains a High-Gradient Clearwater Creek natural community. Area contains many habitat types and is worthy of protection for wildlife.
Delaware River	Milford	Wintering bald eagle habitat; bird migration corridor; shad spawning grounds; rare plants; water supply; river recreation; aesthetics; part of Delaware Water Gap National Recreation Area.
Deep Brook	Milford	Site of local significance for protection of biological diversity and water quality in Delaware River. Tributary to Vandermark Creek. The area does not meet natural community requirements but features steep, forested slopes deserving of protection as a natural area for local residents and tourists.
Milford Cliffs	Milford	Good Shale Cliff community and G5S3 species population in Delaware Water Gap National Recreation Area; recommend National Park Service manage area to ensure survival of community and species; prevent spraying for gypsy moth.
Pinchot Falls	Milford	Waterfall and Plungepool community on Sawkill Creek, a High-gradient Clearwater Creek; falls are protected as part of Grey Towers; Sawkill Creek is a designated Exceptional Value Stream; continue current protection and management

Source: 1990 Pike County Natural Areas Inventory (updated 1995)

Section 6. Cultural and Historic Resources

6.1 Recreational Resources

The natural and historic resources of the Sawkill-Vandermark Creeks Watershed provide a variety of passive and active recreational opportunities. Visitors travel to the watershed in all seasons to experience the Delaware River, unique geologic features, locally unique flora & fauna, historic villages, historic structures in the vicinity of the Sawkill and Vandermark Creeks and their tributaries.

6.1.1 County, State and Federal Parks

One of Pike County's newest recreational areas is **Pike County Park** in Milford Township, which was leased from the State of Pennsylvania in 1997. The park spans 325 acres of the Milford Reservation (now part of the Delaware State Forest) and includes Lily Pond, a popular fishing locale. Near this 25-acre lake, six trails run through the park and into the Delaware State Forest. Municipal parks include Milford Borough's Park, located at West Catherine & 5th Streets, and a second at East Catherine & 3rd Streets.

Pike County is also home to State Parks and Recreation Areas located in the vicinity of the Sawkill-Vandermark Creeks Watershed. These include:

- **Delaware State Forest** - 80,000 acres; Pine Lake Natural Area, picnic areas, nature centers, hiking, boating, fishing, hunting, A.T.V. trails and state parks.
    - **Bruce Lake Recreation Area and Natural Area** (I-84 at Exit 26) - located within the Delaware State Forest and managed by the Bureau of Forestry; hiking and cross-country skiing trails.
    - **Promised Land State Park** - 3,000 acres; two lakes and several small streams, fishing, boating and swimming.
- **Greeley Lake and Access Area** (off Route 6) - 60-acre lake; local fishing and boat access.
- **Shohola Recreation Area** (off Route 6) - bald eagle nesting area; Shohola Falls and 1,137-acre Shohola Lake, created in 1967 by the Pennsylvania Game Commission. http://sites.state.pa.us/PA_Exec/Fish_Boat/afmsho.htm

Two Federal Parks also lie partially within and nearby the Sawkill-Vandermark Creeks Watershed:

- **Delaware Water Gap National Recreation Area** - includes 40 miles of the Delaware River and nearly 70,000 acres along the river's New Jersey and Pennsylvania shores; hiking trails, picnic tables, Milford Beach (public swimming

area) and George W. Childs Park (hiking trails, waterfalls); boat launches located at Milford Beach, Dingmans Ferry Access, Eshback and Bushkill.

- **Upper Delaware Scenic & Recreational River** - longest free-flowing river in the Northeast (73.4 miles along the New York-Pennsylvania border); most adjacent land is privately owned, but public fishing and boating access is available; habitat for wintering bald eagles and other wildlife; includes John Roebling's Delaware Aqueduct (oldest existing wire suspension bridge in the U.S.) and the Zane Grey Museum in Lackawaxen, PA. http://www.nps.gov/upde

Additional information about existing County, State and Federal Parks in the Sawkill-Vandermark Creeks Watershed is available from the following agencies:

- Pennsylvania Department of Conservation & Natural Resources
  RD 2, Box 96, Greentown
  ph: 570-676-3428

- Delaware Water Gap National Recreation Area
  River Road, near Bushkill
  ph: 570-588-2451

- Upper Delaware Scenic and Recreational River
  RR2, Box 2428, Beach Lake
  ph: 570-685-4871

At public project meetings, representatives of all five municipalities within the Sawkill-Vandermark Creeks Watershed (Milford Borough, Milford Township, Dingman Township, Shohola Township and Westfall Township) expressed the need to create additional recreational opportunities for their growing populations.

6.1.2 Recreational Trail Systems

The Trails Subcommittee identified a variety of existing trails and trail linkages throughout the watershed:

- **Callahan House Trail** - runs along the south bank above the Sawkill Creek as it nears the Delaware River between the Mott Street Bridge and Route 209; passes Callahan House, one of the oldest surviving structures in Pike County; also runs along an earthen flume, which fed an early mill from the dam below the bridge.

- **Walking Trail into the Glen** - just above the Mott Street Bridge, this trail winds into "the Glen," a historic walking area in Milford; runs through the gladed area along the Sawkill for 100 yards, then turns toward higher ground leading to The Knob above Milford; private property in Dingman Township leased on an annual basis to Milford Borough.

- **Farm Trace About The Glen** - runs parallel to the Glen for about 150 yards on private property through the forest; prominent examples of the falling escarpment to the Sawkill and Delaware.

- **Trails to the Knob** - two trails lead to the Knob from the far end of the farm trace described above: one rises steeply up the escarpment for about ¼ mile (private property), the second runs ¼ mile around the hill to the top of the Milford Cemetery, where a lightly used fire road leads to the Knob after about ¼ mile.

- **Raymondskill Falls (Cliff) Trail** - about 3 miles; leads from the back of the Knob to the top of the high cliffs above Route 209 to Raymondskill Falls (Delaware Water Gap); overlooks historic Minisink Island, an important spiritual site of the Lenape Indians.

- **Pinchot (Sawkill) Falls Trail** - about ¼ mile; accessible only on foot; runs from the main driveway adjacent to Grey Towers National Historic Landmark to a dramatic waterfall.

- **Pike County Park Trails** - within Pike County Park, six trails near Lily Pond lead into the Delaware State Forest:

    - *South Loop*: loops around from Schocopee Road before it enters the park.
    - *Huckleberry Trail*: leads from the west side of Lily Pond into the Delaware State Forest.
    - *Foundation Trail*: also leads west from Lily Pond into the Delaware State Forest.
    - *Craft Farm Trail*: located northwest of the park; includes a pond and remnant orchard.
    - *Yellow Pine Trail*: leads from the top of Lily Pond north into Delaware State Forest about one mile, then turns east one mile to link with Firetower Road; this is a long-established trail on Forestry Bureau maps, but the Lily Pond link needs to be rediscovered and marked.
    - *Horse Trail*: about one mile; follows the roadway from the east side of Lily Pond past the Promethean Center out to an old Forestry Bureau firing range.

- **Delaware State Forest Trails** (between Lily Pond and Pond Eddy, PA):

    - *Firetower Road*: forks off Schocopee Road near Route 6 north 3 miles to the Buckhorn Firetower; turns to gravel halfway to the fire tower (severely rutted in places); links to the Yellow Pine Trail and two other trails.

- *Lost Camp Trail*: connects to the Stairway Lake Trail; runs about 2 miles northeast from an area roughly opposite the Firetower to Cummins Road; parking lot on each end.
- *Stairway Lake Trail*: accessed from a parking lot a short distance past the Lost Camp lot on Cummins Road; descends to the lake and then to the Delaware at Pond Eddy.
- *Old Road to Pond Eddy*: continuation of Firetower Road; descends 3 miles to Pond Eddy, PA on the Delaware.
- *Quick Island (Santos Farm) Trail*: Begins about 150 yards after leaving Milford Borough on Route 6 East and Route 209 North (take the dirt road on the right between Susie's Sweet Shop and Myer Motel that leads across a field down toward the Delaware to a small wooded parking area); runs about 2 miles upriver.

The Trails Subcommittee also identified a number of existing and potential linkages between various recreational areas within the watershed. These include:

- **Pinchot Greenway** - This proposed 3-mile, multi-modal (bicycling and walking) trail would link three popular sites: Milford Beach (Delaware Water Gap), the northern terminus of the newly constructed, 32-mile Joseph M. McDade Recreational Trail (follows the Delaware River from the Hialeah Picnic Area to the Turn Farm trailhead parking area on River Road in the Delaware Water Gap National Recreation Area), and the Grey Towers National Historic Landmark just west of the Borough of Milford. In June 2002, PADCNR awarded Pike County a $30,000 grant to prepare a project feasibility study and a master site development plan for the greenway.
- **Cliff Park Trail System and Hackers Falls Trail** - The Raymondskill Cliff Trail provides access to both the Cliff Park Inn and Golf Course trail system and nearby Hackers Falls in the Delaware Water Gap National Recreation Area. There is also another connection to this area from Muir House on the east side of Sloat Brook along a farm trace.
- **Milford Experimental Forest** - This forest stretches for 3 miles on either side of Schocopee Road, which leads from Route 6 above Milford to Grey Towers. A proposed trail along the road would include short hikes into the forest.
- **Route 6 Bicycle Trail** - PennDOT identified Route 6 as one of five potential cross-state bicycle and pedestrian trails for mapping, signage and eventual shoulder improvements. The improved bicycle trail would connect the Sawkill-Vandermark Creeks Watershed trail system to the regional high school and state Welcome Center in Westfall Township, the Airport Park Recreation Center in Matamoras Borough and the train station in Port Jervis, NY.
- **Delaware River Road, Milford Borough** - Delaware River Road, which runs along the base of the Delaware River bluff between the Vandermark and Sawkill

Creeks, has historically provided public access to several beach, boating and cottage-resort businesses at the river. It connects the Metz Ice Plant area (Delaware Water Gap) to Milford Borough's ball fields and eastern neighborhoods, with a potential auxiliary route across Vandermark Creek to the upriver Delaware Water Gap lands and the Quick Island Trail. The Borough also owns a strip of land near the river that could be made into a small park.

6.1.3 Scenic Drives

From the days when the Lenni-Lenape Indians lived along the Delaware River and crossed the area on footpaths, to recent times when the completion of Interstate Route 84 connected the county to the national highway system, Pike County's growth and development has been inextricably linked with the transportation systems serving its inhabitants. Among these are a variety of scenic and historic drives along Routes 209, 206 and their collector roadways, which not only provide aesthetic and cultural benefits but also contribute to the economy by increasing tourism.

However, traffic volumes on Routes 209 and 206 in Milford and Matamoras have become critical in recent years, especially at peak daily and seasonal periods. This highlights the need for future transportation planning efforts in the watershed with an emphasis on preserving and maintaining the area's scenic drives.

6.2 Visual Resources

The visual character of the Sawkill-Vandermark Creeks Watershed is important to its recreation-based economy. Not only does Pike County border a National Scenic and Recreational River, it also has many lesser-known visual resources that attract visitors to the area. To ensure that these resources, many of which do not have formal state or federal protection, are safeguarded from development and other impacts, the Steering Committee recommends that visual resources be considered when assessing the impact of any proposed project (see Section 7 for a more detailed discussion).

6.3 Archaeological and Historic Resources

The first human inhabitants of the Sawkill-Vandermark Creeks Watershed were the Lenni-Lenape (Delaware) Indians, who hunted and fished along the shores of the Delaware River and its tributaries. The first recorded white settlers followed them in the early 1700s. Agriculture dominated the local economy until the 1860s, when extractive industries (quarrying) began to increase in importance. By the late 1800s, Pike County was heavily involved in timber production for coal used in the railroad industry.

The Township of Milford developed early as a mill town, centered largely around the Sawkill and Vandermark Creeks. The area's first settlers were quick to recognize the potential power in the cascading waters of these streams as they drop 100 feet over the last mile of their journey into the Delaware River. The watershed's 4 mills and 3 mill dams were an important

part of the regional economy for nearly 200 years, reaching peak productivity after the Civil War.

The Sawkill-Vandermark Creeks Watershed is also home to many historic and cultural landmarks, including 18th-century inns, Civil War-era hotels and historic buildings. Many of these sites have been preserved in Milford Borough, the Pike County seat. Incorporated in 1874, the Borough was originally a village of Milford Township, which was incorporated in 1876. In Milford Borough alone, there are approximately three-dozen homes between 75 and 100 years old, and several churches and other public buildings older than 100 years. One of the most famous of Milford's historic sites is Grey Towers, a National Historic Landmark and home of Gifford Pinchot, first chief of the U.S. Forest Service and former Governor of Pennsylvania. The estate currently houses the Pinchot Institute for Conservation Studies, which was dedicated by John F. Kennedy in 1963.

Other local landmarks include the Mott Street Bridge, the Columns (museum of the Pike County Historical Society) and the Community House, where the "Lincoln Flag"—laid under the President's head after he was shot in Ford's Theater—is displayed. (Though the theater is located in Washington, DC, the daughter of the stage manager who came to Lincoln's aid on that fateful night eventually settled in Milford.)

Section 7. Rivers Conservation Plan Recommendations

The purpose of a Rivers Conservation Plan is to create a framework or foundation for the restoration, maintenance, and/or enhancement of all the resources, natural and anthropical, of a river and its watershed. The Plan begins with the investigation, assessment and documentation of the river's existing ecological, environmental, recreational and cultural/historic conditions, uses, and problems. Given that the Plan is intended to be highly stakeholder-oriented, public input is solicited and then incorporated as part of its preparation. Local citizen participation in the assessment of the river and in the preparation of the Plan results in a Plan truly reflective of community concerns, needs, and goals. A Plan developed in this manner ensures a proper vision for the river's future management and restoration.

This was the essential approach taken from the onset with the preparation of the Sawkill-Vandermark Creeks Watershed Rivers Conservation Plan. Upon review of the history, culture and existing socio-economic aspects of the watershed it was evident that the Plan prepared for Sawkill Creek and Vandermark Creek should concentrate on the recreational attributes of both rivers. For the past three decades, the recreational attractiveness of the rivers and adjacent watersheds have been an important element of the region's economy and a defining element in the factors largely responsible for recent development pressures. This was also reflected in the input obtained through public meetings and discussions with the various stakeholder groups.

As such, the primary goal of the Sawkill-Vandermark Creeks Watershed Rivers Conservation Plan was to develop a set of management recommendations truly reflective of the actions needed to protect, conserve and restore the unique environmental and recreational attributes of the rivers and their watersheds. As detailed in the previous sections of this report, this was accomplished by accurately defining the characteristics and resources of the combined watersheds, properly identifying existing problems and future threats to these resources, and presenting the measures needed to meet the project's primary goal. The Plan's recommended management actions focus on the protection and enhancement of the rivers and their watersheds through proper land use planning, including improvements in the management of stormwater runoff. The demographic data compiled as part of this study clearly shows that the Sawkill-Vandermark Creeks Watersheds will continue to be at risk because of development pressure. In order to maintain, and perhaps even enhance, the watersheds' existing character, it is important that future watershed-wide land use planning be cognizant of the rivers' unique features and reflective of their recreational significance to the local and regional economy.

Because these goals are centered on recreation and the appreciation of the outstanding natural resources in the watershed, emphasis has been given to stream water quality and baseflow protection, stormwater runoff quality and quantity control, open space management, public education, and improvement of public access for tourism and recreation. To summarize, based on the review of current and historical data, stakeholder input and the assessments conducted by the project participants:

- The Sawkill-Vandermark Creeks Watersheds remain largely undeveloped. It is the undeveloped, natural beauty of the rivers and their watersheds that make Sawkill and Vandermark Creeks popular recreational destinations.

- The watersheds' proximity to major urban centers, combined with ready access in the form of well developed highway systems, has increased development pressure.

- Increased development of the watersheds threatens the very character of the area that has served to attract residents and recreational users to the Sawkill-Vandermark Creeks Watersheds.

- The natural and scenic resources of the rivers and their watersheds are not resilient to development related impacts. The rivers and adjacent lands provide unique habitats that support a variety of species, including State and Federally listed species. As such, as more users and more development are attracted to the area, irreversible changes to the very core characteristics of the rivers and their watersheds are anticipated.

- Mitigation of these potential impacts must be based on environmentally sound planning that is reflective of the sensitive environmental attributes of the rivers and their watersheds and the recreational importance of the area.

- Such planning must be conservative, and actively avoid disturbance of riparian areas, wetlands, steep slopes and scenic vistas, as well as the direct protection of the water quality of the creeks and their tributaries. With this comes the safeguarding of the unique habitats and the species supported by these habitats.

- As maintenance of the water quality of the creeks and their tributaries is of utmost importance, emphasis must be given to the proper management of stormwater runoff from existing and future developments. Such stormwater management must address maintenance of base flow through groundwater recharge, mitigation of stream scour and erosion through peak flow management, management of overbank flooding and extreme flood events through rate and volume controls, and the protection of water quality from any degradation through runoff quality management.

The primary goals for this Plan are:

1. Protect the watershed's terrestrial natural, cultural and scenic resources from degradation associated with land development and sprawl.

2. Conserve and protect local and regional natural resources, especially the streams, given their anti-degradation status and the breadth of sensitive and unique species that they support.

3. Protect cultural resources, focusing on bridges and buildings of historic significance and scenic resources such as ridgelines and vistas. Before this can be accomplished, though, it appears a more comprehensive assessment, categorization and mapping of these resources must be conducted.

4. Maintain and enhance the recreational opportunities and the economic benefits of tourism by carefully planning development. Institute the proper development-related mitigative and control measures to protect the resources that attract tourists to the area. Where needed and practical, enhance recreational access.

5. Protect and enhance the exceptionally high water quality of the watersheds and streams.

7.1 Water Quality Protection and Enhancement

The cornerstone goal of this Rivers Conservation Plan for the Sawkill and Vandermark Creeks Watershed is to identify specific actions needed to protect and enhance the exceptionally high water quality of the watershed's streams.

- Protection of terrestrial resources from degradation associated with land development and sprawl;
- Conservation and protection of local and regional natural resources;
- Protection of cultural resources;
- Maintenance and enhancement of recreational opportunities and the economic benefits of tourism; and
- Safeguarding the watershed's unique habitats and the species they support.

Attaining this plan's primary goal and realizing the above benefits will require concerted efforts to address stream corridor protection, stormwater runoff, open space management, public education, and public access and recreation throughout the watershed. This first section focuses on the direct means of protecting and enhancing the high water quality within the watershed.

- **Develop watershed-wide stream buffer protection ordinances** that support a variety of buffer functions important to aquatic ecosystems. Ordinances which strictly limit vegetation removal and earth disturbance within a clearly defined buffer width will be one of the most important components in protecting water quality, cold-water conditions, biological communities, as well as flood-carrying capacities of streams.

- **Develop and implement a uniform stormwater management ordinance that is consistent with or exceeds PADEP recommendations for the control of peak flow, reduction of runoff volume and removal of pollutants.** Such an ordinance will help reduce future impacts to the streams, wetlands and other water resources of the watershed by maintaining natural

hydrologic regimes and reducing stormwater runoff from new development (See 7.2).

- **Make local land use regulations consistent with Phase I and II National Pollution Discharge Elimination System (NPDES) regulations** to address pre- and post-construction stormwater discharges from new development.

- **Develop watershed-wide performance standards for land development activities that are consistent with the Anti-degradation Requirements of the Pa. Code.** Because all streams in the Sawkill and Vandermark watersheds have Exceptional Value or High Quality "special protection" status, their existing water quality is to be protected and maintained as set forth in (25 Pa. Code § 93.4a and c**)**. Evaluation/use of non-discharge alternatives, minimizing earth disturbance and percent impervious cover, maintenance of stream and wetlands buffers and maximizing groundwater recharge are examples of development standards which could be used to protect and maintain existing water quality in these watersheds.

- **Protect existing wetlands through wetland protection and buffer ordinances.** Because wetlands provide irreplaceable environmental services such as stormwater storage, flood control and pollutant removal and unique habitats for native species, the protection of wetlands within the watershed will be vital to maintaining the high water quality of the streams, the functioning of the watershed's ecosystems, and the diversity of plants and animals in the region.

- **Implement a septic system inspection and maintenance program in all municipalities.** Although in-ground wastewater disposal systems can be an effective means of treating human and household wastes in rural environments, older and/or improperly maintained systems can fail and lead to contamination of both groundwater and surface water resources. A program that requires regular inspection and pumping of existing septic systems and works with property owners to find funding for the repair/ replacement of failing septic systems will lead to long-term protections of both groundwater and surface water quality.

- **Establish a well monitoring program**. The five municipalities of the Sawkill-Vandermark Creeks Watershed rely heavily on aquifers for their drinking water. This fact heightens the need to protect these groundwater resources for both the human population and biological communities that depend on them. Comprehensive well monitoring for depth and contaminants should be implemented to provide cost-effective but scientifically valid evaluations of the quality and quantity of groundwater available in the local aquifers.

- **Install stream gauges on the main-stem of both the Sawkill and Vandermark Creeks.** In addition to monitoring the groundwater supply, water levels in the primary channels should be monitored to establish the natural distribution of surface water through time and to evaluate potential changes in the surface water runoff that could result from either excessive use of groundwater supplies, failure to recharge stormwater, or excessive stormwater runoff from impervious surfaces.

- **Evaluate the effect of water treatment activities on Vantine Brook**. The water-supply operation in the headwaters of Vantine Brook is a factor in Vantine Brook being the only stream in the Sawkill Creek watershed that has not received EV designation. Careful management of these operations could lead to improvements in the quantity and quality of stream water in Vantine Brook and thus restoration of the biological communities in this stream to conditions consistent with the rest of the watershed.

- **Evaluate the costs and benefits of maintaining older dams on streams.** Small dams on streams can require expensive maintenance as they age in order to maintain their usefulness and safety. At the same time, these dams and the reservoirs behind them can lead to substantial degradation in the water quality of the streams below the dams, particularly in cold-water areas, as the reservoirs lead to substantial increases in water temperature and transformations in the nutrient and food resources of the water. As such, removal of small dams can lead to improved cold-water fisheries (i.e., trout) and high water quality eliminating the high costs for dam maintenance. Multiple small dams exist within the Sawkill-Vandermark Creeks Watershed and each of these should be evaluated for their condition, their benefits, and the potential benefits of removal for the overall health of the watershed's ecosystems. Because these dams are important cultural and historic resources, the water quality benefits need to be examined carefully in relation to the cultural and historic losses that such dam removals would require.

- **Conduct additional biological and natural resource studies**. Although a substantial body of information exists on the natural resources within the Sawkill-Vandermark Creeks Watershed, especially the freshwater fish and invertebrate fauna, additional scientific studies would provide a stronger basis for prioritizing management alternatives. A number of additional studies would be particularly useful, including but not limited to the following:

    1. Field surveys of PNDI species known in the watershed or in adjacent watersheds.
    2. Mapping and characterization of locally important but less prominent natural features using the County Geographic Information System (GIS).

3. Regular low-cost water quality monitoring to establish existing conditions and benchmarks against which anti-degradation protections can be measured.
4. Mapping of all perennial and intermittent headwater streams so they can be included in municipal protections.

- **Reduce flooding.** Current regulations prohibit the construction or expansion of existing structures currently located within FEMA-mapped floodplains. Watershed municipalities must continue to enforce these ordinances and regulations to decrease the opportunity for flooding, the loss of important riparian habitat, the property damage and associated economic loss, and risk to human health and welfare.

- **Improve water and sewer infrastructure.** It is essential that non-discharge alternatives be fully explored and utilized and that the highest level of treatment that is both environmentally sound and economically feasible be implemented within the Sawkill-Vandermark Creeks Watershed. In order to prevent the deleterious impacts of sprawl development, careful planning and close attention to performance standards for land development must precede the expansion or amendment of sewer service areas.

7.2 Stormwater Management

The Pennsylvania Stormwater Management Act (Act 167) establishes the authority by which stormwater runoff is to be managed, not only for the purpose of controlling flooding but also to preserve and protect "natural, economic, scenic, aesthetic, recreational and historic values of the environment." The Act mandates that *each county shall prepare and adopt a watershed storm water management plan for each watershed located in the county as designated by the department, in consultation with the municipalities located within each watershed*. Sawkill Creek Watershed is one of seven such designated watersheds in Pike County and a Stormwater Management Plan and Model Ordinance were adopted by the County in 1992. The plan needs to be updated to reflect the NPDES Phase II requirements, DEP's 2002 Comprehensive Stormwater Management Policy and the Chapter 93 Antidegradation Requirements. State funding for updating the plan is available, but competitive.

It should be noted that the Sawkill Creek Watershed is designated by PADEP as a Stormwater Management Designated Watershed (Act 167).

- **Update the Sawkill Creek Act 167 Stormwater Management Plan** to more adequately address water quality protection and more effectively manage the volume and rate of stormwater discharges in the Sawkill Vandermark Creeks Watershed.

- **Implement municipal ordinances that not only address stormwater flows and flooding related problems, but also address volume control and nonpoint source pollutant loading.** The goal should be the management of total suspended solids (TSS) loading so that no net increase is experienced as a result of any development or redevelopment project. Reduce, to the fullest extent practical, the post-development nitrogen, phosphorus, petroleum products and heavy metal loads.

- **Require stormwater recharge.** The goal should be no net change in stormwater infiltration before and after development. This will reduce runoff, help maintain stream base flows and decrease the mobilization and transport of pollutants.

- **For new construction, adhere to the soil and erosion control requirements of PADEP.** Specifically, projects must comply with the provisions of the Clean Water Act, 33 U.S.C. Section 1251 et seq., and Pennsylvania's Clean Streams Law, as amended, 35 P.S. Section 691.1 et seq. and PA Code Title 25, Chapter 102 Erosion Control Rules and Regulations.

- **Evaluate retrofit opportunities of established commercial developments.** Due to the large expanse of impervious cover associated with such development, commercial tracts are often sources of non-point source pollution; contribute to thermal pollution and cause groundwater impacts. In many cases, older commercial sites have little if any stormwater management provisions, including peak flow and flood control measures.

- **Evaluate retrofit opportunities for DPW facilities, schools and public buildings.** As with the older commercial developments, these public facilities often were constructed without adequate or proper stormwater management measures. Retrofit solutions can often be implemented at relatively low costs or through grants and public funding programs.

7.3 Open Space Management

The protection of open space, particularly along stream corridors, is a critical element of a comprehensive plan to protect water resources. Vegetated open space supports wildlife habitat, provides a natural buffer for filtering polluted stormwater runoff before it reaches surface water bodies, provides for groundwater recharge and provides recreational and scenic values. This section focuses on acquiring, managing and protecting open space within the watershed.

- **Prioritize open space areas for potential acquisition, easements and other forms of long-term management and stewardship.** Ongoing development in the watershed will inevitably result in the loss of some open space, but state and local agencies and watershed organizations have limited resources to expend on open space acquisition and protection. By identifying parcels in critical areas (e.g., endangered species habitats, contiguous forest), watershed stakeholders can focus their efforts and

limited funds in the places that are likely to have the strongest positive impact on maintaining and enhancing watershed values. It is recommended that the project partners, in consultation with the public, develop a set of watershed-specific criteria to rank parcels for protection and share that information with local land acquisition entities. In particular, the current distribution of private, local, state, and federal open spaces indicates that the Vandermark Creek watershed is much less protected than the Sawkill Creek watershed, with the more scenic and pristine Deep Brook tributary having essentially no existing permanently protected watershed lands. As such, Deep Brook and other areas of the Vandermark Creek watershed should receive particularly strong consideration.

- **Develop and adopt riparian and wetland protection ordinances**. Riparian and wetland buffer ordinances which prohibit disturbance within a prescribed corridor adjacent to a stream or wetland are critical to protecting surface water quality by reducing runoff and stream bank erosion. Many useful model ordinances exist and should be tailored to the specific needs of watershed municipalities.

- **Develop and implement tree preservation ordinances and tree removal permitting programs**. In addition to their many aesthetic values, mature trees provide shade, filter air pollution, buffer noise and wind, and provide wildlife habitat. While development generally results in some loss of trees through land clearing and grading activities, the loss can be reduced or even prevented by setting limits on the number or percentage of trees permitted to be cleared from a lot and requiring replacement trees to be installed. A tree removal permitting program can help ensure that the trees remain protected when construction is completed by requiring residents to obtain a permit for tree removal and setting limits on the number and size of trees that may be removed.

- **Reduce whitetail deer impacts through population control and re-planting.** As noted in Section 5, the watershed's abundant whitetail deer population has resulted in elimination of much of the forest under story, the reduction in habitat complexity, and the reduction in the food sources the deer depend upon. To reduce excessive browsing and help to prevent unsustainable deer population levels, population control efforts are recommended. Re-planting activities to mitigate the deer browsing, involving local volunteers (e.g., watershed residents, students and local service organizations), can be a good way to increase public involvement, stabilize soils and restore valuable forest habitat.

- **Monitor and enhance hemlock trees along riparian corridors in the watershed.** Hemlocks growing in riparian corridors provide important benefits to stream water quality, including reducing erosion and suspended solids by stabilizing stream bank soils and maintaining naturally cool water temperatures by providing shade. Over the past decade, however, the hemlocks of the Sawkill-Vandermark Creeks Watershed have been impacted by an infestation by the hemlock woolly adelgid, an insect pest that has killed many of these trees. The remaining trees should be monitored to track

the infestation and managed to reduce the woolly adelgid population through integrated pest management measures.

- **Develop and implement a coordinated, municipal-level land use planning effort to protect the watershed's rural character and natural beauty.** Preservation of open space, deer management and the other recommendations of this plan will be most successful if approached through a coordinated, inter-municipal planning effort. The watershed municipalities should work together to identify priority protection areas and appropriate tools for land protection. For example, to protect an area of contiguous forest that provides critical wildlife habitat and crosses municipal boundaries, municipalities might consider creating a "conservation zone" or "greenway" in which development would be limited or clustered in less sensitive areas. These strategies would be adopted into the municipalities' Comprehensive Plans and reflected in their land use ordinances.

- **Develop and provide easy access to GIS data layers needed for land use planning**. GIS is an electronic mapping and database tool that allows planners to layer land use information such as wetlands, steep slopes, critical wildlife habitat, zoning, hiking trails, recreation areas and many other features important to watershed planning. However, different agencies and organizations may possess different GIS data layers, with varying degrees of coordination with other entities. A GIS "clearinghouse" should be created to provide access to all available GIS data to watershed municipalities, planning agencies and land acquisition entities. This will allow identification of important data gaps and ensure that all watershed stakeholders have access to the most current data. This GIS repository can be used to identify trends in spatial patterns for watershed decision makers (e.g., land use, land cover, rivers and streams, roads and demographic information) to encourage science-based management decisions.

7.4 Recreation and Trails

Enhancement of recreational opportunities is important to both the economic and ecological health of the Sawkill-Vandermark Creeks Watershed and a central goal of this plan. This section describes specific recommendations and long-term strategies for improving recreation in the watershed.

- **Improve trails along the Sawkill and Vandermark Creeks.** Based on the goals of this plan, Pike County and its watershed partners seek to reconnect Milford Borough and its environs to its streams and rivers. One way to accomplish this is to provide a way for residents and watershed visitors to get close to these waterways. Improving the trails that provide access to the Sawkill and Vandermark Creeks and the Delaware River will promote public understanding of the connection between the streams and their surrounding watershed, including their own municipality. In addition to physical improvements, educational signage describing both the natural and political history of the watershed should be added to local trails.

- **Provide educational / interpretative opportunities relating to riparian buffer systems along the trail network.** As described throughout this plan, riparian buffers provide many benefits to stream water quality, wildlife habitat and aesthetic enjoyment. However, the general public may have a poor understanding of why they should not mow up to the stream's edge or why their views of the stream are blocked by trees and vegetation. Hiking trails provide an excellent opportunity to educate residents and visitors about the values of riparian buffers and to help them understand the natural features around them.

- **Establish a trail system linking Sawkill-Vandermark Creeks Watershed to adjoining watersheds and expand recreational access to public lands.** The parks and recreation areas of the Sawkill-Vandermark Creeks Watershed provide many opportunities for passive recreation, but these should be expanded to create a recreation "network" of trails and open space, which connect public lands to one another and to recreational areas in adjoining watersheds. This would attract more recreational visitors to the area, thereby improving the local economy, and also potentially reducing reliance on automobiles to travel from one location to another.

- **Add new lands to those accessible to the public**. Although Pike County is home to several public parks (described in Section 6), most of these are concentrated outside of the Sawkill and Vandermark Creek watersheds. Additional public lands should be acquired in the Sawkill and Vandermark Creek watersheds and enhanced to provide public recreational opportunities including trails and picnic areas. Wherever possible, these should be developed to provide access to and educational information about local historic and cultural resources.

7.5 Environmental Education and Public Involvement

In order to effectively implement this plan's recommendations for maintaining and enhancing watershed resources, watershed stakeholders (including the "general public") should understand what is being recommended, why it is important and how they can be involved in making it happen. As described in the previous section, recreational resources provide one channel for communicating this information to a large number of people. This section describes other strategies for educating stakeholders and increasing public involvement in watershed management activities.

- **Develop and/or enhance a site-specific watershed curriculum for local schools.** It is often said that children are the future, and this is certainly true in terms of watershed management. In order to ensure that our future watershed stewards are prepared for their responsibilities, watershed education relating specifically to the Sawkill-Vandermark Creeks Watershed should be integrated into school curricula. Watershed education is not only a way to help students understand the land and water around them, but it can show them how their daily actions can have important impacts on future watershed health. Watershed education can also be integrated into

a variety of disciplines, including science, math, language arts, history, social studies and even visual arts, providing educators with an additional teaching tool.

- **Create new nature center(s) in the watershed.** Despite its wealth of natural resources, the Sawkill-Vandermark Creeks Watershed lacks environmental or nature centers (although the Pocono Environmental Education Center in Dingmans Ferry lies just outside the watershed boundary in the Delaware Water Gap National Recreation Area). The development of one or more nature centers within the watershed could provide a focal point for watershed education and public outreach activities, including guided hikes, workshops and volunteer stream cleanups. Such centers would further reinforce the connection between watershed residents and visitors and the natural resources they enjoy and depend on, and would encourage watershed stewardship on a permanent and ongoing basis.

- **Start an annual "Sawkill-Vandermark Creeks Watershed Festival**." A watershed festival is a fun and effective way to bring the community together to celebrate the value of watershed resources, reach large numbers of people and potentially provide additional revenue for watershed protection activities. Such an event could include a variety of educational and volunteer activities focusing on local streams, including a stream cleanup.

- **Create and disseminate educational resources, including brochures, fliers, videos, billboards, commercials, signs, etc.** These are all important tools for spreading the message of watershed protection. Pike County and its partners should work together to develop education and outreach materials specifically targeted at a variety of different audiences, e.g.:

  - **Homeowners**: focus on reducing nonpoint source pollution by decreasing lawn fertilizer use, recycling motor oil, properly maintaining septic systems, landscaping for water conservation.
  - **Public officials**: focus on importance of soil suitability for septic disposal systems, model ordinances, stormwater best management practices, innovative land use planning techniques such as conservation subdivisions, etc.
  - **Hikers/park users**: focus on the value of riparian buffers, proper disposal of litter, and keeping motorized vehicles off stream banks and sensitive areas.
  - **Kids:** focus on simple actions to improve water quality and appreciate watershed resources.

- **Consider forming a municipal advisory committee for the watershed.** One of the biggest challenges to watershed management is coordinating land use planning and other activities among different municipalities. An advisory committee made up of representatives from each of the five watershed municipalities and Pike County would provide a forum for sharing information, ideas and model ordinances, as well as coordinating regional planning and land acquisition activities across the watershed.

- **Hold regular stream cleanup days.** These events would get people directly involved in caring for local water resources and increase public understanding of human impacts on stream water quality. These are also excellent learning opportunities for students and can be integrated into lessons about water chemistry and biology.

7.6 Economic Development

As discussed throughout this plan, the economy of Pike County and the municipalities of the Sawkill-Vandermark Creeks watershed is significantly dependent on revenue associated with outdoor recreational activities, and thus also dependent on the natural resources that sustain those activities. This section describes several strategies for promoting economic development compatible with watershed protection.

- **Implement planned development and innovative land use/zoning strategies designed to stimulate business growth while protecting natural amenities.** Businesses that take advantage of watershed resources without depleting or degrading them have the best chances for long-term success. For example, tubing and boating companies should protect their riverfront property with vegetated buffers to maintain stable stream banks and clear water for their customers. Likewise, municipalities should adopt zoning requirements that protect riparian areas and wetlands, maintaining their communities' natural character and increasing tourism. Local governments should also provide financial incentives/rewards (e.g., tax breaks) for businesses that implement measures to reduce nonpoint source pollution and protect watershed resources.

- **Promote a highly visible natural, green, and/or scenic identity and sustainable tourism in the watershed.** This recommendation is closely tied to the previous one. The watershed's most prominent economic advantage is its unspoiled natural beauty and vacation resort appeal. All businesses benefit when people visit or move there to enjoy these benefits. There should be a concentrated, inter-municipal effort to promote a highly visible nature preserve identity for the watershed. Local businesses should reinforce this image wherever possible through their advertising materials, business practices and even their interior and exterior design.

- **Create a "Sawkill or Pike County Center for Historical Culture and Conservation-Science.**" Such a center would feature the unique history, cultural resources and natural beauty of the Sawkill-Vandermark Creeks Watershed and its environs and attract paying visitors from the surrounding area.

- **Establish a partnership with the Delaware Water Gap National Recreation Area and the Upper Delaware River Council to increase recreation-based tourism.** These two agencies are well-established and enjoy strong recognition and support in this region. The county, municipalities and other watershed partners should establish an official partnership with them to coordinate marketing and education efforts and

inform visitors about the recreational and other leisure activities available beyond the Delaware River itself. Such a partnership would facilitate cost-sharing among the entities involved and would encourage longer tourist visits to the area.

7.7 Historical and Cultural Conservation

Like its natural resources, the historical and cultural resources of the Sawkill-Vandermark Creeks Watershed are an integral part of the region's character. This section describes recommendations for ensuring their long-term protection.

- **Identify potential historical and cultural resources.** Although the watershed's better-known historic sites (e.g., Grey Towers) have official state and/or federal recognition and protection, there are many other sites and natural features of historical significance in the watershed that are currently unprotected. These include:
    - Railroad bridges over 60 years old
    - Stone and barrel vault culverts
    - Historic cemeteries with pre-1900 burials
    - Dams and waterworks
    - Archeological sites

  There should be an organized effort to identify, map and record these features and gain official recognition and protection for them. This information should also be integrated into other marketing and educational activities throughout the watershed to further increase interest in the long-term protection of these important cultural resources.

- **Identify and preserve currently unprotected historic buildings.** Milford Borough in particular is well known for its historic buildings, but those without official state or federal recognition as historic sites may not have any guarantee of their long-term protection. Moreover, many of these buildings' owners may lack sufficient funding to adequately maintain them. There should be an effort to identify and permanently protect historic buildings throughout the watershed, potentially through grants or long-term agreements with building owners.

7.8 Visual Resources

The watershed's visual resources not only attract visitors but also are a highly visible sign of watershed health. Yet visual resources are rarely considered in development and planning decisions. The following recommendation describes a plan for protecting these valuable watershed assets from development and other impacts.

Identify and prioritize visual resources for environmental impact assessments. Visual resources are essential to the recreational values and economy of the watershed. To ensure that these resources, many of which do not have formal state or federal protection, are safeguarded from development and other impacts, it is recommended that visual resources be considered when assessing the impact of any proposed project.

7.9 Conclusions

The primary goals for this Plan are:

1. Protect the watershed's terrestrial natural, cultural and scenic resources from degradation associated with land development and sprawl.

2. Conserve and protect local and regional natural resources, especially the streams given their anti-degradation status and the breadth of sensitive and unique species that they support.

3. Protect cultural resources, focusing on bridges and buildings of historic significance and scenic resources such ridgelines and vistas. Before this can be accomplished, though, it appears a more comprehensive assessment, categorization and mapping of these resources must be conducted.

4. Maintain and enhance the recreational opportunities and the economic benefits of tourism by carefully planning development. Institute the proper development-related mitigative and control measures to protect the resources that attract tourists to the area. Where needed and practical, enhance recreational access.

5. Protect and enhance the exceptionally high water quality of the watersheds and streams.

The realization of the above Plan goals will take time and money, and most importantly, the continued involvement of all the watershed stakeholders. The coordination of the public and harnessing their energy and resources is required to bring this Plan to fruition. This means recreational enthusiasts, conservationists, business owners, developers, landowners, administrators and regulators working in concert. As difficult as this may sound, it is achievable if the primary goal of this Plan is maintained in the forefront: ***to protect, conserve and restore the unique environmental and recreational attributes of the Sawkill Creek and Vandermark Creek and their watersheds***.

Fortunately, Pennsylvania, through the PADEP and DCNR, has created an excellent framework for use in comprehensive watershed efforts of this nature. The Commonwealth's regulatory and monitoring programs complement and benefit watershed restoration and management efforts, especially with respect to stormwater management, riparian and wetland protections and maintenance of clear, clean surface water. Sustainable restoration, especially that which emphasizes increased public use and recreation, requires the integration of science, planning and engineering skills. But even more, it requires public support, commitment and involvement. It is anticipated the recommendations and management actions outlined in the Sawkill-Vandermark Creeks Watersheds Rivers Conservation Plan will demand community involvement, now and in the future, in order the maintain and expand on the extraordinary natural, recreational, and cultural resources of this combined watershed.

Rivers Conservation Plan Final Recommendations

Water Quality Protection and Enhancement

1. Develop watershed-wide stream buffer protection ordinances
2. Develop and implement a uniform stormwater management ordinance that is consistent with or exceeds PADEP recommendations for the control of peak flow, reduction of runoff volume and removal of pollutants
3. Make local land use regulations consistent with Phase I and II National Pollution Discharge Elimination System (NPDES) regulations
4. Develop watershed-wide performance standards for land development activities that are consistent with the Anti-degradation Requirements of the Pa. Code
5. Protect existing wetlands through wetland protection and buffer ordinances
6. Implement a septic system inspection and maintenance program in all municipalities
7. Establish a well monitoring program
8. Install stream gauges on the main-stem of both the Sawkill and Vandermark Creeks
9. Evaluate the effect of water treatment activities on Vantine Brook
10. Evaluate the costs and benefits of maintaining older dams on streams
11. Conduct additional biological and natural resource studies
12. Reduce flooding
13. Improve water and sewer infrastructure

Stormwater Management

1. Update the Sawkill Creek Act 167 Stormwater Management Plan
2. Implement municipal ordinances that not only address stormwater flows and flooding related problems, but also address volume control and nonpoint source pollutant loading
3. Require stormwater recharge
4. For new construction, adhere to the soil and erosion control requirements of PADEP
5. Evaluate retrofit opportunities of established commercial developments
6. Evaluate retrofit opportunities for DPW facilities, schools and public buildings

Open Space Management

1. Prioritize open space areas for potential acquisition, easements, other forms of long-term management and stewardship
2. Develop and adopt riparian and wetland protection ordinances
3. Develop and implement tree preservation ordinances and tree removal permitting programs
4. Reduce whitetail deer impacts through population control and re-planting
5. Monitor and enhance hemlock trees along riparian corridors in the watershed
6. Develop and implement a coordinated, municipal-level land use planning effort to protect the watershed's rural character and natural beauty
7. Develop and provide easy access to GIS data layers needed for land use planning

Recreation and Trails

1. Improve trails along the Sawkill and Vandermark Creeks
2. Provide educational / interpretative opportunities relating to riparian buffer systems along the trail network
3. Establish a trail system linking Sawkill-Vandermark Creeks Watershed to adjoining watersheds and expand recreational access to public lands
4. Add new lands to those accessible to the public

Environmental Education and Public Involvement

1. Develop and/or enhance a site-specific watershed curriculum for local schools
2. Create new nature center(s) in the watershed
3. Start an annual "Sawkill-Vandermark Creeks Watershed Festival
4. Create and disseminate educational resources, including brochures, fliers, videos, billboards, commercials, signs, etc.
5. Consider forming a municipal advisory committee for the watershed
6. Hold regular stream cleanup days

Economic Development

1. Implement planned development and innovative land use/zoning strategies designed to stimulate business growth while protecting natural amenities
2. Promote a highly visible natural, green, and/or scenic identity and sustainable tourism in the watershed
3. Create a "Sawkill or Pike County Center for Historical Culture and Conservation-Science
4. Establish a partnership with the Delaware Water Gap National Recreation Area and the Upper Delaware River Council to increase recreation-based tourism

Historical and Cultural Conservation

1. Identify potential historical and cultural resources
2. Identify and preserve currently unprotected historic buildings

Visual Resources

1. Identify and prioritize visual resources for environmental impact assessments