Upper Perkiomen Creek

WATERSHED CONSERVATION PLAN

Prepared by:

NATURAL LANDS TRUST

THE UPPER PERKIOMEN WATERSHED COALITION

Pennsylvania Environmental Council

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FOREWARD

The Upper Perkiomen Creek Watershed Conservation Plan has been produced through a partnership of the Upper Perkiomen Watershed Coalition, the Pennsylvania Environmental Council, and Natural Lands Trust.

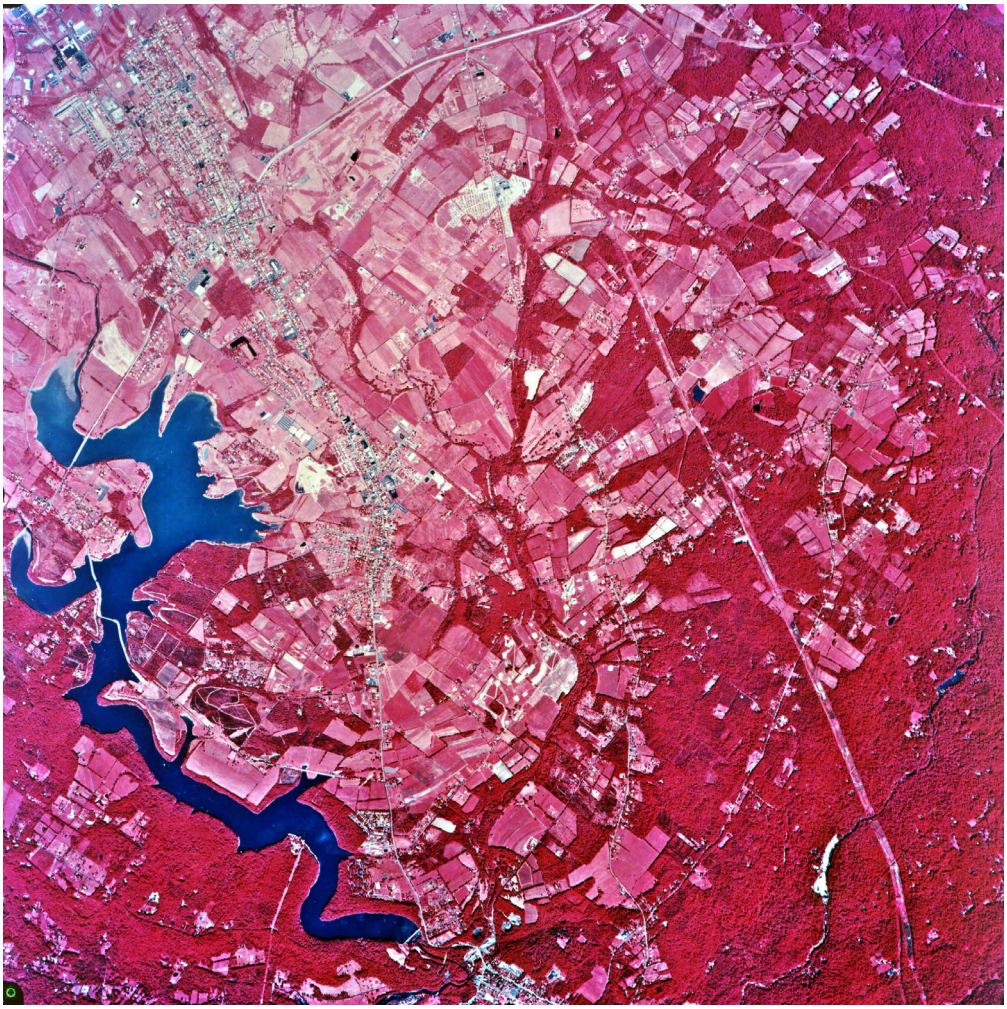
The mission of the Upper Perkiomen Watershed Coalition is "to protect, enhance and conserve the water resources of the Upper Perkiomen Watershed for the benefit of the human community and the natural environment." The Coalition achieves this mission through watershed management education, local government support and assistance, facilitating municipal cooperation, cooperation with civic, educational and environmental groups, database development to evaluate land use impacts in the watershed, identifying and prioritizing outstanding aquatic resources and threats they face, and promoting the preservation of environmentally sensitive areas.

The Pennsylvania Environmental Council improves quality of life for all Pennsylvanians by enhancing the Commonwealth's natural and built environments by integrating advocacy, education and implementation of community and regional action projects. The Council values reasoned and long-term approaches that include the interests of all stakeholders to accomplish its goals.

Natural Lands Trust works proactively to protect significant open lands in the Philadelphia region by acquiring and protecting natural lands, optimizing the use and composition of its system of 45 nature preserves, and by working with landowners, municipalities, agencies, institutions and conservation organizations to promote and implement ecologically-sound land use policies and practices.

The Upper Perkiomen Creek Watershed Conservation Plan is designed to serve as a guidebook for landowners, municipalities, conservation groups, and citizens interested in taking concrete steps to enhance the long-term health of the Upper Perkiomen and its enjoyment by the public. A major portion of the plan is devoted to management recommendations for municipalities and landowners in the 144 square mile Upper Perkiomen Creek watershed. It also includes a summary of findings on existing physical conditions and regulatory restrictions in the watershed, and a summary of the input of municipal and county officials, landowners, and private citizens (solicited through public workshops, questionnaires and interviews). The Plan provides, for the first time, a comprehensive geographic information system (GIS) database of computer map information available for environmental planning, conservation and restoration efforts in the watershed.

The Conservation Plan was produced with financial assistance obtained by the Upper Perkiomen Watershed Coalition from the Rivers Conservation Program, administered by the Pennsylvania Department of Conservation and Natural Resources (DCNR). When DCNR approves the final Conservation Plan, the Upper Perkiomen Creek will be submitted for inclusion on the "Pennsylvania Rivers Conservation Registry", providing the basis for DCNR matching grants to municipalities that have adopted the plan by resolution. These municipalities, or groups sponsored by them, will be eligible to apply annually to DCNR for grants to implement the recommendations in the report. Therefore, unlike the older State Scenic Rivers program, the incorporation of the Upper Perkiomen Creek into the Rivers Conservation Registry can provide monetary benefit to participating municipalities.



This 1987 USGS Infrared aerial photograph shows a crossection of characteristic land uses in the Upper Perkiomen Creek Watershed, with Green Lane Reservoir to the left, the villages along Route 29 and productive farmland along the Macoby Creek in the center, and the Unami Forest to the right.

The Conservation Plan was prepared for
the Upper Perkiomen Watershed Coalition
by the Pennsylvania Environmental Council and Natural Lands Trust

Your comments on this Conservation Plan are welcome. Please address them to:

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A CASE FOR PROTECTION OF THE UPPER PERKIOMEN CREEK WATERSHED

The Perkiomen Creek rises in Hereford Township, Berks County on the south-facing slopes of a wooded ridge near Seisholtzville. The major tributaries of the upper portion of the Perkiomen Creek, the Northwest Branch, Indian Creek, and Hosensack Creek also have their source along this ridge, which includes Blackhead Hill, Furnace Hill and South Mountain. The Perkiomen flows for over 15 miles to the southeast, through Green Lane Reservoir and over its impoundment, before reaching the confluence with the Unami Creek. This upper segment of the Perkiomen is fed by literally dozens of miles of headwaters tributaries. For the purpose of this Conservation Plan, the southern limits of the Deep Creek and Unami Creek subwatersheds form the southern limit of the Upper Perkiomen Creek watershed. The communities of the Upper Perkiomen Creek watershed are home to an estimated 48,000 residents, within a politically complex landscape that includes portions of 26 municipalities (7 boroughs and 19 townships) located within four counties. **(see Figure 1 – Location map)**

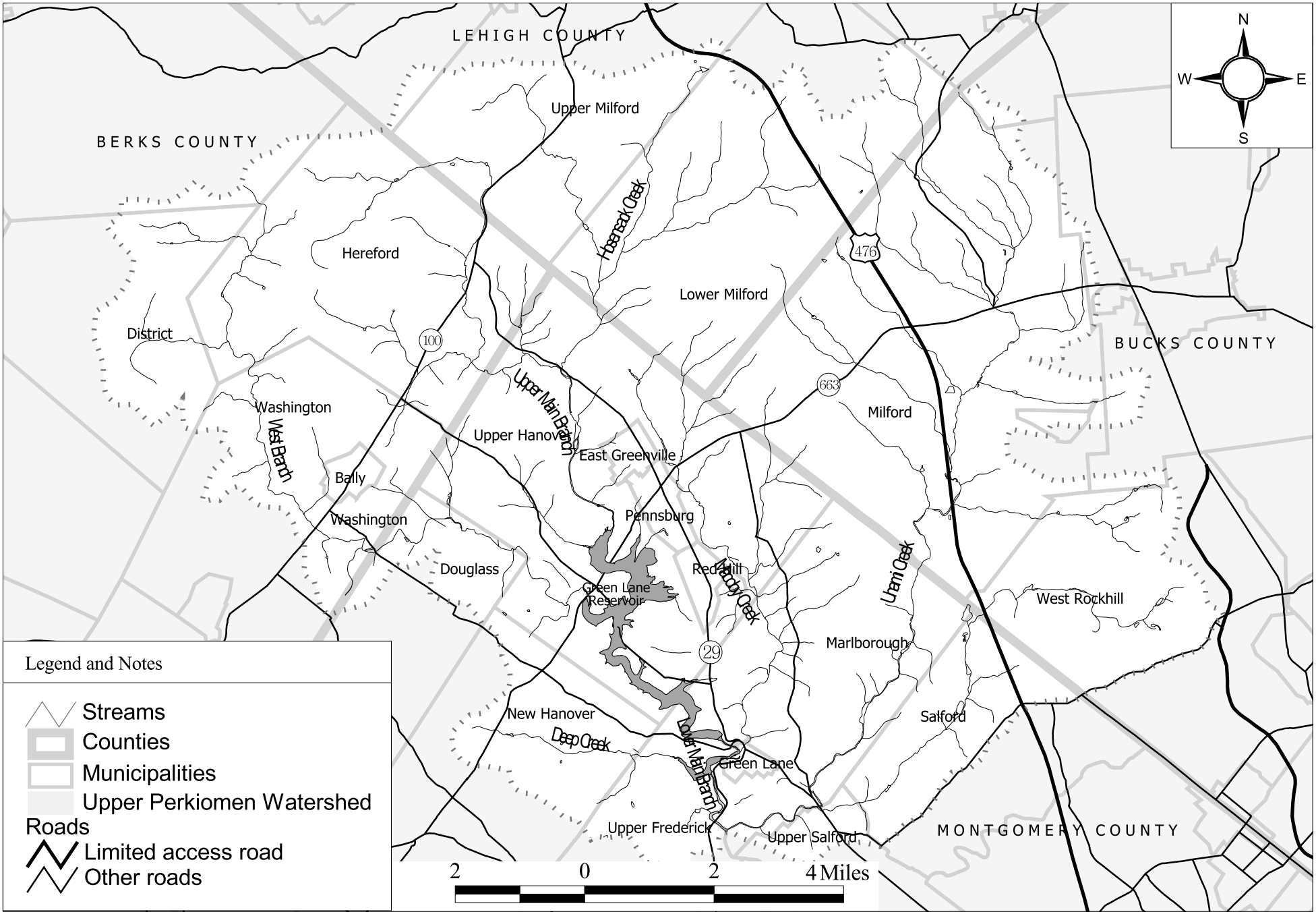
The Perkiomen Creek and its tributaries meander through the communities of the Upper Perkiomen Valley, connecting many places and people, and weaving together a local story of ecology, agriculture, industry and changing land use. The living history of the Upper Perkiomen Valley can be read in the deep woods of the Unami Hills, the productive farms of Hereford Township, historic villages such as East Greenville, Pennsburg, and Red Hill, and the expanding water supply system of the Green Lane Reservoir. The stewardship ethic of local residents is evident in the well-maintained farmsteads, liveable towns, and rich natural areas that define the landscape. It is also evident in the growing awareness among local residents, businesses, municipalities and organizations that the quality and quantity of ground water and surface water are important and integral to a healthy living environment, and the emergence of organizations such as the Upper Perkiomen Watershed Coalition.

However, the last 300 years of land use in the Upper Perkiomen Valley have left a legacy of serious degradation among certain streams, wetlands, groundwater – a legacy in which the quality and quantity of water, and the health of the living environment for people, plants and animals have been compromised. Several hazardous waste sites in the watershed have polluted local aquifers. Numerous wetlands in the Upper Perkiomen have been drained and filled to support agriculture and development, and their vital natural functions as water purifiers, flood control devices, and rich habitat for flora and fauna have been lost. The quality of many streams in the watershed has been degraded due to combinations of tree clearing along banks, floodplains and slopes, unrestricted livestock access, construction of dams and ponds, runoff carrying pollutants from roads, parking lots, lawns, crop fields and construction sites, discharges from

industrial and sewage treatment plants, and ongoing problems such as failing septic systems. All of these stream quality impacts are exacerbated by reduced baseflows resulting from increased stormwater runoff and pumping of groundwater. Breeding populations of native brook trout, an important indicator of stream health once common throughout the Upper Perkiomen stream network, are today limited to only a small number of remote tributaries.

The *Upper Perkiomen Creek Watershed Conservation Plan* provides an overview of these key natural and cultural elements and water quality and quantity concerns, while also foreshadowing major land use changes with the potential to seriously alter the health of the watershed and the quality of life of its residents. Although water is a vital resource, it is not infinitely available and it is vulnerable to pollution. Trends in the ownership of land, the body of laws that govern land use, the pattern and density of development, demands for water supply, wastewater treatment and stormwater management, and the eternal natural cycles of flooding and drought are all critical factors influencing the future of the Upper Perkiomen Valley as a desirable place to live and work.

For many communities in the Upper Perkiomen Valley, the pattern and intensity of development over the next 20 years will decide the fate of the land and water resources that make up the watershed. The *Major Issues for the Upper Perkiomen Creek Watershed Conservation Plan* represent an effort by residents of the watershed, municipal officials, local watershed organizations, local and regional land trusts, and County agencies to identify major issues affecting water quality and quantity, and the living environment for local residents. These issues, ranging from land development to the need for environmental education, are accompanied by a series of Implementation Recommendations contained in the Action Plan.



Upper Perkiomen
Rivers Conservation Plan

Figure
Location Map

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The communities of the Upper Perkiomen Creek watershed are fortunate in that they have managed to retain their rural landscapes and historic villages and high quality streams and aquifers that have provided a healthy living environment for people, plants and animals. With population projections for many municipalities estimated at increases of over 50% in the next two decades, the rapid and widespread suburban development pattern that has altered much of the land and water resources of southeastern Pennsylvania threatens to forever alter the Upper Perkiomen Valley. Along with the increasing population and consumption of land, our lifestyles are demanding more water. Between 1900 and 2000, the human population of Pennsylvania more than doubled, while its consumption of water has increased over 1,000% from 5 gallons per person per day to 62 gallons per day (Pennsylvania DEP, 2000).

The concluding Action Plan section of this Conservation Plan is based on the recognition that the communities of the Upper Perkiomen watershed have reached an important crossroads – the irreversible impacts of suburban sprawl are just now beginning to be felt in the still-rural landscape of farms, woodlands and older towns, villages and hamlets. Now is the time to plan wisely and guide that growth in a way that preserves, restores and maintains key land areas and the quality and quantity of water in the streams and aquifers that sustain life for the people, plants and animals that inhabit the watershed. The Action Plan provides a road map for guiding growth in the watershed, and an important avenue for funding watershed conservation projects.

This Plan is an important step toward addressing the following challenge: to understand the water quality and quantity of the Upper Perkiomen watershed -- the "water budget" -- so we may guide future growth, development, land use and conservation in a way that respects the natural carrying capacity of the land -- the "water balance".

PRINCIPLES OF THE CONSERVATION PLAN

The Upper Perkiomen Creek Watershed Conservation Plan is prepared with the guidance of the following principles. Throughout the document, more specific goals, objectives and recommendations developed from these primary principles are described:

- **General Awareness.** The Upper Perkiomen Creek watershed should come to be widely understood by those who live and work in the area as an interrelated natural system of land and water on which humans, plants and animals depend. This awareness should include the recognition that the issues affecting water quality and quantity in the Upper Perkiomen also affect the ability of the watershed to support all forms of life.

- **Coordinated Action within the Watershed.** Through the coordinated actions of all parties – municipalities, agencies, landowners, citizens, institutions, businesses and private groups – the ecology and scenic beauty of the Upper Perkiomen Creek, its tributaries and watershed should be preserved and, where possible, restored.

- **Coordinated Action with other Watersheds.** Groups and individuals involved with the planning and implementation of the *Upper Perkiomen Creek Watershed Conservation Plan, the Lower Perkiomen Creek Conservation Plan and the Schuylkill River Watershed Conservation Plan* should be cognizant of the importance of coordination between each plan and the resources, issues and implementation strategies they identify.

- **Central Role of Municipalities.** Municipalities and organizations active in watershed planning and conservation should pursue the implementation recommendations found in this Watershed Conservation Plan, using matching funding sources such as the Pennsylvania Rivers Conservation Program.

ENVIRONMENTAL, CULTURAL AND HISTORIC RESOURCES

The following natural features characterize the Upper Perkiomen Creek watershed and present very real planning implications for future development and conservation.

Physiographic Region

The Upper Perkiomen Creek valley forms the 144 square mile northern portion of the Perkiomen Creek watershed, which, at 362 square miles in area, is the largest subwatershed of the Schuylkill River watershed and a major headwaters area within the Delaware River basin. The streams of the Delaware drain much of the southeastern Pennsylvania portion of the Northern Piedmont province, a physiographic region extending from northern Virginia to southwestern Maine (The Nature Conservancy, 1996). The area is reminiscent of the Piedmont or foothill sections of southern Europe, and is named for the Italian Piemonte, meaning "foot of the mountain" (Godfrey, 1980). The Northern Piedmont is characterized by a gently rolling landscape of temperate deciduous forest underlain by crystalline bedrock and clayey soils on the eastern foothills of the Appalachian Mountains reaching eastward to the Atlantic Coastal Plain.

The lower half of the Upper Perkiomen watershed (primarily the area within Bucks and Montgomery County) is a fine representative example of the Triassic Lowland section of the Northern Piedmont landscape. The Triassic Lowlands are generally underlain by softer sedimentary geology such as red shale and sandstone. The prominent ridges that define the Unami Creek and Deep Creek valleys are also in the Triassic Lowlands, but are defined by more erosion-resistant diabase bedrock.

The northern half of the Upper Perkiomen watershed is part of a physiographic formation known as the Reading Prong. This landform crosses through the watershed in a northeast-to-southwesterly direction, forming the ridges that constitute the headwaters area above Green Lane Reservoir. The Reading Prong is a landmass that originates in Connecticut, east of the Hudson River, includes the Highlands region of northwestern New Jersey, and terminates west of Reading, and is actually part of the much broader New England Highlands province extending north into Vermont. It is underlain by Precambrian and Cambrian geology such as Gneiss. (Shultz, 1999) The local place names of this ridge include Blackhead Hill, Furnace Hill, Carl Hill and South Mountain. The drier, thin soils and steep topography of these ridges support a more northern forest type and less intensive land use pattern than the deeper, moist soils of the rest of the watershed. (**See Figure 2: Physiographic Region)**

Geology

The southern half of the Upper Perkiomen Creek watershed is situated within the Newark Basin portion of Triassic Lowland Province, a broad basin within the Northern Piedmont defined by its fairly young (210 million to 250 million year old) sedimentary shale bedrock geology. The eastern third of the watershed includes a broad (8 mile wide) circle of igneous diabase bedrock intrusions, perhaps the most dramatic landform within the Triassic Lowlands, dating to between 175 million and 200 million years ago. The headwaters areas in the northern half of the watershed fall within the Reading Prong, a ridge of Precambrian (> 590 million year old) granitic gneiss and Cambrian Hardyston quartzite trending from the northeast to southwest.

The Unami Creek and Ridge Valley Creek subwatersheds, the steep valley along Deep Creek, and the ridges north of Green Lane Reservoir are almost entirely underlain by diabase bedrock, with small areas of Brunswick shale interspersed. This diabase formation was intruded into the 210 to 240 million-year-old Brunswick shale as molten lava sometime during that time period. The igneous (molten lava) bedrock heated the adjacent sedimentary Brunswick shale to form a more dense, crystalline, metamorphic rock type known as "hornfels", which may appear at the surface as small diabase boulders with a pink or light brown tint. The pattern of diabase and associated hornfels in the Perkiomen Valley forms an unusual, broad circle of ridges with the boroughs of Pennsburg and Red Hill at its Center. This diabase ring could be a caldera, a remnant of an ancient volcano. The Unami Creek Valleys is situated along the broad eastern portion of that diabase formation. The stream valleys within the watershed are generally underlain by softer the hornfels and red shale. **(See Figure 3: Geology)**

Diabase

Diabase is the primary rock type underlying many of the prominent wooded ridges, steep slopes, boulder-strewn hillsides and narrow stream valleys in the Upper Perkiomen. Some of the broadest diabase outcrops in the region occur in the Unami area, with sections along Upper Ridge Road and Hill Road reaching one-half mile or more in width. The formations within the Upper Perkiomen watershed are part of two diabase sheets -- East Greenville (7.1 cubic miles in volume) and the Quakertown pluton (28.6 cubic miles), one of the largest diabase intrusions in the region.

The igneous nature of diabase explains its physical characteristics as a dense, crystalline, erosion-resistant outcrops that weather to form large boulders, occasionally in broad fields of "Ringing Rocks." Boulder fields such as the one along the east side of King Road at Natural Lands Trust's Fulshaw Craeg Preserve in Salford Township are examples of natural features that have become local cultural landmarks. Many generations of local residents have come to climb on the rocks and strike them together

to make the ringing sound associated with sound waves traveling through dense crystalline interior and the almost metallic weathered surface.

Groupings of large diabase boulders along steep slopes form small "caves" in some areas along the Unami Creek, Ridge Valley Creek and Deep Creek. These caves may support nesting habitat for bird species such as Turkey Vulture and Black Vulture, but have not been documented as roosting habitat for bat species in the area. Some of these caves have been documented as the Unami Creek Rock Shelters used by the native Lenai Lenape people up to the 18th century.

In the 19th and early 20th century, diabase in the area was quarried to form "Belgian blocks" that lined major Philadelphia streets such as Broad Street. Drill marks for dynamite can still be seen in boulders on the Fulshaw Craeg Preserve and surrounding areas. Diabase, also known as "black granite" or "trap rock", has been used for headstones and support stones for large engineering projects, but was generally considered too dark to be used as building stone.

Hornfels

The igneous diabase intrusions in the Brunswick formation of the Perkiomen Creek watershed are so pronounced that it is likely that nearly all of the adjacent shale was heated and compressed to form metamorphic hornfels. Therefore, many of the reddish-brown Lehigh, Brecknock and Croton soils adjoining Diabase areas are more likely to be hornfels-based rather than formed from unmorphosed sedimentary Brunswick shale.

Brunswick Formation

The rock types associated with the Brunswick formation are generally reddish brown shales, mudstone and siltstone. These shales are moderately resistant to erosion and weathering. The greatest concentrations of this Triassic rock is centered along Macoby Creek and the Route 29 corridor and the eastern side of the Route 100 corridor, where it provides the parent material for some of the most productive agricultural soils in the Valley. Many of the historic structures in northern Montgomery County and Berks County were made with the reddish-brown stone quarried in the region. Weathering parent material from the Brunswick geology also directly forms the reddish-brown soils of the Lehigh-Brecknock-Croton series.

Precambrian Gneiss and Hardyston Formation

The headwaters streams at the northern limit of the Upper Perkiomen Creek watershed rise in an area underlain by Precambrian Gneiss geology, part of the Reading Prong section of the New England province. At a minimum of 590 million years old, these are among the most ancient rocks in the region. Granodiorite and granodiorite gneiss are included in this formation, and are interspersed with large patches of Cambrian sandstone known as the Hardyston Formation . This geology weathers at varying rates, with more highly erodible areas forming broader, rolling landscapes. The dense, less

erodible Gneiss forms the steeper wooded ridges and valleys in this area, with the even denser Cambrian quartzite known as Hardyston quartzite forming the ridgetops and along the bases of some slopes. The high iron content in some of this bedrock provided the raw material for the 18th and 19th century furnaces and forges in the upper part of the watershed.

Leithsville Formation and other Limestone

Leithsville Formation, a carbonate limestone rock dating to the Cambrian period (500 to 590 million years ago), underlies a small area in the northwestern headwaters area of the watershed. This limestone reaches a thickness of up to 1,000 feet, and is concentrated along the Northwest Branch of the Perkiomen Creek above the village of Dale and along Route 100 north of the village of Bally. This limestone geology is characterized by numerous fractures and solution openings, forming one of the most productive aquifers in the watershed. The Gabel Quarry is located in this area. Additional limestone formations can be found along the east side of Route 100 near Bally and Hereford. The generally soft, erodible nature of this geology defines the broad, flat topography of the "Butter Valley" in relation to the adjacent hills.

Planning Implications

The strong influence of the underlying diabase and gneiss bedrock on the topography and vegetation of the Unami Creek and Deep Creek valleys and the headwaters ridges also provides natural limitations for agriculture and land development. In particular, the steep, rocky nature of the land has historically limited the use of these areas for cultivation. Numerous stone walls and stone house ruins in some sections of these woodlands indicate that small-scale sheep or cattle farming probably represented the pinnacle of agricultural use in these landscapes over 100 years ago. The floodplains in diabase and steeper gneiss ridges were never broad enough or extensive enough to support the larger scale cultivation and pasturing found in more gently rolling portions of the Perkiomen Creek watershed where Brunswick shales and Gneiss is present. These same steep slopes and rocky soils present natural limitations today to large-scale development, road construction, and septic systems and private wells in the Unami Creek and Deep Creek valleys.

The carbonate limestone of the Leithsville Formation and limestone along the east side of Route 100, though limited in area, includes a large capacity for water storage and well supply. The *Upper Perkiomen Creek Watershed Management Study: Technical Report* notes that the numerous joints and fractures in this formation allow for water movement but are often filled with quartz. The thick soils formed over this limestone are an important storage area for groundwater in the first 80 to 150 feet below the surface. The average well depth recorded in the Lehigh County portion of this formation is 200 feet, with yields exceeding 1,000 gpm (Cahill, 1994). The same qualities that produce high well yields in these limestone aquifers also make groundwater contamination and excessive groundwater depletion equally important concerns. Land use practices in these areas

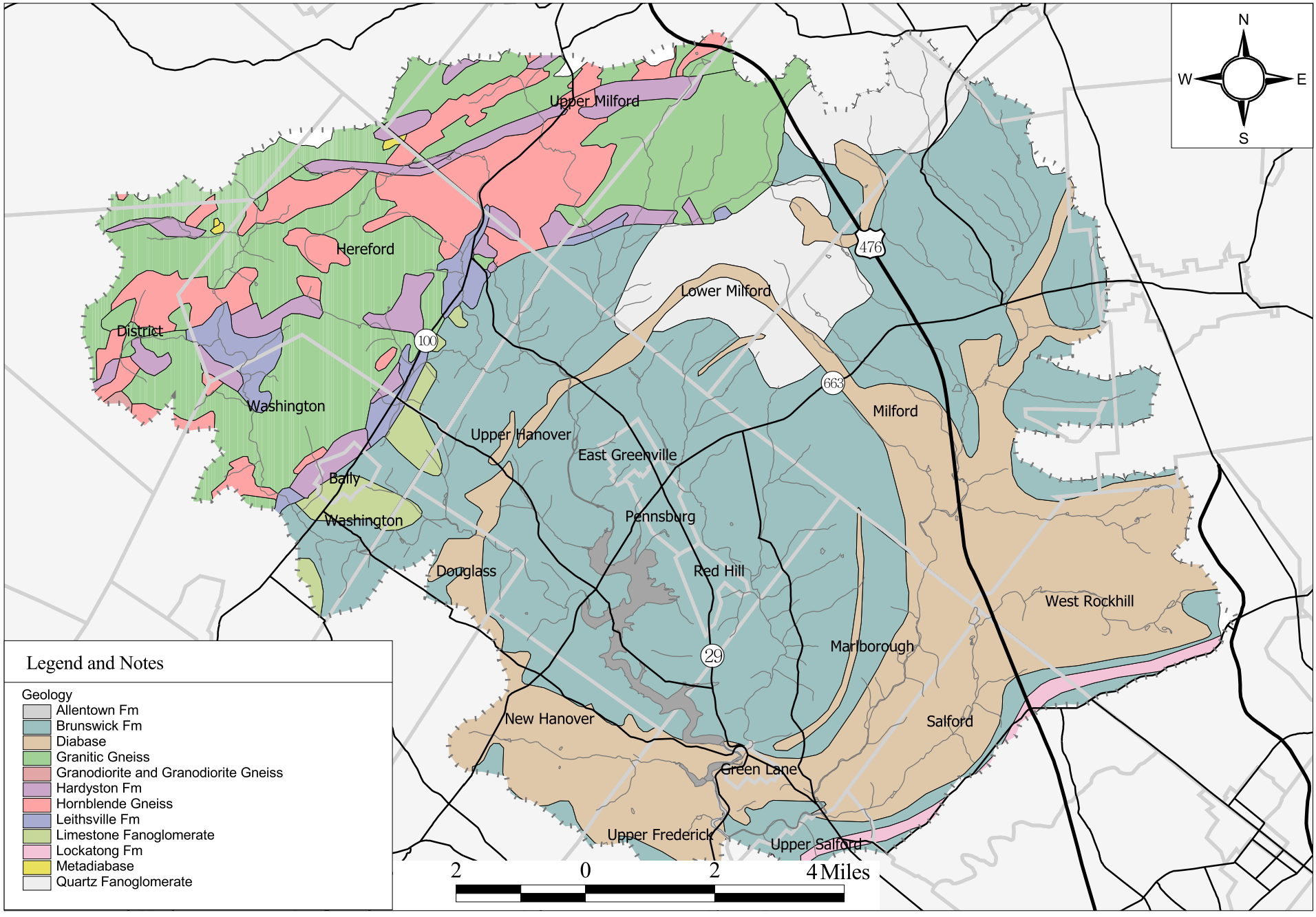
should be limited to those which pose no great threat to the quality or quantity of water in the Leithsville or other limestone aquifers. These areas may also be prone to sinkhole formation, which poses structural concerns for buildings, roads, utility lines and other infrastructure. Careful testing should be done prior to development in limestone areas, and stormwater and septic systems should be designed to avoid concentration of subsurface water – the primary factor leading to sinkholes.

The aquifers of the Brunswick Formation centered along Route 29 are generally the most productive in the watershed. As noted in the *Upper Perkiomen Creek Watershed Management Study: Technical Report,* the Triassic rocks include numerous faults, weathered areas and joints that are "very important for the storage and transmission of groundwater (Longwill and Wood, 1965). The maximum yield of groundwater occurs between 200 and 550 feet below the land surface. The increased yield at 200 feet is due to the way the rock weathers; openings above 200 feet are commonly plugged with clay and silt. The Brunswick Formation is considered a reliable source of groundwater with yields greater than 100 gpm (gallons per minute) in places (Longwill and Wood, 1965) (Cahill, 1994)."

Groundwater found in quartzite areas along the northernmost ridges in the watershed tends to be 200 to 400 feet below the surface, and may yield an average 30 gpm through fractures and fissures. The *Upper Perkiomen Creek Watershed Management Study: Technical Report* documents that the gneiss formation that characterizes much of the northern half of the watershed is more productive for wells. "Primary porosity and permeability within the gneiss metamorphic and igneous rocks of the Reading Prong is low. Therefore, groundwater must be stored and transmitted in the weathered zone near the surface and/or in secondary openings such as fractures, joints, and faults near the surface in the unweathered rock. Generally, water-bearing zones deeper than 150 feet are unusual and rare (Wood, et al., 1972). Despite the seemingly poor hydrologic characteristics, the median yields for wells developed in the granite gneiss is approximately 50 gpm (Cahill, 1994)."

Diabase is considered a poor source of groundwater, with most groundwater only available within the weathered zone to 30 feet deep, and median yields of 5 gallons per minute (gpm) reported (Cahill, 1994). Most of the underlying geology is too dense, and the fractures and fissures too narrow, to provide reliable well water on a large scale. The shallow depth to bedrock through much of the Unami and Deep Creek area presents difficulties for excavation of on-site septic systems, and sand mound systems are commonly used as a way of defeating this natural constraint. Extension sewer lines from municipal or community sewage treatment plants in the vicinity of Green Lane or Sumneytown could mean that geology is taken out of the equation as a limiting factor for wastewater treatment in the area.

Radon gas accumulation in houses should also be considered a potential hazard associated with development on underlying geologic formations in the Upper Perkiomen Valley. Radon gas is a product of radioactivity in certain rock types, and has been linked to human health problems and lung cancer. This problem occurs throughout southeastern Pennsylvania, and has been documented on the geologic formations of the Reading Prong. "In the Reading Prong, high uranium values in rock or soil and high radon levels in houses are associated with Precambrian granitic gneisses commonly containing 10 to 20 ppm (parts per million) of uranium, but locally containing more than 500 ppm uranium." (Shultz, 1999) In fact, the first large-scale radon scare in the world was centered in neighboring Colebrookdale Township, Berks County area in the late 1980's, when an employee at the Limerick nuclear power plant tested for high levels of radiation, and his home was found to support radon levels many times the guidelines set by the Environmental Protection Agency.



Upper Perkiomen
Rivers Conservation Plan

Figure 3:
Geology

Pennsylvania Environmental Council
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Topography and Landforms

The upheaval and gradual weathering and erosion of the diabase, gneiss and shale/sandstone geology over the last 200 to 240 million years largely shape the topography of the Upper Perkiomen Creek watershed. These events have produced at least three main topographic landscape types: with the narrow, steeply sloping stream valleys of the Unami Creek and Deep Creek, draining toward the Perkiomen; the broad headwaters valleys in the upper reaches of the watershed; and the prominent ridges that provide the source waters for the Perkiomen. The northeast-southwest orientation of the diabase and gneiss ridges is due in part to their location in the southwest section of a broad circle of diabase bedrock, approximately 8 miles across in the upper Perkiomen Creek watershed. This circle may have resulted from the intrusion of the igneous diabase as molten lava in the form of a "caldora", or volcanic formation.

The highest point in the Upper Perkiomen Creek watershed occurs along the ridge above Bally and Hereford, which reaches an elevation of 1,100 feet above sea level. Mill Hill, located just north of Pennsburg, is the highest point in Montgomery County at 700 feet above sea level. The lowest point in the Upper Perkiomen Valley is at the confluence of the Unami and the Perkiomen, which is approximately 200 feet above sea level. The steepest slopes throughout the area can be found along the ridges and narrow valleys at the headwaters of the watershed, and along the Unami Creek and Deep Creek valleys. The sides of the diabase and gneiss ridges feature numerous areas of steep slopes ranging from 15 to 25%, and 25% or greater. Some of the most dramatic examples of this steep topography (often in excess of 25% in grade) can be found along the Ridge Valley Creek and the Unami Creek, which experience drops of 300 feet over distances of less than 1,000 feet, from ridgetops to stream channels. The Unami Hills area, though steep, only reaches a high elevation of 620 feet at the base of the radio tower along Hill Road. However, the Unami Creek valley has one of the steeper drops in the area, falling 400 feet in approximately 1.5 miles before reaching the confluence with the Perkiomen.

The topography of the majority of the watershed is more gently rolling, with low hills and broad, level headwaters areas. Floodplains of the Upper Perkiomen Creek watershed are formed over thousands of years of floodwaters causing scouring and deposition of material. In some portions of the watershed, the alluvial sediment deposits form specific floodplain soils that spread throughout floodplains and support native vegetation such as floodplain forest and marsh conditions.

Planning Implications

The underlying geology and topography has determined much of the land use in the Upper Perkiomen Valley, and will continue to play an important role in the future. While the area has a long history of agricultural use in the rolling topography and industry in the valleys, many of the ridges, slopes and narrow valleys of the area today

are left wooded with scattered residential development in less steep or wet areas. Road networks in the area are local, indirect and winding, and in some of the wooded ridges roads are unpaved. In the Unami Creek area only the ridge top roads provide through access to other destinations. The topography of the Unami Creek and Ridge Valley Creek, Deep Creek, and the headwaters area ridges is not conducive to high-density residential development, modern industrial or commercial development or agricultural use. The diabase topography reinforces the sense of this land use division by the limitation it places on the use of on-site septic systems, water supply and the construction of new access roads.

To best protect the steep slopes in the Upper Perkiomen watershed area, the local municipalities should enact updated ordinances to restrict development on inappropriate topographic areas. Steep slope ordinances limit, and sometimes prohibit, development on slopes considered too steep to be built upon without danger to public health and safety. Steep slopes erode rapidly if exposed, which can cause silting of streams. It is also difficult to build safe driveways and roads on steep slopes without excessive grading, disturbance to vegetation, erosion of soils and sediment, and salt impacts to streams in winter. Generally two categories of steep slope are defined:

- slopes falling one vertical foot for every 6.67 linear feet (15%) to one foot for every four linear feet (25%),
- slopes greater than 25%.

Restrictions on the second category are greater, concomitant with their greater sensitivity. These are overlay-zoning districts, like the floodplain districts. Residential structures on large lots (3 to 5 acres or more) can be designed to be "notched" into a slope (like a bank barn), rather than re-grading the slope to create a flat "pad" site for construction.

In the greater than 25% slope areas (often called "Very Steep Slopes"), structures and septic fields are usually prohibited. In the 15-25% category ("Steep Slopes") buildings and septic systems are often allowed as conditional uses requiring Zoning Hearing Board approval. In other cases a maximum percentage of each slope type may be disturbed (e.g., Upper Providence). Marlborough Township's Zoning Ordinance includes a Steep Slope Overlay District and maps that show the greatest concentration of slopes over 15% along both sides of the Unami Creek. Development on slopes of 15% or greater is limited to state- and county-permitted on-site sewage disposal systems. Public wells, stormwater facilities, underground utility lines, roads and driveways, and construction of structures on slopes of 15% or greater are permitted, but only as a Special Exception when the applicant has demonstrated to the Zoning Hearing Board that no alternative exists and that health, safety and welfare of the community are protected. *All such ordinances should include standards greatly limiting development and protecting vegetation, particularly on slopes adjacent to the floodplain and small tributaries.*

Soils

Soils are perhaps the fundamental resource linking geology, topography, hydrology, vegetation and land use. They are formed over thousands of years by a combination of weathering bedrock and decomposing forest organic matter. The varying rates of permeability determine the balance of runoff and recharge throughout the watershed, and shape the natural pattern of vegetative communities. Agriculture has historically been focused on the deepest, most productive soils of the broad valleys, whereas the thin soils of the ridges have typically been managed for timber and recreational uses such as hunting and summer camps. Soils are also critical components of the water quality equation due to their varying capacities for filtering pollutants generated by human activities such as septic systems and fertilizer applications.

Neshaminy, Mount Lucas and Watchung soils make up the portion of the Upper Perkiomen watershed soils overlying the diabase formation. These soils are mostly deep, well drained to poorly drained silt loams on diabase hills and ridges. The Lehigh, Brecknock and Croton soils are the most common soil types in the watershed found over the Brunswick shale areas at the perimeter of the program area. **(See Figure 5: Soils)**

Neshaminy (NsD, NsB, NeB)
Neshaminy soils are by far the most common soil type in the program area, with Neshaminy (NsD) very stony silt loam, 8 to 25 percent slopes most common along the slopes above the Unami Creek and Ridge Valley Creek. Some areas of this soil are more sandy and shallow over bedrock, and small areas are extremely stony. The less steeply sloping NsB soils have a top layer of woodland leaf litter and humus. The diabase boulders beneath the subsoil are from 1 foot to more than 12 feet in diameter. The hilltops and ridges in the area are dominated by Neshaminy (NeB) extremely stony silt loam, 0 to 8 percent slopes. These are the soils of rock outcrops and shallow depth to bedrock areas.

Mount Lucas (MoB2, MoC2, MuB, MuD)
Mount Lucas soils are silt loams commonly found throughout the hilltops, ridges and lower slopes adjacent to the Neshaminy soils and the Watchung. Mount Lucas soils in particular have moderately slow permeability in the subsoil, and are rated as hydric soils with a depth to seasonal high water table averaging 1 to 2.5 feet. These soils also feature large, round diabase boulders from 1 foot to 12 feet in diameter. Hard bedrock is usually 5 to 10 feet beneath the surface, with numerous boulders interspersed in the soil above that level. Mount Lucas soils are also slightly acid to neutral. Some areas of Mount Lucas soil (MoB2) have slow permeability and form wet depressions and seeps at the bases of slopes from spring through early summer. The Mount Lucas very stony silt loams on 0 to 8 percent slopes (MuB) occur along ridgetops in the area, and those on 8 to 25 percent slopes (MuD) occur on lower slopes.

Lehigh (Lh, Li, Ls), Brecknock (Bs, Bt, Bv) and Crofton (Cr, Cs)
Lehigh, Brecknock and Croton are the common soils overlying the Brunswick formation geology at the northern and southern limits of the program area. These soils are moderately deep, poorly drained to well-drained soils of uplands underlain by metamorphosed shale. These soil types include substantial areas of prime agricultural soils.

Planning Implications
Poor drainage, high water table, shallow depth to bedrock, and rocky ridges, outcrops and slopes characterize the majority of the soils that constitute the landmass of the Upper Perkiomen Creek watershed. These qualities demonstrate that the gradual erosion of the underlying diabase geology has created a landscape where water and rock are common factors affecting the uses of the land and soil.

Natural constraints to development are most frequently due to poor recharge qualities, high groundwater table, or shallow depth to bedrock. These qualities are typical of the most common soil types in the area, and they point to the fact that the area cannot handle significant increases in on-lot disposal of sewage effluent (with or without sand mounds) without seriously threatening the carrying capacity of the land to supply clean groundwater for the private wells used by most residents.

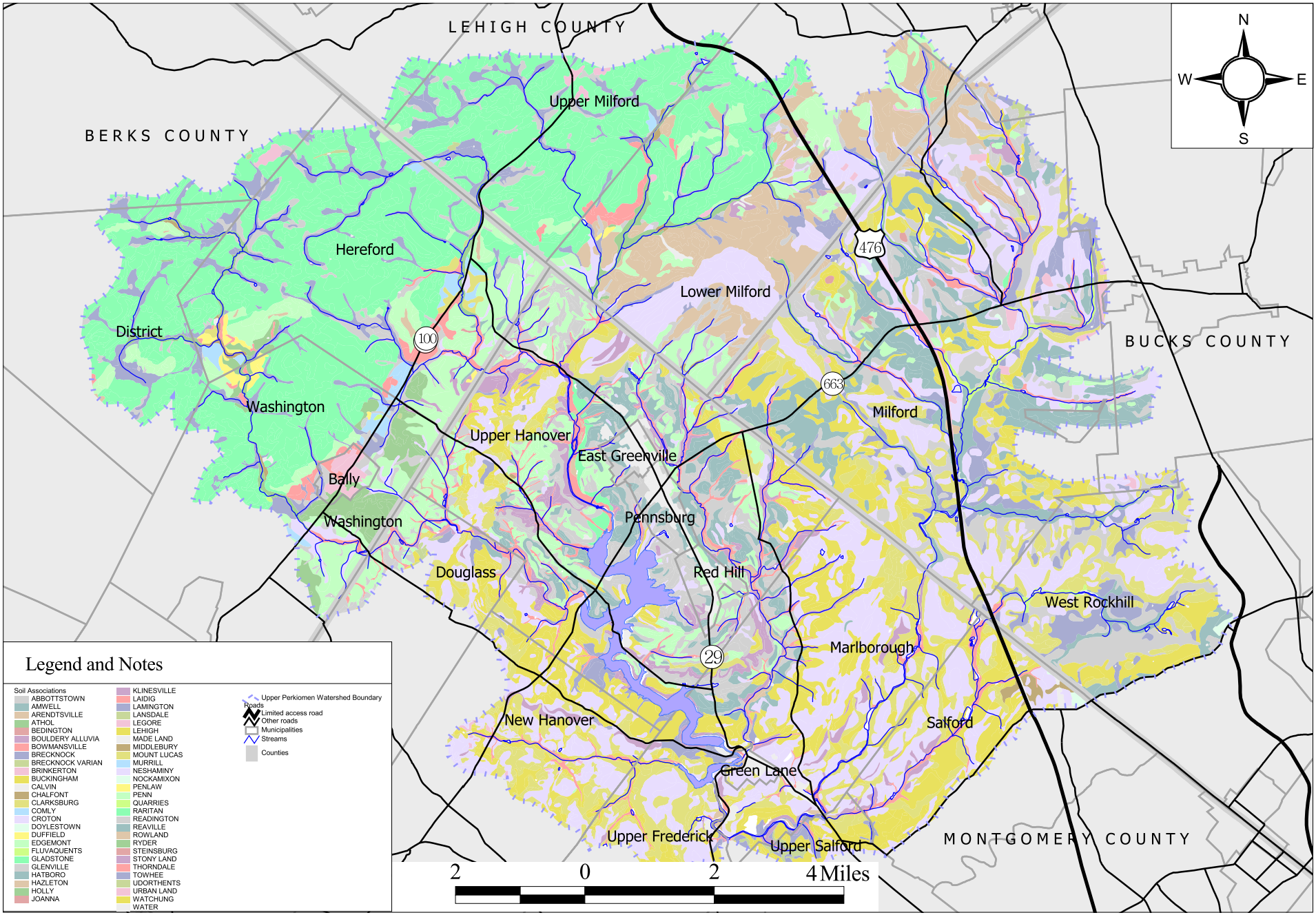
The Hydrologic Soil Group classification in the Soil Surveys for the area categorizes soils in terms of their recharge suitability, with the best soils being well drained and the worst being poorly drained. These soils were analyzed in the *Upper Perkiomen Creek Watershed Management Study: Technical Report* (Cahill, 1994). The majority of the soils in the Upper Perkiomen watershed are classified as Hydrologic Soil Group C, meaning they typically have limited recharge capacities for stormwater management and septic systems, and they generate significant amounts of runoff during storm events. The best-recharging soils (Group B) are concentrated in the northwestern portion of the watershed, along the ridges and valleys that form the headwaters of the Northwest Branch and the main stem Perkiomen Creek. There are virtually no Group A soils (with the highest recharge capacity) and significant amounts of poorly recharging Group D soils along most floodplains and the headwaters of Unami Creek in Milford Township.

Neshaminy and Mount Lucas soils are commonly found over diabase. The Neshaminy soils tend to be fairly well drained, with a depth to seasonal high water table averaging 3 feet below the surface. Most of the Neshaminy soils are rated as having moderate to severe limitations for on-site septic systems. All of the Mount Lucas soils are rated as having severe limitations if used as disposal fields for septic effluent. Water supply in these soils is generally poor due to the relatively shallow depth to bedrock and low well yields from tight fractures in diabase bedrock.

These limitations are serious enough to warrant careful consideration of the groundwater impacts that may result with each new proposed land development plan in the area. Where construction of new septic systems is permitted, protection of existing wells and ground water quality in the area should be guaranteed with accurate hydrologic documentation and escrow funds to cover the cost of replacing failed wells.

The attached hydrologic resources map shows areas of hydric and alluvial soils in the project area. These are the soils of most concern and interest for conservation planning, indicating preservation opportunities. While a small amount of hydric soils have been recorded and mapped by the USDA-NRCS Soil Survey for Montgomery County, there are quite extensive areas that are candidates for hydric inclusions where seeps, springs and rivulets emerge along the bases of slopes in the area.

A substantial area of the watershed supports Prime Agricultural Soils, which are rated by in the Soil Surveys as being productive for a variety of row crops, hay grass and pasturage. The greatest concentrations of Prime Agricultural Soils are found along the shale and sandstone based Lehigh-Brecknock soils in the central portion of the Valley. Properties over 50 acres in size in these areas are candidates for agricultural preservation through Pennsylvania's Agricultural Easement program, as administered locally by the various County governments and, in some cases, with the assistance of municipal open space funding. The critical mass areas (several hundred acres) of contiguous Class 1, 2 or 3 Prime Agricultural Soils that occur in the watershed area should be closely evaluated as potential agricultural preservation areas. **(See Figure 6: Prime Agricultural Soils)**



Upper Perkiomen
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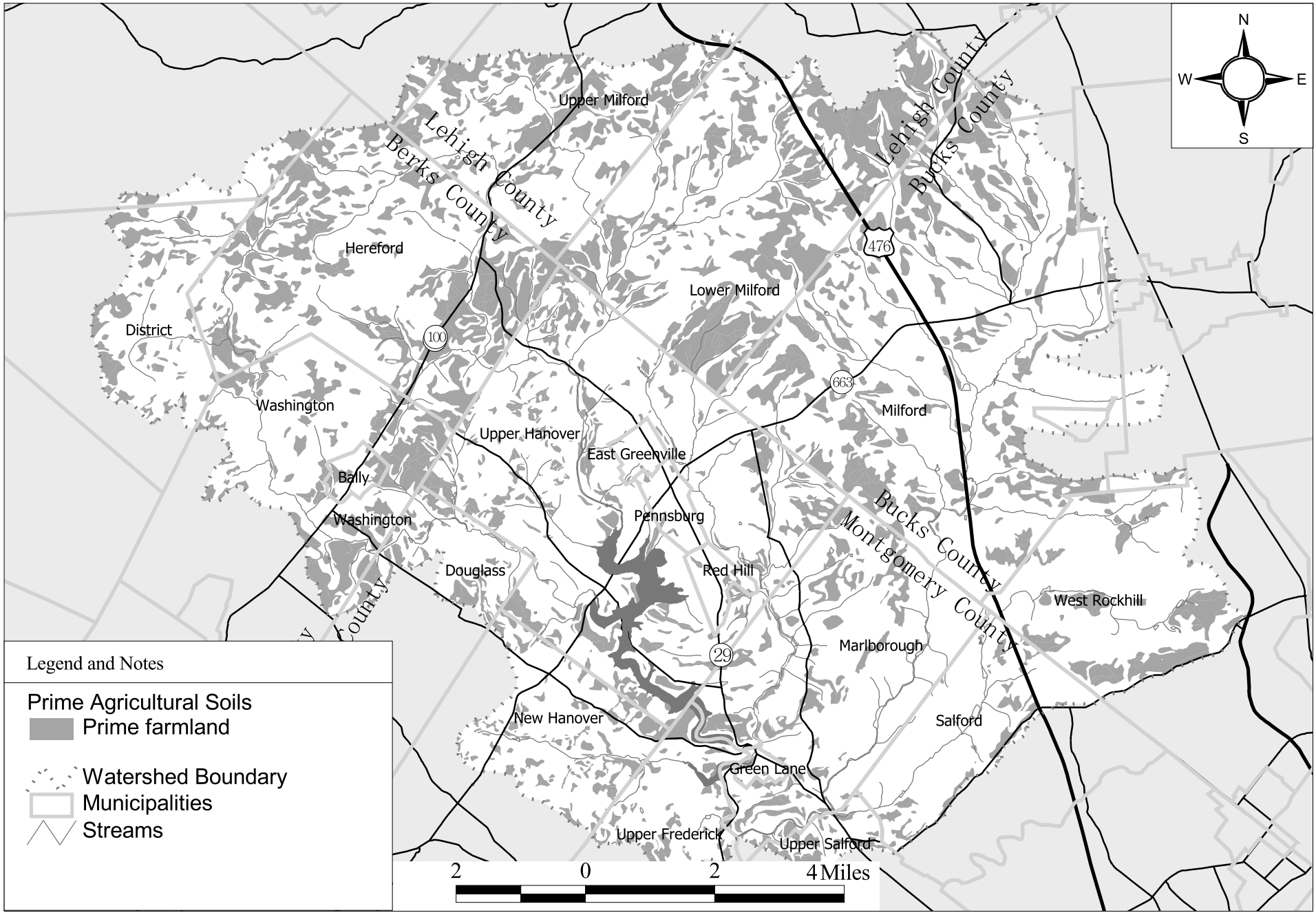
Figure 5
Major Soil Associations

Pennsylvania Environmental Council
117 South 17th Street, Suite 2300, Philadelphia PA 19103
(215) 563 0250 http://www.pecpa.org

Natural Lands Trust
Hildacy Farm, Palmers Mill Road, Media PA 19063
(610) 353 5587 http://www.natlands.org

Upper Perkiomen Watershed Coalition
P.O. Box 233, Palm, PA 18070-0233
http://www.upwcwatershed.org



Upper Perkiomen
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Figure 6
Prime Agricultural Farmland

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Hydrology

Overview of Water Quality and Quantity

The hydrology of the Upper Perkiomen Creek watershed can be considered a complex, interrelated natural system of surface water (runoff, streams, wetlands) and ground water (recharge, soil storage, aquifers) that operates within the laws of the *Hydrologic Cycle*. The *quantity and quality of ground water and surface water* are key concerns for all life in the Upper Perkiomen Creek watershed. The hydrologic cycle explains how water circulates through Earth and its atmosphere, including: rainfall; partial infiltration of water into the soil mantle and underlying rock formations; uptake by surface vegetation; evaporation into the atmosphere; and partial runoff of precipitation into local streams. This cycle is driven by climate and precipitation, and is frequently altered by human activity. All life in the watershed depends on this natural cycle. The recharge of water into soils and aquifers provides the source for wells and the baseflow for streams and wetlands, even during periods of drought. The runoff of water to wetlands and streams contributes to the quantity of water sustaining streams, wetlands and reservoirs. The hydrologic cycle accounts for the *water quantity* aspect of the watershed. **(see Figure 7a: Hydrologic Cycle)**

According to the *Upper Perkiomen Creek Watershed Management Study: Technical Report*, a rain gage maintained at the village of Palm by the National Oceanic and Atmospheric Administration between measured an Average Annual Rainfall of 44.7 inches between 1948 and 1992. Of this amount, approximately 33.2 inches (74%) recharges into the soil mantle and geology as infiltration, while 10.5 inches (23.5%) resulted in surface runoff, and the remaining 1-inch was temporarily absorbed in the soil as depression storage and then evaporated. An estimated 21.2 inches of groundwater recharge (47% of total precipitation) is taken up by vegetation and returned to the atmosphere through "evapotranspiration", with only 13 inches (29% of total precipitation) actually reaching the aquifers that form the groundwater reservoir supplying wells and baseflow for streams (Cahill, 1994). This breakdown is shown in Figure 7b, Hydrologic Cycle of the Upper Perkiomen. These numbers are based on current land use conditions – the presettlement Piedmont forest that defined this region for most of the last 10,000 years would surely generate less runoff and more recharge. It is important to note that, in the temperate northern Piedmont region, precipitation is distributed relatively evenly over the year, with peak periods in late winter/early spring and lows in late summer/early fall.

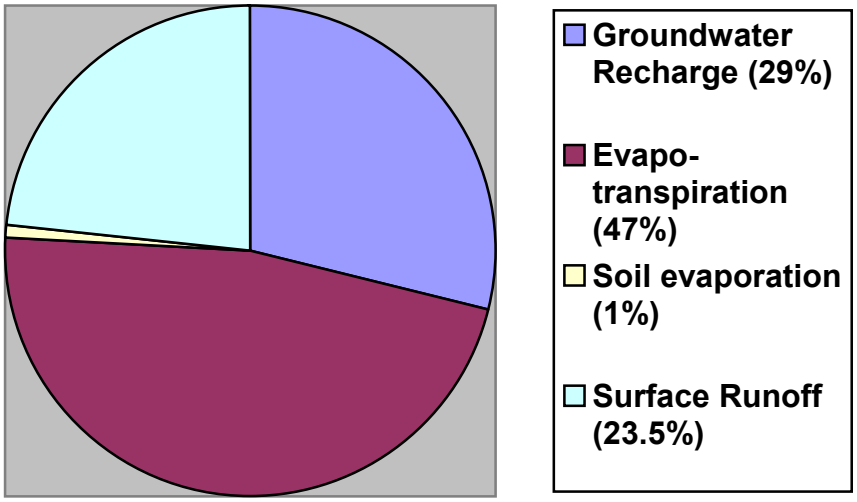


Figure 7b. *Hydrologic Cycle of the Upper Perkiomen (based on Cahill,1994).*

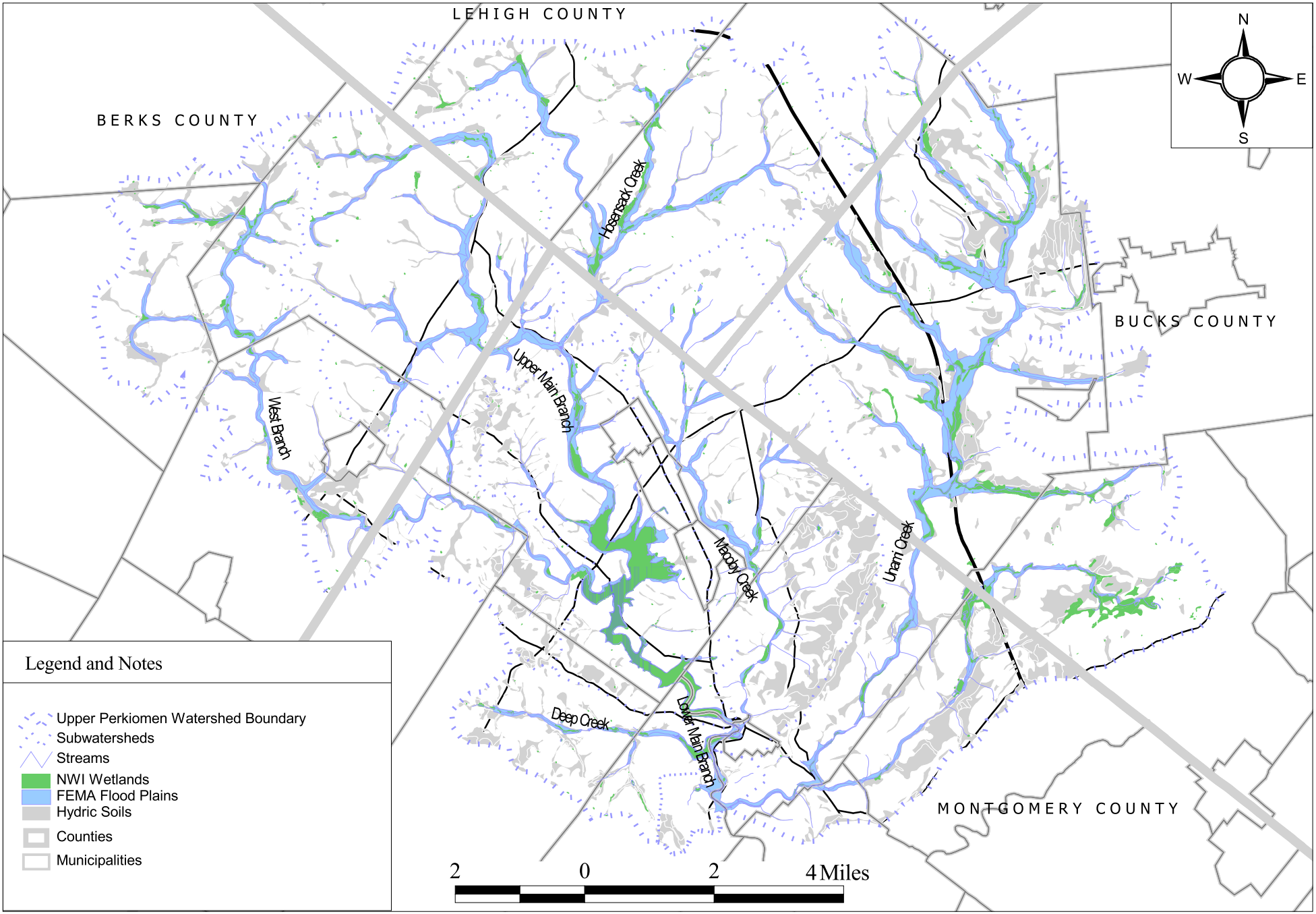
Human interventions with the hydrologic cycle often result in significant alterations of groundwater recharge and stream flows over the course of the year. In the Upper Perkiomen Valley, these interventions parallel the history of the last 300 years. Clearing of woodlands, plowing of soil, construction of dams for mills, ponds and reservoirs, digging and drilling of wells, construction of impervious surfaces and stormwater management systems, construction of water supply systems and construction of wastewater treatment systems key aspects of the increasing manipulation of *water quantity* that defines the hydrologic cycle of the Upper Perkiomen.

The *water quality* aspect of the watershed is also a major factor for consideration in the Upper Perkiomen. The natural forest cover that defined the watershed for much of the last 10,000 years provided a living filter and sponge to regulate the quality of water in aquifers, streams and wetlands. The relatively pure air and precipitation, the level and dispersion of animal and human waste, the rich leaf litter and humus of the forest soils, and the biological diversity of plants and organisms in the pre-settlement ecosystem functioned as the best water purifier ever known. Over the last three centuries, humans have steadily altered the landscape and the quality of water it provides. We now have surface and ground water with various levels of contaminants ranging from nutrients to sediments, and heavy metals to toxic chemicals.

Key concerns for water quality of streams and wetlands in the Upper Perkiomen are "point source pollution", such as discharges from sewage treatment plants or industrial facilities, and "non-point source pollution" such as runoff from agricultural fields, parking lots and chemically treated lawns. Ground water quality has already been

impacted in several areas of the watershed by careless or unknowing operation of dumps and landfills. The number of EPA Superfund sites or candidate sites in the watershed is a clear indication of this threat to ground water quality and the well supplies on which most residents depend. Contamination from septic systems is also an ongoing concern.

The challenge for the communities of the Upper Perkiomen is to understand the water quality and water quantity characteristics of surface water and ground water in the watershed, determine goals for sustaining and improving water quality and quantity in the face of pending growth, and then seek the tools and guidance for achieving that "water balance". The ultimate goal for the watershed should be nothing less than clean, plentiful water to sustain people, plants and animals. Growth cannot be allowed to seriously degrade or deplete the vital water resources of the Upper Perkiomen. **(See Figure 7c: Hydrologic Resources)**



Upper Perkiomen
Rivers Conservation Plan

Figure 7c
Hydrologic Resources

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Surface Water Quality and Quantity

The Upper Perkiomen Creek watershed includes six main subwatersheds: the Main Branch Perkiomen Creek; the Northwest Branch (or West Branch) Perkiomen Creek; Hosensack Creek; Macoby Creek; Unami Creek; and Deep Creek. The *stream order* of these watersheds is important to note, since the Upper Perkiomen Creek watershed includes vast areas of headwater tributaries. The majority of stream miles in these subwatersheds consist of First Order and Second Order streams. A First Order stream is the original headwaters tributary that flows from a spring or seep. A *perennial* stream that flows year round should be counted for this purpose, while an *ephemeral* or temporary stream should not. When two First Order streams converge, they form a segment known as a Second Order stream. Two Second Order streams merge to form a Third Order stream, and so on. The Upper Perkiomen Creek watershed can be considered largely a headwaters area, so that the stream reaches only a level of Fourth Order at the Green Lane Reservoir, and does not constitute a large river. Like the fine bronchial tubes in the human lung, the First Order and Second Order headwater streams in the watershed provide the greatest surface area for pollutants to enter the system.

The *quality and quantity* of water in these streams, and the condition of the stream channel and stream bed are generally characterized by the influence of natural conditions such as the underlying geology, topography, and soils, and the adjacent vegetation, combined with the long history of human influence – with the initial forest clearing, agricultural use, construction of mills, dams and ponds, road and building construction, and modern development, conservation and restoration. The physical characteristics of the stream channel, the quality of the water (both chemical, biological and physical), and the quantity of water during periods of average flow, draught and flooding are all influenced by the interaction of these natural and cultural forces.

The stream quality of the Upper Perkiomen Creek watershed is relatively good, with PA DEP classification of protected status for "Cold Water Fishes" on 3 of the main tributaries (Hosensack, Indian Creek, and the Northwest Branch of Perkiomen Creek) and "Trout Stocking Fishes" on 4 main stream segments (Unami/Ridge Valley Creeks, Macoby Creek, the main stem of Perkiomen Creek, and Deep Creek). The only designation of "Warm-Water Fishes/Migratory Fishes" is a small section of the main stem of Perkiomen Creek, just below the impoundment for Green Lane Reservoir. Certain stream segments are believed to be higher in quality than their current designations reflect. The growing amount of volunteer stream monitoring in the Upper Perkiomen can provide an important basis for potential nominations to upgrade the quality designations of these streams in the future.

Municipal officials responding to questionnaires and interviews recognized water quality issues as important. 12 of the 14 respondents to the municipal survey thought

that stream water quality was important to their municipality and 10 indicated that improving water quality in their municipality as well as for the entire creek should be emphasized in this Conservation Plan. 9 respondents thought that existing storm water regulations were not sufficient to maintain the integrity of receiving waterways and 11 thought groundwater protection (recharge, quality, well drawdown, and septic systems) was important. Watershed assessments and actions taken by the various counties over the years have confirmed that septic systems are a concern for stream quality in the Upper Perkiomen watershed, however, 11 of the 14 respondents to the municipal survey felt that septic systems were adequately regulated within their jurisdiction.

Numerous water quality issues were identified at the public meetings. It was noted that Cold Water Fishes (CWF) designations should remain in portions of streams where they are in effect and, where applicable, these designations should be upgraded to EV status. There were several comments regarding locating and eliminating off-line, artificial ponds and in-line dams that are serving no valuable purpose and are causing increases in water temperature. Other water quality issues raised in public meetings included:

- The proximity of septic tanks to streams
- Septic regulations and maintenance
- Protecting riparian buffers where currently existing or restoring them where lost
- Erosion along streambanks
- TCE contamination of groundwater associated with Superfund and other hazardous waste sites
- Well head protection

As land in the watersheds continues to face increasing pressure for subdivision and land development, the need to maintain and restore the quality and quantity of the streams of the Upper Perkiomen watershed program area must be central to the decision-making process. Conservation and restoration of land along streams are perhaps the most important steps that can be taken to balance the impacts of future development.

Surface Water Quantity

Stream Flow

Two stream flow gages are maintained by the United States Geological Survey (USGS) in the Upper Perkiomen watershed, just above Green Lane Reservoir. These gages have provided a continuous daily record of flow levels, volumes and velocities for streams draining most of the northern and western portions of the watershed since they began recording in 1982. Information for these gages is available through the USGS web site – including "real time" measurements of gage height in feet and discharge in cubic feet per second relayed to the internet via satellite. This system allows important, nearly immediate information on flooding or drought problems. Interested parties can log on

to the USGS web site at http://water.usgs.gov/pa/nwis to obtain information about stream level, volume and velocities posted every few hours.

Station #01472198 is located on the main stem Perkiomen Creek 100 feet upstream from the bridge on Church Road, 0.9 miles upstream from Molasses Creek and 1.0 miles southwest of East Greenville. This gage is 288.5 feet in elevation above sea level, and measures flows from a 38-square mile drainage are that includes the upper portion of the main stem Perkiomen Creek, Hosensack Creek and Indian Creek.

Name	Length (mi.)	Drainage Area (sq.mi.)	Stream Order	Quality	Discharges	Intakes
Perkiomen Creek	14.7	29.6	4th	TSF	14	1
NW Branch	11.8	23.1	3rd	CWF	6	--
Hosensack/Indian Creeks	7.4	18	3rd	CWF	0	--
Macoby Creek	10.5	18	3rd	TSF	12	--
Unami/Ridge Valley Creeks	28.6	50	3rd	TSF	6	--
Deep Creek	2.1	5.7	2nd	TSF	2	--

Table 1. This table provides an overview of the range of subwatershed sizes, the lengths of stream in each, stream quality designations and discharges/intakes. A stream such as Macoby Creek stands out as handling a high amount of discharges from wastewater and industrial treatment plants relative to its size. The overall number of discharge points (42) is unusually high for a rural watershed.

A summary of daily mean streamflow values for this station over 20 years of record indicates that the highest flows generally occur during the winter and early spring months from December through April, with the highest daily mean flows ranging from 171 to 198 cubic feet per second (cfs). The highest recorded peak flow at this station was 4,800 cfs on September 16, 1999, generated by Hurricane Floyd (a "100-year storm").
Table 1.
The wet year of 1984 produced the highest monthly mean flow for a consecutive 6-month period in the last 20 years. The lowest flows over the last 20 years have typically occurred during the late summer and early fall months of July through October, with the lowest daily mean flows ranging from 17.1 to 27.3 cfs. The lowest recorded peak flow at this station was 4.2 cfs, however, the 20-year low of 6.24 cfs was recorded on August 5, 1999, exactly 6 weeks before the 20-year high during Hurricane Floyd. The drought in the summer of 1999 produced the lowest monthly mean streamflow for a consecutive three-month period in the last 20 years. The highest and lowest 20-year gauge height readings also correspond with the tumultuous weather of 1999, ranging from a low of 1.37 feet on August 5 to a high of 6.53 on September 16.

Station #01472199 is located on the Northwest Branch Perkiomen Creek at Hillegass, 0.3 miles downstream from a bridge on a private road. These gages provide a valuable long-term record of stream flow in the watershed – including both the baseflow of

streams fed by groundwater seeps and springs, and the influence of runoff (or "overland flow") on stream volume and velocity. The record from these gages demonstrates, predictably, that rainfall and stream flow are closely related, with wet periods generating high flows and droughts producing low flows.

Station	**Low Flow**	**Peak Flow**	**Avg. Year Round Flow**	**Avg. August Flow**
Main Branch	4.2 cfs	2,800 cfs	62 cfs	29.6 cfs
NW Branch	3.8 cfs	1,760 cfs	39 cfs	16.0 cfs

Table 2. *The low, peak and average flow rates (in cubic feet per second, or cfs) for the two USGS stream gages in the Upper Perkiomen Creek.*

In many watersheds, including the Upper Perkiomen Creek, the amount of runoff (as measured in stream flow) is influenced by other factors in addition to total precipitation, including: the pattern of precipitation (the duration of rain or snow falling in different parts of the watershed); the soil moisture content between storm events; the land cover (parking lots generate many times more runoff than forests); land forms (such as slopes); and the presence of frozen ground (Cahill, 1994).

For example, the 1984 water year (Oct. 1 to Sept. 30) was very wet, with 66.3 inches of precipitation measured at the NOAA rain gage in Palm -- a *48% increase* in the amount of precipitation over the average of 44.7 inches. The mean stream flow in that year measured at the East Greenville gage on the main stem Perkiomen Creek was 103 cubic feet per second (cfs) – a *77% increase* over the 1982-1992 average of 58.3 cfs. In other words, *increased precipitation lead to a disproportionately higher increase in runoff*, leading to greater volume and velocity of water in streams, flooding potential, greater erosive force and higher reservoir levels.

During the same 11 year period, the 1992 water year was relatively dry, with only 35.6 inches of precipitation measured at the Palm gage – *20% below* average. The mean stream flow in that year at the East Greenville gage was 35.7 cfs – a *39% decrease* over the 11-year average. This means that *decreased precipitation lead to a disproportionately larger decrease in runoff*, with associated impacts to stream and wetland ecosystems, and lower reservoir levels. The 1994 Watershed Management Study calculated that approximately 13 inches of the 44.7 inches of precipitation form the annual stream baseflow, which is slightly higher than adjacent watersheds (Cahill,1994).

Natural cycles of drought and flooding characterize the climate of the northern Piedmont region in general and the long-term hydrology of the Upper Perkiomen watershed in particular. These cycles of drought and flooding have historically influenced stream channel characteristics, the diversity of aquatic life, groundwater levels. With the introduction of human land use patterns over the last three centuries, the impacts of drought and flooding cycles have in many ways been exacerbated – such

as the accelerated erosion of streambanks devoid of woodland cover, and reduced stream baseflow (and reservoir levels) in areas with extensive impervious surface coverage.

Flooding

While the Upper Perkiomen Creek watershed certainly experiences significant amounts of stormwater runoff reaching streams, flooding has not yet proven to be a major problem in terms of property damage or safety concerns. Floodplains are mapped on the Hydrologic Resources map **(see Figure 7c)**. Stream corridors and floodplains are still relatively undeveloped, and impervious surface coverage in the watershed is relatively minimal compared to more developed areas. The watershed has not yet been impacted by the typical flood problems associated with conventional stormwater management systems in suburban areas -- basins scattered throughout each subwatershed, discharging increased volumes of water directly to wetlands and streams over extended periods of time. *With proper planning in the Upper Perkiomen watershed, the cumulative flooding impacts of conventional stormwater management systems can be avoided as development continues.*

The greatest concentrations of impervious surface coverage occur in the villages along Route 29, adjacent to the Green Lane Reservoir. Therefore, the greatest concentrations of stormwater runoff do not have much opportunity to reach serious volumes and velocities prior in the Macoby Creek and main stem Perkiomen Creek before they merge with Green Lane Reservoir. Areas of severe streambank erosion are probably the most tangible signs of flood problems.

Numerous flooding events on the Perkiomen Creek were documented in the Schuylkill River Basin Limited Reconnaissance Study prepared by the Army Corps of Engineers in 1990, however these were all located in the lower portions of the watershed in Collegeville, Schwenksville and Perkiomen Junction. *The Army Corps study is an important reminder that the land use decisions in the Upper Perkiomen Creek watershed can have serious implications, including exacerbated flooding problems, for downstream communities.*

The Pennsylvania Floodplain Management Act of 1978 (Act 166), requires all municipalities in the state to adopt floodplain ordinances that meet minimum standards for their citizens to be eligible for federal flood insurance and for the municipalities to continue to receive state funding. Thirteen respondents to the municipal survey reported that they had adopted floodplain regulations in accordance with Act 166.

Surface Water Quality

Water quality refers to the current condition of stream water relative to its natural physical, chemical and biological characteristics. The highest quality streams are those that tend to occur in forested watersheds, with low levels of

sedimentation and turbidity, minimal streambank erosion, balanced levels of pH, total phosphorus, nitrogen, and naturally occurring chemicals and minerals, high levels of dissolved oxygen, low levels of bacteria and algae, and a rich biota of native aquatic plants, benthic macroinvertebrates and fish. Unfortunately, these optimum "presettlement" conditions are often difficult to find in watersheds such as the Upper Perkiomen that have experienced centuries of changing land use patterns.

Maintaining stream quality to the highest possible standards in the Upper Perkiomen watershed is critically important for several reasons. The health and diversity of the plants and animals that make up the stream ecosystem hinges on clean water. The wide range of human uses of stream water, such as swimming, fishing, drinking and household use, industrial and agricultural use, all depend on clean water. The direct benefits to the local economy generated by these human uses also rely on stream quality.

The three questions to ask about stream quality in the Upper Perkiomen Creek watershed, then, are:

1) how close to optimum stream quality are the various streams in the watershed?
2) what are the main reasons they are not optimum?
3) how can stream quality be maintained and improved to the highest standard possible?

Stream Quality Classifications

Pennsylvania's Department of Environmental Protection has established a system for classifying streams in the State as specified in Chapter 93, Title 25 of the Pennsylvania Code. The standards are based on water uses which are to be protected and will be considered by DEP in its regulation of discharges from sewage treatment plants, industrial plants and stormwater management facilities. Current Water Quality Classifications for the Upper Perkiomen watershed are summarized in map form in this report **(see Figure 8: Water Quality Classifications)**. The highest quality designations for the watershed (Cold Water Fishes – CWF) are found in the less developed headwaters areas of the Northwest Branch, main stem Perkiomen, and Hosensack/Indian Creeks. The majority of the watershed (roughly 2/3rds) including the lower portion of the main stem Perkiomen, Macoby Creek, and Unami/Ridge Valley Creeks is rated as Trout Stocking Fishes (TSF). A small area of Warm Water Fishes (WWF), the lowest category in the watershed, occurs along the stretch of the main stem Perkiomen below the Green Lane Reservoir impoundment.

The various uses are summarized below:

- CWF-- *Cold Water Fishes* – Maintenance and/or propagation of fish species including the family Salmonidae and additional flora and fauna which are indigenous to a cold water habitat.

- MF – *Migratory Fishes* – Passage, maintenance, and propagation of anadromous and catadromous fishes and other fishes which ascend to flowing waters to complete their life cycle.

- TSF – *Trout Stocking* – Maintenance of stocked trout from February 15 to July 31 and maintenance and propagation of fish species and additional flora and fauna which are indigenous to a warm water habitat.

- WWF -- *Warm Water Fishes* – Maintenance and propagation of fish species and additional flora and fauna which are indigenous to a warm water habitat.

Chapter 93 also includes two categories of Special Protection Waters:

- HQ – *High Quality Waters* – A stream or watershed which has excellent quality waters and environmental or other features that require special water quality protection.

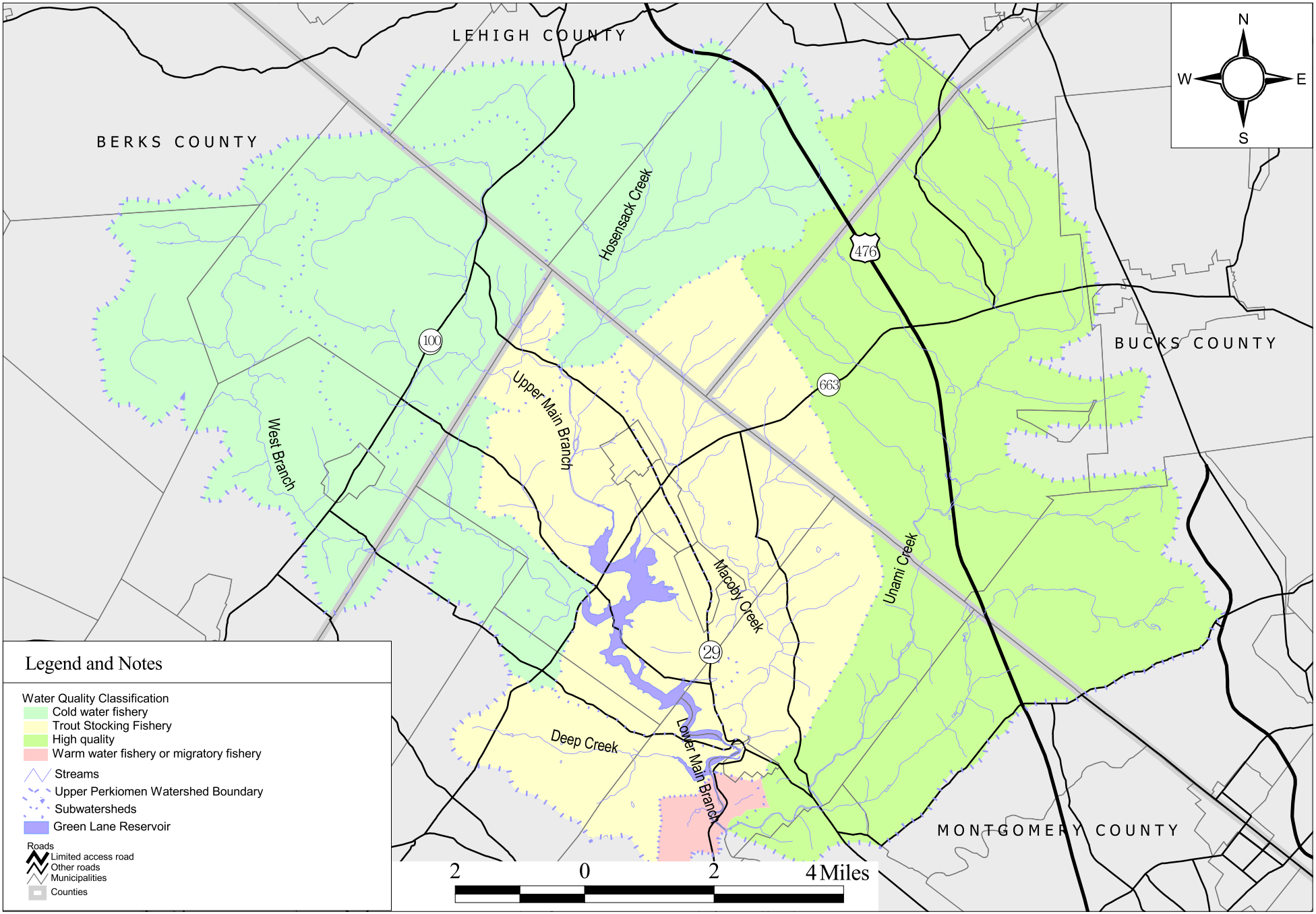
- EV – *Exceptional Value Waters* – A stream or watershed which constitutes an outstanding national, State, regional, or local resource, such as waters of national, State, or county parks or forests, or waters which are used as a source of unfiltered potable water supply, or waters which have been characterized by the Fish Commission as "Wilderness Trout Streams," and other waters of substantial recreational or ecological significance.

The Perkiomen Valley chapter of Trout Unlimited (PVTU) has stated that one of its goals is to upgrade the status of the Northwest Branch to Exceptional Value. This group has also discussed upgrading the entire upper portion of the watershed above Green Lane Reservoir to EV status before it is degraded by development. The ongoing assessment of streams in the watershed by DEP as part of the Unassessed Waters program described in this section may provide valuable data on stream quality to help support such nominations.

Point Source Pollution

The numerous industrial plants and sewage treatment plants in the Upper Perkiomen Creek watershed are the main sources of "point source" pollution, or pollution that can be tracked to a single source (such as a discharge pipe). Wastewater from residential uses in these plants generally contributes nutrients such as nitrogen and phosphorus from human waste and household detergents. Industrial wastewater may have far more complex pollutants related to specific manufacturing and processing equipment. **(see Figure 9: Point Source Discharges).**

A total of 42-point source discharges exist in the Upper Perkiomen Creek watershed, although at least 7 of these are "land application" systems (6 spray irrigation/1 drip irrigation) that discharge to soil rather than streams. These discharges are summarized in the following table. Six public sewage treatment plants serve the Upper Perkiomen Valley: the Upper Montgomery Joint Authority's plan on Mensch Road at the Green Lane Reservoir; the Upper Hanover Authority's plant on Frey Road at Macoby Creek; the Green Lane-Marlborough Joint Authority plant on Park Drive at the Perkiomen Creek; the Milford-Trumbauersville plant on the Unami Creek; and the Washington Township plant and the Bally plant on the Northwest Branch. In addition, at least 15 privately run sewage treatement plants (STP's) operate in the watershed. These include package plants servicing: five mobile home parks; two schools; one dairy; two restaurants; and a summer camp. With the exception of the mobile home parks, the regional trend toward constructing package treatment plants for large-scale residential subdivisions has not yet reached the Upper Perkiomen watershed.



Upper Perkiomen
Rivers Conservation Plan

Figure 8
Water Quality Classifications

Pennsylvania Environmental Council
117 South 17th Street, Suite 2300, Philadelphia PA 19103
(215) 563 0250 http://www.pecpa.org

Natural Lands Trust
Hildacy Farm, Palmers Mill Road, Media PA 19063
(610) 353 5587 http://www.natlands.org

Upper Perkiomen Watershed Coalition
P.O. Box 233, Palm, PA 18070-0233
http://www.upwcwatershed.org

Upper Perkiomen
Rivers Conservation Plan

Figure 9a
Point Source Discharges

Pennsylvania Environmental Council
117 South 17th Street, Suite 2300, Philadelphia PA 19103
(215) 563 0250 http://www.pecpa.org

Natural Lands Trust
Hildacy Farm, Palmers Mill Road, Media PA 19063
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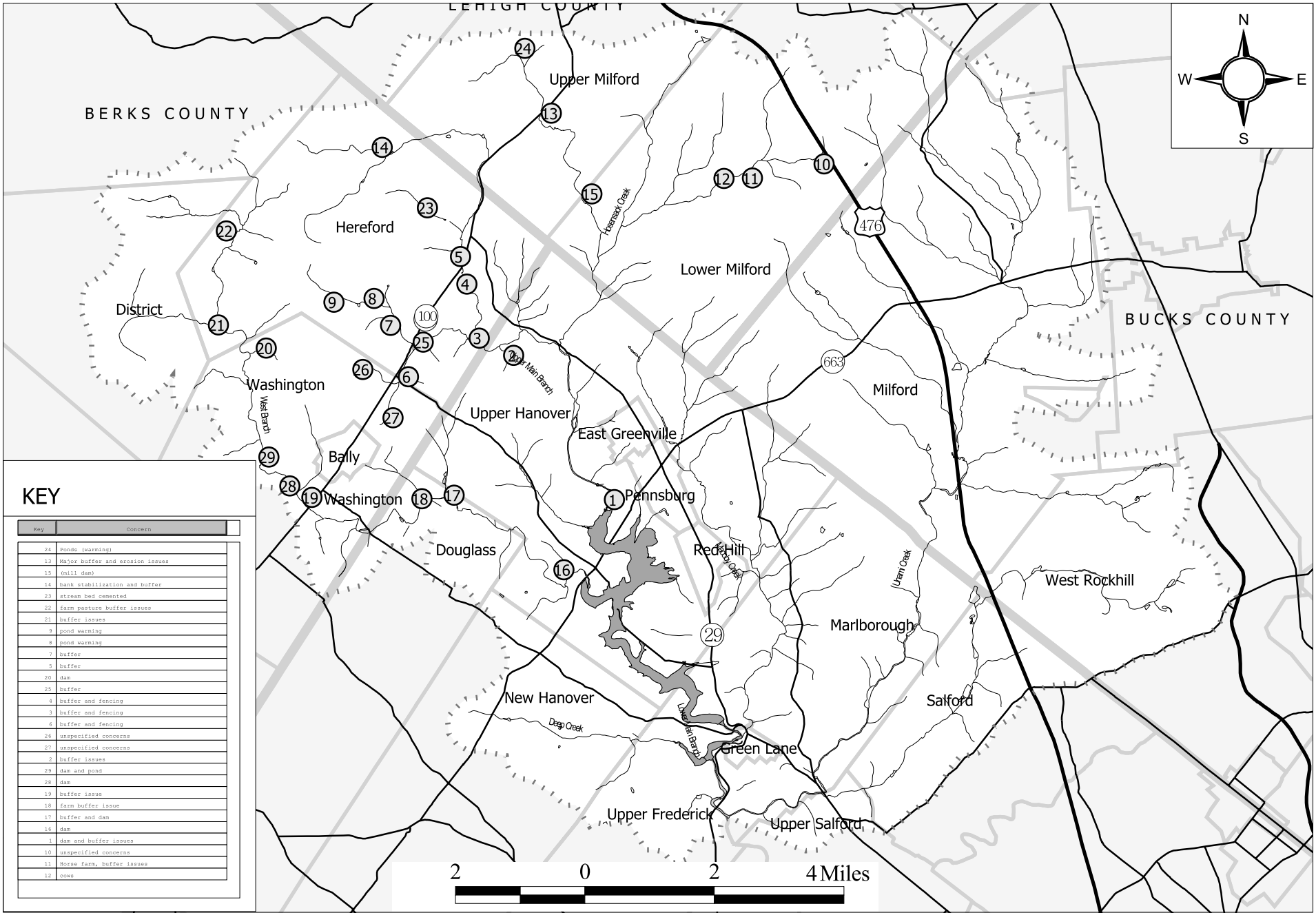


KEY

Key	Concern
24	Ponds (warming)
13	Major buffer and erosion issues
15	(mill dam)
14	bank stabilization and buffer
23	stream bed cemented
22	farm pasture buffer issues
21	buffer issues
9	pond warming
8	pond warming
7	buffer
5	buffer
20	dam
25	buffer
4	buffer and fencing
3	buffer and fencing
6	buffer and fencing
26	unspecified concerns
27	unspecified concerns
2	buffer issues
29	dam and pond
28	dam
19	buffer issue
18	farm buffer issue
17	buffer and dam
16	dam
1	dam and buffer issues
10	unspecified concerns
11	Horse farm, buffer issues
12	cows

Upper Perkiomen
Rivers Conservation Plan

Figure 9b
Potential Stream Health Concerns

Pennsylvania Environmental Council
117 South 17th Street, Suite 2300, Philadelphia PA 19103
(215) 563 0250 http://www.pecpa.org

Natural Lands Trust
Hildacy Farm, Palmers Mill Road, Media PA 19063
(610) 353 5587 http://www.natlands.org

Upper Perkiomen Watershed Coalition
P.O. Box 233, Palm, PA 18070-0233
http://www.upwcwatershed.org

Facility	Basin	Municipality
Brown Printing Co.	Macoby	Upper Hanover
Pillsbury Co.	Macoby	Upper Hanover
Cherrydale Farms	Macoby	Upper Hanover
C&D Power Systems	Macoby	East Greenville
Knoll Group – sludge	Main Branch	East Greenville
Knoll Group - chem. Treat	Main Branch	East Greenville
Knoll Group – discharge	Main Branch	East Greenville
Red Hill Grinding	Macoby	Pennsburg
Longacres Modern Dairy	NW Branch	Washington
Plummer Precision Optics	Macoby	Upper Hanover
Delfoil Tool & Die, Inc.	Macoby	Marlborough
Highway Materials, Inc.	Ridge Valley	Marlborough
Hallcraft Products Co.	Ridge Valley	Marlborough
Upper Montgomery Joint Sewer Authority	Macoby	Upper Hanover
Knoll International	Macoby	East Greenville
Hershey's Chocolate WWTP	Macoby	Upper Hanover
Macoby Creek WWTP	Macoby	
Hanover Ridge SPP		
Flaming Smith Bur Dev Spray Irrigation SPP		
Milford-TrumbauersvilleWWTP	Unami	Milford
Steskal SPP		
O'Leary Package Plant		
Schlichter Package Plant		
Stauffer Spray Irrigation SPP		
Steakhouse Spray Irrigation SPP		
Strawberry Diner		
Pleasant Run Trailer Park		
Godschall Sewage Package Plant		
Greenhill Trailer Park		
Marlborough Elementary WWTP	Unami	
Bergey Package Plant		
Camp Green Lane WWTP	Ridge Valley	Salford
Hereford Estates WWTP	Main Branch	Hereford
Hereford Estates Elementary School WWTP	Main Branch	Hereford
Washington Twp. WWTP	West Branch	
Bally WWTP	West Branch	
Evergreen Trailer Park WWTP	West Branch	
Mountain Village MHP WWTP	West Branch	

Table 3 -- *Point Source Dischargers*

At least 14 industrial wastewater treatment plant discharge points are documented for the Upper Perkiomen Creek watershed. Many of these are concentrated along the Route 29 and Route 663 corridors in the Macoby Creek and main stem Perkiomen Creek watersheds. Knoll Furniture and Brown Printing each have plants just north of East Greenville. In the same area, the former Pillsbury sewage treatment plant has been offered for sale to Upper Hanover Township. The Hershey chocolate company and Entrance Systems, Inc. each have plants east of Pennsburg. In the event that industrial wastewater from these facilities was proposed for treatment in the public sewage treatment plants, the industrial STP's would have to be converted for use as pre-treatment facilities that would send pre-treated wastewater to public plants.

To address stream pollution issues, the National Pollution Discharge Elimination System (NPDES) permitting system was created as part of the federal Clean Water Act in 1972. Initially, this program concentrated on point source pollution. Consequently, significant reductions in point source pollution were achieved and the NPDES program shifted to address nonpoint source pollution.

There are other point source dischargers not reflected in the Table. These include mobile home park treatment systems, single-family residential treatment systems, and the East Greenville Water Filtration Plant filter backwash. Regarding single-family residential treatment systems, Cahill referenced a 1990 PA DER study that found over 50% of these systems operating in the Delaware Valley were not in compliance with their permits. This is due mostly to the minimal amount of monitoring for these systems.

The concern over point source discharges was mentioned in the public meetings, particularly potential increases in municipal treatment plant discharges due to development as well as exceedences and violations. However, none of the municipal survey respondents reported knowing of any frequent or repeated permit violations of municipal or industrial sewage plant discharges. There was also discussion at the public meetings about alternative technologies (i.e. shifting to spray irrigation and the use of grey water, or treated wastewater, on golf courses), the need for better sewage planning, and unpermitted point sources (summer camps and individual cottages). The Montgomery County Planning Commission has expressed its interest in promoting coordinated planning for sewage treatment among neighboring municipalities in the Upper Perkiomen watershed.

The Cahill study estimated that a significant reduction in phosphorus loadings from treatment plants occurred between 1973 and 1993 (56,000 lb/yr to 3,500 lb/yr). However, some plants will likely increase their discharge as they are not yet at capacity and additional plants may be built to handle increased demand. Without proper planning, point source phosphorus loadings to streams in the Upper Perkiomen can be expected to increase in the future.

Nonpoint Source Pollution

The NPDES permitting system focuses on nonpoint source pollution, which has the most significant impact to stream quality in the Upper Perkiomen Creek watershed. Nonpoint source pollution is less easily defined, and is often tied to broad areas influenced by a certain land use pattern or land management approach. This type of pollution is closely tied to both agricultural and suburban landscapes and the behavior patterns of residents throughout the watershed. Nonpoint source pollution is often carried as stormwater runoff from the following sources:

- roads and parking lots (i.e. hydrocarbons, heavy metals, sediment, road salt);
- lawns (fertilizers, pesticides, dog waste);
- cultivated fields (soil erosion/sedimentation)
- construction sites (soil erosion/sedimentation)
- livestock pastures (manure, soil erosion/sedimentation)
- stormwater management facilities
- on-lot septic systems

Source	**Sediment (soil/gravel)**	**Nutrients (nitrogen/ phosphorus)**	**Biocides (insecticides/ herbicides)**	**Heavy metals (lead/zinc)**	**Bacteria (fecal coliform)**	**Road salt**
Roads/ parking lots	√	√		√		√
Lawns	√	√	√			
Cultivated Fields	√	√	√		√	
Livestock Pastures	√	√	√		√	
Construction Sites	√					
On-lot septic systems		√			√	

Table 4. T*he nonpoint source pollutants affecting streams in the Upper Perkiomen originate in a variety of common rural and suburban land uses and land management approaches.*

The Cahill study estimated that nonpoint sources accounted for 84 percent of the pollutant loadings in the three reservoirs in the watershed (Cahill, 1994). Browne estimated that nonpoint sources contribute 93 percent of annual phosphorus loads and 100 percent of annual sediment loads to Green Lane Reservoir and 100 percent of both phosphorus and sediment loads to Deep Creek Lake (Browne, 1998).

The public opinion poll indicates that the general population is not adequately aware of the nonpoint source pollution problems in the Upper Perkiomen watershed. While most

respondents did correctly identify septic systems, waterfowl or animals, residential development runoff, or agricultural runoff as major causes of pollution, many others thought that industrial and sewage plant discharges were more problematic.

Cahill further quantified that 47 percent of nonpoint phosphorus loadings occur during dry weather. The probably sources are malfunctioning or poorly maintained septic systems and livestock encroachment directly into streams. Browne found that agricultural runoff contributes 84 percent of total phosphorus loads to Green Lane Reservoir and 76 percent of total phosphorus loads to Deep Creek Lake. Conversely, Cahill quantified that 53 percent of nonpoint phosphorus loadings occur during wet weather. The probable sources are agricultural and existing suburban development runoff. Agricultural runoff sources include sediment laden with fertilizers on cultivated crops or livestock waste from pastures and feedlots or manure applied on cropland. The primary suburban runoff sources are lawn areas where fertilizers are applied.

The Clean Water Act also requires states to report the status of water resources within their boundaries and to provide a summary of identified nonpoint source problem areas. Pennsylvania's Unassessed Waters Program was created to address this requirement. Stream assessments through this program include a reconnaissance of the watershed and sampling of stream bottom-dwelling invertebrate organisms. The results are evaluated using biological criteria to distinguish between healthy and impaired conditions and the results reported in the State's 305(b) list submitted to the Environmental Protection Agency (EPA) every two years. Streams that are found to be impaired are included on the State's 303(d) list which is also submitted to the EPA.

Once included on the 303(d) list, streams are then subject to TMDL or Total Maximum Daily Load calculations. A TMDL is the maximum amount of a pollutant that a water body can receive and still meet water quality standards, and an allocation of that amount to the pollutant's sources. States identify the uses for each water body, for example, drinking water supply, contact recreation (swimming), and aquatic life support (fishing), and the scientific criteria that support that use. A TMDL is the sum of the allowable loads of a single pollutant from all contributing point and nonpoint sources. The calculation must include a margin of safety to ensure that the water body can be used for the purposes the State has designated. The calculation must also account for seasonal variation in water quality (for example, during droughts in which pollutants may be concentrated in low stream flows).

The Pennsylvania Department of Environmental Protection (DEP) has been evaluating the streams of the Upper Perkiomen Creek watershed as part of the Pennsylvania Unassessed Waters Program. To date, only the main stem of the Perkiomen has been evaluated and no impaired segments were found between the headwaters through the southern boundary of the watershed. However, the classification of a stream as unimpaired can be somewhat misleading as pollution can still exist but not in quantities

significant enough to be labeled as impaired. The Unami Creek and other tributaries are scheduled to be evaluated in the Fall of 2000, with results pending.

Another measure of stream quality, albeit one based on far less specific measurements, is the amount of impervious cover in a watershed. The work of the Center for Watershed Protection (CWP) in Ellicott City, Maryland, is often cited in this regard. CWP has produced a widely recognized guide for managing urbanizing watersheds called "Rapid Watershed Planning Handbook" that includes the development of threshold amounts of imperviousness and subsequent stream impacts. It is generally thought that a stream is able to maintain biodiversity and channel stability when the surrounding watershed has less than a 10 percent impervious cover. Once a watershed reaches this threshold, it will generally show a decline in physical, biological or water quality indicators.

The following table provides further insight into the overall quality of the Upper Perkiomen Creek and demonstrates a general consistency between current DEP Water Quality Designations and the percent of impervious cover:

Table 5 -- Impervious Cover by Subwatershed.

Subwatershed	Imperviousness
Main Branch (above Green Lane Reservoir)	1.3%
Main Branch (below Green Lane Reservoir)	6.6%
Northwest Branch	1.5%
Hosensack Creek	0.9%
Macoby Creek	2.5%
Unami Creek	2.1%
Deep Creek	0.4%

Streams throughout the Upper Perkiomen watershed are significantly less impacted by development than streams in the lower portions of the Perkiomen watershed and the majority of streams in southeastern Pennsylvania. The following section summarizes the surface water quality conditions of each stream in the Upper Perkiomen Valley.

Surface Water Quality by Subwatershed

Perkiomen Creek, Main Branch

The Main Branch of the Perkiomen Creek can be understood as the segment extending from the bridge at Route 29 in Upper Hanover Township to the confluence with the Unami Creek below Sumneytown. This stream segment includes the 829 acre Green Lane Reservoir owned by Philadelphia Suburban Water Company, and the adjoining land owned and maintained by Montgomery County. The 25 acre Knights Lake reservoir has also been constructed along this segment. The Perkiomen is a Fourth Order stream at this point, and the subwatershed does not include many headwaters

tributaries. At 29.6 square miles and 14.7 linear miles of stream, the Perkiomen is the second largest subwatershed in the Upper Perkiomen Valley.

The main branch originates near the hamlets of Seisholtzville and Harlem in Berks County and flows to the southeast past Hereford and into the central valley past Palm and East Greenville before it reaches the Green Lane Reservoir. The headwaters of this subwatershed are dominated by forested ridges, with a fairly complete forested riparian buffer, while the middle section is primarily farmland with scattered residential development. The lower portion closest to the reservoir includes more intensive uses such as industrial sites and densely developed villages.

The current water quality designation for this portion of the creek is Cold Water Fishery in Berks County and Trout Stocking Fishery in Montgomery County upstream of the Green Lane Reservoir dam, and Warm Water Fishery/Migratory Fishes downstream of the dam. The conditions downstream of the dam are noted as having point source and non point source pollution and significant demand for dissolved oxygen.

The watershed draining into the main stem of the Perkiomen Creek includes approximately 7.9% impervious coverage, and includes the Boroughs of East Greenville, Pennsburg, Red Hill, and Green Lane. This is by far the highest amount of paved areas and buildings of any subwatershed in the Upper Perkiomen, and it has serious implications for the health and quality of the stream. According to the Center for Watershed Protection, streams are able to maintain biodiversity of aquatic life and channel stability (with less severe erosion) when the surrounding watershed has less than 10% impervious cover. Future development in this section of the watershed should be closely monitored with this threshold in mind.

While non-point source pollution such as runoff from agricultural fields, construction sites and effluent from septic systems presents serious problems for the main stem, the addition of numerous point source pollutants from wastewater and industrial treatment plants compounds the water quality problems facing the stream system. The package plants servicing the Hereford Estates and Mountain Village mobile home parks have been a source of point source pollutants.

The *Upper Perkiomen Creek Watershed Management Study* identified that Green Lane Reservoir and Knights Lake have been over-enriched by phosphorus loadings. This has resulted in the excessive growth of algae and other aquatic plants that have depleted oxygen levels required to support aquatic life, particularly in the later summer months (Cahill, 1994). This unnatural over-enrichment, known as "eutrophication," can lead to serious degradation of the stream ecosystem and associated water quality. F.X. Browne in the Green Lane Reservoir and Deep Creek Lake Water Quality Management Study confirmed these findings and stated that Green Lane Reservoir and Deep Creek Lake are

both "hypereutrophic" and contain high levels of nutrients and algae and low levels of dissolved oxygen in the bottom waters (Browne, 1998).

The proximity of malfunctioning or poorly maintained septic systems with respect to streams can result in leachate reaching streams – providing a widespread and consistent source of phosphorus, nitrogen, fecal coliforms and other contaminants. Upstream from the Green Lane Reservoir, and estimated 150 septic systems lie within 100 feet of a stream, over 400 systems are within 200 feet of a stream, and over 2,400 systems are within 1,000 feet. These estimates do not include septic systems within the Unami Creek watershed. In general, Cahill determined that phosphorus loadings into Green Lane Reservoir need to be reduced by 55 percent to reverse the serious eutrophication problems.

Hammell, in the working draft of *Planning for Water Quality Monitoring and Riparian Restoration in the Schuylkill Watershed* referenced a 1986 DEP study that found the main branch of the Perkiomen upstream of Green Lane Reservoir exhibits fairly good water quality and aquatic habitat. Downstream, however, the creek is subject to additional point source and nonpoint source pollution and significant oxygen demand. (Hammell, 1996). At the time, DEP recommended downgrading the main branch below the Green Lane Reservoir dam from Trout Stocking Fishes (TSF) to Warm Water Fishes (WWF), a change that was subsequently done.

In a more recent analysis by Boyer entitled *Aquatic Biology Investigation for the Perkiomen Creek in Berks and Lehigh Counties* in 1998, physical characteristics, field parameters (pH, dissolved oxygen, temperature, specific conductance), samples for laboratory analysis (SAC 035), qualitative invertebrate data and fish community information were collected at two stations in the Perkiomen Creek headwaters in Hereford Township, Berks County. The water quality was reported "very good" at one station and "excellent" at the other. The report concluded that the Perkiomen Creek headwaters support a well-established trout fishery as well as an extremely diverse benthic community. It recommended consideration of the Perkiomen Creek north of the S.R. 1010 bridge for re-designation to Special Protection status as an Exceptional Value stream.

Development in this subwatershed is rapidly changing the landscape. Land use statistics for the 38-square mile watershed upstream from Green Lane Reservoir for the 11 years ending in 1994 are summarized in the following table:

Table 6 – *Changes in Estimated Land Uses in Upper Watershed (above Green Lane Reservoir)*

Land Use	Browne (1983)	Cahill (1994)
\Agricultural	55.5%	43.6%
Forest	37.4%	36.1%
Developed	7.0%	20.0%

West Branch Perkiomen Creek

The West Branch of Perkiomen Creek, also known as the Northwest Branch, extends from the wooded ridge above Bally in District Township, Berks County down to the confluence with the Green Lane Reservoir in Upper Hanover. This segment is designated as a Cold Water Fishery. The impervious coverage for this subwatershed is 1.5%. The West Branch is the third largest tributary system in the Upper Perkiomen watershed. It drains an area of 23 square miles with over 11.8 miles of streams. The headwaters portion of this subwatershed includes a mix of woodland and scattered residential development, with agricultural lands in the uppermost reaches. The stream has a fairly significant drop in gradient before reaching the more level central valley of agricultural lands adjacent to Green Lane Reservoir.

The Berks County Conservancy prepared a *West Branch Perkiomen Creek Preliminary Assessment* that found that, overall, the water quality of the West Branch is "excellent". The primary threats to the West Branch are sediment and nutrient problems due to agriculture and runoff from increased development in the watershed. The West Branch has been identified by the Tributary Coldwater Action Council (TCAC) of Berks County as a "Priority 1" high quality cold water resource. Stream restoration and monitoring projects have been initiated as a result. A wild brown trout population in the upper stream sections is an indication of the relative health of this stream, and has prompted efforts by the Pennsylvania Fish and Boat Commission to have the stream upgraded to Exceptional Value.

The West Branch has a long history of stream monitoring, with a 1937 National Youth Administration sanitary survey documenting "good" water quality with some agricultural runoff impacts (Cahill, 1994).

Sewage impacts are increasingly evident in the West Branch, both from failing on-lot septic systems and wastewater treatment plants. The Forgedale Mobile Home Park is also located in this watershed, posing water quality impacts to the stream from a wastewater treatment plant for many residential units. The Bally Wastewater Treatment Plant also discharges to this stream, providing a source of nitrogen and phosphorus.

Indian Creek

Indian Creek is a small (4.4 square mile) headwaters tributary of Hosensack Creek that rises along the wooded ridge known as South Mountain in Upper Milford Township, Lehigh County and flows south to its confluence with the Hosensack Creek. The current water quality for this creek is Cold Water Fishery. This subwatershed supports a mix of various land uses ranging from forested to agricultural and residential. Over half of the watershed is in woodland cover. Earlier in the 1990's, the Pennsylvania Fish Commission petitioned the former Department of Environmental Resources to elevate

the Indian Creek's status to Special Protection Waters. This effort was denied based upon chemical and biological sampling as well as existing and prospective land use. Sampling indicated levels of aluminum, copper, and lead above water quality standards.

The biological community of the stream was described by Cahill as "common and not exceptionally diverse". It was noted that a 1989 PA DER sampling revealed a less vibrant trout population than a PFC sampling five years earlier. Benthic macro-invertebrate studies indicated good water quality but not an exceptionally diverse or productive community.

Hosensack Creek

The Hosensack Creek drains a small headwaters area, and rises along the Northeast Extension of the Pennsylvania Turnpike in Lower Milford Township, Lehigh County, and flows south and west toward the Perkiomen. This subwatershed is predominantly rural, with woodland and agricultural land defining most of the land cover. Agricultural impacts have been noted along the Hosensack Creek in the past. The Hosensack is fortunate to not be impacted by any point-source pollution, and few residential-related non-point source impacts.

The current water quality designation for this creek is also Cold Water Fishery. Cahill noted, in general, water quality appears to be good although sedimentation problems have been observed in the past. A Pennsylvania Fish and Boat Commission investigation in 1983 revealed a decline in fish diversity between the upper reaches of the stream and the lower reaches, but a relatively high diversity of 17 fish species in headwaters streams. Regardless, the Hosensack Creek still showed a more diverse fish community than its primary tributary, Indian Creek. The impervious coverage in the Hosensack Creek watershed (including Indian Creek) is among the lowest in the Upper Perkiomen, with only .9% coverage.

Macoby Creek

Macoby Creek is a relative large, narrow subwatershed that drains an area of 18 square miles that constitutes much of the land in Upper Hanover and Marlborough Townships east of Route 29. Over 10.5 miles of stream drain form the Macoby network. This subwatershed is relatively undeveloped, with agricultural areas in the upper reaches and some residential in the lower section. The total impervious surface coverage in the Macoby Creek subwatershed is only 2.5%.

Of particular note in this drainage is the unusual "trellised" type of stream network, with many small tributaries draining almost perpendicularly to the main stream of the Macoby. Nearly all of the other streams in the Upper Perkiomen exhibit a more "dendritic" or treelike drainage patter. This may be a function of the geology of the area, with its underlying Brunswick shale and sandstone and heavy influence from denser diabase and hornfels.

The current water quality of the Macoby is Trout Stocking Fishery, indicating the influence of agricultural and developed lands in the watershed. There is limited water quality data available for analysis on this stream. The most recent investigation performed by PA DER was in 1983. This study, based upon aquatic biota sampling, characterized the Macoby Creek as "good water quality". In fact, this study noted an increase in biological diversity over previous reports. However, it also noted evidence of water quality degradation for parameters such as total dissolved solids and fecal coliforms. The DER study determined that algae blooms and other impacts from nutrients were evident in the lower stretches of the Macoby, and attributed these impacts to residential septic system malfunctions, a golf course, and a "wildcat" sewage pipe.

Unami Creek

The Unami Creek, at the eastern limit of the Upper Perkiomen watershed, drains a large watershed area with an extensive network of headwaters tributary streams. At 50 square miles, the Unami is the single largest subwatershed in the Upper Perkiomen drainage. The Unami and Ridge Valley systems include over 28 miles of streams. The Unami is a Fourth Order stream that rises in a broad, rural headwaters area to the northwest of Quakertown. The Northeast Extension of the Pennsylvania Turnpike forms a major man-made feature that bisects the watershed. The diabase hills of the Unami Forest form the lower half of this system, and include at least eight First Order tributaries draining the uplands. The Unami flows in a southwesterly direction before converging with Ridge Valley Creek at Sumneytown. Ridge Valley Creek is the major tributary of the Unami. Swamp Creek Road parallels the stream for most of its length. The impervious coverage for this subwatershed is 2.1% -- a surprising amount considering the presence of the Unami Forest. The presence of villages and towns such as Sumneytown, Trumbauersville, and Quakertown all have an influence on this calculation.

Ridge Valley Creek is somewhat smaller tributary of the Unami, originating just north of Camp Skymont Park along the PA Turnpike. This Second Order stream flows entirely through diabase, and also includes an extensive network of headwaters tributaries. At least six main First Order tributaries drain the uplands in the Unami Forest portion of the Ridge Valley Creek subwatershed.

Although the Pennsylvania Department of Environmental Protection has rated the Unami Creek and Ridge Valley Creek as a Cold Water Fishery (CWF), they are potential candidates for upgrading to High Quality or Exceptional Value due to the relatively undeveloped agricultural and natural landscapes that form their drainage area. Still, the streams suffer from non-point source pollution such as runoff and sedimentation from inadequately protected construction sites, effluent from failed on-lot septic systems, and runoff from agricultural lands lacking Best Management Practices (BMP's).

These problems are more concentrated in the Unami due to its broader headwaters area. At least 6 point-source discharges exist in the subwatershed.

The stream channels of both creeks are relatively shallow but wide, with a pool-and-riffle pattern formed between large diabase boulders and smaller deposits and islands of alluvial silts, sediments, sands and gravels. Several dams maintained for recreational purposes impede both streams. A dam on the Musser Boy Scout Camp property alters the natural flow of the Unami. Dams at Camp Skymont and Whites Mill Park are the main impoundments on the Ridge Valley. The benefits of these sites as historic resources, recreational areas and unique open water habitats should be carefully weighed with the effects they have on the overall health and viability of the stream ecosystems.

In general, the portions of the Unami and Ridge Valley flowing through the study area do not suffer from severe erosion and cutting of stream banks due to the prevalence of diabase boulders, which form a natural rip-rap in some areas. The gradual drop of the streams over these boulders forms small waterfalls that serve as a natural aeration for the water, increasing levels of dissolved oxygen that are vital to aquatic life. The steeply sloping topography and narrow floodplain along most of the Unami and Ridge Valley provides a natural constraint to degrading uses such as large-scale development or agriculture. Almost the entire length of the lowland corridors along both streams in the study area is mapped as floodplains, although these areas are quite narrow.

Deep Creek

Deep Creek is a small, primarily wooded subwatershed of 5.7 square miles draining a steep valley of forested diabase hills between Route 663 and Green Lane. The stream network is only 2.1 miles in length. The Deep Creek subwatershed includes the 38 acre Deep Creek Lake impoundment and park, holding 31 million gallons of water. The Lake serves recreational purposes at the Montgomery County park. At only .4%, this subwatershed has the lowest percentage of impervious surface coverage in the Upper Perkiomen Valley. The Montgomery County Health Department documented 300 single-family residences in the Deep Creek subwatershed in the early 1990's. The Department documented highly eutrophic conditions such as algae mats, and elevated levels of fecal coliform bacteria in Deep Creek Lake. Given the lack of agricultural uses in the subwatershed, these symptoms indicate that malfunctioning on-site septic systems and the presence of Canada geese are generating nutrient and bacteria pollution (Cahill, 1994).

Planning Implications

The streams in the area are vulnerable to ongoing non-point source pollution impacts and erosion and flooding problems. On the quality side, pollutants such as road salt, hydrocarbons and sediments carried by runoff channels along the ditches of paved and dirt roads drain directly into these streams through culverts, swales and sheet flow.

Runoff from farm fields and lawns in the watershed carry nutrients, pesticides and sediments. Where the stream is buffered by a wooded strip of 50 feet or more, these pollutants are less likely to reach the stream as sheet flow is intercepted by natural vegetation and pollutant-laden sediments settle out and are filtered by plants and soils.

The greatest concerns for water quality in the study area are pollutants and sediments carried by runoff from roadside ditches along public and private roads and driveways, the prevalence of failed or poorly functioning septic systems, and increased clearing of woodlands, construction of impervious rooftops and driveways, and resulting erosion along steep slopes. As development continues to increase the scope and severity of these impacts, the need for protected open space, clearing and grading standards, and innovative stormwater management approaches will become increasingly important to the health and viability of local streams. The proposed PANDA power plant provides a clear example of a utility-oriented land use that poses serious concerns for surface water quality and quantity – both through interbasin transfers of treated effluent from the Lehigh River drainage, and through discharge of heated wastewater.

Two of the most important strategies to protect streams include the preservation and restoration of sizeable natural open space networks along streams, and the use of stormwater management systems that maximize filtration and recharge of stormwater runoff. To maintain stream water quality and quantity in the Upper Perkiomen Valley, additional stream-discharge of treated sewage effluent should be prohibited, as should export of groundwater (via wells) to sewage treatment systems discharging out of the local watersheds. Consideration should also be given to the feasibility and benefits of removing or partially breaching certain dams in the area.

In light of the changing land use pattern and concerns about contamination and pollution, water quality should be periodically sampled in the Upper Perkiomen Valley, and records kept indicating trends. Voluntary submission of residential well testing results to a centralized database maintained by the local townships would also provide for tracking and trend analysis of water quality, as well as water quantity provided by the underlying aquifer. The Schuylkill Riverkeeper can be consulted for protocols and training of volunteers for stream water quality sampling. In addition, an annual stream walk along local stream segments would serve to both visually check stream condition and also provide the opportunity for community residents to remove trash and check for evidence of new point-source or non-point-source pollution impacts.

Goals should be set for restoration of streams throughout the watershed with the goal of improving the stream designations for current Cold Water Fishery streams to "High Quality" or "Exceptional Value".

Wetlands and Vernal Pools

Wetlands are not a particularly significant natural feature of the Upper Perkiomen watershed study area. They are probably an underrepresented habitat type compared to

the historic condition of the site, with some of the broader floodplain areas along the Unami Creek and Ridge Valley Creek now supporting man-made ponds and lakes. Most of the natural wetlands in the study area are associated with the stream corridors or seeps and springs in headwaters areas. The Hosensack Marsh is perhaps the most significant, intact natural wetland in the watershed. The greatest concentration of mapped wetlands on the National Wetlands Inventory can be found along the Ridge Valley Creek in the vicinity of Camp Skymont Park and Whites Mill Park. Perhaps the most significant unmapped wetlands include the extensive amount of small seeps and springs that emerge from diabase slopes and feed small rivulets and tributary streams. Some of the hydric soils, which have high seasonal water tables –typically those in the 'severe' category with season water table fluctuations in the 0-1.5' below surface depth, may also be considered wetlands. All wetlands need field verification. It is likely that any wetlands that have not yet been mapped in the area by the National Wetlands Inventory (which on average only represents about 50% of actual wetlands in Pennsylvania), would be of a riverine nature and fairly small features such as seeps and springs.

Vernal Pools are important conservation features at a local level, since they are the focus of most amphibian and some reptile reproductive viability. These ephemeral pools that appear as the spring high water table and spring rains saturate the soils, may only be present for a few months of the year. Vernal Pools most commonly occur along forested floodplains in the area where floodwaters deposit sediments that form natural "levees" along the tops of stream banks, thereby impeding direct runoff to streams (Godfrey, 1980). Certain poorly drained upland soils along fairly level, forested diabase ridgetops also exhibit ponding effects that may serve to support Vernal Pools. They are usually so small that they are easily overlooked. None of the GIS mapping completed for this project is detailed enough to capture the locations, if any, of these critical conservation features. If they are locally known of, every effort should be made to protect them, and their immediate upstream watershed and buffer areas.

Wetlands are important habitats for native plants and wildlife, and also act as the valve, sponge and filter of the hydrological system, holding floodwaters after a storm, cleaning them naturally through biofiltration, and then letting the water out slowly.

In the Upper Perkiomen watershed study area, more natural wetlands may have existed in the area before local streams were dammed for mills and recreational purposes. The hydric soils, particularly along small tributaries and the bases of slopes, however, may be the most extensive network of important, unmapped wetlands. Although no site-specific investigations have been completed under this study, there could be opportunities to identify, protect, and restore wetland habitats and vernal pools on mapped hydric soils and in areas altered by dams and ponds in the Upper Perkiomen watershed area.

Wetlands are important habitats, and also act as the valve, sponge and filter of the hydrological system, holding floodwaters after a storm, cleaning them naturally through biofiltration, and then letting the water out slowly.

In the Upper Perkiomen watershed study area, more natural wetlands may have existed in the area before dams and ponds were constructed and wider floodplain areas were converted to limited agricultural or residential use. Although visual expressions of wetlands along open floodplains are limited where large ponds and fields exist, the soils in these areas may still exhibit the hydric characteristics of wetlands. While no site-specific investigations have been completed under this study, there could be opportunities to recreate and/or restore wetland habitats on mapped hydric soils in the Upper Perkiomen watershed area.

Ponds

None of the many ponds and three lakes that currently exist in the Upper Perkiomen Creek watershed can be considered "naturally occurring". The physiographic and geological setting of the Perkiomen Creek watershed indicates that it has not been influenced by glacial activity related to the most recent Wisconsin Ice Age of 10,000 to 15,000 years ago or previous glacial events. This means that any ponds or lakes that exist in the watershed have not been created by glacial scouring or filling of valley but, rather, by artificial impoundments created by human activity. Historically, beaver (*Castor Canadensis*) would have been the primary force behind pond creation in the watershed, creating temporary impoundments that lasted for several years then deteriorated. As beaver moved throughout the watershed in search of food sources and breeding habitat, their flooding effect on streams and altering of forest and wetland habitats shifted with them. As this pattern of ponds and emergent or forested wetlands shifted over time through the watershed, it created habitat diversity that supported rich plant communities and food webs on which diverse wildlife communities depended. It allowed for forests to regenerate to continue shading and cooling stream water, and it did not fragment streambeds to block the migration of aquatic species such as shad, native brook trout, or freshwater mussels.

Humans have extirpated beaver from the area and assumed the role of "stream impounders" over the last 300 years, creating and maintaining more permanent impoundments and removing adjacent woodlands and wetlands. The early industrial development of the Perkiomen Creek watershed hinged on an extensive network of 18th and early 19th century mills for grinding grains, sawing timber, and producing paper. These mills generally obtained water power by damming streams and creating mill ponds which fed controlled flows of water with a desired force or "head" along millraces to turn water wheels and mill stones or saws. Most farms in the valley dug farm ponds along streams and wetlands to water livestock and irrigate crops.

Today, the remnants of these mill ponds and farm ponds are evident throughout the Upper Perkiomen Creek. In the mid 20th century, as some of the historic mill dams and ponds deteriorated, the Upper Perkiomen Creek became a focal point for several water supply and recreation-oriented impoundments that were constructed on a much larger scale and with a more permanent life expectancy than any previous impoundments.

The Perkiomen Valley Chapter of Trout Unlimited conducted a Stream and Pond Temperature Study in the summer of 1998 encompassing 11 ponds and approximately 4.5 miles of an unnamed headwaters tributary of the Perkiomen Creek. This study concluded that warming of this tributary stream as it flows through unforested agricultural areas is a factor in raising the overall stream temperature, and that ponds are contributing significantly to this warming. Temperatures in the upper 70's were recorded, and the study proposed that reductions in pond discharges could achieve the goal for supporting cold water aquatic life by reducing stream temperatures in summer to below 70 degrees. The cold-water goal, replicating more natural conditions, could be achieved by removing certain ponds and restricting the stream withdrawal and discharge rates from other ponds, and adding to the area of riparian buffer reforestation (Macdonald and Wentz, 1998).

Riparian Buffers

Riparian buffers are defined in this Plan as wooded corridors paralleling streams and extending outward 75 to 100 feet from the tops of both banks of a stream. They provide numerous community benefits, and are often the first line of defense for non-point source surface water quality concerns such as sediment, erosion, nutrients and other pollutants. The roots of trees, shrubs and herbaceous vegetation help to anchor streamside soils and reduce flooding. The leaves, twigs, branches and logs of trees provide food and habitat on which the entire food web of a healthy stream ecosystem is based, and tree canopies provide shade to maintain cooler water temperatures necessary for many native aquatic organisms, including native brook trout.

Since a minimum of 75 feet of forest cover on each side of a stream is recommended for most of southeastern Pennsylvania, certain forested areas of the Upper Perkiomen Creek watershed has the potential to protect significantly wider buffers to benefit the health of the stream ecosystem. Areas with full riparian buffers are good candidates for voluntary protection agreements such as conservation easements. Partial buffers can be expanded with tree planting efforts and by fencing streams in areas where floodplain meadows or fields exist, extending the width of existing riparian buffers to, ideally, at least 100-feet on either side of the stream. Missing buffers, areas where streams flow unprotected through fields or lawns, are "opportunities" for reforestation. The only exceptions to this recommendation apply in areas where native herbaceous wetlands (i.e. sedge marshes and wet meadows) provide important habitats for native plants and wildlife.

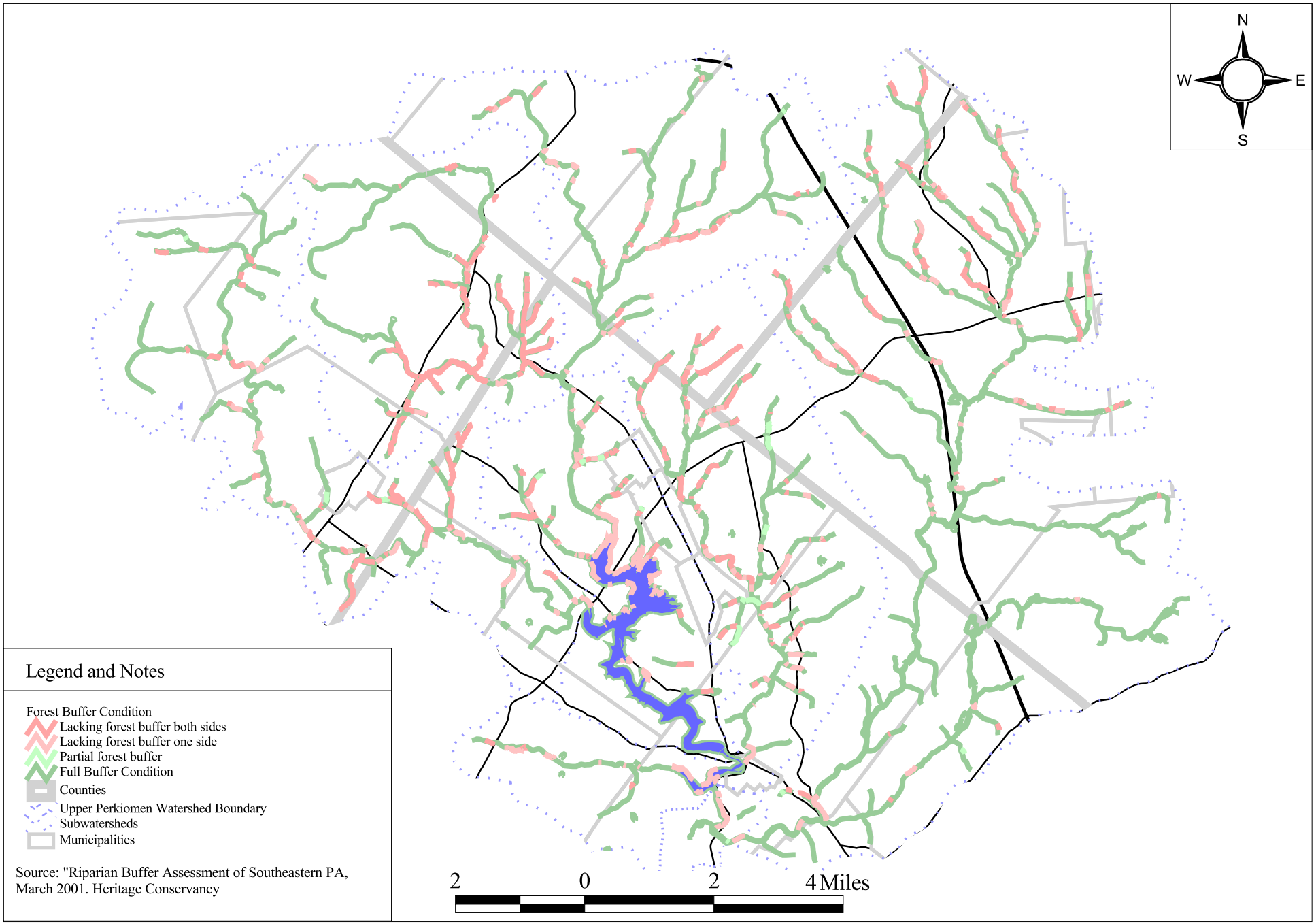
The *Riparian Buffer Assessment of Southeastern Pennsylvania* ("the Assessment") completed by the Heritage Conservancy in 2001 includes an assessment of riparian buffer coverage in the Perkiomen Creek watershed, in addition to the Chester Creek, Neshaminy Creek and Valley Creek. Tab. The goal of the Assessment is "to promote non-point source (NPS) pollution prevention and mitigation." This study involved helicopter flights and video assessments of riparian corridors along the main stem Perkiomen Creek, and aerial photograph evaluation and field verification of riparian corridors throughout the watershed.

The results include documentation of 4 categories: "full" riparian forest buffers (at least 50 feet of woodland on each side of a stream);"partial" riparian forest buffers (less than 50 feet of woodland on one or both sides of a stream); streams "lacking buffer on one side"; and stream segments "lacking buffers on both sides", where riparian forest buffers are missing. This information is scheduled to be posted this summary on the Internet at the Pennsylvania Spatial Data Access (PASDA) website and the results are included here in the Riparian Buffers and Woodlands map and are summarized in the following table. **(see Figure 9: Riparian Buffers and Woodland).**

The results of the Assessment and subsequent analysis provide important guidance for ongoing riparian buffer conservation and restoration activities in the Upper Perkiomen Valley. Perhaps the most important factor is that none of the subwatersheds had less than 50% Full Forest Buffer coverage. This is an uncommonly high amount of stream buffering relative to other watersheds in the Schuylkill River and Delaware River basin.

Conservation Priorities

A total of 155 stream miles (69%) of the 226 miles of waterways in the Upper Perkiomen Creek watershed benefit from Full Forest Buffers. This number is remarkably high, yet the majority of these corridors are *unprotected* from clearing for other uses. This fact points to the importance of *conservation efforts* to keep these buffers in place and providing their vital functions amidst shifting patterns of ownership, logging, development and other activities. The location and contiguous nature of these fully buffered streams is also important. For example, headwaters streams (1st and 2nd Order) and streams draining to water supply sources such as the East Greenville Plant and Green Lane Reservoir are among the most important locations for reducing NPS pollution through riparian buffer protection.



Upper Perkiomen
Rivers Conservation Plan

Riparian Issues

Pennsylvania Environmental Council
117 South 17th Street, Suite 2300, Philadelphia PA 19103
(215) 563 0250 http://www.pecpa.org

Natural Lands Trust
Hildacy Farm, Palmers Mill Road, Media PA 19063
(610) 353 5587 http://www.natlands.org

Upper Perkiomen Watershed Coalition
P.O. Box 233, Palm, PA 18070-0233
http://www.upwcwatershed.org

Table # _____ *Riparian Buffer Coverage by Subwatershed.* *The subwatersheds are listed in*

Subwatershed (Area - acres)	Total Stream Length	Lacking Buffer Both Sides	Lacking Buffer One Side	Partial Forest Buffer	Full Forest Buffer	% Total in Full Forest Buffer
Unami Creek (31,998 ac)	411,296 ft.	52,819 ft.	30,810 ft.	3,051 ft.	**324,615 ft.**	**79%**
West Branch (14,768 ac)	186,474 ft.	38,386 ft.	20,746 ft.	1,865 ft.	**125,477 ft.**	**67%**
Macoby Creek (11,481 ac)	171,684 ft.	41,385 ft.	19,877 ft.	6,877 ft.	**103,545 ft.**	**60%**
Hosensack Creek (11,510 ac.)	126,690 ft.	15,626 ft.	12,443 ft.	342 ft.	**98,279 ft.**	**78%**
Perkiomen – Upper Main (10,837 ac.)	133,995 ft.	59,206 ft.	4,171 ft.	0 ft.	**70,618 ft.**	**53%**
Perkiomen – Lower Main (8,127 ac.)	126,059 ft.	16,510 ft.	40,841 ft.	2,123 ft.	**66,585 ft.**	**53%**
Deep Creek (3,664 ac.)	35,730 ft.	1,783 ft.	7,077 ft.	0 ft.	**26,870 ft.**	**75%**
Totals	**1,191,928ft.**	**225,715 ft.**	**135,965ft.**	**14,258 ft.**	**815,989 ft.**	**69%**

descending order of Full Forest Buffer coverage, with Unami Creek providing the greatest amount and therefore ranking as a prime candidate for ***conservation.*** *The upper portion of the Perkiomen Main Branch has the greatest amount of stream Lacking Buffer – Both Sides, and therefore is a prime candidate for* ***restoration****.*

As might be expected, the Unami Creek rises to the top of the list of the 7 subwatersheds for several reasons:

- *It has the greatest linear stream miles (62 miles) in Full Forest Buffer coverage;*
- *With 62 out of its 78 stream miles in Full Forest Buffer coverage, the Unami has the greatest percentage (79%) of total stream miles bordered by forest.*
- *At 31,998 acres, the Unami is also the largest subwatershed in the Upper Perkiomen Valley, measuring over twice as large than the West Branch (14,768 acres), and it contains the highest percentage of forested cover . It provides full buffering of 27% of the total stream miles in the Upper Perkiomen watershed.*

The contribution of this nearly contiguous forested stream frontage to the overall health and quality of the Upper Perkiomen watershed cannot be overestimated, and it should be considered a prime candidate for riparian buffer conservation activities.

The West Branch of the Perkiomen Creek stands out as having the second greatest coverage in the watershed, with 24 out of its 35 stream miles (67%) in Full Forest Buffer. It is also the second largest subwatershed in the Upper Perkiomen Valley, and provides full buffering for nearly 11% of the total stream miles in the Valley. Hosensack Creek also ranks highly due to its high percentage of Full Forest Buffer coverage (19 out of 24 miles, or 78%). Deep Creek, though relatively short in length, supports a Full Forest Buffer for 5 of its 7 miles (75%), and includes a heavily forested watershed.

Restoration Priorities

A total of 43 stream miles (19%) of the 226 miles of waterways in the Upper Perkiomen Creek watershed can be considered as fully exposed to erosion, pollutants and sunlight, and are listed in the Assessment as Lacking Buffer on Both Sides. While the percentage is not dominant, the location and extent of these gaps is critically important in terms of impacts to otherwise healthy stream segments and valuable community water supplies. These areas are prime candidates for *restoration efforts* such as those that have been underway in the watershed through streambank fencing and tree planting projects. The amount of effort to reforest this relatively small percentage of stream miles can produce major benefits for stream quality and result in major cost savings by reducing future flood damage, dredging frequency and water treatment procedures.

In addition, the Assessment noted 26 stream miles (11% of the total in the watershed) as Lacking Buffer on One Side but having a full 50' buffer on one side. The Unami and the lower section of the Main Stem Perkiomen support the greatest segments with these characteristics. A total of 2.7 miles of streams (about 1% of the total in the watershed) are mapped as having Partial Forest Buffers of less than 50' on both sides, with the Macoby providing the greatest coverage in this category.

The largest *gaps* in riparian buffer coverage the watershed can be found along streams such as the upper portion of the Main Stem of the Perkiomen, which passes through broad areas of farmland and includes 11 out of its 25 miles of stream mapped as Lacking Buffer on Both Sides. This means that 44% of all streams in the upper Main Stem have no riparian buffer coverage. The second largest gap (10 miles) also happens to be in the Unami Creek watershed, which is large enough to provide some of the best and worst coverage statistics. Although the number is large, the gaps in the Unami are located primarily in the headwaters areas where agriculture and residential uses are predomant and only represent about 13% of the total stream miles in the Unami. Macoby Creek also suffers from a relatively large segment (nearly 8 of its 32.5 miles, or 25%) of stream with no buffer protection. Given the relatively high number of stream discharges into the Macoby, this buffer gap could have compounding affects on stream water quality.

Planning Implications

Creative and innovative ways should be pursued to encourage landowners to maintain and restore sizeable riparian buffers – particularly where large "missing links" are evident between substantial sections of otherwise well buffered stream. In many cases,

the use of conservation easements or "riparian buffer easements" is the most effective approach. These voluntary agreements help to ensure that stream corridors remain natural without future clearing or construction of improvements. The Township may want to consider financial incentives, such as property tax rebates, for landowners who are willing to install and maintain high quality riparian buffers on their property. Riparian buffer ordinances are used in many municipalities to ensure that future development does not unnecessarily intrude on these valuable natural areas, and a model Riparian Buffer ordinance is available through the Montgomery County Planning Commission. A program should be developed and goals set – such as achieving 100% steam bank fencing and riparian buffers along all surface water streams and wetlands in ten years.

Perkiomen Valley Trout Unlimited partnership with Schuylkill Riverkeeper on a major restoration project for ¾ mile of an unnamed tributary rising on South Mountain in Berks County and flowing east to its confluence with the Perkiomen Creek at a bridge on Tollgate Road in Hereford Township, Berks County. The restoration includes stream bank fencing, bank stabilization, and 2 cattle crossings. Its purpose is to cool the stream down during the warm summer months, to provide a sustainable wild trout fishery in the tributary, and to cool the main branch of Perkiomen Creek. The Chapter completed a similar project on the Masemore Farm in 1996, with fencing and shading along 2/5 of a mile of the same tributary. (MacDonald and Wentz, 1998).

Stormwater Management

Many conservation concerns arise from poor stormwater management. Surface water non-point pollution (particularly sedimentation), erosion and lack of groundwater recharge are perhaps the biggest concerns. Although no site-specific analysis of stormwater conditions have been conducted for this report, some general guidelines can be recommended.

Excellent recommendations for stormwater and impervious surface ordinances and sustainable taxation schemes suitable for implementation throughout the region have been provided in the Wissahickon River Conservation Plan, page V-10 through V-23 (Delta Group et al 1999). The following is a brief summary of the highlights.

Stormwater management ordinances should be consistent with approaches presented in *Pennsylvania Handbook of Best Management Practices for Developing Areas* (1998). By and large, the uncontrolled small storms cause most stormwater problems in the region. The 2-year storm (3.2 inches in 24 hours) is the most frequent storm with erosion and flooding implications.

Comprehensive ordinances should provide:

- Performance standards

- Appropriate storm designs (e.g. detention of the 1 and 2-yr storms)
- Improvement in groundwater recharge, including:

– Retain first ¾ inch of rainfall on-site (rain barrels)
– Preserve the same volume of infiltrated rainfall as in pre-development condition (based on annual rainfall)

- Lists of recommended BMPs

Also, the following are encouraged:

- Reassessment of stormwater management objectives by municipalities
- Retrofitting grandfathered properties with up to date stormwater management levels as they are redeveloped
- Requirements for the management of roof runoff
- Requirements for agricultural lands

Municipalities should have policies and ordinances that incorporate provisions to reward developers and homeowners (like relaxing some permitting requirements or shortening review cycles), for using low-impact site design principles.

Finally, tangible financial incentives are justified where voluntary measures will substantially reduce the costs that would otherwise be incurred by municipalities for water treatment, maintenance, repairs or improvements to publicly owned facilities. *This could include financial payments to local landowners - compensating them if they agree to set-aside ideally 100-foot riparian buffers on each side of a stream, as well as hydric soils for riparian buffer and wetland restoration.*

At the same time, Stormwater Utilities (SWU) (a mechanism to fund stormwater facilities and services) are being implemented with greater frequency in the United States. Tax payments can be made to the municipality on the basis on some index of stormwater impact created by the property – such as total impervious area or contiguous impervious area. The revenues from these taxes should be used to fund watershed studies, GIS databases, direct subsidies to landowners who install BMPs, and where appropriate, upgrades to public works projects (e.g. tertiary treatment sewage treatment plants).

Ground Water Quality and Quantity

The Upper Perkiomen Creek watershed is characterized by soils and geologic formations that have relatively limited aquifers as compared to other areas. Of the estimated 33.2 inches of precipitation that infiltrate the soil in an average year, only 13 inches reach the aquifers that form the groundwater reservoir. The remaining 21.2 inches are taken up by vegetation and returned to the atmosphere through

"evapotranspiration" (Cahill, 1994). Given the fact that the vast majority of residents and businesses depend on water from private or public wells, the natural limitations on groundwater quantity raise serious questions about the "carrying capacity" of the watershed to support projected growth over the next 20 years. Groundwater *quantity* has not yet proven to be a concern in most of the watershed, with the exceptions being the loss of historic springs and impacts to adjacent wells associated with excavation at the Gabel Quarry.

Groundwater *quality* has already proven to be a serious issue in the Upper Perkiomen watershed, with a series of hazardous waste and Superfund sites that have contaminated a number of private wells. The Borough of Bally has even lost one of its public water supply wells due to contamination. The Berks Sand Pit Superfund Site is a well-documented example of groundwater contamination that affected over 30 residences in Longswamp Township, Berks County near Huffs Church at the headwaters of the main stem Perkiomen Creek. This ongoing Superfund site cleanup of a former residential and industrial dump site is being conducted by the US Environmental Protection Agency (EPA) and has cleaned over 330 million gallons of groundwater cost federal taxpayers over $10 million. The project involves pumping and filtering volatile organic compounds (VOC's) such as the solvent trichloroethylene (TCE), and discharging treated wastewater to a headwaters tributary of the main stem Perkiomen Creek. These groundwater quality concerns serve to compound the natural limitations on groundwater quantity – with limited aquifers, increasing numbers of wells, and changing land use with greater potential for contamination (EPA, 2001).

The varying geology, soils and land cover of the Upper Perkiomen Valley creates varying conditions for groundwater quality and quantity. The majority of groundwater recharge is stored temporarily in the soil mantle, or infiltrates through the upper layer of weathered rock in the dominant formations of Brunswick shale and sandstone, gneiss and diabase. Water takes much longer to migrate down through the more limited cracks, joints and fissures in the bedrock geology. The storage capacity and well supply capabilities of these aquifers, and their vulnerability to drawdown or contamination, varies throughout the watershed. *Given the dependency of most residents on private wells, and the vast water supply in the reservoirs fed by groundwater, these are extremely important considerations for current and future land use planning. The type and intensity of development, the associated water supply and wastewater treatment, and the management of stormwater can all have major effects on groundwater quality and quantity.*

Those involved with land use planning in the Upper Perkiomen should look to the natural hydrologic cycle as a model, with optimum water quality and quantity benefits achieved in a forested condition, where groundwater recharge and filtration are the key characteristics. The worst case scenario is one that literally "bleeds" groundwater by linking homes on well water to public sewage treatment systems discharging directly to

streams, combined with impervious coverage and stormwater management that reduces recharge and maximizes stream discharge.

Fractures and solution channels in diabase areas and seasonal high water table in many parts of the study area provide for a direct connection between land surfaces and groundwater, thus greatly increasing the potential for groundwater contamination, aggravated by the potential for direct interchange between surface and groundwater as groundwater seeps and springs feed the local stream network.

Both Unami Creek and Ridge Valley Creek flow over the diabase aquifer that many residents used as their prime source of drinking water. This may be very difficult to replace if it becomes contaminated. Groundwater resources are considered limited in diabase geology, and water availability may be an important limiting factor on future growth in the area. And while still considered relatively clean in the region, concerns about water quality and quantity are likely to mount as threats of sprawl and intensified uses of the land build momentum in the area.

Planning Implications

Concerns for ground water quality have already been raised at a number of hazardous waste sites in the watershed. These include EPA Superfund sites, and candidate sites, mostly former landfills contaminated by either chemical solvents or heavy metals. The contamination of wells and dependence on bottled water in these areas is clear evidence that ground water quality is a vital yet vulnerable resource that should be protected with vigilance.

The vulnerability of ground water quantity has been highlighted in the ongoing conflicts associated with the Gabel Quarry in Washington Township, owned and operated by Martin Limestone. This quarry encompasses over 100 acres in area (the company owns several hundred acres) and has been excavated to a depth of over 400 feet. The quarry has impacted groundwater aquifer and the neighboring wells dependent on that aquifer within 1,000 feet of the site. Depletion of wells in the area is a major concern. This type of extractive use, or similar uses such as water bottling plants, are obvious concerns to ground water supplies in the watershed.

Where public water supply and wastewater treatment are not used, the dense crystalline nature of diabase geology should place a limit on the development potential of the land. The prospect of large-scale community wells or sewage treatment systems is not likely in the immediate study area, however, nearby shale and sandstone-based areas, and the close proximity to Green Lane Reservoir, represent potential sources for public water and sewer systems that could be used to undermine the natural carrying capacity of the Upper Perkiomen watershed to provide sustainable water supply for its residents.

Most groundwater recharge in the area results from precipitation. A good five-feet of permeable soil overburden is recommended to cleanse most ordinary suspended and dissolved contaminants – i.e., there should be at least 5-feet of soil between the *bottom* of a septic system and the *top* of the water table. In the Unami Creek Valleys area, where soils are often thin and poorly drained, the use of sand mound systems is increasingly common. Sand mounds should not be seen as a solution to the looming problem of groundwater contamination. In areas along the Unami and Ridge Valley Creeks where the water table is high, contaminants may not have a chance to be ameliorated by the soil before entering the water supply, with or without sand mounds. Shallow wells in these areas are likely to become contaminated by septic effluent more easily than deep wells. To provide reasonable assurances that septic leachate does not contaminate domestic water supply wells were local sewer and public water are not supplied, residential densities should not exceed one residence in 5 acres.

The Delaware River Basin Commission (DRBC) regulates water withdrawals of 10,000 gallons per day (gpd) or more in a "Groundwater Protected Area" that includes the majority of the Upper Perkiomen Creek watershed (including all of the Montgomery County portion, Douglass and Hereford in Berks County, Milford, West Rockhill and Trumbauersville in Bucks County, and Lower Milford in Lehigh County). Municipalities that are not included are: District, Washington and Bally in Berks County and Upper Milford in Lehigh County. This Area was established by DRBC in 1980 at the request of the Commonwealth of Pennsylvania when it became evident that development was negatively impacting ground water levels. With more and more private wells drilled each year, this program requires permits for the largest water users, often community wells or commercial facilities such as water bottling companies, golf courses or nurseries and greenhouses. An important goal of the program is that it sets withdrawal limits that will correspond with Integrated Water Resource Plans (such as "water budgets") and Special Protection streams such as those designated as High Quality or Exceptional Value.

Summary of Municipal Water Supply Systems
In the Upper Perkiomen Creek Watershed

System	Number of Connections	Service Area	Source(s)	Avg.DailyUse (gallons per day)	Capacity (gpd)
Upper Hanover Water Authority	1,023	Pennsburg(79%) U.Hanover(17%) Hereford(4%)	3 wells (1 in U.Hanover, 2 in Hereford)	726,000 gpd (60% of capacity)	1.2 million gpd
Milford Water Authority	1,080	Milford (eastern) Trumbauersville	5 wells in Milford	220,000 gpd (49 % of capacity)	450,000 gpd
Red Hill Water Authority	705	Red Hill (92%) Hereford (3%) U.Hanover (4%) U.Milford (1%)	2 wells and a spring-fed reservoir	400,000 gpd (51% of capacity)	791,000 gpd
E. Greenville Borough Water Authority	1,082	E.Greenville(100%)	1 well and main stem Perkiomen withdrawal	242,000 gpd (34% of capacity)	710,000 gpd
Bally Borough	___	Bally Borough	1 well	100,000 gpd	____

Table 7. *This Summary of Municipal Water Supply Systems provides an overview of existing public water supplies servicing residential and business uses in the Upper Perkiomen Valley. This overview indicates that the public system service areas are concentrated around the more densely developed, historic boroughs and villages along Route 29.*

Vegetation

The native vegetation of the Upper Perkiomen Creek watershed is characterized as part of the Mixed Oak Forest Region that extends from northern Georgia to southern New England. This forest region was formerly known as Oak-Chestnut, with named for the American Chestnut (*Castanea dentata*) that was the dominant species (and a major sources of lumber for a variety of uses) prior to succumbing to the Chestnut blight introduced to this country in the early 1900's (Braun, 1950). Although the entire region was almost thoroughly cleared of the pre-settlement forests by the late 18th century and most forests have experienced various levels of logging and clearing since that time, the forest types we see today along the ridges, slopes, ravines and stream valleys of the Upper Perkiomen are direct descendants of the original forest cover.

Though a walk through a woodland or along a stream may be peaceful and uneventful, the natural areas of the Upper Perkiomen Valley are the "engine rooms" of the watershed. The rich forests, wetlands, streams and meadows that characterize much of the area are constantly operating natural systems that provide "ecosystem services" to support the lives of people, plants and animals in the watershed. Among its many functions, native vegetation regulates temperatures and wind, provides natural filters for pollution humans release into air, water and soil, cycles water and oxygen to the atmosphere, reduces flooding, erosion and sedimentation impacts in the watershed, creates productive soils, promotes recharge of groundwater, and supports the biological diversity of plants and wildlife.

According to the classification system presented in *Terrestrial and Palustrine Plant Communities of Pennsylvania*, by Jean Fike of the Pennsylvania Natural Diversity Inventory, the region in which the Upper Perkiomen is located supports as many as eight different forest types, two shrub wetland communities and two herbaceous wetland communities. In addition, successional upland communities such as meadows and old fields/thickets represent various stages of regrowth that define abandoned farm fields before they reach the woodland stage. The vegetative communities are described as follows (Fike:

Tuliptree-Beech-Maple Forest
Sugar Maple-Basswood Forest
The slopes and other well-drained areas in the diabase region along Unami, Ridge Valley and Deep Creeks and the north- and east-facing slopes above waterways in the Triassic shale region at the perimeter of the study area support these two similar forest types. Dominant species include:

American beech	*Fagus grandifolia*
Basswood	*Tilia americana*
Red Oak	*Quercus rubra*

Sugar maple	*Acer saccharum*
Tuliptree	*Liriodendron tulipifera*
White ash	*Fraxinus americana*
White oak	*Quercus alba*

Red Oak-Mixed Hardwood Forest

The more level uplands on Triassic shale tend to support this forest type, often maturing from an early successional stage of nearly solid thickets of Eastern redcedar (*Juniperus virginiana*). Dominant species include:

Mockernut hickory	*Carya tomentosa*
Red oak	*Quercus rubra*
Shagbark hickory	*Carya ovata*
Tuliptree	*Liriodendron tulipifera*
White oak	*Quercus alba*

Successional Red Maple Forest

This forest type is typically found in low-lying areas along streams, floodplains and headwaters areas with hydric soils, particularly those that have been logged or abandoned from farming within the last 20 to 30 years. Dominant species include:

Eastern redcedar	*Juniperus virginiana*
Red maple	*Acer rubrum*
Tuliptree	*Liriodendron tulipifera*
White ash	*Fraxinus Americana*

Bottomland Oak-Hardwood Palustrine Forest

Forested areas along broader floodplains mature to this forest type. Dominant species include:

Black walnut	*Juglans nigra*
Box elder	*Acer negundo*
Hop hornbeam	*Ostrya virginiana*
Pin oak	*Quercus palustris*
River birch	*Betula nigra*
Shagbark hickory	*Carya ovata*
Silver maple	*Acer saccharinum*
Sycamore	*Platanus occidentalis*

Silver Maple Flood Plain Forest

Sycamore-River Birch-Box Elder Flood Plain Forest

Flood plains may also support a forest type with greater representation of silver maple or sycamore and river birch.

Conifer Plantations
Planted stands of evergreen species such as Norway spruce (*Picea abies*) and white pine (*Pinus strobes)* can be found in certain parts of the program area. These plantations are not a native forest type, but often date back 50 to 75 years when seedlings were widely distributed.

Buttonbush Wetland
Alder-Ninebark Wetland
Shrubby wetland communities in the study area are known to support the following species:

Alder	*Alnus spp.*
Arrowwood	*Viburnum dentatum*
Buttonbush	*Cephalanthus occidentalis*
Elderberry	*Sambucus canadensis*
Red-osier dogwood	*Cornus amomum*
Silky dogwood	*Cornus racemosa*
Spicebush	*Lindera benzoin*
Swamp Rose	*Rosa palustris*
Willow	*Salix spp.*
Winterberry holly	*Ilex verticillata*

Tussock Sedge Marsh
Mixed forb Marsh
Openings in shrubby wetlands, and broader wet meadow areas support these communities, including species such as tussock sedge, sweet flag iris, sensitive fern and skunk cabbage. In some areas, tussock sedge marsh is overtaken by the red maple that indicates a shift toward the Successional Red Maple Forest type.

The woodlands in the Upper Perkiomen support distinctive plant communities and contain over a dozen canopy tree species including red, white, black and chestnut oak, sugar maple, black birch, white ash and tulip poplar.

Planning Implications
The US Forest Service urged protection of large contiguous forests (defined as areas of more than 5,000 acres) as part of the New York – New Jersey Highlands Regional Study in 1990. If the Highlands province is extended into Pennsylvania, additional funds for voluntary protection of forestlands may be available from a special set aside from Pennsylvania's Land and Water Conservation Fund. Pennsylvania may also consider the Highlands province as a Forest Legacy project site, which would again mean that funding would be available for forested tracts of land to be protected.

The US Forest Service Highlands study also addresses the issue of timber management and production, noting that the timber resources of the region may be underutilized.

The Forest Legacy Program also endorses sustainable forestry, promoting selective cutting with good environmental best management practices. Selective harvesting can occur without causing too much harm to forest and aquatic systems; however, local controls need to ensure that over-harvesting and clear-cuts are avoided, especially within riparian zones and on the steepest slopes, which have the most erodible soils.

At the end of the last ice age (Pleistocene), the area forests probably consisted primarily of spruce, pine, birch and alder, which gave way to chestnut-oak forests as the climate warmed. Indians likely burned the forest periodically, while subsequently early European settlers cleared and plowed many forests and introduced new species, both intentionally (e.g. Norway maples) and unintentionally (e.g. chestnut blight). While chestnut, elm and hemlock have declined locally due to disease, and oaks, beech and hickories are now probably *underrepresented* due to high-grade lumbering, ash, maple, sycamore and tulip poplar are probably more common than they once were in the landscape.

Any future restoration activities involving forests and/or riparian buffers should consider *emphasizing* the underrepresented native species to reinstate biological balance. This will also ensure that appropriate seed-sources are reintroduced to the region, which will in turn provide for long-term viability and balance of the common plant communities.

A final note about *local provenance* is applicable at this point: Efforts should be made to ensure that, where possible, any plants used for restoration (or even for horticultural use – at least by the local institutions if not by residences) should be obtained from local growers. Much discussion in the ecological and native plant communities in recent years has promoted the concept of purchasing plants grown within, ideally, less than 50 miles of the planting site – and certainly no more than 100 miles – to promote a strong, diverse gene pool reflecting long-term adaptation to local conditions.

Invasive Exotic Plant Species

The combination of thin, low-nutrient diabase and gneiss soils, extensive forest cover and lack of soils disturbance, and the prevalence of north-facing slopes along the ridges, hillsides and ravines of the Upper Perkiomen has greatly limited the spread of invasive exotic vegetation so commonly found throughout southeastern Pennsylvania. However, in disturbed areas, such as successional oldfields and abandoned pastures, along woodland edges and hedgerows, forest gaps or clear-cuts, a slate of invasive exotic plants may be evident, intermixed with ruderal (i.e. opportunistic) natives such as cherry, red cedar, dogwood, crab apple, maple and tulip poplar. Invasive exotic plant species of particular concern in the area typically include, but are not limited to:

- Trees such as: Norway & sycamore maples; ailanthus;
- Shrubs including: Multiflora rose; blackberry; wineberry; Russian and autumn olive; tartarian and amur honeysuckle; Japanese knotweed; Japanese barberry; winged euonymus (a.k.a. burning bush)
- Vines such as: Japanese honeysuckle; Oriental bittersweet; akebia vine; Japanese hops; porcelain-berry; mile-a-minute vine;
- Grasses including: Japanese stiltgrass; miscanthus; pennisetum; reed canary grass.
- Herbaceous plants including: Garlic mustard, lesser celandine, dame's rocket, purple loostrife

This list represents only some of the most infamous species. More extensive lists are available through the Pennsylvania Department of Conservation and Natural Resources, which also consider potentially harmful species that are still being evaluated locally for detrimental impacts. The major concern with these invasive species is their ability to outcompete and dominate native plants, thereby reducing plant species diversity and providing degraded habitat and food sources for native wildlife.

At the same time, there is also a general overabundance of native ruderal species that prefer 'edge' or disturbed environments in the region. Human impacts in the past few centuries have created many more of these habitat types than there were in pre-colonial times through fragmentation. This imbalance can be address through public awareness and discouraging over-abundant, aggressive native species in favor of underrepresented native species. For example, fox grape is an over-abundant native species in the area that thrives in disturbed edge habitat conditions. Although it provides good wildlife food, its extent should be monitored carefully. If it becomes overabundant, it should be carefully controlled - but not necessarily eradicated. If there are local concerns about loss of food and cover sources for wildlife as invasives are removed, encouraging natural regeneration or planting native shrubs that produce high-lipid berries and nuts (e.g. viburnums, hazel) – is a good alternative.

Planning Implications

While the health of the local forests in the Upper Perkiomen is relatively good, local conservationists must be vigilant. Invasive exotic plant species spread typically by bird droppings (for berry-or seed reproducing species) or wind. Since most invasives were introduced by man, either by accident or purposefully, their distribution is typically highest around urban areas, with concentric rings of decreasing density moving into the countryside. In this area, if the seed-source for many of these species is not yet evident – they will probably be arriving soon.

It is no longer sufficient to conveniently assume that nature is maintaining a self-perpetuating balance. With the invasion of aggressive non-native species, many native plant populations can be severely impacted. Highly disturbed forests can loose their

naturally high biodiversity in the face of these alien invasions – and surprisingly quickly.

It is recommended that local conservation groups undertake annual monitoring of the natural habitats throughout the Upper Perkiomen, particularly those that house rare plant species and in protected parks and nature preserves. At the first signs of invasion by exotics, volunteers should be solicited to manually remove the invasive plants, paying particular attention to removing all roots and seed-heads to avoid resprouting or new germination. If necessary, a skilled, qualified and certified professional can be hired to spot-spray herbicide (typically in the late summer with Roundup,) to control patches of invasive exotic plants that don't respond to manual removal. A public education campaign should be initiated to inform local landowners of the issue and concerns. Natural Lands Trust's Fulshaw Craeg Preserve provides a valuable local demonstration site to learn techniques for management of invasive species.

As a compliment to the native plant species local provenance ordinance proposed above (under the Vegetation Communities section), the local townships should also consider implementing an Invasive Exotic Plant ordinance to ensure that future plantings do not use known invasive species. Again, institutions and corporations could be *required* to adhere to the guidelines, while residential landowners might be *encouraged*, perhaps through property tax rebate incentives, to follow the recommendations. Numerous counties and municipalities in southeast Pennsylvania have such ordinances that could serve as models.

Wildlife

The Upper Perkiomen includes a broad network of forest-interior habitat, forested stream corridors and wetlands, and herbaceous and shrub wetlands and meadows that supports a relatively high diversity of native wildlife species. Owing to the relative lack of forest fragmentation and habitat disturbance in the valley, a number of wildlife species are present that are not commonly found in the more heavily agricultural or developed landscapes of southeast Pennsylvania. Mammal species such as gray fox, forest-nesting birds including scarlet tanager and pileated woodpecker, and reptiles such as Northern Copperhead are all indicative of the ecological integrity of the Unami area.

The distinction between wildlife species that are *habitat specialists* and those that are *habitat generalists* is important to consider in prioritizing natural areas for protection. Habitat *specialists* depend on specific habitat types (e.g. grasslands, forest-interior, cold-water streams), whereas habitat *generalists* are more adaptable to a variety of human-influenced environments. Habitat generalists such as gray squirrels, white-tailed deer and blue jays are more often likely to be commonly found in the suburban landscapes of residential areas, woodland edges and woodlots, and small fields that are becoming more ubiquitous throughout the region. Habitat specialists such as bald eagles, wood frogs and luna moths rely on larger, undisturbed blocks of interconnected natural areas – the very kind of networks that are being replaced by suburban landscapes favoring habitat generalists.

The largest blocks land containing the broadest networks of forest, wetland and stream habitat are those with the greatest potential habitat value for wildlife conservation. The deep woods, wooded stream corridors and wetlands along the headwaters ridges, the Unami Creek and Ridge Valley Creek, and Deep Creek, and many of the natural stream segments and wetlands in the watershed are all ecologically valuable habitat networks tracts of land for supporting native wildlife. More intensively used agricultural and developed areas of the watershed are somewhat less important for supporting all but the most common species of wildlife. Agricultural and developed areas that maintain connected networks of natural habitat have greater wildlife value. **(see Figure 8: Habitat Networks)**

Aquatic Species (fish, invertebrates)

The major streams, tributary streams, wetlands and ponds that constitute the aquatic ecosystems of the Upper Perkiomen Creek watershed provide food and habitat conditions suitable for a rich diversity of aquatic life. These include an array of benthic macroinvertebrates (insects and larvae found in stream beds) such as caddisfly nymphs, stonefly nymphs, and mayfly nymphs. Freshwater mussels, snails and crayfish also fall into this category. These species form the base of the food web in stream ecosystems,

and are important indicators of stream health or degradation. The diversity of aquatic life includes fish such as dace, darters, minnows, suckers, brown trout and native brook trout.

The best habitats for supporting aquatic species are (obviously) streams, ponds and wetlands, but also associated forest areas which provide important filtration and recharge benefits to maintain the critically important quality and quantity of water on which aquatic organisms depend. Freshwater stream ecosystems evolved in a forested condition, and their richness and viability are inherently connected to the presence of healthy streamside and upland woodland networks. Developed areas and agricultural land are less important for these species unless they retain significant natural buffers along streams and wetlands.

Bird Species

Given the size, diversity and quality of habitats in the Upper Perkiomen Creek valley, the total number of overwintering, migratory and breeding bird species utilizing the area is expected to be high, particulary with forest dwelling and edge dwelling species. The watersheds of the Delaware River basin are important stopover points in the Atlantic Flyway, the major migratory corridor for birds along the east coast of North America. In addition to migratory functions, local habitats support breeding grounds and overwintering areas for numerous bird species. The deep woods habitats and wooded riparian corridors of the ridges and valleys in the watershed attract numerous species of woodland warblers and other habitat specialists such as woodpeckers, owls and small hawks and wood ducks. Even shrubbier successional old field habitats attract less-common edge species such as American woodcock, yellow-breasted chat, and indigo bunting. One of the added benefits of reservoirs in the watershed is the habitat diversity they add for bird species. Large bodies of open water attract a variety of waterfowl, particularly in winter, along with the large resident Canada goose population that is a source of concern for water quality and human health. Shorelines, wetlands and mudflats along the perimeter of the reservoirs provide habitat for a variety of wading birds and other species.

These woodland/stream/wetland/river habitat networks are critical for supporting bird species diversity in the Upper Perkiomen Valley. Lower density developed residential areas and agricultural lands with hedgerows, woodlands and stream corridors and less intensively maintained hayfields have significant habitat value for birds. Intensively farmed agricultural lands and developments dominated by lawns and paved areas and the historic villages of the area are generally less important for most bird species, owing to the lack of food and cover opportunities for many of the habitat specialists that make up the list for the area.

Herpetofauna (Reptiles and Amphibians)
The same habitat networks that support aquatic and bird species diversity are also critical for the reptiles and amphibians of the Upper Perkiomen Valley – but riparian and wetland habitats are most important. Amphibians such as frogs (at least 7 species), toads and salamanders (at least 5 species) are perfect examples of habitat specialists, often reproducing in small vernal pools and shallow wetlands during the spring breeding season, then dispersing to streamside and upland woodlands and wet meadow areas. Reptiles including turtles (at least 5 species) and snakes (at least 6 species) are also found more commonly in natural areas rather than residential or agricultural landscapes. Stream, pond, wetland and river habitats offer the most value for these species, with the majority of woodlands in the area ranking as moderately important. Large woodlands adjoining forested wetlands and streams are important habitats. Agricultural and residential landscapes are less important habitats for reptiles and amphibians due to the lack of food, cover and breeding sites.

Invertebrates (Terrestrial)
Invertebrates are perhaps the most diverse yet least understood and appreciated of the wildlife taxa groups. The myriad of ants, beetles, worms, and larvae that live in the forest leaf litter and upper soil layers in the region are the "decomposers" that play a crucial role in maintaining healthy ecosystems and stream quality. The more charismatic butterflies, moths, dragonflies, damselflies, and the less popular bees, wasps, flies and mosquitoes play crucial roles as pollinators and/or decomposers, and are often *plant specific* in their habitat requirements, in addition to being habitat specific. They also form a critical layer in the food web for the vast majority of other wildlife species. Invertebrates are most dependent on forested habitats for their survival, due to the combination of high plant diversity and accumulation of organic matter they provide. Agricultural and residential landscapes are less beneficial, however, the use of native plants in gardens, landscaping, wildflower meadows and even stormwater management basins can add significant habitat and food for insects, including butterflies.

Mammals
The habitat networks of the Upper Perkiomen may support as many as 50 different species of mammals. Some of these are more common habitat generalists or woodland edge species found in many backyards. Species such as white-tailed deer, gray squirrel, groundhog, white-footed mouse, raccoon, opossum, moles, shrews, and eastern cottontail rabbit fall into this category.

White-tailed deer in particular are a concern, as their population has boomed in recent decades to many times its natural density. The natural density of deer populations in Pennsylvania averages roughly 5 deer per square mile. Today, in much of southeastern Pennsylvania, there are more than 20 deer per square mile. This change is due to a combination of factors, including the ability of deer to adapt to human environments

and the resulting loss and fragmentation of natural habitats, the long absence of historic top predators such as gray wolf and mountain lion, and the cultural shift away from hunting as rural populations become more suburbanized. There are at least three major impacts of white-tailed deer overpopulation in the Upper Perkiomen – the overbrowsing of the forest understory and loss of plant diversity and future canopy trees; the loss of farm crops; and the hazard of collisions between deer and automobiles.

The potential list of less common and more habitat specific species in the area includes several types of weasels (including mink – which have been confirmed along the Unami Creek), gray fox, up to 10 species of bats, eastern coyote and red squirrel. Several larger mammal species that are indicators of large, healthy habitat networks may pass through the area, or could be attracted in the future. These include bobcat, black bear, beaver and Eastern wood rat -- an important, declining native rodent that may be present in this area. As with so many other forms of wildlife, the interconnected woodland/stream/wetland/river networks are critically important for mammals. Agricultural and residential landscapes tend to support the more generalist species, and have secondary value for mammals. The buffering and linking value of farmland adjoining woodlands is certainly an important factor in maintaining the diversity of mammals in the Upper Perkiomen.

Planning Implications

Habitat destruction, fragmentation and disturbance are the primary causes of loss of flora and fauna diversity across the region, and in the Upper Perkiomen landscape. However, studies show that the introduction or invasion of exotic species now has the second largest impact in reducing species diversity across the nation. Deer browse is also a concern for plant species diversity and the wildlife diversity that depends on native vegetation. Locally, gypsy moth invasions are a good example of invasive exotic wildlife, but there are many others – the newest of which are the growing concerns about Asian longhorn beetle and Asian and European earthworm impacts in natural woodlands, although no sustainable solutions to these problems have yet been developed.

As with many other areas in the region, some wildlife species are bouncing back from human impacts – such as white-tailed deer, wild turkey, Canada goose and red fox – while others continue to decline. Typically invertebrates, amphibians and reptiles continue to be disproportionately impacted by our modern world, while other vertebrates, and mammals in particular, seem better able to adapt. Species of all taxon groups that have difficulty adapting to disturbance, or those that *require* specific disturbance regimes or that are area-sensitive and affected by habitat fragmentation, continue to decline in the region. Many bird species – neotropical migrants and grassland species in particular, are showing marked population declines on the east-coast. Many amphibians and reptiles suffer as wetlands, vernal pools and other surface waters are 'improved' for higher-value land use or compromised by pollution. While

water habitats may be essential for breeding, there is a growing realization that many of these species also need an undisturbed upland habitat buffer adjacent to their breeding habitats for foraging and hibernation in non-breeding season.

It is, of course, very difficult to obtain accurate wildlife survey information - and even when we do obtain it, we must acknowledge that it is always over-representative of charismatic megafauna (i.e. deer, great-blue heron) and under-representative of the lower orders of faunal life forms.

Unlike flora, it is difficult to know where wildlife is located at any given time – since these species move around over both the short and long term. Seasonal migrations are particularly difficult to provide for in conservation planning, especially when the migrations are of large geographic extent, particularly international. Neotropical migratory birds are perhaps the best example of this scale. *Successful land preservation efforts to support viable wildlife populations therefore needs to focus more on providing a suitable regional habitat network, rather than just focusing on site-specific parcels where species have been seen and are presumed to reside. Local land use ordinances must also consider the importance of wildlife habitats in guiding development. In addition, more detailed surveys of local fauna are needed to better assess the health or crises facing wildlife communities in the area.*

Management strategies for overabundant species such as white-tailed deer and Canada goose should be considered in areas where impacts are most evident.

To do a better job of protecting the most ecologically valuable natural areas, we need a better understanding of how wildlife are using those areas. Where do we find the greatest concentrations of amphibians such as frogs and salamanders -- are they found around the vernal pools and the seeps and springs along small rivulets in the area? Are top-predator mammals such as coyote or bobcat found in the area? Do mink utilize the stream corridors? Where are the greatest concentrations of forest-nesting warblers and bats in the area? These are extremely important questions for honing-in on the "hotspots" of biodiversity in the Upper Perkiomen.

So far, these questions have only been addressed based on educated assumptions, and the limited surveys of the Montgomery County Natural Areas Inventory. The best way to answer questions about patterns of wildlife occurrence and diversity is to enlist the assistance of ornithologists, zoologists, herpetologists, etymologists and other wildlife experts in conducting field surveys of the area. Local bird clubs and local sportsmen's clubs are also good sources of information regarding wildlife and local habitats. A wildlife inventory initiative for the Upper Perkiomen could help to establish baseline data on species diversity and habitat use.

Natural Areas Inventories

The four counties within the Upper Perkiomen watershed have participated in the Natural Areas Inventory program sponsored by the Pennsylvania Science Office of the Nature Conservancy and funded in part through the Pennsylvania Department of Conservation and Natural Resources. The purpose of these Inventories is to assess the biological importance of various natural areas throughout each county, and to confirm historic or new records of state or federally listed rare, threatened or endangered plant or wildlife species. In most counties, these Inventories represent the most complete compilation of data on native flora and fauna available, yet they are typically not done in a great level of detail and should be considered a foundation for much needed detailed surveys.

Montgomery County

The Montgomery County Natural Areas Inventory of 1995, prepared by the Pennsylvania Science Office of The Nature Conservancy, lists an unusually rich array of six (6) Priority 1 Sites of Statewide Significance and one (1) Priority 2 Site of Local Significance within the Upper Perkiomen as priorities for biodiversity conservation. The Upper Perkiomen Valley supports the highest concentration of Natural Areas Inventory priority sites in all of Montgomery County. These include:

Priority 1 Sites:

The Ridge Valley Site: this site includes the meadows at NLT's Fulshaw Craeg Preserve and some adjacent meadows on the PECO Energy property. Two plant species of special concern (SP556 and SP562) and a diversity of meadow wildflowers and grasses are noted for the site. Succession and invasion of exotic plant species were noted as potential threats to this plant community. The "Potato Patch" boulder field is also included as a locally-significant geologic feature.

The Sumneytown South Slopes: this site includes wooded slopes of sugar maple, oak and hop-hornbeam along Unami Creek, in which a rare plant is found. The forested buffer along the creek and lack of disturbance are noted. Exotic invasive vegetation such as garlic mustard and stilt grass are present. These, along with potential gaps in the forest canopy, are noted as potential threats to the rare plant population, pointing to the need for management.

Upper Ridge Road: this site includes two subpopulations of a wildflower species of special concern growing in open meadow areas. "A management plan defining an annual mowing regime could help to secure the long-term viability of this species here. Herbicides would be

detrimental to the plants." The site is partially on property of the Hart Boy Scout Camp.

Unami Creek Site: this site includes a sedge of special concern and a threatened species of rush along Unami Creek, partially within the Hart Boy Scout Camp. The boulders along Unami Creek are also noted as a locally-significant geologic feature.

Boutcher Road Site: this site includes wet meadows and shrubland along a PECO Energy corridor, and supports two species of special concern. Herbicide use and succession are noted as concerns.

Green Lane Marsh/New Goshenhoppen Meadows: The northwest end of Green Lane Reservoir supports a graminoid marsh with breeding habitat for rare wildlife species, and is frequented by a diversity of birds and other animals. New Goshenhoppen Meadows adjoin the Perkiomen Creek just upstream from the Green Lane Reservoir, and also support rare wildlife species and uncommon grassland nesting birds such as savannah sparrow, meadowlark and bobolink. The wet meadows contain a diversity of sedges and native wildflowers with good butterfly habitat.

Priority 2 Sites:

Whites Mill Swamp: this site is a forested wetland and shrub swamp along Ridge Valley Creek near the intersection of Whites Mill and Reller Roads. It is considered "one of the largest areas of this type in the county" and contains several shallow man-made or enlarged ponds with abundant aquatic vegetation. Birds, dragonflies, and damselfly communities are all rich at this site.

In addition, the Inventory lists a number of Locally Significant natural areas based on their size, diversity of wildlife and plant life, water quality protection, and recreation potential.

Whites Mill Meadow is a seasonally wet meadow along Ridge Valley Creek that includes an abundance of native plants such as Indian grass, big bluestem, little bluestem, goldenrods, asters, ironweed and others including eastern redcedar. This site is listed as having High importance.

Macoby Creek Ravine is a site containing a large population of a state-listed rare plant species. Sugar maple, flowering dogwood and a variety of wildflowers are noted at this site adjacent to the quarry.

Deep Creek Reservoir is a site of a small population of a Pennsylvania rare plant species along a woodland edge within the Upper Perkiomen Valley County Park. A Pennsylvania threatened aquatic plant is also found along the shoreline of the reservoir.

Deep Creek Woods is a site with a poor population of a rare plant documented in 1989.

Knight Road Bluffs is a site hosting a small population of a state-listed endangered plant on shale slopes within Green Lane Reservoir Park.

Deep Creek Marsh is a wetland site with a rare sedge population. Other sedges, grasses, mountain mint and agrimony are noted as part of this plant community.

Church Road Floodplain is a locally significant floodplain forest with species such as silver maple, ash, and spicebush, with an adjoining upland woods supporting sugar maple, beech and hemlock along the Perkiomen Creek. This site adjoins the New Goshenhoppen Meadows.

Mill Hill Woods is a large contiguous tract of woodland on the diabase ridge known as Mill Hill just north of Pennsburg in Upper Hanover and Lower Milford Townships. There may be seepage wetlands and at least 2 plant species of special concern at this site. At 700 feet above sea level, Mill Hill is the highest point in Montgomery County.

Henning Road Woods is a well developed mixed hardwood forest community on the steep diabase slopes above Deep Creek. At least 13 species of trees occur at this site, including red maple, oaks, ash, beech, hickory, flowering dogwood, sassafras, and paw paw. The shrub and herbaceous layers are well defined.

Bucks County

The BucksCounty Natural Areas Inventory of 1999, prepared by the Morris Arboretum, lists an unusually rich array of five (5) Priority 1 Sites of Statewide Significance and one (1) Priority 2 Site of Local Significance within the Upper Perkiomen as priorities for biodiversity conservation. The Unami Creek Valleys supports one of the highest concentrations of Natural Areas Inventory priority sites in all of Montgomery County.

These include:

Ridge Valley Creek (Priority 1)

"In the section west of Ridge Valley Road the creek flows through a broad flat valley where sediment accumulation has occurred forming extensive areas of swampy floodplain forest and marsh. Headwaters areas in the vicinity of Forest Road and Mountain View Road contain sphagnous shrub swamps, and unusual feature in the diabase region." The stream valley supports a diversity of native forest and wetland communities, including: an herbaceous wetland type (bluejoint-reed canary grass

emergent wetland); two shrub wetland types (highbush blueberry-meadow sweet wetland and buttonbush wetland); vernal ponds; four forest types (red maple-mixed shrub palustrine wetland, bottomland oak-hardwood palustrine forest, red oak-mixed hardwood forest, tuliptree-beech-maple forest). Five state-listed plant species are also identified in this area, including: eastern floater; Oake's pondweed (PA Endangered); Pineland pimpernel (PA Endangered); Scarlet Indian paintbrush (PA Threatened); and swamp doghobble (PA Threatened).

Butter Creek (Priority 2)
"Most of the creek valley is forested…the lower part is characterized by a broad flat stream valley with mucky shrub and sedge-dominated marshes that spread out from the creek on both sides providing habitat for birds, reptiles and amphibians." The Natural Areas Inventory notes one notable wetland type (tussock sedge marsh), three forest types (red maple-mixed shrub palustrine wetland, tuliptree-beech-maple forest, and red oak-mixed hardwood forest), and a state-listed plant species (Eastern floater).

Unami Creek from Upper Ridge Road to the County Line (Priority 2)
"This site is a continuation of the Unami Hills area of Montgomery County which was identified as a major priority for preservation in the Montgomery County Natural Areas Inventory." The forested slopes, diabase outcrops, small streams and seeps, floodplain forests and backwater channels are all listed as important natural features. Four forest types are listed (sugar maple-basswood; red oak-mixed hardwood; tuliptree-beech-maple; and bottomland oak-hardwood palustrine forest). Three state-listed aquatic species are also noted (Allegheney River skimmer; Eastern floater; and Pineland pimpernel – PA Endangered).

Hazelbach Creek (Priority 3)
The Natural Areas Inventory notes that "The Hazelbach Creek corridor is typical of diabase streams, with extensive wooded, shrubby and herbaceous wetlands forming a mosaic of habitats which includes amphibian and reptile habitat." Tussock sedge marsh, red maple-mixed shrub palustrine woodland, and bottomland oak-mixed hardwood forest are all noted in the area.

Unami Creek in the vicinity of Allentown Road (Priority 3).
This site is noted for its forested floodplain and wooded slopes, and aquatic species. "A 1997 survey of fish documented high native fish diversity (15 species) in this section of Unami Creek."

The Inventory notes that the continuous expanse of the Unami forest in both Bucks and Montgomery Counties provides habitat for birds such as Barred owls and Pileated woodpeckers that require large expanses of forest.

Lehigh County

The Natural Areas Inventory of Lehigh and Northampton Counties identified four sites within the Upper Perkiomen watershed. These include:

Indian Creek Floodplain in Upper Milford Township

Hosensack Marsh

This site is listed as a high priority (Priority 1) site in Lehigh County, one of the highest-ranking wetlands in the Upper Perkiomen watershed. The marsh is noted for its combination of marsh and shrub swamp habitat, supporting a good example of an animal species of special concern.

Lower Milford Marsh (Lower Milford Township)

This site supports a "Basin Graminoid-Forb Fen Natural Community" along the floodplain of Hosensack Creek. The northern section of this wetland includes seeps and springs, marsh, and then a forested swamp. The southern portion gradually becomes marshy and is densely vegetated by grasses and sedges. Tree species noted in the Inventory include black walnut, willow, and ash, with herbaceous plants including sweetflag iris, sensitive fern and skunk cabbage. Several species of special concern are suspected at this site, both plants and wildlife.

Mill Hill (Lower Milford Township and Upper Hanover Township)

This wooded diabase ridge in the Hosensack Creek subwatershed supports an extensive forested area with possible plant species of special concern. Beech, tulip poplar, sugar maple, basswood, ash, hickory, and oak are dominant species on lower slopes. Herbaceous plants are diverse, with numerous species of woodland wildflowers and ferns. The upper slopes are dominated by chestnut oak, sweet birch, tulip poplar and red oak, with witchhazel, dogwood, choke-cherry and maple-leaved viburnum common in the shrub layer. A rich herbaceous plant community is present in the upper slopes. Mill Hill is noted for its diversity of forested and stream habitats. Upper Hanover Township has acquired the majority of the Montgomery County portion of the site as a protected area.

Big Beech Woods (Lower Milford Township)

This site is a southeast-facing slope along Hosensack Creek with a maturing second-growth forest of beech, tulip poplar, sugar maple, hickory, oak and birch. Some of the trees are measured at over 2 feet in diameter. Hemlock is also present in the understory, along with a diversity of shrubs and a rich herbaceous layer. The Inventory also notes

the importance of protecting this woodland to support the quality of the Hosensack Marsh.

Berks County

The Natural Areas Inventory of Berks County did not identify any high priority sites within the Upper Perkiomen watershed. However, Berks County Conservancy, in the West Branch Perkiomen Creek Preliminary Assessment noted that portions of District and Hereford Townships mark the nesting locations of a bird species imperiled at the state level due to rarity. Per the 1991 Pennsylvania Natural Diversity Inventory (PNDI), there are not any plants of concern in the West Branch Watershed.

Cultural and Historic Resources

From the earliest human inhabitants, the cultural history of the Upper Perkiomen Creek watershed has been characterized by a unique legacy of human interaction with natural features. This legacy extends from the Lenni Lenape people who inhabited the native woodlands for thousands of years, to European settlers who established farms and villages in the 18th and 19th centuries, to today's 21st century mix of towns and suburban and rural communities. While the Lenape were the longest inhabitants of the area to date, the most tangible influence on the local landscape resulted from the steady stream of German immigrants and their descendants who settled the Valley starting in the early 1700's. It was these settlers who named the Valley "Goschenhoppen", with "New Goschenhoppen" pertaining to areas north of Green Lane, and "Old Goschenhoppen" referring to areas from Green Lane to Schwenksville.

To this day the legacy of Goschenhoppen can be experienced as an intact folk region -- in the character of the farmland, the architecture of the buildings and layout of villages, and the family names and social institutions that define the area. The Valley is dotted with local place names such as Shimerville, Seisholtzville and Kleinville that reveal the roots of the area as a Pennsylvania German farming community. Schwenkfelder and Lutheran churches have long been religious and social centers of the community.
Early farmsteads, churches, mills and villages provide an important visible record of the heritage of the Upper Perkiomen Valley. The scenic landscape of gently rolling farmland, hedgerows, historic trees, woodlots and wooded ridges also stand as testimony to this 18th century Pennsylvania German heritage. *To the extent that these features can be catalogued and understood as the defining features that set the Upper Perkiomen Valley apart from other areas, they can be retained through conservation, preservation, and innovative municipal land use planning even as growth continues.*

Lenni Lenape/Late Woodland Period (to 1680)

The Unami clan of the Lenni Lenape means "the original people, those who live along streams." The Lenape were the oldest of the Algonquian tribes of the northeast. Their totem was the turtle. The Lenape were truly a woodland people who lived as part of the native hardwood forest by deriving most of their foods, medicines, and materials from the diversity of plants and animals.

With early Dutch and Swedish settlers settling in the region by the mid-17th Century, the Lenape became caught up in the fur trade. The Schuylkill Valley and tributaries such as the Perkiomen became known as major sources for commodities such as fur, tobacco and shad.

Though the Lenape did not view land as a commodity, by 1684, the Perkiomen Valley had been purchased in a deal between William Penn and Chief Maughousin.
Chief Tamenund was Chief of the Unami, and of all the Lenape at the time of European settlement. Tamenund lived in the adjacent Neshaminy Creek valley, and it was he who negotiated the famous treaty with William Penn under the treaty elm. The Perkiomen Valley was included in a 1685 sale to William Penn, which included an amount of land that was measured "as far as a man can ride for two days". The purchase price included guns, knives, beads, tobacco boxes, bells and other trinkets.

Early European Settlement Period (1680 – 1800)
The majority of the land in the Upper Perkiomen Valley was conveyed to European settlers in the mid-18th Century (1730-1770) by patent by the heirs of William Penn or later by the Commonwealth of Pennsylvania. The average size of parcels in the Upper Perkiomen Creek watershed were surveyed in the range of 100 to 150 acres, though some were smaller (30 to 50 acres). The earliest settlers belonged mostly to Lutheran Church or Reformed Church, with Schwenkfelders establishing the New Goschenhoppen Reformed Church in 1727.

Catholic settlers had established a Roman Catholic Chapel in Bally by 1741, which was known at the time as Churchville. Mennonite settlers established a meeting houses in Hereford and Upper Milford.

The early history of the Valley is defined by the combination of natural features and the social and economic forces of the 18th Century. Settlers cleared timber from the broad, forested valleys along present day Route 100 ("the Road to Boyertown") and Route 29 (Gravel Pike) to establish farms on the productive soils that define the area. The steeper topography of headwaters valleys along the Unami, Hosensack, and West Branch Perkiomen Creeks provided suitable volume and velocity of streamflow to power literally dozens of mills, including sawmills, gristmills, (linseed) oil mills, and powder mills which provided gunpowder to the Continental Army during the Revolutionary War. The ingredients for making gunpowder, including saltpeter, sulfur and charcoal, were readily available in the wooded areas of the Valley.

Early powder mills were established on the Unami Creek by 1740 and along Indian Creek in the Hosensack shortly thereafter. Indian Creek was one of the earliest mill locations in the Valley, starting with its first mill in 1737 and expanding soon to include over 10 mills that include grist, fulling, oil, saw, and powder operations. The earliest millstones in the Valley were actually brought over from Germany by the settlers, who preferred those from Andernoch on the Rhine River. During the Revolutionary War, French burr stones were brought over from the Marne River. Do any of these imported Colonial-era millstones survive in the Valley today?

The Indian Creek supported so many gunpowder mills it became known locally as "Powder Valley". The Hosensack Creek also supported at least 10 mills in the 18th century, dating to 1740. The Dubbs Mills and Schantz Mills were two of the largest operations, with Dubbs expanding to include an iron forge and a tannery that ground tree bark and treated hides. Schantz was the first in the area to develop a vertical pit saw mill before 1765. Downstream millers complained that the larger upstream mills monopolized the water power and left them with "tired water". It is said that Funks Grist Mill on the Hosensack ground flour that was used by the Continental Army at Valley Forge.

The importance of mills to the early social and economic fabric of the Valley cannot be overlooked. "People from miles around came to have their grain ground into flour or their logs sawed into beams, joists or boards. Teams were lined along the roads leading to (the mill) and patrons had to wait in order to be accommodated. It was almost a community center, for here people would meet and exchange bits of news and ideas while waiting to be served." (Kline, 1934)

The natural resources of the Perkiomen Valley attracted business-minded settlers who developed the area as an Early American center for iron production. Iron forges and furnaces dotted the ridges and narrow valleys that define the headwaters areas of the Upper Perkiomen. The reason: a combination of water power to operate the blast furnaces, a ready source of iron ore, limestone, and charcoal (local oak, hickory and ash) in sufficient quantities and close proximity to overcome the poor road systems, and close proximity to the Schuylkill River where barges could transport iron to markets in and around Philadelphia. Forges produced utilitarian implements such as household tools, farm tools, hinges, and some munitions for the Revolutionary War. The iron furnaces required vast tracts of forest (several thousands of acres per year per furnace) to generate enough charcoal to provide fuel to smelt the ore into pig iron. The necessary "iron plantations" were established on many wooded slopes in the headwaters areas.

"The Perkiomen is the first stream of any size on the East Bank of the Schuylkill after the traveler leaves Philadelphia. The headwaters emerge from steeply rising hills of Hereford and Washington Townships, Berks County. It is here along the picturesque West Branch that most of the old iron works on the Perkiomen were located." (Gemmell, 1949)

Early maps and records of the watershed document that iron furnaces and forges were operated at Green Lane Ironworks (c. 1733), Mount Pleasant Forges near Barto, Dale Ironworks and Hereford Furnace in Hereford (formerly Treichlersville), Colebrookdale Iron Works near Boyertown, Forgedale Iron Furnace and Forge, Hampton Ironworks on Furnace Hill, and forges at Salford, Wellers, and Dub's Forge along the Hosensack Creek.

19th Century

The 19th Century was a period of great industrial growth in the nation and the Upper Perkiomen Valley. The villages in the eastern portion of the Valley were conveniently located at the intersection of three main roads or "turnpikes", with the "Sumneytown and Springhouse Pike" (Route 63), "Green Lane and Goschenhoppen Turnpike" extending to Berks County, and Perkiomen Turnpike (Route 29) linking the area to Collegeville. The Perkiomen Railroad reached Green Lane in 1872 and helped to spur the growth of the major villages of East Greenville, Pennsburg, Red Hill, and Green Lane that define the Route 29 corridor. These villages became manufacturing centers and commercial hubs, with general stores, hotels, rail road stations, school houses, blacksmith shops, carriage works, and breweries.

This was also a period in which the growing number of settlers coming into the area were forced to settle more remote and rugged sections of the Valley, and smaller farms were established in the steeper wooded headwaters valleys in the watershed. "In the middle of the nineteenth century, there seemed to be a marked influx of people from Philadelphia. Among these were people of English, French, Irish, German and other nationalities. They were probably attracted here by tales of wealth from farming and other achievements, told them by land speculators. Many did not remain here long, soon returning to the city from whence they came." (Kline, 1934).

The success of mills in these areas spawned a generation of mill families that established small farms. Powder mills were a strong presence in the Unami Creek valley, and even the E.I. duPont deNemours Company operating a mill in the late 19th Century. Over the years, the volatility of the gunpowder caused explosions in many of the mills. In 1829, the Kemperer gunpowder mills along Indian Creek were struck by lightning and exploded, killing a number of workers. By the late 1800's, as the children of the mill families left home to find work, the mill industry declined and the forest returned. Second and third growth forests were maturing by the late 19th century, and spurned the growth of saw mills, which were eventually replaced by portable gasoline saw mills.

Today, the remnants of these mills and small farms can found throughout the headwaters areas of the Valley. Stone walls, stone foundations and ornamental plantings in the second or third growth woodlands along places like Ridge Valley Creek provide clues of past history. The stone walls indicate that sheep farms may have been established at the time. The presence of remnant mill dams and ponds, mill races, mill foundations and standing mill structures can be seen throughout the upper reaches of the watershed.

20th Century

By the early 20th Century, the towns of the Upper Perkiomen Valley was in the midst of an industrial boom and its farms were part of an expanded dairy industry throughout the region providing milk products to urban areas. The towns along Route 29 became manufacturing centers, providing factories and a stable, skilled work force to produce a wide variety of goods. There were clothing and hosiery plants, broom factories, cigar factories, breweries, furniture manufacturers, printers, metal stampings and wire factories, greenhouses. This manufacturing hub attracted many settlers to towns in the area. For example, in the 1920's the local hosiery companies hired many East German immigrants as knitters. The majority of these industrial facilities utilized the water resources of the Valley in some way, either as part of the manufacturing process or as a means of disposing the wastewater they generated. Many of these red brick factories are still in use today. The growth of residential neighborhoods and commercial shopping districts in the towns was closely linked to the jobs provided by local businesses.

The dairy industry growth meant that farms throughout the Valley, particularly the "Butter Valley" along Route 100, were heavily focused on providing pasture and fodder crops for dairy cattle. Creameries in the area processed and bottled and milk products for distribution (via road and rail) to urban markets. The early aerial photographs (dating to the 1930's) reveal that the economics of this period placed great pressure on the landscape – with few woodlots and hedgerows in areas heavily devoted to grazing and cultivation, and sizeable woodlands limited to the steepest areas of the hills. This pattern is still evident today, although there has been much regrowth of woodland vegetation in the Valley over the last 70 years as dairy production and distribution shifted throughout the region.

In the Unami Creek area, some of the same land that was used for powder mills was converted to use as summer camps where those weary of the city could retreat to the fresh air of the woods within a day's drive. Other forested headwaters areas were discovered as summer home communities where urban residents build summer cabins and bungalows to enjoy the woods and streams.

By the early 20th Century, city-based organizations began to buy land in the area to establish summer camps for inner-city children. In 1910, the Christian Association of the University of Pennsylvania's camp on the Unami Creek where "children and mothers with their babies could come for a week or two to enjoy and be refreshed by the warm sunshine, the cool and invigorating nights, listen to the ripple of the Swamp Creek, hear the rumbling of thunder and see the flashes of lightning, listen to the gentle patter of the rain and be inspired by the songs of the birds and at night sleep in God's great tent studded with the millions of stars and the moon flooding everything with mellow light." (Kline, 1934)

By 1916 the Delaware and Montgomery Counties Council of the Boy Scouts acquired the land along the Unami for Camp Delmont. Philadelphia County established Camp Hart in 1930, and the area was used by the Philadelphia Troops of the Boy Scouts "..for here in this tract are found some of the rarest orchids and ferns, trees in endless variety, immense rocks, wild animal life of all sorts…". Both camps are today part of the Musser Scout Reservation. Further downstream, Camp Unami was established by the Baptist Conference in the 1930's. (Kline, 1934)

Unlike other communities in the Philadelphia region, the Post World War II period in the Upper Perkiomen Valley did not generate a large-scale shift toward suburban development. While many smaller custom homes were built, these tended to be on individual rural lots and small subdivisions. In addition, the majority of commercial and industrial development during this period was still concentrated in or near the existing towns and villages rather than sprawling onto productive farmland or important woodlands.

Planning Implications

In the early 21st Century, the Upper Perkiomen Valley is still a place where the historic landscape of farms and villages and the cultural institutions and descendants of early settlers can all still be experienced in a very tangible way. The homogenizing effects of suburban sprawl have not yet taken their toll on this cultural/historic landscape and the communities it supports. It is still possible to see working family farms, a thriving creamery, preserved mills, historic inns, churches and downtown areas. The remnants of the extensive network of mills, forges, furnaces and railroads that defined the early industrial uses of the watershed can still be found. The historic towns along Route 29 are perhaps the most tangible legacy of this era. This intact pattern of 18th and 19th Century villages and farms, and the people who inhabit them, is increasingly rare, and should be maintained. The importance of being able to experience and interpreting these qualities all in one place cannot be overestimated – it helps us to understand where we came from, and where we can be headed. Once it is gone, it cannot be reproduced.

The current combination of Zoning and Subdivision and Land Development Ordinances that govern land use in the municipalities of the Upper Perkiomen Valley are designed to generate an overall pattern of residential and commercial development that will erode the experience of this unique cultural/historic landscape. Without more flexible development approaches and standards that require careful consideration of historic resources and landscapes, conventional development patterns will prevail. Historic structures may gradually be cleared to accommodate more profitable land uses or to avoid the cost of maintenance and restoration. Historic landscapes will be lost to development plans that space buildings and roads evenly across the land. Historic downtown areas of villages will be subject to piecemeal alterations that take away from the overall character that keeps them vital places to live, work and shop.

The municipalities of the Upper Perkiomen Valley take a page from other historic landscapes in the region – places like the Oley Valley of Berks County and the Brandywine Valley of Chester County that have fought hard to guide development around the most treasured areas, through combinations of private incentives and public programs. The villages of the Valley can adapt historic downtown renewal strategies used in communities like Doylestown, Bucks County and West Chester, Chester County to keep businesses thriving and maintain liveable neighborhoods.

A variety of land use planning and conservation strategies are available to communities who wish to proactively work with landowners and developers to retain valuable historic resources. Agricultural Land Preservation programs can be used to purchase development rights on concentrated areas of historic, productive farmland. Transfer of Development Rights programs can be designed to preserve clusters of historic farmsteads as "sending areas" and to renew and expand historic villages as "receiving areas". Innovative zoning strategies can be used to generate "conservation design" plans that shift the layout of residential and commercial development to retain historic resources and landscapes. Local Historic Districts can be created to further strengthen the protection of key resources, and initiatives can be launched to nominate historic structures and landscapes to the National Register of Historic Places as a means of protecting these features from the impact of Federally-funded projects such as highway construction.

The Montgomery County Planning Commission prepared an Inventory of Historic and Cultural Resources (1975) that listed the following resources in the Upper Perkiomen Valley as worthy of preservation.

Douglas Twp:
Schultz Mill (Niantic and Miller Rd.) along West Branch
Catholic Farmstead and Mill (house c. 1730, mill c. 1800) originally a Catholic settlement

East Greenville Borough:
Mill on Bank St. c. 1897

Green Lane:
Redmen's Hall, rt. 29 c. 1880 (was a PA Dutch village hall)

Marlborough Twp.:
9 sites (Hoppenville Road, Gerryville Pike, Sumneytown Village, Upper Ridge Road,
Nyce Mill c. 1850

Pennsburg:
Perkiomen School

Heilig House c. 1750

Upper Hanover Twp.:
7 sites, New Goschenhoppen Reformed Church (c. 1857), Perkiomen Heights Hotel, Hosensack Meeting House, Log House

Upper Salford Twp:
17 sites

Hereford, Berks Co.:
Cemetery and site of Washington Schwenkfelder Meeting at County Line and Kutztown Rd.
Dubbs Home, Niantic Road, Washington Twp. (c. 1740)

Land Use Patterns and Trends

"Central and western Montgomery County experienced a 242 percent increase in developed acres between 1965 and 1990…Even though our rate of population growth is slowing down, our rate of land consumption is increasing. Much more land is used for each new house than in previous decades. In 1965 there were 0.8 acres of developed land per household. Between 1965 and 1990, land was developed at a rate of 1.4 acres per household." (Montgomery County Open Space Plan, 1996)

The Census 2000 findings of the Census Bureau document that the municipalities of the Upper Perkiomen Creek watershed have seen slower growth (so far) than their surrounding municipalities over the last two decades. The slower growth rates surely result from a combination of factors: environmental constraints; access/roadway limitations; distance from growth centers; real estate market; zoning, slow turnover of family-owned lands; however, *slower growth rates should not be mistaken as a relief from future growth pressure.* As surrounding municipalities experience rapid growth along Route 422 and Route 29, and the Lansdale exit of the Turnpike, the Quakertown and Allentown area, development pressure will be expected to increase on the Upper Perkiomen Valley as a desirable location for construction of increasingly larger-scale residential subdivisions. Seasonal home construction is also a factor in the more remote woodlands.

The traditional land use pattern of farms, woodlots, hamlets, villages, and towns that shaped the Upper Perkiomen Valley over the last three centuries is still evident in the landscape today – and provides an important example of a pattern for managing growth and sustainable watershed management. Changes in land use over the last 50 years, including highway development, suburban development (residential, commercial and industrial), and the decline of farming in the region show a progression of development in the region and reflect steady increases in population. The watershed also has a long history of supporting extractive uses such as rock quarries and public water system impoundments. The impoundments also form the core of existing recreational land in the watershed.

What will the land use pattern of the Upper Perkiomen Valley be like 20 years from now? Will the underlying aquifers produce water as clean and plentiful as it is now? Will streams and wetlands in the watershed teem with life and maintain a constant flow of high quality water? The population of many municipalities that make up the Upper Perkiomen Creek watershed is projected to grow by over50 percent during that timeframe. These future watershed residents will require residences, businesses, industries, public services, and roads, and will increase demands for water supply, wastewater treatment, and stormwater management. The pattern and

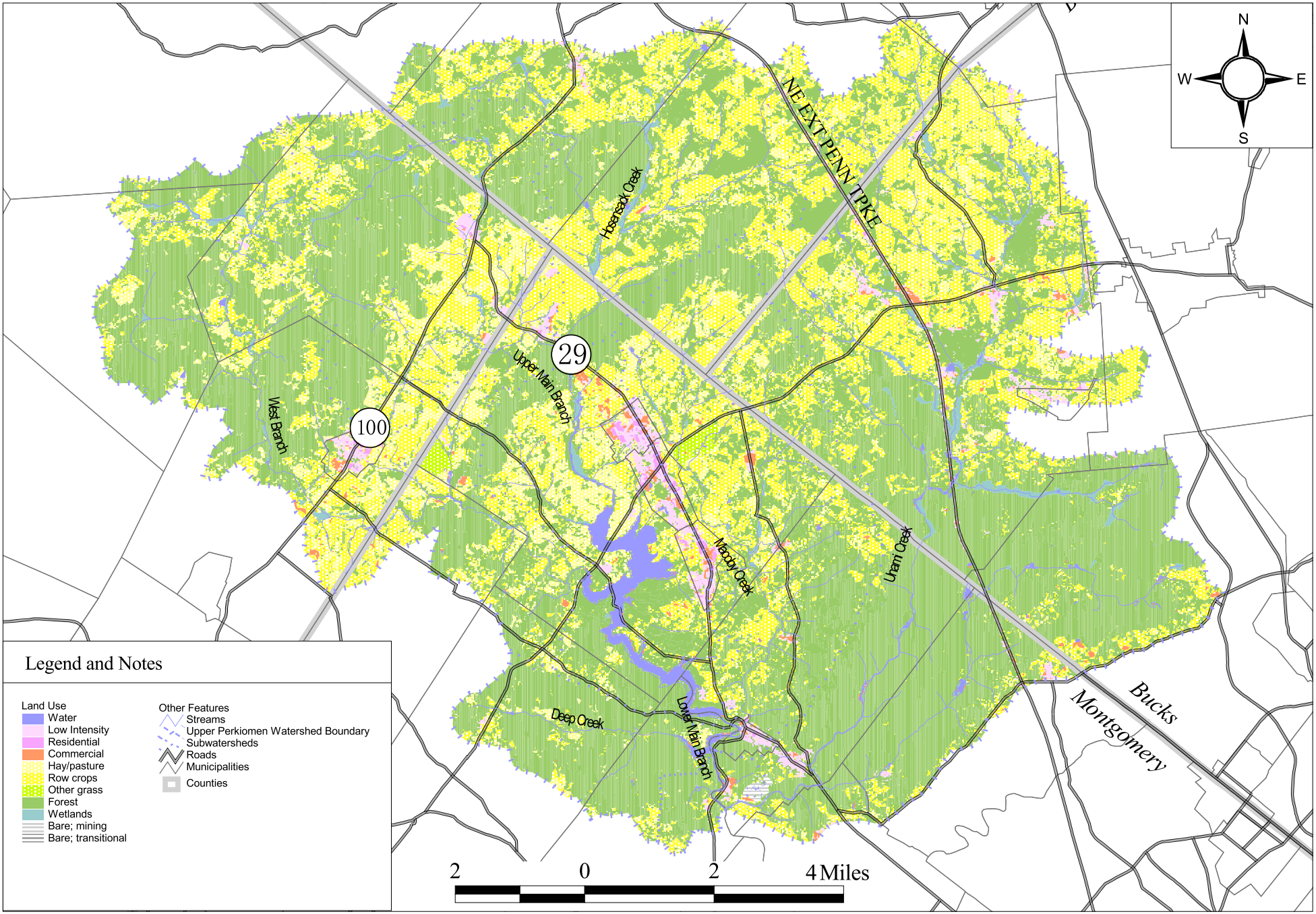
intensity of this land use that results from this growth will determine the future health and sustainability of the Upper Perkiomen watershed. If that pattern is sprawling and converts critical open space areas into conventional suburban landscapes of lawns and paved area, then the streams, wetlands and aquifers of the Upper Perkiomen can be expected to become drier and more degraded, just as they have in countless other "built-out" communities.

For these reasons, municipalities in the Upper Perkiomen Valley should carefully craft land use regulations – including Comprehensive Plans, Zoning Ordinances, and Subdivision and Land Development Ordinances – with the goal of generating a pattern of development that continues the traditional land use pattern of farms, woodlots, hamlets, villages and towns….and that sustains the quality and quantity of ground and surface water.

The breakdown of land uses by percentage in the Upper Perkiomen watershed points to the important fact that the area is still largely rural and undeveloped. Forest land, perhaps the best land cover condition for sustaining the quality and quantity of ground water and surface water, ranks as the most dominant category, accounting for over 55% of the land in the watershed. This is followed by agriculture, which makes up 35% of the land. These "open space" uses are relatively uniformly throughout the watershed, with greater concentrations of woodland on ridges at the perimeter and farmland centered in the broader valleys. The remainder of land is devoted to residential, commercial and industrial uses, generally concentrated along Route 29, Route 100 or other major roads **(see Figure 10: Land Uses).**

Current land uses by acreage are summarized in descending order as follows, based on an evaluation of land use mapping by EPA Region III:

Land Use	**Area (acres)**	**Percentage of watershed**
Deciduous forest	40,729	51.1%
Row crops	20,292	25.5%
Hay/pasture	8,226	10.3%
Mixed forest	3,304	4.2%
Evergreen forest	2,444	3.1%
Low-intensity developed	1,516	1.9%
Water	965	1.2%
Woody wetland	833	1.1%
High intensity commercial/industrial	587	0.7%
Emergent herbaceous wetland	265	0.3%
Other grass (lawns, parks, golf)	230	0.3%
High intensity residential	224	0.3%
Bare: quarries, strip mines, sand pits	60	0.1%



Upper Perkiomen
Rivers Conservation Plan

Figure 10
Land Uses

Pennsylvania Environmental Council
117 South 17th Street, Suite 2300, Philadelphia PA 19103
(215) 563 0250 http://www.pecpa.org

Natural Lands Trust
Hildacy Farm, Palmers Mill Road, Media PA 19063
(610) 353 5587 http://www.natlands.org

Upper Perkiomen Watershed Coalition
P.O. Box 233, Palm, PA 18070-0233
http://www.upwcwatershed.org

Agricultural Land

Agricultural land is concentrated in the following three areas:

1) The northeast portion of the watershed, at the headwaters of Unami Creek along the Northeast Extension of the PA Turnpike just west and north of Quakertown. This is the largest concentration of contiguous farmland.
2) The central portion of the watershed, east and north of Green Lane Reservoir along Route 29;
3) The northwest portion of the watershed along Route 100;

Additional agricultural land is scattered in smaller blocks following valleys and broader areas of level topography. These blocks are primarily separated by woodlands along steeper ridges and slopes.

Farms in the region include a mixture of both row crops and hay or pasture land, including a relatively small number of dairy operations, beef cattle farms, and equestrian properties. The greatest concentrations of hay land appear to be along the north end of Green Lane Reservoir near East Greenville and Fruitville.

The long-term viability of agriculture in the region depends on the continued operation of farmland in nearly contiguous blocks of at least 500 or more acres. Adjoining farms that total this acreage provide a "critical mass" of land in one area that is not broken by conflicting uses such as residential neighborhoods or commercial highway strips, and enable farm-supply businesses to continue operating in the area. The Pennsylvania Agricultural Land Preservation program, in partnership with similar County-based programs, is an ideal funding source for preserving farmland in these concentrated areas. The program provides funds to purchase agricultural easements on farms of at least 50 acres, enrolled in Agricultural Security Districts, and containing with high percentages of prime agricultural soil.

Woodland

Wooded acreage in the Upper Perkiomen Valley constitutes over 55% of the total land area. This is a significantly higher percentage than the average of 35% coverage for most of the Piedmont forests in southeastern Pennsylvania. More importantly, the configuration of this woodland cover as large, contiguous forest blocks (i.e. "deep woods") is relatively uncommon in the more fragmented pattern of isolated woodlots and steep slopes that are more typically found in adjacent watersheds. The fact that most of these woodlands are situated in headwaters areas along First Order and Second Order streams is also critically important for maintaining water quality and quantity.

An analysis of forest blocks in the Unami Creek and Ridge Valley Creek area by Natural Lands Trust documented over 4,000 acres of nearly contiguous tracts of deep woods. At

least 12 of these tracts range between 250 and 500 acres in size, and are unbroken by roads, driveways or clearings for residences. This one of the largest concentration of deep woods or forest-interior habitat in all of southeastern Pennsylvania. Large, mature forests are critically important as habitat for forest-nesting birds, uncommon mammals, salamanders and native plants.

The land use pattern in the wooded ridges and valleys of the Unami Creek, Deep Creek and hills of the Reading Prong are closely linked to the ownership pattern, the natural constraints of the land, demographic trends, local land use regulations, and the local real estate market. The area can generally be described as a historic 2nd-growth forested landscape of wooded diabase and gneiss ridges, steep wooded valleys with scattered 19th century homes and mill sites with nearby historic hamlets and villages, and with the small-scale suburban residential development encroaching on all of these landscape types. There are no major industrial or commercial land uses present in the woodlands of the Upper Perkiomen Valley, other than small businesses and remnant dumps. There are several larger-scale recreational uses in wooded areas, including seasonal campgrounds. The history of large camps in the woodlands of the Unami Creek and Deep Creek areas is symbolic of the long-running status of the Upper Perkiomen Valley as a relatively remote, natural getaway within a reasonable drive of the population centers of the Philadelphia region.

Residential

A relatively small area (less than 2%) the Upper Perkiomen Creek watershed consists of residential land use. Of particular importance is the fact that the vast majority of this residential land consists of either lower density single-family properties or higher density homes in towns and villages. The emergence of large-scale residential subdivisions in the watershed has occurred in relatively few areas. The majority of these subdivisions are concentrated along the Route 29 and Route 100 corridors. A relatively small number of mobile home parks are also present in the watershed, also concentrated along major roads.

Lower Density Residential

Lower density residential land use is commonly found along existing roads throughout the watershed, with single family homes on large lots ranging from 1 to 5 acres in size. Many of these were built between the 1970s through the 1990s, reflecting the steady increase in population in many local communities during that time period and a nationwide suburbanization trend. Some sections of the watershed, particularly in the municipalities along the Route 100 corridor, are experiencing a recent trend toward construction of new homes in large lot subdivisions off of major roads, with new roads, private lanes or long private driveways.

Higher Density Residential

The majority of the population density of the watershed can be found in residential neighborhoods of single-family, duplex and multi-family homes in the six boroughs and smaller villages and hamlets scattered along major roads and crossroads throughout the watershed. These lots are generally less than an acre, with a typical neighborhood block in a local borough supporting 8 to 12 homes to the acre. The Boroughs of Bally, East Greenville, Pennsburg, Red Hill, Green Lane, and Trumbauersville and larger villages such as Perkiomenville, Sumneytown, Hereford, and Palm include a relatively large stock of late 18th and early 19th century homes constructed to support a growing population as the towns prospered on an economy of mills, markets and industry.

Commercial

Commercial development (including shopping centers, smaller stores, and offices) in the Upper Perkiomen watershed is concentrated primarily along Route 29, Route 100, and Route 663, with scattered stores and offices in other areas. The watershed does not include large-scale office parks, regional malls, or extensive highway commercial corridors that have altered the character and environmental qualities of many neighboring communities. The fact that the majority of commercial uses are concentrated in or near existing villages and boroughs provides an important template for continuing this pattern. Municipalities can craft zoning ordinances to guide future commercial development to the periphery of existing villages and hamlets, thereby avoiding the scenic viewshed degradation and traffic problems associated with conventional highway strip centers along major road corridors.

Industrial

The Upper Perkiomen Creek watershed, for its relatively rural character, supports a substantial among of industrial land use (including factories and utilities). These total less than 1 percent of the watershed area, and are primarily concentrated along the Route 29 and Route 100 corridors. The Upper Perkiomen Valley has traditionally been considered an area suited for manufacturing businesses due to its labor pool, close proximity to major highways, and certainly due to its water supply. Major manufacturing plants in the watershed include major manufacturers such as Brown Printing, Knoll Group, Cherrydale Farms candies, Pillsbury Company. These facilities have developed over time on larger individual lots rather than in the industrial park complexes that are increasingly common.

Demographics

The population of the Upper Perkiomen Valley is relatively rural, yet projections for suburban growth over the next 20 years anticipate increases of at least 50% in many areas. The current population of the Upper Perkiomen watershed has been estimated at approximately 47,972. This figure is provided by the Upper Perkiomen Watershed Association based on data provided by Census 2000 for each municipality in the watershed, and has been further refined by calculating the percentage of the Upper

Perkiomen watershed in each municipality and the proportionate number of residents in that watershed area **(See Figure 11: Population and Area of Municipalities of the Upper Perkiomen Watershed)**.

Growth projections prepared by the Delaware Valley Regional Planning Commission and the counties of Berks, Bucks and Lehigh estimate that the population of at least 9 municipalities in the watershed will increase by between 50% and 120%. Some communities, Washington Township in particular, have already exceeded their estimated growth projection for the year 2020, most likely due to higher density mobile home park construction. The assumption is that rapid growth will continue on the remaining buildable land in this area.

Adjusting for the percentage of each municipality within the Upper Perkiomen Creek watershed, communities such as Milford, Richland, West Rockhill, New Hanover and Upper Hanover are all projected to grow by at least 50% over the next 20 years within the watershed. The Upper Perkiomen portions of municipalities such as Lower Milford, Upper Milford, Douglass, Marlborough, Salford, Upper Frederick and Upper Salford are all projected to grow in population by between 25% and 50% by the year 2020. The six boroughs within the watershed are relatively limited in area and are fairly built out. Most of the populations of these communities are expected to stay fairly static, with minor fluctuations of 5 to 10% up or down. Villages such as Red Hill, Bally and Green Lane are expected to loose larger percentages of their population (9%, 15.8% and 29%, respectively) most likely due to the trend toward conversion of residences to businesses.

Current and future municipal zoning ordinances will determine what the pattern and intensity of this growth will be in each municipality and each section of the Upper Perkiomen watershed. The current land use regulations enacted in most municipalities calls for this growth to be spread fairly uniformly across the landscape, taking up valuable farmland, fragmenting rich woodlands, degrading groundwater, streams and wetlands and lining scenic roads with highway commercial strip development.

Planning Implications

The problems associated with conventional suburban land development are evident in many "built out" communities of southeast Pennsylvania. With more land consumed per residence and per person as compared to more traditional patterns of development, protection of critical natural resources such as stream corridors, wetlands and forested areas becomes more difficult. Growing demand for water supply, wastewater treatment and stormwater management in these built-out communities is typically addressed in a non-integrated fashion, inevitably leading to unnecessary degradation of water quality and reduction of water quantity in streams, wetlands and aquifers. Sprawling development patterns also generate higher costs for services such as roads, police, fire, schools, water and sewer as infrastructure must be expanded to service widely dispersed neighborhoods. *With careful planning and design among the communities of the*

Upper Perkiomen Valley, these problems can largely be reduced or eliminated as the watershed continues to experience growth and development.

Currently, most residents of the Valley have access to shopping centers and stores in or near the existing boroughs and villages. Demand for broader shopping opportunities such as "big box" stores, outlets and regional malls is currently met by traveling to neighboring communities such as Allentown/Bethlehem, Quakertown, Montgomeryville, Plymouth Meeting, King of Prussia, Pottstown, or Reading (Montgomery County Planning Commission, 1995). Based on current zoning ordinances and the need to serve growing residential populations in the Upper Perkiomen Valley, the prospect of highway commercial strip developments and regional malls along the major roads in the watershed is very real. The impacts associated with this type of commercial growth could severely alter the environmental and scenic qualities of the area, and generate major traffic problems and stormwater runoff. Careful thought should be given to guiding the *location* of new commercial development to appropriate areas near existing population centers, to *redeveloping* older industrial sites or brownfields as new shopping areas, and designing those shopping areas to be pedestrian-friendly with parking lots, walkways and greens rather than a sea of parking.

The following list of development related impacts to watershed resources is listed here, and should be considerations for any municipality in shaping its Comprehensive Plan and land use regulations:

- Traffic impacts of increased residential and commercial development.
- Truck traffic associated with major manufacturing, utilities, quarries and landfills.
- Loss of agricultural land and biodiversity with increased development.
- Loss of scenic/historic landscape that characterizes the Valley.
- Major industrial uses – power plants, factories, gas pipelines, electric transmission lines, fiber optics, and associated environmental impacts.
- Major extractive uses – quarries, reservoirs, timber, topsoil/sod removal.
- Water quality/quantity impacts (point source/non-point source/overconsumption/interbasin transfers)

Population & Area Of Municipalities Of The Upper Perkiomen Watershed

(Jim Walsh 3/25/01 using area and % from E Bryson received 3/19/01)

County	Municipality	Total Area (sq miles)	% in Watershed	Area in Watershed (sq miles)	Pop. 1990	Pop. 2000	Pop 2000 in UPWS	% of Watershed Pop.	2000 County Pop Totals
Berks	Bally	0.53	100.00	0.53	973	1062	1062	2.21	
Berks	District	11.53	43.60	5.03	1211	1449	632	1.32	
Berks	Hereford	15.43	98.19	15.15	3026	3174	3117	6.50	
Berks	Longswamp	22.91	4.32	0.99	5387	5608	242	0.51	
Berks	Washington	14.13	57.32	8.10	2799	3354	1923	4.01	6975
Bucks	Milford	27.94	93.83	26.22	7360	8810	8266	17.23	
Bucks	Quakertown	1.84	1.06	0.02	8982	8931	95	0.20	
Bucks	Richland	20.88	5.14	1.07	8560	9920	510	1.06	
Bucks	Springfield	30.77	0.97	0.30	5177	4963	48	0.10	
Bucks	Trumbauersville	0.36	71.47	0.25	894	1059	757	1.58	
Bucks	West Rockhill	16.47	48.33	7.96	4518	4233	2046	4.26	11722
Lehigh	Lower Macungie	22.82	1.43	0.33	16871	19220	275	0.57	
Lehigh	Lower Milford	19.71	81.73	16.11	3269	3617	2956	6.16	
Lehigh	Upper Milford	17.71	50.11	8.88	6304	6889	3452	7.20	6683
Montgomery	Douglass	15.38	17.50	2.69	7048	9104	1593	3.32	
Montgomery	East Greenville	0.49	100.00	0.49	3117	3103	3103	6.47	
Montgomery	Green Lane	0.31	100.00	0.31	442	584	584	1.22	
Montgomery	Marlborough	12.41	99.33	12.32	3116	3104	3083	6.43	
Montgomery	New Hanover	21.69	24.14	5.24	5956	7369	1779	3.71	
Montgomery	Pennsburg	0.80	100.00	0.80	2460	2732	2732	5.70	
Montgomery	Red Hill	0.68	100.00	0.68	1794	2196	2196	4.58	
Montgomery	Salford	9.84	53.05	5.22	2216	2363	1254	2.61	
Montgomery	Upper Frederick	10.06	32.61	3.28	2165	3141	1024	2.14	
Montgomery	Upper Hanover	21.17	100.00	21.17	4604	4885	4885	10.18	
Montgomery	Upper Salford	9.11	11.86	1.08	2719	3024	359	0.75	22592
Totals		324.98		144.22	110968	123894	47972	100.00	47972

Does not include Upper Saucon, Lehigh County, whose area in UPWS is less than 0.4%

Figure 11

Protected Open Space, Parks and Recreation

The Upper Perkiomen Valley supports a growing network of public and private land that is permanently protected from residential and commercial development and, in some cases, is available for public recreation. As growth continues to change the pattern of land use in the watershed, the size, shape and location of this protected open space network will be increasingly important for guaranteeing the quality of life enjoyed by residents, maintaining habitat for native plants and animals, and protecting critical water resources. While protected open space in some regions is considered a luxury, *the communities that make up the Upper Perkiomen Valley cannot afford to forego carefully planned strategies to protect critical lands through flexible zoning ordinances, creative planning tools, and partnerships with state and county government agencies and conservation organizations.*

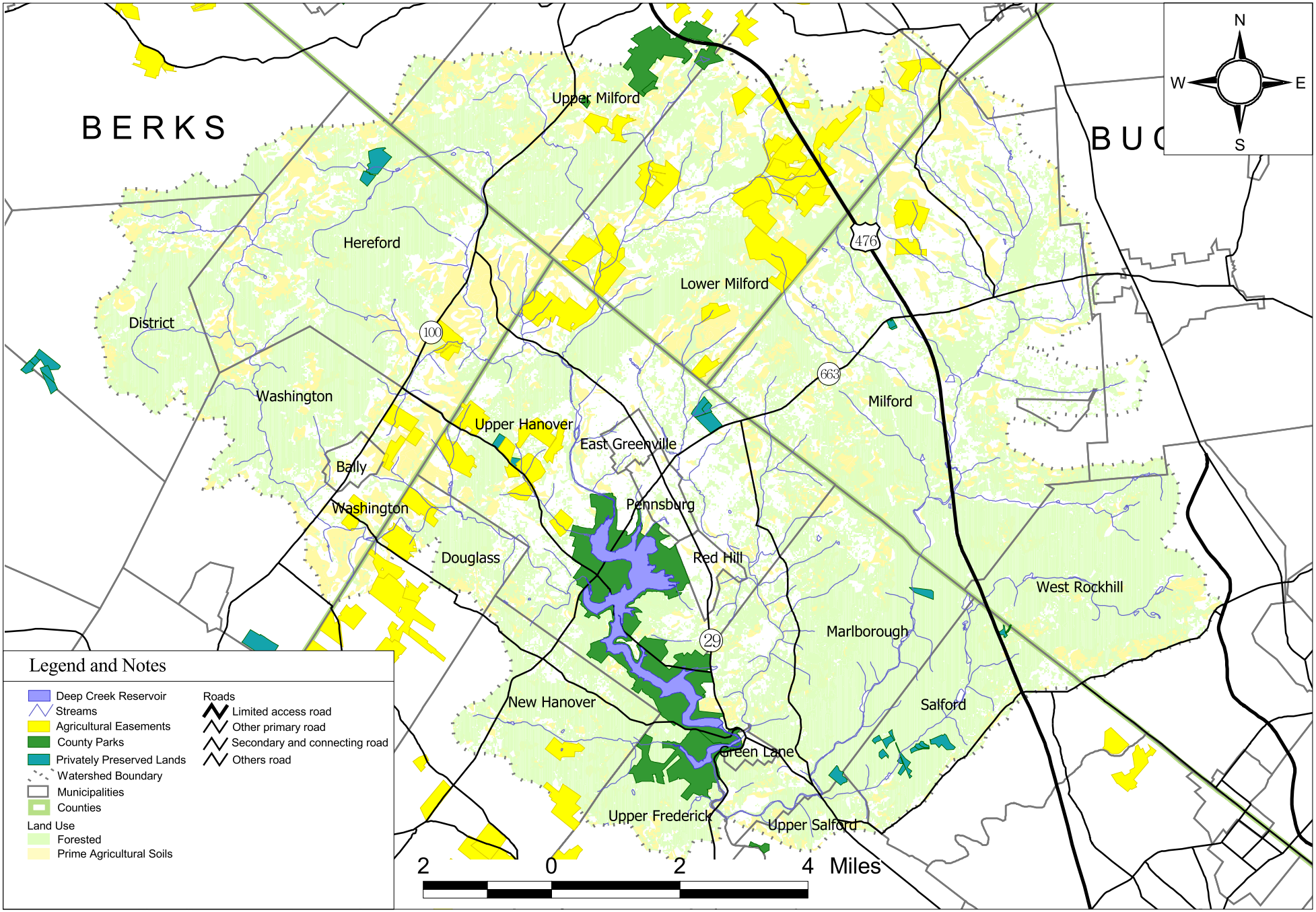
The current network of protected open space includes several categories totaling an estimated 7,970 acres, or 8.6% of the watershed **(see Figure ___: Protected Open Space)**. The categories and approximate acreages are as follows:

Agricultural Easements	4,182	acres	4.5 % of watershed
Privately Preserved Lands	363	acres	.04 % of watershed
County Parks	3,425	acres	3.7 % of watershed

The greatest concentrations of protected open space in the watershed can be found in the Montgomery County Parks and Recreation Department's land surrounding and including Green Lane Reservoir, and the agricultural easements in the Butter Valley along the east side of the Route 100 corridor and also in the Indian Creek headwaters area. Smaller concentrations of privately preserved lands (generally conservation easements) are situated in the Ridge Valley Creek portion of the Unami Creek watershed, and properties along the Macoby Creek and the headwaters of the main stem Perkiomen Creek.

Agricultural Easements

Agricultural easements in the Upper Perkiomen Valley are purchased by the Agricultural Land Preservation Boards (ALPB) in Montgomery, Berks, Lehigh and Bucks Counties. These easements are voluntary, legally-binding agreements between the landowner and the ALPB, generally restricting the use of the land for farming and other open space uses, and prohibiting most development, other than agricultural-related structures. Funds for these programs are generated by the Pennsylvania Agricultural Land Preservation Program, using income from a real estate transfer tax and a cigarette tax. In some cases, these funds are matched by County open space funding. All 4 counties have worked to preserve farmland in the watershed, although Montgomery and Lehigh Counties have contributed nearly 80% of this acreage. These easements are secured according to the following process:



Upper Perkiomen
Rivers Conservation Plan

Figure __
Preserved Open Space

Pennsylvania Environmental Council
117 South 17th Street, Suite 2300, Philadelphia PA 19103
(215) 563 0250 http://www.pecpa.org

Natural Lands Trust
Hildacy Farm, Palmers Mill Road, Media PA 19063
(610) 353 5587 http://www.natlands.org

Upper Perkiomen Watershed Coalition
P.O. Box 233, Palm, PA 18070-0233
http://www.upwcwatershed.org

1) A landowner voluntarily submits an application to their county's ALPB for an annual round of funding. The landowner may prepare this application on their own, or may work with a local conservation organization or other advisor to make sure the submittal achieves its highest potential score. Applications focus heavily on the percentage of prime agricultural soils, conservation practices, proximity to other farms and protected lands, threat of development, and other factors. Certain factors may be tailored individually by each county ALPB, but generally follow state standards.

2) Applications are then reviewed for completeness and accuracy and are scored according to how well they address the criteria for the program. Each year, based in part on available funds, a certain number of high-scoring farms qualify for an "offer" to sell an agricultural easement through the ALPB. These programs often set "caps" or limits on the amount of funds to be paid per acre for an easement. *If caps are set too low, they can prove to be a serious deterrent to farmland preservation in strong real estate markets. Wherever possible, these caps should reflect the fair market value of conservation easements in each County.*

3) Landowners who accept an offer then enter into an agreement with the ALPB to sell their easement, thus preserving the productive farmland for future use.

The protection of prime farmland in the Upper Perkiomen Valley has far reaching benefits for the community, the environment and future generations. In addition to retaining 300 years of cultural history dating back to the earliest European settlers, preserving farms contributes to ongoing food production, protection of rural areas and agricultural-related businesses and employment, and for contribute to groundwater recharge and protection of streams and wetlands. Numerous side benefits relate the reduction of sprawl – protected farms don't generate roads, traffic congestion, new houses, shopping centers, schoolchildren, crime, fires, don't use large amounts of water, and don't generate large amounts of wastewater. The communities of the Upper Perkiomen Valley should work closely with conservation groups and landowners to explore every opportunity to save farms and farming in the Valley.

Privately Preserved Lands

Conservation easements are similar to agricultural easements in that they are voluntary, legally-binding agreements between the landowner and either a private non-profit land trust or land conservancy, or a government entity such as a county or municipality. Both kinds of easements are perpetual in nature, meaning they "run with the land" and apply to successive owners. Conservation easements may include protection of farmland, but also include protection of natural features such as woodlands, meadows, streams and wetlands, and may include protection of historic resources early American farmsteads or specimen trees. They may reserve certain areas as potential house sites, and may include reserve timber harvesting rights and other conservation uses. Conservation easements are frequently donated by landowners, who are then eligible to

treat the value of the donation as a charitable gift and a deduction on their federal income tax or capital gains tax. Current tax law also allows conservation easements to play an important role in reducing the value of inheritance taxes in estate situations involving land. Conservation easements may also be purchased, similar to the agricultural easements, although sources of funding in the Upper Perkiomen Valley have typically included a "mix-and-match" approach of DCNR Keystone Land Trust Grants (or "Growing Greener" grants), County Open Space funds, and private foundation grants.

County Parks

County parks play major role in the Upper Perkiomen Creek watershed by allowing public access to large-scale protected open space areas offering multi-faceted active and passive recreation opportunities. At 2,342 acres, Green Lane Reservoir Park in Montgomery County is clearly the largest, most varied county park in the watershed. This includes 1,101 acres of fee-owned lands, an 805 acre surface water easement on the reservoir, and an additional 436 acres of land under easement with the Philadelphia Suburban Water Company. This park includes a wide variety of uses such as picnic areas, ballfields, recreational boating, fishing (including fly-fishing), hiking and horseback riding. The Montgomery County Open Space Plan of 1996 identifies 8 private properties that are priorities for permanent preservation and/or acquisition to maintain the integrity of the park's character.

A second county park adjoins Green Lane – Upper Perkiomen Valley Park, which includes 567 acres encompassing Deep Creek Lake and Knight Lake. This park is one of the oldest in the area, dating to 1939. It provides opportunities for fishing, camping, picnicking, boating, playing tennis, ice-skating, cross-country skiing and sledding. Until the summer of 2001, the lakes provided public swimming. These were recently closed due to high levels of fecal coliform and e-coli bacteria, most likely due to a combination of failing septic systems, a large Canada goose population, and overland runoff containing animal waste. The 1996 Open Space Plan identifies at least 7 privately owned tracts adjoining the park that are important for acquisition and/or permanent protection.

The proposed 25.5 mile Perkiomen Trail is a long-term objective of the Montgomery County Parks Department that follows the old Reading rail line from Oaks in Upper Providence to the Green Lane Reservoir Park area in Upper Hanover Township. The first segment of the trail is currently being established, and the plan is for it to eventually link communities all along the Perkiomen Creek with a broader network of trails and open space in the Upper Perkiomen Watershed and beyond.

Other public open space resources include a large Lehigh County park in Upper Milford Township at the headwaters of the Hosensack Creek, a number of municipal parks, and Game Commission lands in District and Hereford Townships.

ACTION PLAN
FOR THE
UPPER PERKIOMEN CREEK WATERSHED

The Action Plan topics that follow are organized according to the Major Issues that affect the conservation of streams, wetlands, and ground water aquifers. Each section begins with one or more Goal statements specific to the Upper Perkiomen Creek, followed by a series of Implementation Action" that are based on the goals. These Implementation Actions identify ways to strengthen current regulations, land management, public education, etc., that would increase protection of key watershed resources. Following certain Implementation Actions are Background sections that explain the rationale for the Actions.

The identification of Major Issues, Goals and Implementation Actions in the Upper Perkiomen Creek watershed is based on a combination of input from public meetings, survey questionnaires, interviews with municipal officials, and from research and analysis of data from a variety of sources.

The "Participating Parties" listed in the table are individuals or organizations with a logical connection to the projects with which they are listed. They may be able to provide support staff or funding (e.g. the County Planning Commissions or Pennsylvania Department of Environmental Protection), undertake the project as part of their mission (e.g. Trout Unlimited), or may simply be directly affected by the project (e.g. landowners).

It is important to realize that the issues that affect stream, wetland and aquifer protection tend to overlap, making their separation into these discrete topics at times artificial. Quite often an Implementation Strategy for one issue is also an objective for another. In fact, the most important objectives, for example a commitment to preserving and enhancing riparian buffers, are those that address most of the issues simultaneously. Rather than repeating similar information, the recommendations are placed under what seem to be the most fitting issue.

1

GUIDE LAND DEVELOPMENT

GOALS

The overall pattern and intensity of land uses in communities throughout the Upper Perkiomen Creek watershed should be planned in a manner that:

- *Permanently protects critical environmental features such as streams, wetlands, floodplains, riparian woodlands, major forest blocks and steep slopes from clearing, excavation and development.*

- *Retains the traditional pattern of development in the area, with homes and businesses on smaller lots in or near existing hamlets, villages and towns and crossroads (where major roads and utilities already exist), and rural lots and large properties in areas dominated by farmland and woodlands.*

- *Provides flexible standards for developers to design more compact communities adjoining substantial areas of protected open space.*

- *Explicitly recognizes the value of regional planning among neighboring municipalities.*

IMPLEMENTATION ACTIONS

1. Flexible zoning and subdivision ordinances should be adopted by municipalities. Enacting "*Conservation Design*" ordinances can strongly encourage a shift from conventional residential development on 1 or 2 acre lots to more *open space-oriented development* with residences on lots of less than 1 acre in size and substantial areas of protected open space encompassing sensitive natural features and historic resources and also otherwise "buildable" land. "*Traditional Neighborhood Design*" ordinances should be enacted to shift Highway Commercial development away from wide extended strips along major roads and toward existing "nodes" at crossroads and existing developed areas. Model ordinances from county planning commissions or nonprofits and enacted by other communities to achieve these goals should be provided to municipalities for consideration.

2. Municipalities should review and consider establishing Transfer of Development Rights (TDR) programs. This strategy includes identifying important "sending zones" (such as prime farmland and large forests) where important land areas should be protected and "receiving zones" (such as village extension areas or existing "nodes" of development) where higher densities of residential or mixed-use development can be accommodated in a creative and environmentally-sensitive manner. Model ordinances enacted by other communities to achieve this goal should be provided to municipalities for consideration. This approach is also compatible with strategies such as Agricultural Land Preservation, Effective Agricultural Zoning, ,Village Extension Overlay Zones and Joint Municipal Comprehensive Planning.

3. Municipalities should review and consider adopting Village Extension Overlay ordinances. These can be useful in areas where important farmlands or woodlands adjoin existing villages or hamlets, and would allow development densities to be shifted from the majority of a tract of land to the portion closest to the existing village or hamlet, while requiring the new development to be planned and designed for compatibility with the existing community. This approach is also compatible with strategies such as Agricultural Land Preservation, Effective Agricultural Zoning and Transfer of Development Rights.

4. Increase enrollment of Upper Perkiomen farms in County and State Agricultural Land Preservation programs. This effort can be made by a coalition of municipalities, county agencies and conservation groups. Important issues to address include: greater consistency between actual appraised easement values and the per-acre price "ceilings" for purchasing agricultural easements; consideration of municipal funds as a match for County and State funds.

5. Municipalities should consider the use of Effective Agricultural Zoning in areas where farming is a primary use of land. This type of ordinance can be used in conjunction with Transfer of Development Right programs, Village Extension Overlay zones and Agricultural Land Preservation programs to create zoning districts that promote the viability of agricultural operations on minimum lot sizes of 25 acres or greater.

6. Neighboring municipalities should consider working together to adopt Joint-Municipal Comprehensive Plans, as allowed under the Pennsylvania Municipalities Planning Code. Since the scale and rate of development that is occurring in the Upper Perkiomen Valley affects entire landscapes and subwatersheds, a coordinated, regional approach to land use planning among neighboring municipalities allows for more realistic growth management and resource protection than the conventional mosaic of small, fragmented plans. Regional comprehensive planning is being conducted in the watershed and

should be considered in municipal land use planning. These efforts include the Quakertown Area Regional Planning Commission, Upper Perkiomen Valley Regional Planning Commission and several communities in Berks County.

7. Municipalities should consider the use of environmental impact fees and requirements for environmental impact mitigation for major energy generation facilities and quarries.

8. Enhance the livability of the Boroughs of East Greenville, Pennsburg, and Red Hill through the promotion of revitalization programs and joint municipal planning with neighboring Townships.

9. Ensure that municipalities throughout the watershed adopt the full range of environmental protection ordinances, including those dealing with wetlands, floodplains, riparian buffers, steep slopes and grading. Most of these regulatory approaches are described in under the relevant section of this plan. Steep slope ordinances should be adopted by municipalities to protect steep slopes and limit development in these areas. Steep slopes are naturally constrained in that they often have shallow depth to bedrock and highly erodible soils. Construction on steep slopes generally require excessive amounts of grading that alters natural hydrology and generates accelerated erosion and sedimentation in areas adjacent to streams.

Implementation Action Summary:
Issue #1: Guide Land Development

Specific Tasks Involved	***Potential Participating Parties***
1) Flexible Zoning and Subdivision Ordinances should adopted by municipalities.	*Municipalities, County Planning, Conservation. Organizations, DCNR (Growing Greener)*
2) Municipalities should review and consider establishing Transfer of Development Rights (TDR) programs.	*Municipalities, County Planning, Conservation Organizations*
3) Municipalities should review and consider adopting Village Extension Overlay ordinances.	*Municipalities, County Planning, Conservation Organizations*
4) Increase enrollment of Upper Perkiomen farms in County and State Agricultural Land Preservation programs.	*A coalition of Municipalities, County Agencies and Conservation Organizations*
5) Municipalities should consider the use of Effective Agricultural Zoning in areas where farming is a primary use of land.	*Municipalities, County Planning, Conservation Organizations*
6) Neighboring municipalities should consider working together to adopt Joint-Municipal Comprehensive Plans.	*Same as above*
7) Municipalities should consider the use of environmental impact fees and requirements for environmental impact mitigation for major energy generation facilities and quarries.	*Same as above*
8) Enhance the livability of the Boroughs of East Greenville, Pennsburg, and Red Hill through the promotion of revitalization programs and joint municipal planning with neighboring Townships.	*Municipalities, County Planning*
9) Steep slope ordinances should be adopted by municipalities to protect steep slopes and limit development in these areas.	*Same as above*

BACKGROUND

Land development is perhaps the single most critical issue facing the Upper Perkiomen Creek watershed. Of all the issues affecting watersheds in the rapidly growing region of southeast Pennsylvania, suburban sprawl typically has the most far-reaching effects on the quality and quantity of both ground and surface water resources. This fact, combined with the significant growth projections facing the communities of the Upper Perkiomen, place the land development issue at the top of the list for watershed conservation planning.

Poorly planned growth and overdevelopment in other watersheds in the region are directly linked to a broad array of serious, often interrelated watershed impacts. These include:

Water Quantity Impacts

- *Severe flash flooding due to increased runoff from impervious surfaces and poor stormwater management practices*
- *Depletion of aquifers and resulting well failures due to increased runoff, reduced ground water recharge, and increased reliance on ground water for public and private water supply wells (occasionally discharging to streams via sewage treatment plants).*
- *Unnaturally low stream flows during droughts due to increased runoff, depletion of aquifers and loss of wetlands*

Water Quality Impacts

- *Groundwater contamination due to failed septic systems and pollutants found in runoff*
- *Stream contamination due to increased discharges from industrial plants, municipal and package sewage treatment plants, and non-point sources such as stormwater runoff washing pollutants from roads, parking lots, and lawns.*

Water Quality *and* Quantity Impacts

- *Loss of critical wetland habitats and associated flood control, water filtration and stream baseflow functions*
- *Erosion, sedimentation and channelization of streams due to increased runoff and loss of natural stream and wetland vegetation*
- *Loss of aquatic biodiversity of plants and organisms and associated water filtration functions*

Land consumption is one of the greatest impacts of sprawl – we are wasting valuable farmland and natural areas by converting it to suburban environments. While the population of the Philadelphia region has remained relatively constant over the last 30 years, the acreage of land consumed to accommodate that population and related services and businesses has increased dramatically. The costs associated with excessive land consumption extend beyond the loss of important open space to include the community costs of maintaining unnecessarily large infrastructure and utility systems.

Conservation Design

One of the most effective approaches communities in southeastern Pennsylvania are using to deal with these sprawl-related watershed impacts is to change the *pattern and intensity* of land development through flexible, open space-oriented zoning and subdivision ordinances. The municipal zoning district codes described above often include provisions for concentrating development in part of a property, and leaving the remainder in a form of open space, either public park land, common open space owned by a Homeowners' Association, or in some cases privately owned. Conservation subdivision (often referred to as cluster development) has been permitted as an option in modern zoning codes for several decades because smaller lots generally require less roadway and utility lines to service the homes, meaning less municipal maintenance, and the provide a public amenity and environmental protection in the preserved open space.

To protect municipal government and taxpaying residents from the public costs of poorly conceived designs, cluster ordinances lay out a number of standards that the developments must meet. They generally include:

- either on-lot wells with a certain percentage permitted within the open space, community wells in the open space, or public water
- either on-lot septic systems with a certain percentage permitted within the open
- space, community systems in the open space, or public sewer.
- A minimum percentage of open space, often at least 50% including buildable land
- above and beyond constrained land (i.e. floodplains and steep slopes).
- Some provision for active recreation (i.e. ballfields) or passive recreation (walking
- trails) within the open space.
- A mechanism to establish the maximum density of units to be built on the site.
- Modest density bonuses to encourage use of the Conservation Design option, and to
- encourage optimum size and layout of open space.

Traditional Neighborhood Design

One of the most important national trends in planning has been a rediscovery of the value of traditional neighborhoods, such as those that exist in the historic villages and hamlets of the Upper Perkiomen Valley. As an alternative to the isolated, land consumptive, automobile-dependent pattern of suburban development, many communities are promoting new neighborhoods with features such as sidewalks, front porches, small front yards, village greens, and corner stores to create a sense of community and a sense of place. This pattern of development can be encouraged in developments adjoining existing villages and hamlets.

2

RIPARIAN FOREST BUFFER PROTECTION AND RESTORATION

GOAL

Protection, restoration and management of a full riparian buffer extending 75 to 100 feet from each stream bank of streams throughout the ***entire*** *Upper Perkiomen Creek watershed. Where this width cannot be achieved, a sliding scale of buffer widths should be considered. The majority of these buffers should consist of native floodplain forest vegetation, however, existing herbaceous wetland vegetation, meadow, and shrub vegetation should be considered as alternatives where forest buffers are not feasible. In addition, historic settings should be respected.*

IMPLEMENTATION ACTIONS

1. Establish an Upper Perkiomen Riparian Buffer Initiative. Protection, restoration and management of riparian forest buffers and, in some cases, vegetative buffers, should be established as the goal of a watershed-wide program such as an *Upper Perkiomen Riparian Buffer Initiative*. The initiative should be sponsored by a coalition of local watershed and conservation organizations and should promote this goal by encouraging the adoption of riparian buffer ordinances by municipalities. The Initiative utilize the *Riparian Buffer* Assessment prepared by Heritage Conservancy as a basis, and should involve local volunteers in conducting a more detailed assessment of riparian corridor priorities. In addition, funding assistance should be encouraged and provided for private, institutional and government landowners to voluntarily protect and restore these areas on their lands through easements, fencing, and reforestation.

2. Municipalities throughout the watershed should consider adoption of a Riparian Buffer Ordinance. This ordinance would require anyone submitting a land development plan application or a building permit application to demonstrate that a full riparian buffer zone of 75 to 100 feet on either side of a stream or wetland has been protected as a condition of approval (as recommended by the USDA Forest Service and the Stroud Water Research Center). When larger-scale residential, industrial or commercial developments are proposed, reforestation of unforested riparian buffer zones (as identified in the Heritage Conservancy *Riparian Buffer Assessment*, summarized in this Plan) should be required as a

mitigating measure and stormwater Best Management Practice to offset the impact of the development on streams running through or adjacent to the site. A sliding scale of alternative buffer widths (15-25 feet, 25-50 feet, 50-75 feet, based on stream size) should be provided where applicants can demonstrate that 75 feet or greater is not feasible. Riparian buffer ordinances can be freestanding, to apply to specific areas of degradation along streams. The Montgomery County Planning Commission has developed a model ordinance that has been adopted in Upper Hanover, Upper Salford, and Pennsburg. Additional models are available through the Pennsylvania Stream ReLeaf manual prepared by DEP.

3. Provide Riparian Forest Buffer protection/restoration funding assistance to landowners. Landowners should be encouraged to consider implementing voluntary riparian buffer projects including streambank fencing, reforestation, and conservation easements. Riparian buffer projects have been instituted on a number of farms and properties in the watershed by the Berks County Conservancy, Perkiomen Valley Trout Unlimited, the Upper Perkiomen Watershed Coalition and Milford Township. Philadelphia Suburban Water Company has worked to restore portions of the Perkiomen Creek in the fly fishing area near Green Lane. Such projects should also follow the 75-100 foot standard for each side of the stream, but should allow for a sliding scale of reduced buffer widths where the full amount cannot be achieved.

4) Develop riparian habitat restoration and interpretive projects at locations throughout the watershed.

a) Establish riparian restoration and natural landscaping projects at the Pennsburg Nature Preserve and Green Lane Nature Center. These projects are key locations for promoting riparian buffer awareness through demonstration projects developed at public education facilities. These projects should be developed as part of an overall Restoration and Management Plan for each site.

b) Additional restoration and interpretive projects include:
Riparian habitat restoration should be continued in and around Green Lane Reservoir, Deep Creek Lake, and Knight Lake, specifically:

- install reed beds and sediment basins along Deep Creek inflow to lake
- install natural landscaping, erosion control, stormwater management facilities adjacent to Deep Creek Lake
- construct environmental education stations, bird blinds, boardwalks
- expand natural areas, wildflower plantings, and aforestation programs along streams and lakes
- acquire land to preserve woodlands around streams and lakes
- install shorebird habitat around Knight Lake
- eradicate and control invasive vegetation along waterways

c) Protect land along the Unami Creek adjacent to Milford Middle School in Milford Township

d) Restore buffers, remove invasive vegetation, develop trails and provide signage and educational programs in Tollgate Park in Hereford Township.

e) Restore streambanks along the Unami Creek at Unami Creek Park in Marlborough Township and install wetland boardwalks in Township parks.

f) Conduct educational outreach programs on riparian buffers in Upper Hanover Township.

Implementation Action Summary:
Issue #2: Protection/Restoration of Riparian Forest Buffers

Specific Tasks Involved	***Potential Participating Parties***
1) Establish an Upper Perkiomen Riparian Forest Buffer Initiative	*Coalition of Conservation Organizations, County Agencies, Municipalities*
2) Municipalities throughout the watershed should consider adoption of a Riparian Buffer Ordinance	*Coalition of Conservation Organizations, Municipalities, County Planning*
3) Provide Riparian Forest Buffer protection/restoration funding assistance to landowners.	*Coalition of Conservation Organizations, Landowners, Funding Agencies*
4) Develop riparian habitat restoration and interpretive facilities throughout the watershed	*Conservation Organizations, County Parks, Municipalities, Landowners, Conservation Districts*
a) Establish riparian restoration and natural landscaping projects at the Pennsburg Nature Preserve and Green Lane Nature Center.	*Pennsburg Borough and Montgomery County Parks*
b) Continue riparian habitat restoration in and around Green Lane Reservoir, Deep Creek Lake, and Knight Lake	*Montgomery County, Philadelphia Suburban Water Company, Conservation Organizations*
c) Protect land along the Unami Creek adjacent to Milford Middle School in Milford Township	*Milford Township*
d) Restore buffers, remove invasives vegetation, develop trails and provide signage and educational programs in Tollgate Park in Hereford Township.	*Hereford Township, Conservation Organizations*

e) Restore streambanks along the Unami Creek at Unami Creek Park in Marlborough Township and install wetland boardwalks in Township parks.	*Marlborough Township, Conservation Organizations*
f) Conduct educational outreach programs on riparian buffers in Upper Hanover Township.	*Upper Hanover Township, Conservation Organizations*

BACKGROUND

The riparian forest, or the woodland that lines the banks and corridors along streams, has been shown to be critical to the continued stability and health of waterways (US Forest Service, *Riparian Forest Buffers*, 1991). Most streams in the northern Piedmont region evolved within a naturally forested cover, including those of the Upper Perkiomen watershed. With the human alteration of land over the last 300 years, many streams have been taken out of these natural settings and instead flow through miles of agricultural fields, lawn grasses and even paved areas. *Protection and restoration of riparian forest buffers is perhaps the single most important strategy that can be used to maintain the health of streams in the Upper Perkiomen Valley.*

Riparian forest buffers are natural sponges that have been shown to absorb and bind much of the sediments, nutrients and some of the pollutants in runoff before it reaches the waterway. The shade provided by the trees and shrubs maintain lower water temperatures and their leaves and twigs are the primary source of food for the aquatic food web. They slow the speed of stormwater, reducing erosion of the small swales and gullies that feed the stream. Research by the Stroud Water Research Center on the White Clay Creek in Chester County has shown that forests along streams also support cooler, wider streams (Sweeney 1992). The US Forest Service publication cited above, and the 1995 paper by the Montgomery County Planning Commission titled "*Riparian Corridor, the Benefits of Protection*," are both excellent brief descriptions of the many benefits of riparian forests.

An increasing number of funding sources are available for riparian buffer protection and restoration. Different programs are set up to fund different riparian project types, including streambank fencing, streambank restoration, agricultural properties, easement acquisitions, stormwater management projects. A partial list of funding sources includes the USDA Conservation Reserve Program, Act 319 Clean Streams grants, Pennsylvania Fish and Boat Commission, Pennsylvania Game Commission, PA Department of Environmental Protection (Growing Greener), certain county programs, Ducks Unlimited and Trout Unlimited, and certain private foundations. Local or regional conservation groups such as the Upper Perkiomen Watershed Coalition, Perkiomen Watershed Conservancy, Montgomery County Conservancy, Berks County

Conservancy, Wildlands Conservancy, Heritage Conservancy, Natural Lands Trust, Schuylkill Riverkeeper and County agencies can all be considered as partners that are active in riparian corridor protection and restoration.

3

CONSERVATION OF MAJOR WOODLANDS

GOAL

Large, contiguous blocks of "deep woods" (or forest-interior habitat) should be identified and prioritized for conservation to limit impacts from clearing and development.

IMPLEMENTATION ACTIONS

1). Establish an Upper Perkiomen Woodland Conservation and Restoration Initiative. Partnerships between Pennsylvania DCNR, parks departments and planning departments in the four counties, municipalities, land trusts, local conservation and watershed organizations, and landowners should be established and maintained with the goal of permanent forest conservation in priority locations throughout the watershed. In addition, priority areas for expansion of existing forest networks should be identified, with the goal of increasing the size, shape, connectivity and health of these networks through reforestation and restoration.

2) Prioritize the largest blocks of contiguous forest in the watershed for conservation. These include the Deep Creek woodlands, Unami Forest in Salford, Marlborough, Milford and West Rockhill Townships, (identified as a high priority for conservation in numerous plans prepared by county and municipal agencies and conservation organizations) , and other large wooded tracts in the headwaters areas for the West Branch, Main Stem Perkiomen, and Hosensack Creek.

3) Utilize the full range of conservation options for parcels containing key woodlands. Partnerships should tailor one or more options to each situation, including donation of land or conservation easements, bargain sale of land or conservation easements, purchase of land or conservation easements, transfer of development rights (TDR), and limited development with conservation of key wooded open space. The Pennsylvania Forest Stewardship Program and the Forest Legacy Program should be pursued where appropriate.

4) Municipalities should consider adoption of a woodland conservation ordinance to reduce the impacts of land development in priority woodlands.

Implementation Action Summary:
Issue #3: Conservation of Major Woodlands

Specific Tasks Involved	***Potential Participating Parties***
1) Establish an Upper Perkiomen Woodland Conservation and Restoration Initiative.	*Partnerships of State, County, Local Governments, Conservation Organizations, landowners*
2) Prioritize the largest blocks of contiguous forest in the watershed for conservation.	*Same as above*
3) Utilize the full range of conservation options for parcels containing key woodlands.	*Same as above*
4) Municipalities should consider adoption of a woodland conservation ordinance to reduce land development impacts to priority woodlands.	*Municipalities, Conservation Organizations*

BACKGROUND

Forest fragmentation and destruction due to urbanization and conversion to other uses is perhaps the greatest threat to the biological diversity of northern Piedmont forests.

The forests of the Upper Perkiomen watershed are among the largest, most unfragmented networks of "deep woods" or forest-interior habitat in the region, and are concentrated in the Unami Creek, Ridge Valley Creek, and Deep Creek valleys, and along major ridges and slopes at the headwaters of the West Branch, Main Stem Perkiomen, and Hosensack Creeks. The wide variety of Sites of Statewide Significance and Sites of Local Significance identified in the Natural Areas Inventories for Montgomery, Berks, Bucks and Lehigh Counties includes a number of ecologically important woodlands in the watershed. In addition, the entire Ridge Valley Creek watershed within the Unami Forest is identified as a Priority 1 Site within the Bucks County Natural Areas Inventory. The Montgomery County Open Space Plan of 1996 identified the Unami Forest as a Significant Natural Area of special emphasis for biodiversity conservation, and recommends it be preserved. The Unami Creek Valleys Landscape Conservation Plan prepared by Natural Lands Trust focuses on the importance of conservation and restoration of this area as a regionally-significant forested landscape.

Natural Lands Trust, Montgomery County Land Trust, Heritage Conservancy, Montgomery County, Bucks County, DCNR, local townships, local citizens groups and private foundations and organizations have already contributed to the conservation of many significant wooded

parcels in the Upper Perkiomen Valley, with several critical acquisition projects pending on major wooded tracts.

A local citizens group in Salford and Marlborough Townships, the Unami Hills Preservation Association, is actively involved in preservation of the Unami Forest. Preservation of the Unami Forest has been identified by the Upper Perkiomen Watershed Coalition as consistent with other long-term natural areas conservation efforts, including those of Bucks County and Montgomery County, the Quakertown Swamp, and the Highlands Coalition strategy for protecting a landscape-scale corridor linking the Highlands of northern New Jersey and the diabase woodlands extending to Reading.

4

PROTECTION AND RESTORATION OF WETLANDS

GOALS

- *Permanently protect existing wetlands throughout the Upper Perkiomen Creek watershed from excavation, filling and clearing of native vegetation.*
- *Provide adequate open space buffers between all wetlands and adjacent land uses such as lawns, agricultural fields, and improvements such as roads, parking lots, stormwater basins and structures*
- *Previously drained, filled or cleared wetlands should be restored wherever possible.*

IMPLEMENTATION ACTIONS

1). Establish a watershed-wide initiative to accurately *identify and characterize* all existing wetlands. This can be achieved through a combination of aerial photo interpretation, Soil Survey and National Wetland Inventory (NWI) mapping, field verification, and in some cases wetland delineation. Characterization should be based on general wetland types including forested, shrub, emergent, wet meadows and other wet habitats such as vernal ponds. Data should be compiled and regularly updated on the *Upper Perkiomen GIS Database.*

2) Establish a Wetland Conservation Initiative in the watershed. Partnerships between Pennsylvania DEP, DCNR, parks departments and planning departments in the four counties, municipalities, land trusts, local conservation and watershed organizations, and landowners should be established and maintained with the goal of permanent wetland protection throughout the watershed. Vernal ponds should also be protected, such as those along Unami Creek, Ridge Valley Creek and along the headwaters tributaries of the Main Stem Perkiomen Creek Adoption of riparian buffer and wetland protection ordinances should be promoted in municipalities throughout the watershed to avoid impacts from adjacent land development.

3) Protect and restore wetlands listed as high priority sites in county Natural Areas Inventories. These sites are described in the Vegetation and Wildlife section of this Plan, and include: Green Lane Marsh/New Goschenhoppen Meadows, Whites Mill Swamp and Deep Creek Marsh in Montgomery County; Hosensack Marsh and Lower Milford Marsh in Lehigh County; and Ridge Valley Creek floodplain marsh, Butter Creek floodplain marsh, Unami Creek from Upper Ridge Road to the County Line, and Hazelbach Creek wetlands. The drainage areas helping to supply water to these wetlands should also be prioritized for conservation to minimize the impacts of adjacent land uses.

4) Establish a Wetland Restoration Initiative in the watershed. Public and private partnerships should be established and maintained with the goal of identifying degraded or destroyed wetlands altered by draining (tiling, ditching), excavation or filling, and areas with potential for reestablishment of wetland soil, vegetation and habitat conditions. Programs such as the *PA DEP Wetland Mitigation Banking* program can provide funding for projects as a means of mitigating impacts from permitted development projects located elsewhere in the region.

5) Utilize the full range of conservation options for parcels containing important wetlands. Partnerships should work to educate landowners and tailor one or more conservation options to each situation, including donation of land or conservation easements, bargain sale of land or conservation easements, purchase of land or conservation easements, transfer of development rights (TDR), and limited development with protection of key wetlands and buffers.

6) A *wetland assessment service* should be initiated by the Upper Perkiomen Watershed Coalition. This service should provide professional wetland delineation expertise to local groups, landowners or municipalities. It would provide additional detail for watershed-wide wetland inventory mapping, and allow additional evidence as a ("second opinion") for wetland delineations presented as part of a land development project.

Implementation Action Summary:
Issue #4: Protection/Restoration of Wetlands

Specific Tasks Involved	***Potential Participating Parties***
1) Establish a watershed-wide initiative to accurately identify and characterize all existing wetlands	*Partnerships of State, County, Local Governments, Conservation Organizations, landowners*
2) Establish a Wetland Conservation Initiative in the watershed	*Same as above*
3) Protect and restore wetlands listed as high priority sites in county Natural Areas Inventories.	*Same as above*
4) Establish a Wetland Restoration Initiative in the watershed	*Same as above*
5) Utilize the full range of conservation options for key wetland parcel.	*Same as above*
6) A "wetland assessment service" should be initiated by the Upper Perkiomen Watershed Coalition	*UPWC*

5

IMPROVED WASTEWATER TREATMENT AND REDUCTION OF POINT-SOURCE POLLUTION

GOAL

Existing and future wastewater treatment facilities, including residential septic systems, package plants, industrial plants, and community treatment plants, should not degrade water quality in the Upper Perkiomen Creek watershed.

IMPLEMENTATION ACTIONS

1) Establish homeowner education programs regarding septic system issues. Such programs should be established by watershed organizations (with DEP and County Health Department assistance) to raise awareness about the importance of proper septic system maintenance, upgrading of failing systems, and the availability of potential funding sources or incentives.

2) Promote voluntary and funded upgrades of old or failing cesspools and septic systems. On-lot and community septic systems and cesspools throughout the Upper Perkiomen Creek should be gradually upgraded to current County Health Department and Pennsylvania Department of Environmental Protection (DEP) standards, and funding sources such as grants and low-interest loans or other incentive programs such as property tax relief should be pursued to assist homeowners on a sliding-scale basis.

3) Promote proper maintenance of on-site wastewater treatment systems according to current County Health Department and PA DEP standards. Ordinances mandating these requirements should be adopted by municipalities, such as those in Milford and Washington Townships.

4) Ensure that construction, upgrades and maintenance of public and private sewage treatment plants meets current County Health Department and PA DEP standards for discharge of treated effluent. Plants should be constructed and upgraded to maximize efficiency of biological treatment, incorporation of tertiary treatment, or to utilize land

application alternatives to stream discharge wherever feasible. To maintain hydrologic balance, interbasin transfers of wastewater into the Perkiomen Creek watershed or between subbasins should be avoided.

5) Promote coordination between municipalities to address public sewer needs at the subwatershed scale. Careful coordination between municipalities should take place prior to construction of new package or community sewage treatment facilities. Multi-municipal sewage authorities should be considered as an appropriate, watershed-scale alternative to individual municipal authorities.

6) Ensure that current and proposed wastewater discharges from industrial and commercial operations meet current Best Management Practices. Federal and state design and maintenance standards for elimination of point-source contaminants should be followed. Wherever possible, alternatives to stream discharge of wastewater should be considered, with an emphasis on land application and biological treatment technologies.

Implementation Action Summary:
Issue #5: Improved Wastewater Treatment

Specific Tasks Involved	***Potential Participating Parties***
1) Establish homeowner education programs regarding septic system issues.	*UPWC, County Health Depts., PA DEP, Municipalities, Homeowners*
2) Promote voluntary and funded upgrades of old or failing septic systems and cesspools.	*Same as above*
3) Promote proper maintenance of on-site systems according to current state or county standards.	*Same as above*
4) Ensure that construction/upgrades of sewage treatment plants meet state/county standards, promote land application alternatives to stream discharge.	*UPWC, County Health Depts., PA DEP, Municipalities, Utilities*
5) Promote coordination between municipalities to address public sewer needs at subwatershed scale.	*Same as above*
6) Ensure that current/proposed wastewater discharges from industrial and commercial operations meet BMPs.	*UPWC, County Health Depts., PA DEP, private companies*

BACKGROUND

Sewage treatment is an aspect of water quality that is considered separately in this report because it is a well-understood "point source" of pollution that, due to its potential impact on public health, is closely regulated by all levels of government. Thanks largely to the Clean Water Act with its attendant "National Pollution Discharge Elimination System" (NPDES) permitting system, the outflow from sewage treatment plants and industry (the two most recognizable point sources) is no longer the primary cause of pollution in streams across the country. The Upper Perkiomen Creek clearly has impacts from a total of 42 discharge points, including a mix of sewage treatment plants and industrial treatment plants. At least five spray irrigation systems are in operation in the watershed and at least one drip irrigation system is in use. Sewage Treatment Plants

A number of municipal and private treatment plants discharge treated effluent directly into the streams of the Upper Perkiomen Creek watershed. These plants are regulated through the NPDES permitting system administered by DEP. They are inspected at regular intervals and must renew permits every five years. Municipal survey responses indicate that water quality impacts of from sewage treatment plants on the Perkiomen are perceived as a concern, both due to the number of plants and their locations.

Private Septic Systems

The majority of developed land in the Upper Perkiomen Creek watershed is serviced by private, on-lot septic systems. These in-ground systems range in age from mid-20th century cesspools to modern septic systems, and their rates of failure vary, with older systems and poorly-recharging soils as the leading factors. A number of newer systems are constructed with sand mounds due to poor perking conditions on certain soils with shallow depth to bedrock or poor recharge capacity. Since poorly functioning septic systems are so widespread and pose the threat of contamination (fecal coliform bacteria, nitrogen, phosphorus) to streams and groundwater throughout the watershed, the importance of proper installation, maintenance and upgrading of these systems cannot be overestimated.

6

PLAN FOR WATER SUPPLY NEEDS

GOALS

- *Determine the water budget for the Upper Perkiomen Creek watershed and ensure that growth is managed to guarantee that water supply is sustainable within the carrying capacity of the natural system of surface water and ground water.*
- *Manage land use and water resources to protect and guarantee the availability of clean, plentiful water as a drinking water supply for the millions of residents who rely on the Perkiomen Creek and Schuylkill River.*

IMPLEMENTATION ACTIONS

1) Prepare a *Water Management Plan* (or Integrated Resource Plan) for the Upper Perkiomen Creek watershed, emphasizing the water budget, for adoptionby all municipalities in the watershed. This Plan can allow municipalities to build upon Groundwater Protected Area withdrawal limits set by the Delaware River Basin Commission. Models of this type of planning are available from the Green Valleys Association and Cahill Associates (Sustainable Watershed Management) and the Chester County Water Resources Authority's "Watersheds" plan.

2) Establish current and future water supply and water demand estimates. The *Water Management Plan* should establish *current water supply* estimates for the Upper Perkiomen Creek watershed, considering both ground and surface water supplies and accounting for interbasin transfers of water – both exports and imports. It should also establish *current water demand* figures, and project forward to *predict increased water demand* associated with growth over the next 20 years. This calculation should include *estimated buildout* for each municipality in the watershed. Current water supply within the watershed should be compared to *projected increased demand* calculations to determine *potential shortfalls*

3) The Water Management Plan should link the water budget to land use planning in every municipality. The overall density of development planned for in each municipality should be based on the sustainable water supply calculations for the watershed. Artificial imports of water

from other watersheds should not be considered a necessary factor in accommodating future growth needs. The quality and quantity of surface and ground water sources within the watershed should be determining factors for growth density and location. A watershed-wide initiative to promote this *water balance* should be promoted by local watershed organizations and government agencies.

4) Municipalities should review and consider adopting wellhead protection ordinances. Such ordinances ensure protection of public health, prevent groundwater contamination, prevent the need for costly treatment for compliance with drinking water standards, and promote sound land use planning. This would involve identifying existing community wells and "cones of depression" where ground and surface water is drawn into wells, and establishing buffer areas limiting land use impacts to wells.

5) A watershed-wide assessment of hazardous materials storage practices, locations and hazardous waste sites should be conducted. Municipalities should coordinate with DEP, County Health Departments and water supply utilities to prepare and adopt ordinances that set detailed requirements for safe and proper storage, transport, disposal and cleanup of hazardous materials. In addition, Emergency Response Planning and an early warning system is recommended in the Source Water Assessment for the Schuylkill River Water Supply

6) Any proposed interbasin transfers of water out of the watershed should be discouraged, and transfers between subwatersheds should be closely examined for their impact on the hydrologic balance of the watershed. Rather than serve development projects with artificially high densities or water consumption rates, the priority in maintaining hydrologic balance is to avoid negative impacts to the baseflows and ecology of streams, wetlands and groundwater levels supporting local wells.

7) Increase the use of water conservation measures in households and businesses throughout the watershed. The Rain Barrell Give-Away program proposed by the Montgomery County Conservation District will provide homeowners with an understanding that "recycling" of stormwater runoff for outdoor/garden applications can reduce demand on wells depending on limited groundwater aquifers. Water conservation programs sponsored by PA DEP and the Delaware River Basin Commission should be promoted among residents.

8) Specific measures to protect Green Lane Reservoir, Knights Lake, and Deep Creek Lake from sedimentation and pollution. Trail management

plans and rules for trail usage should be established in public lands adjacent to these reservoirs. In addition, proven management programs for reducing Canada Goose populations should be implemented, including replacement of lawns with native wildflower meadows as the dominant vegetation type along shorelines.

Implementation Action Summary:
Issue #6: Plan for Water Supply Needs

Specific Tasks Involved	***Potential Participating Parties***
1) Prepare a Water Management Plan (or Integrated Resource Plan) for the Upper Perkiomen Creek watershed, emphasizing the water budget, for adoptionby all municipalities in the watershed.	*Conservation Organizations, Municipalities, County Agencies, Utilities*
2) Establish current and future water supply and water demand estimates.	*Same as above*
3) The Water Management Plan should link the water budget to land use planning in every municipality	*Municipalities, County Planning*
4) Municipalities should review and consider adopting wellhead protection ordinances.	*Same as above*
5) A watershed-wide assessment of hazardous materials storage practices, locations and hazardous waste sites should be conducted.	*PA DEP, County Health Departments, Municipalities, Conservation Organizations, Utilities, USGS*
6) Any proposed interbasin transfers of water out of the watershed should be discouraged, and transfers between subwatersheds should be closely examined for their impact on the hydrologic balance of the watershed.	*UPWC, Coalitions, County Planning, municipalities*
7) Increase the use of water conservation measures in households and businesses throughout the watershed	*State Agencies, County Agencies, Municipalities, Conservation Groups, Utilities, Homeowners, Businesses*

8) Specific measures to protect Green Lane Reservoir, Knights Lake, and Deep Creek Lake from sedimentation and pollution	*Montgomery County Parks, Philadelphia Suburban Water Company, users groups, conservation groups*

BACKGROUND

One of the most important functions of the Perkiomen Creek watershed is its contribution to the water supply for millions of people in the Philadelphia region. The Perkiomen can be considered a regionally-significant water source. It supports thousands of private wells, dozens of community wells supplying water to nearly 48,000 residents and to businesses, institutions, farms and industries in the Upper Perkiomen Valley, the Green Lane Reservoir connecting to a regional system operated by Philadelphia Suburban Water Company that supplies at least 780,000 customers, and downstream intakes on the Schuylkill River serving boroughs, water supply companies, and the Philadelphia Water Department system.

The Source Water Assessment prepared by the Philadelphia Water Department for the Schuylkill River Supply highlights the importance of maintaining the quality and quantity of water in the Perkiomen Creek as a means of protecting and improving the water supply for the City of Philadelphia. The Assessment identifies and evaluates the possibility for contaminants to potentially enter the Schuylkill River upstream from the water intake prior to treatment. The process and categories are consistent with the Safe Drinking Water Act and guidelines and standards established by Pennsylvania DEP.

In particular, the Assessment highlights the need for "enhancing wastewater discharges and mitigating stormwater runoff from urban and residential areas. These will have the greatest overall impacts on improving source water quality and the Schuylkill River." (Philadelphia Water Department, 2001). It can be said that protection strategies for water intakes on the Schuylkill River also apply to water intakes on the Perkiomen Creek.

The Assessment contains a Summary of Protection Priorities for Various Upstream Sources, and specifically notes the Perkiomen Creek as a potential source of agricultural runoff, which may contribute pathogens, bacteria, viruses, Cryptosporidium, nutrients and sediment.

Other potential sources of source water contamination include:
discharges from wastewater treatment plant. Reduction of pathogens, bacteria, viruses, Cryptosporidium, nutrients, sediment, and organic chemicals are all cited as concerns related to these plants. Operation of existing plants should be optimized to reduce the discharge of these pollutants, including strategies such as enhanced biological treatment, tertiary treatment, and land application alternatives.

- *Urban and residential runoff, which is noted for its contribution of pathogens, bacteria, viruses, Cryptosporidium, nutrients, metals and sediment.*

- *Industrial facilities including the storage and use of hazardous chemicals, which are potential sources of metals, nutrients, and organic chemicals.*

- *Above-ground storage tanks which have potential for leaks and spills, and may include petroleum hydrocarbons, metals, and phosphorus.*

- *Landfills, which may leach contaminants into streams, including petroleum hydrocarbons and metals.*

- *Spills and accidents associated with cars, trucks, trains, and pipelines. These pose a watershed-wide threat of polluting source waters with petroleum hydrocarbons and organic chemicals.*

Petroleum hydrocarbons include chemicals found in oils and greases, and organic chemicals include chemicals found in solvents, degreasers, varnishes, paints, gasoline, plastics, insect and weed killers.

The Assessment notes that source water protection efforts in the Perkiomen Creek watershed should be coordinated with the Philadelphia Suburban Water Company's programs to maintain source water quality for its system.

7

REDUCTION OF NON-POINT SOURCE POLLUTION AND FLOODING IMPACTS TO STREAMS

GOALS

- *Protect and enhance stream water quality throughout the watershed by reducing the impact of non-point source pollution and preventing future non-point source impacts.*
- *Restore the watershed's natural capacity to remove pollutants from stormwater.*
- *Protect the watershed as a major source of clean, plentiful drinking water for communities throughout the region, and avoid the need for development of costly water treatment systems to meet drinking water standards.*
- *Protect the health, safety and welfare of residents in the watershed and downstream communities by reducing flood hazards and damage.*

IMPLEMENTATION ACTIONS

1). Municipalities should review and consider adopting innovative stormwater management ordinances. Such ordinances require innovative techniques or Best Management Practices (BMP's) to improve the *quality of runoff* by minimizing sediment and other pollutants contained in runoff from developed areas, and to *maximize recharge* of groundwater by directing runoff into the ground. A model ordinance should be provided to all municipalities in the watershed for consideration, in anticipation of a watershed-wide Stormwater Management Plan as per Act 167 standards and pending US EPA National Pollution Discharge Elimination System (NPDES) Phase II requirements. This recommendation is consistent with the findings of the Schuylkill River Source Water Assessment.

2). A Stormwater Management Initiative should be established to identify existing problem areas as "BMP retrofit" candidates. The initiative should be launched by local watershed organizations with technical and funding assistance from DEP and the county Conservation Districts. Identifying and addressing existing stormwater management problem areas (i.e. poorly designed basins, gully erosion problems, paved surfaces draining directly to streams, flooding problems) through incorporation of current stormwater Best Management Practices can greatly improve the quality and quantity of water in streams,

wetlands and aquifers. Milford Township has prepared an initial map of 25 basins that are candidates for retrofitting to BMP standards.

3). Encourage preservation and creation of wetlands, wooded riparian buffers and vegetated swales as "green infrastructure" through municipal subdivision and land development codes and through educational outreach and technical assistance to landowners.

4). Establish a watershed-wide volunteer stream monitoring program . A network of volunteers and sampling stations should be established to collect, analyze and publish data on stream water quality. The GIS database for the watershed can be utilized to track trends in various subwatersheds.

5) Municipalities should review and consider adopting current floodplain regulations to address the impacts and hazards of development in flooplain and floodway. These regulations should provide detailed requirements regarding storage of hazardous materials.

6) A resident education program for non-point source pollution impacts should be established. This type of program should be modeled after those used in the Chesapeake Bay Program, stressing actions such as reduction of lawn chemicals, natural landscaping and stenciling of storm drains in boroughs.

7) County Planning Commissions should prepare and implement Act 167 Comprehensive Stormwater Management Plans for major subwatersheds in the Upper Perkiomen. Such plans would address many of the Implementation Actions listed above, and would allow for different strategies to be applied in different portions of a watershed according to hydrologic conditions.

Implementation Action Summary:
Issue #7: Reduction of NPS Pollution

Specific Tasks Involved	***Potential Participating Parties***
1) Municipalities should review and consider adopting innovative stormwater management (SWM) ordinances,	*Municipalities, County Planning, Conservation Organizations, Conservation Districts*
2) A Stormwater Management Initiative should be established to identify existing problem areas as "BMP retrofit" candidates.	*Same as above*
3) Encourage preservation and creation of wetlands, wooded riparian buffers and vegetated swales through municipal subdivision and land development codes and through educational outreach and technical assistance to landowners.	*Same as above*
4) Establish a watershed-wide volunteer stream monitoring program.	*Conservation Organizations, PA DEP*
5) Municipalities should review and consider adopting current floodplain regulations to address the impacts and hazards of development in flooplain and floodway.	*Municipalities, County Planning, PA DEP*
6)A resident education program for non-point source pollution impacts should be established.	*Municipalities, County Planning*
7) County Planning Commissions should prepare and implement Act 167 Comprehensive Stormwater Management Plans for major subwatersheds in the Upper Perkiomen.	*County Planning Commissions, DEP, Municipalities, Conservation Groups, Utilities, Conservation Districts*

8

ASSESS COSTS AND BENEFITS OF PONDS AND IMPOUNDMENTS

GOAL

Reduce impacts of current and future ponds and impoundments on the health of stream ecosystems throughout the watershed, specifically the effects of artificial heating of stream water, fragmentation of streambed and stream channel, and loss of wetlands.

IMPLEMENTATION ACTIONS

1) Establish a watershed-wide initiative to identify and characterize ponds, lakes dams and impoundments, evaluate costs/benefits, and prioritize removal candidates. This initiative should be led by a coalition of groups and agencies to identify ponds and lakes throughout each subwatershed and characterize by type of impoundment, function, ownership, ecological benefits (such as bird species diversity, associated wetlands, or fire control) and impacts (thermal pollution, stream fragmentation, wetland loss) and cultural benefits (such as fishing, boating or historic significance).

2) Establish a fund for pond and dam removal and encourage removal of priority candidates. Assess ponds or lakes that may be candidates for removal to restore natural stream hydrology and reduce thermal and chemical pollution, and contact landowners to discuss options for each site. A fund for pond removal and breaching and/or removal of dams should be established. Prior to recommendation of any dam removal project, environmental impact assessments should be conducted to determine: potential loss of habitat for plant and animal species; the potential for stream contamination from release of trapped sediments; potential loss of public recreational resource.

3) Establish and promote standards for restoration of existing ponds and construction of new ponds. These standards should be established due to the importance of stream water quality in the Upper Perkiomen as a public water supply, recreational resource and high quality habitat for a rich diversity of aquatic life. These should include criteria for siting, design standards for

minimizing solar exposure (i.e. orientation, shape and shade trees), the use of bottom-discharge outflow structures to discharge cooler water instead of heated water, and the use of native vegetation buffer areas to filter chemical pollutants from lawns and agricultural fields and discourage large Canada goose populations.

Implementation Action Summary:
Issue #8: Assess Costs and Benefits of Ponds, Dams and Impoundments

Specific Tasks Involved	***Potential Participating Parties***
1) Establish a watershed-wide initiative to identify and characterize ponds, lakes dams and impoundments, evaluate costs/benefits, and prioritize removal candidates.	*Coalition of Conservation Organizations, PA DEP, Municipalities, County planning.*
2) Establish a fund for pond and dam removal and encourage removal of priority candidates.	*Same as above*
3) Establish and promote standards for restoration of existing ponds and construction of new ponds.	*Same as above*

9

PROVIDE KEY LANDOWNERS WITH INFORMATION ON CONSERVATION AND MANAGEMENT OPTIONS

GOALS

- *Reduce the number of properties sold for development by raising awareness among large property owners throughout the watershed regarding the benefits of land conservation, and the many options and programs available.*

- *Improve restoration and management potential on key properties by educating landowners about and available options and program.*

IMPLEMENTATION ACTIONS

1) Establish education and outreach programs to raise awareness among landowners of land conservation options. These options may involve protection of part or all of their properties, and may offer associated financial and tax benefits. Landowners throughout the watershed should also be made aware of the importance of conservation, restoration and management of woodlands, wetlands, meadows, other successional lands, and streams, and the relationship of these practices to water quality and quantity, biodiversity, and human health.

2) Establish education and outreach programs to raise awareness among landowners and developers of land restoration and management options. Landowners and developers should be educated about the wide range of restoration and management options available for their land. These options may include the importance of establishing and maintaining riparian forest buffers, removal of invasive exotic vegetation, and establishment of native meadows and reforestation areas as alternatives to lawns and old fields.

3) Municipalities should review and consider adopting Natural Landscaping Ordinances as alternatives to Weed Laws. Such ordinances recognize the environmental and aesthetic value of meadows and naturally landscaped areas as alternatives to lawn, and encourage homeowners to pursue these approaches in a manner that avoids causing nuisances with neighboring properties.

Implementation Action Summary:
Issue #9: Provide Key Landowners with Conservation/Management Information

Specific Tasks Involved	***Potential Participating Parties***
1) Establish education and outreach programs to raise awareness among landowners of land conservation options.	*Conservation Organizations, Landowners, Municipalities.*
2) Establish education and outreach programs to raise awareness among landowners and developers of land restoration and management options.	*Conservation Organizations, Landowners, Developers, Municipalities.*
3) Municipalities should review and consider adopting Natural Landscaping Ordinances as alternatives to Weed Laws.	*Conservation Organizations, Municipalities*

10

IDENTIFY RECREATIONAL OPPORTUNITIES. INCLUDING TRAILS AND GREENWAYS

GOALS

- *Increase enjoyment and appreciation of the Upper Perkiomen Creek watershed by residents and visitors through expansion of active and passive recreation facilities, including parks, trails and greenways.*
- *Expand the existing economic benefits of fishing, ecotourism (such as birdwatching) and recreational tourism.*

IMPLEMENTATION ACTIONS

1) State, County and local governments should acquire, or otherwise make available to the public, selected open space properties and greenways.

2) New trails along streams and other open space corridors in the watershed (including road and utility rights-of-way) should be established. Such corridors may include the Macoby Greenway, the Unami Walking Trail, and other trails identified in the watershed or linking protected open space areas. To create an interconnected trail network, consideration should be given to securing linkages with the proposed Perkiomen Trail at Green Lane and trails planned for northwestern Bucks County.

3) Modest facilities for parking, wildlife observation, fishing, interpretive walks and other passive activities should be constructed on public streamside lands. Trail management plans should be adopted to manage public access and address existing trail management needs including erosion problems adjacent to Green Lane Reservoir.

4) Public and private landowners should be made aware of the liability protection offered by state law for opening their land to limited public use.

5) Local governments should encourage private landowners to provide reasonable public access to the stream in key locations, and should assist in risk management.

6) Non-profit institutions with large land holdings in the watershed should be provided technical assistance to develop public access where appropriate.

7) Consider strategies for marketing the Upper Perkiomen watershed as a destination for fishermen, boaters, bird watchers, bikers, hikers and hunters.

Implementation Action Summary:
Issue #10: Identify Recreational Opportunities (including trails and greenways)

Specific Tasks Involved	***Potential Participating Parties***
1) State, county and local governments should acquire selected open space properties and greenways.	*PA DCNR, County Parks, Municipalities, Conservation Organizations.*
2)New trails and other open space corridors should be established in the watershed.	*Same as above*
3) Modest facilities for parking, wildlife observation, fishing, interpretive walks and other passive activities should be constructed on public streamside lands.	*Same as above*
4) Public and private landowners should be made aware of the liability protection offered by state law for opening their land to limited public use.	*Same as above*
5) Local governments should encourage private landowners to provide reasonable public access to the stream in key locations, and should assist in risk management	*Municipalities, Conservation Organizations*
6) Non-profit institutions with large land holdings in the watershed should be provided technical assistance to develop public access where appropriate.	*PA DCNR, County Parks, Municipalities, Conservation Organizations.*
7) Establish strategies to market the Upper Perkiomen Valley as an ecotourism and recreation destination.	*Same as above, Tourism Bureau, local business organizations.*

11

ESTABLISH WATERSHED-WIDE PROGRAMS AND ALLIANCES TO ADDRESS WATERSHED ISSUES AND ENVIRONMENTAL EDUCATION

GOALS

- *Increase long-term conservation and management of surface and ground water quality and quantity throughout the Upper Perkiomen watershed by establishing watershed-wide programs to promote better coordination and effectiveness in addressing watershed issues.*

- *Raise the awareness of local residents, businesses and groups about the importance of the watershed, their potential impact on water resources, and their potential involvement in watershed conservation activities.*

IMPLEMENTATION ACTIONS

1) Form an Alliance of watershed organizations to establish and coordinate programs and initiatives addressing watershed-wide issues. , including representation from the Upper Perkiomen Watershed Coalition (UPWC), the Perkiomen Watershed Conservancy, Trout Unlimited, the Unami Hills Preservation Association, and others. UPWC should regularly convene this Alliance to address watershed issues and advance the goals of this Plan. The recommendations of the Schuylkill River Source Water Assessment highlight the need for this level of coordination. This process has begun with Conservation Meetings held in the watershed by the Pennsylvania Environmental Council.

2) Establish an Upper Perkiomen Legal Defense Fund . This fund can provide local communities and organizations with a means of addressing major land development plans or land use activities that pose potential threats to the quality or quantity of surface water or ground water.

3) Organize citizen groups to participate in watershed-related activities. These groups may include employees of professional organizations, corporations, and local businesses, volunteer service organizations, neighborhood associations, boy scout and girl scout groups, and students. They can be mobilized to assist in

various environmental activities such as stream cleanups riparian buffer plantings and water quality monitoring programs

4) The Upper Perkiomen Watershed Coalition (UPWC) should work with partners to develop a traveling watershed educational/informational program to use in presentations to area schools and local groups. This type of program could use multi-media approaches such as slides, video, PowerPoint and large-scale maps, and could be scripted to allow numerous members of the UPWC to easily make the presentation.

5) A "speakers bureau" of volunteers should be established to provide "watershed updates" in public meetings. Volunteer speakers can regularly attend Board of Supervisors and Planning Commission meetings in local municipalities and provide talks that cover positive gains in water resource conservation and restoration efforts, and outline issues and concerns. Links between land use and water resources should be stressed.

6) Launch a unified initiative to establish a watershed-based curriculum in local schools. This initiative should involve cooperation between local conservation groups, environmental educators, the school board, principles and teachers. A watershed-based curriculum , based in part on existing programs established by the Green Lane Park Nature Center, the Perkiomen Watershed Conservancy and the Environmental Science program of Upper Perkiomen High School, should be introduced to elementary and secondary schools in the watershed. This initiative should stress a holistic approach to watershed education involving field studies, identifying solutions to watershed problems, and student participation in hands-on restoration projects along streams and wetlands in the watershed. This type of curriculum should be considered a means of addressing current statewide environmental education requirements.

7) A dedicated demonstration site should be established in the watershed for students to engage in long-term watershed restoration projects. This type of site should be located in an area where classes can regularly participate in soil preparation, seeding and planting of native vegetation, and ongoing vegetation management and learn about the water quality and quantity benefits of their work. Restoration goals can include establishment of native forest, wetland, stream and meadow communities, and also establishment of sustainable food production systems such as edible landscaping and forest gardens with native fruits and nuts, and vegetable and fruit gardens.

Implementation Action Summary:
Issue #11: Establish Watershed-wide Programs

Specific Tasks Involved	***Potential Participating Parties***
1) Form an Alliance of watershed organizations to establish and coordinate programs and initiatives addressing watershed-wide issues. .	*UPWC, PWC, PVTU, UHPA, others, County Conservation Districts (the "Alliance")*
2) Establish an Upper Perkiomen Creek Watershed Legal Defense Fund	*Same as above*
3) Organize citizen groups to participate in watershed-related activities.	*UPWC, Alliance*
4) UPWC should work with partners to develop a traveling watershed educational/informational program to use in presentations to area schools and local groups.	*Same as above*
5) A "speakers bureau" of volunteers should be established to provide "watershed updates" in public meetings.	*Same as above*
6) Launch a unified initiative to establish a watershed-based curriculum in local schools.	*UPWC, Alliance, School District, Green Lane Nature Center*
7) A dedicated demonstration site should be established in the watershed for students to engage in long-term watershed restoration projects.	*UPWC, Alliance, School District, key landowners (public or protected lands).*

12

ASSIST MUNICIPALITIES IN DEVELOPING GIS CAPABILITIES

GOAL

Develop Geographic Information System (GIS) capabilities in every municipality in the Upper Perkiomen watershed, with a shared GIS database of information and maps based on this Upper Perkiomen Creek Watershed Conservation Plan.

IMPLEMENTATION ACTIONS

1) An assessment of current uses of and needs for GIS should be prepared. A Geographic Information System (GIS) is one of the most important tools for municipal governments throughout the Upper Perkiomen Creek watershed to use in guiding growth and offsetting potential negative impacts of sprawl. To ensure that municipalities develop GIS capabilities, intermunicipal cooperation should address the need for technical and financial assistance in acquiring GIS software (and in some cases computer hardware), training for staff and volunteers, technical support from consultants, and sharing of data. The data from this Upper Perkiomen Creek Watershed Conservation Plan should be made available to all municipalities as a foundation for a GIS database. County Planning Commissions and the Upper Perkiomen Watershed Coalititon can play important coordination roles for municipalities and groups in the watershed.

2) Assistance in writing and/or supporting applications for grants to acquire GIS systems should be provided.

3) Training programs for municipal staff and volunteers in the use of GIS should be provided.

4) A watershed-wide conference should be organized to examine current and potential uses for GIS.

5) Establish UPWC as a local resource for GIS data

Implementation Action Summary:
Issue #12: Assist Municipalities in Developing GIS Capabilities

Specific Tasks Involved	***Potential Participating Parties***
1) An assessment of current uses of and needs for GIS should be prepared.	*UPWC, Municipalities*
2) Assistance in writing grant applications to acquire GIS systems should be provided.	*UPWC, Consultants.*
3) GIS training programs for municipal staff and volunteers should be provided.	*UPWC, Municipalities*
4) a watershed-wide GIS conference should be organized to assess current and potential uses.	*UPWC, Municipalities, Conservation Organizations, utilities*
5) Establish UPWC as a local resource for GIS data	*UPWC, Conservation Organizations, County Agencies*

13

SUPPORT THE CREATION OF ENVIRONMENTAL ADVISORY COUNCILS THROUGHOUT THE WATERSHED

GOALS

Environmental Advisory Councils (EAC's) are the main locally-based environmental organizations permitted under the Pennsylvania Municipalities Planning Code. All municipalities in the watershed should be urged to form EAC's to monitor environmental issues and advocate for environmental protection.

IMPLEMENTATION ACTIONS

1) Encourage municipalities to form individual or multi-municipal EAC's. Environmental Advisory Councils (EAC's) should be encouraged in every municipality in the watershed, or in multiple municipalities. These Councils can be considered as a specialized volunteer body to monitor and provide advocacy and information on key environmental issues affecting environmental resources in the municipality. In addition, a watershed-wide coalition of EAC's should be established (or a single Upper Perkiomen EAC) to create a unified voice for issues affecting municipalities throughout the watershed.

2) Provide technical and financial support for establishing EAC training and capacity building. UPWC, and groups such as Perkiomen Valley Trout Unlimited and the Pennsylvania Environmental Council should provide support and technical and financial assistance should be provided to develop training programs for EAC's in the watershed.

3) Organize a watershed-wide EAC conference. A watershed-wide EAC conference should be organized to coordinate activities and share inspiration and support between volunteers throughout the Upper Perkiomen Valley.

Implementation Action Summary:
Issue #13: Support Creation of EAC's

Specific Tasks Involved	***Potential Participating Parties***
1) Encourage municipalities to form individual or multi-municipal EAC's	*Conservation Organizations, PEC, municipalities.*
2) Provide technical and financial support for establishing EAC training and capacity building.	*Same as above*
3) Organize a watershed-wide EAC conference	*Same as above*

14

CONDUCT DETAILED INVENTORIES OF NATIVE FLORA AND FAUNA OF THE WATERSHED

GOALS

Detailed surveys of wildlife should be conducted, including birds, mammals, reptiles, amphibians, invertebrates, fish, and aquatic invertebrates. These surveys are important for several reasons. Very little is known about the native plants and animals that inhabit the watershed and constitute its biodiversity. Natural areas are one of the main defining characteristics of the Upper Perkiomen watershed, and are among the most vulnerable resources to be impacted by conventional land development practices.

IMPLEMENTATION ACTIONS

1) Detailed surveys of native plant and wildlife communities should be conducted. Such surveys can be done with the assistance of botanists, naturalists, ornithologists, bird clubs, and biology programs from nearby universities. Surveys should emphasize characterization of woodlands, wetlands, meadows and stream corridors, and assess species diversity, rare, threatened and endangered species. GIS and Global Positioning System (GPS) technology should be used for accurate mapping of key plant populations. The survey should include roadside locations and public access areas, and permission should be obtained from landowners to access private properties in key locations.

2) The Natural Areas Inventories prepared for Montgomery, Berks, Lehigh and Bucks Counties should be updated and expanded periodically (3 to 5 years). Recommendations from these Inventories should be included in a GIS database for the watershed.

3) Establish a GIS-based Upper Perkiomen Biodiversity Database . The survey information should be compiled as an Upper Perkiomen Biodiversity GIS Database that is accessible to local residents, groups and municipalities and that can be updated periodically with additional survey information.

4) The Unami Woods area and the wetlands and meadows surrounding Green Lane Reservoir should be surveyed for flora and fauna populations.

Implementation Action Summary:
Issue #14: Conduct Detailed Inventories of Native Flora and Fauna

Specific Tasks Involved	***Potential Participating Parties***
1) Conduct detailed surveys of native plant and wildlife communities throughout the watershed.	*UPWC, Conservation Organizations.*
2) The Natural Areas Inventories prepared for Montgomery, Berks, Lehigh and Bucks Counties should be updated and expanded periodically (3 to 5 years).	*County Planning, PNDI*
3) Establish a GIS-based Upper Perkiomen Biodiversity Database.	*UPWC, Conservation Organizations.*
4) The Unami Woods area and the wetlands and meadows surrounding Green Lane Reservoir should be surveyed for flora and fauna populations.	*Conservation Organizations, County Planning, Philadelphia Suburban Water Company*

15

ASSEMBLE A HISTORY OF THE NATURAL AND CULTURAL FEATURES OF THE UPPER PERKIOMEN WATERSHED

GOAL

In addition to natural areas, the historic pattern of land use is the other main defining feature of the Upper Perkiomen landscape. Farmland, historic farmsteads, mills, rail lines, bridges, archaeological sites, villages and towns tell the history of the Upper Perkiomen and should be carefully understood and documented prior to the advance of suburban development.

IMPLEMENTATION ACTIONS

1) Organize a coalition of conservation and historic groups to prepare a natural and cultural history of the Upper Perkiomen watershed. A history of the natural and cultural features of the Upper Perkiomen watershed should be prepared, highlighting the historic dependency on water resources. This could be done by a coalition of groups interested in the history of the area, including local historical societies.

2) Historic and cultural resources should be documented and catalogued using the watershed-wide GIS system. Resources should be identified according to their status on the National Register of Historic Places, Pennsylvania list of Determination of Eligibility resources, local historic districts and lists.

3) Share this history with the public through publishing and presentations. This information should be made widely available to residents and municipal officials throughout the watershed.

Implementation Action Summary:
Issue #15: Assemble a Natural/Cultural History

Specific Tasks Involved	***Potential Participating Parties***
1) Organize a coalition of conservation and historic groups to prepare a natural and cultural history of the Upper Perkiomen watershed.	*UPWC, Conservation Organizations, Historical Societies and Libraries, PA Historic and Museum Commission..*
2) Historic and cultural resources should be documented and catalogued using the watershed-wide GIS system	*Same as above*
3) Share history with public through publishing and presentations.	*Same as above*

APPENDIX A: Public Participation Program

Informational public meetings

A series of informational public meetings were held to introduce the Upper Perkiomen Creek Watershed Conservation Plan and solicit comments from residents, businesses, organizations and government agencies. Meetings were held on:

July 22, 1999, at the Upper Perkiomen Library in Red Hill, Montgomery County.
July 27, 1999, at the Milford Township Hall, Bucks County.
July 29, 1999, at the Washington Township Hall, Berks County.

Minutes were recorded at each public meeting, and are maintained by Natural Lands Trust as part of the project background files. A written list of conservation issues was presented by the Perkiomen Valley Chapter of Trout Unlimited (PVTU) at one of these meetings. Since these issues were discussed and recorded at the meeting, they have been incorporated as part of the public hearings comments. Subsequent correspondence from Trout Unlimited included a map with accompanying text describing known issues and proposed projects **(see Figure 9b: Potential Stream Health Concerns).**

A public survey was prepared to augment the input received at the meetings. The survey was distributed through a number of mechanisms. It was available at the municipal buildings in all of the townships or boroughs and was also placed in the Red Hill Library. Availability of the survey in these locations was announced through editorials in the three area newspapers: The Morning Call (Quakertown edition), the Quakertown Free Press, and the Boyertown Times. An advertisement was placed in the Town and Country. In Bucks and Montgomery Counties, the survey was distributed through the County Extension Services newsletters. In these two counties, the survey was mailed to a sample of land owners owning five acres or more. Washington Township in Berks County distributed the survey in its newsletter. Other efforts were made to distribute the surveys in Berks and Lehigh Counties by UPWC. Ninety-two of these surveys were returned although for six if these, the homeowner's township was either not filled out or was not within the Upper Perkiomen Creek watershed. A summary of results is included in Appendix C.

A municipal survey was sent to the twenty-one municipalities that have a substantial amount of land in the watershed, with a total of fourteen were returned. Phone interviews were also conducted with a cross-section of municipal officials throughout the watershed. In addition, phone interviews were conducted with Alan Everett of PA DEP, Beth Pilling of the Montgomery County Planning Commission, Michael Kane of the Bucks County Planning Department, and Frederick Brock of the Lehigh County Planning Department. The responses of these surveys and interviews are referenced throughout this document.

Presentation of Preliminary Findings Report
Three public meeting were held to present the preliminary findings report for the Upper Perkiomen Rivers Conservation Plan. The meetings were held on:

March 30, 2000, at the Washington Township Building in Barto, Berks County.
April 6 , 2000, at the Milford Township Building in Bucks County.
April 10, 2000 at the Upper Perkiomen Library in Red Hill, Montgomery County.

Comments from all three meetings have been summarized and are on record with the Pennsylvania Environmental Council. The comments are limited to items specifically addressing the River Conservation Plan.

Presentation of Draft Rivers Conservation Plan
A second series of public meetings were held to present the Draft of the Upper Perkiomen Creek Watershed Conservation Plan and solicit comments. Comments from all three meetings have been summarized and are on record with the Pennsylvania Environmental Council. These meetings were held on:

June 12, 2001, at the Washington Township building in Barto, Berks County.
June 14, 2001, at the Milford Township building in Bucks County.
June 19, 2001, at the Upper Perkiomen Library in Red Hill, Montgomery County.

Final Public Hearing
The final Upper Perkiomen Creek Watershed Conservation Plan was presented on November 29, 2001, at the Upper Perkiomen Library in Red Hill, Montgomery County. Public comments were solicited at that time. *Copies of public comments are available by contacting the Pennsylvania Environmental Council at (215) 563-0250.*

The Upper Perkiomen Creek watershed was toured on two occasions, in 1999 and 2001, by representatives from the Upper Perkiomen Watershed Coalition, Pennsylvania Environmental Council, and Natural Lands Trust. The tour included the Northwest Branch and headwaters of the Perkiomen Creek in Washington and Hereford Townships, Berks County, highlighting a variety of specific sites such as Gabel Quarry, Forge Dale Park mobile home park, several hazardous waste and Superfund sites, new home construction near Bally, several streambank fencing projects, and the proposed Panda Energy International power generating plant site (Hereford and Upper Hanover Townships). The tour included the headwaters areas of Hosensack and Indian Creeks in Upper Milford and Lower Milford Townships, Lehigh County, with both high quality wetlands and Superfund sites. The tour passed through the Montgomery County portion of the watershed, including Macoby Creek and Green Lane Reservoir in Upper Hanover Township and the Boroughs of East Greenville, Pennsburg, and Red Hill. The diabase woodlands of the Unami Creek valley in Marlborough and Milford Townships was also included.

APPENDIX B: Opinion Surveys

The following Appendix provides a summary of the responses to the "Upper Perkiomen Landowner Survey".

(to be added)

APPENDIX C: Sources of Further Information

Rivers Conservation Program Bureau of Recreation and Conservation DCNR Rachel Carson State Office Building, 6th Flr. P.O. Box 8475 Harrisburg, PA 17105-8475 (717) 783-4734 www.dcnr.state.pa.us	***Riparian Buffer Ordinances*** Montgomery County Planning Commission Montgomery County Courthouse Norristown, PA 19404 (610) 278-3722 Center for Watershed Protection: www.cwp.org	***Riparian Buffer Functions*** Stroud Water Research Center 512 Spencer Road Avondale, PA 19311 (610) 268-2153
Innovative Wastewater Treatment Chester County Water Resources Authority 601 Westtown Road West Chester, PA 19382-4501 (610) 344-5400	***Erosion Control and Stormwater Management*** County Conservation Districts – Montgomery, Berks, Lehigh, Bucks PA DEP Center for Watershed Protection: www.cwp.org	***Watershed-Based Environmental Education*** County Conservation Districts Perkiomen Watershed Conservancy -- (610) 287-9383 Upper Perkiomen Watershed Coalition – www.upwcwatershed.org Wildlands Conservancy -- (610) 965-4397 Brandywine Valley Association -- (610) 793-1090
Conservation Easements and Land Conservancies Berks County Conservancy – (610) 372-4992 / www.berks-conservancy.org Heritage Conservancy – (215) 345-7020/ www.heritageconservancy.org Montgomery County Lands Trust -- (215) 513-0100/ www.mclt.com Natural Lands Trust -- (610) 353-5587/ www.natlands.org Wildlands Conservancy – (610) 965-4397/ www.wildlandspa.org	***Water Quality Testing Programs*** United States Geological Survey 111 Great Valley Parkway Malvern, PA 19355 (610) 647-9008	***Flood Hazard Mitigation Program*** PA Emergency Management Agency Disaster Field Office 3600 Vartan Way Harrisburg, PA 17110

Conservation Design/Ordinances --Brandywine Conservancy P.O. Box 141 Chadds Ford, PA 19317 (610) 388-2700 -- Heritage Conservancy 85 Old Dublin Pike Doylestown, PA 18901 (215) 345-7020 -- Natural Lands Trust Hildacy Farm 1031 Palmers Mill Road Media, PA 19063		

APPENDIX D: Bibliography

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APPENDIX E: Sample Municipal Resolution

The following sample resolution should be considered for adoption by municipalities once the final Upper Perkiomen Creek Watershed Conservation Plan has been completed.

WHEREAS, *the Board of Supervisors (Borough Council) recognizes the importance of conservation and improvement of the Upper Perkiomen Creek and its tributaries to the continued quality of life in _____ Township (Borough); and*

WHEREAS, *Resolution _____, passed on _____, 2001 stated _____ Township's (Borough's) support and endorsement for the efforts of the Upper Perkiomen Watershed Coalition (UPWC) and Pennsylvania Environmental Council (PEC) to secure funding for an "Upper Perkiomen Creek Watershed Conservation Plan" from the Commonwealth of Pennsylvania's Rivers Conservation Program; and*

WHEREAS, *the grant was received by UPWC and PEC and the Conservation Plan has been completed; and*

WHEREAS, *the Conservation Plan contains a number of conservation recommendations suitable for utilization in _____ Township (Borough), and throughout the entire Upper Perkiomen Creek watershed; and*

WHEREAS, *the Conservation Plan has been reviewed and found acceptable by the Board of Supervisors (Borough Council);*

NOW, THEREFORE, *the Board of Supervisors (Borough Council) of _____ Township (Borough) do hereby endorse the Upper Perkiomen Creek Watershed Conservation Plan, and will endeavor to take appropriate action to implement its recommendations.*

Resolved this _____th day of _____, 2001.