ELK CREEKS WATERSHED CONSERVATION PLAN

I. Introduction

The Elk Creeks Watershed (see Map 1-Watershed Location) is at a turning point in its history. From Cochranville to Oxford, and New London to the state line at Fair Hill, the centuries-old pattern of productive, family-owned farms, densely forested stream valleys, historic villages, hamlets and churches is gradually giving way to a new land use pattern – one of shopping centers, convenience stores, residential subdivisions, retirement communities, and the utilities, roads and other infrastructure required to service this new pattern. Over the past 20 years, the population living in the Elk Creeks Watershed has grown by 50%, from 20,197 to 30,350 residents. This is more growth than the watershed had experienced in the previous 300 years. The magnitude and the nature of this growth can seriously impact the natural environment and it raises critical questions about the quality of life for local residents.

Over the next 20 years this rate of growth is expected to increase, with more and more people and businesses moving to the far reaches of suburban Philadelphia, Wilmington, and Newark. The question facing communities throughout the watershed is this: *how can this growth be accommodated in a way that maintains the health and quality of the land and water on which all residents depend?* Will the Elk Creeks Watershed lose its high quality streams, its clean, plentiful groundwater, its productive farmland, and its rich forests to an unbroken wave of suburban development? Or can the 10 communities that make up the watershed work together to guide new development to fit the landscape and to make sure that the Elk Creek and its environs remains as desirable a place to live in the future as it is today?

The sprawling pattern of land development presents a scope of impacts to land and water that reaches well beyond the boundaries of each municipality. The Elk Creeks Watershed Conservation Plan (the Plan) defines, for the first time, the current condition of land use and water resources at the watershed scale, and shapes a vision for managing growth while sustaining the natural and agricultural environment that defines the Elk Creeks Watershed. The Plan evaluates the need for protecting and restoring the most important lands and waters and provides strategies for municipalities and landowners to play a vital role in balancing development and conservation.

The Plan is the result of over 3 years of research, computer mapping, and public meetings conducted by a Steering Committee consisting of members of the Elk Creeks Watershed Association, representatives from local municipalities, landowners and residents of the Watershed and the Brandywine Conservancy. The Plan will provide the Elk Creeks Watershed Association with information and guidance for its important education, outreach, and conservation activities. It is our hope that the municipalities, landowners, residents and businesses of the Elk Creeks Watershed will adopt and use the Elk Creeks Watershed Conservation Plan as a starting point for working together to accomplish the goal of conserving a healthy watershed.

II. Background

The Elk Creeks Watershed contains all or part of ten municipalities:
(1) Londonderry Township
(2) Upper Oxford Township
(3) Lower Oxford Township
(4) East Nottingham Township
(5) New London Township
(6) Franklin Township
(7) Elk Township
(8) Penn Township
(9) West Fallowfield Township
(10) Oxford Borough

History of Conservation Activity in the Watershed
The watershed has benefited from the actions of a number of individuals, conservation groups and agencies seeking to maintain the quality of soil, vegetation and water that form the basis of the local environment. In general, the watershed is fairly well-studied but lacks public awareness and involvement in issues related to watershed quality. The watershed is also underserved by public and private land conservation efforts and best management practices for agriculture and forestry. The Elk Creeks Watershed Conservation Plan provides an opportunity to recognize these efforts and to identify conservation actions for the future.

Elk Creeks Watershed Association
The Elk Creeks Watershed Association is a non-profit, volunteer organization committed to maintaining and improving the quality of the natural environment in the drainage areas of the Big and Little Elk Creeks. Since the late 1980's the Elk Creeks Watershed Association (ECWA) has been active developing public awareness of watershed issues and was instrumental in promoting the Pennsylvania Department of Environmental Protection (PADEP) upgrade of Barren Run and Jordan Run to Exceptional Value status. In 1998 ECWA formed a partnership with Brandywine Conservancy and Pennsylvania Environmental Council to apply to the Pennsylvania River Conservation Program for a grant to prepare this Elk Creeks Watershed Conservation Plan.

Public and Private Land Conservation
Land conservation activity in the Elk Creeks Watershed has been fairly limited to date, with over 2200 acres of land protected by conservation easements held by the Brandywine Conservancy, the Chester County Agricultural Land Preservation Board, and land owned by the Natural Lands Trust and by The Nature Conservancy as part of their Chrome Barrens preserve, and township parks. The Chester County Preservation Partnership Program and the Pennsylvania Department of Conservation and Natural Resources' (DCNR) Keystone Land Trust Grant Program have both funded land conservation projects in the watershed (see Map 2-Targeted Parcels).

United States Environmental Protection Agency
The United States Environmental Protection Agency (USEPA) maintains computer databases known as STORET, which stores all of the chemical data and BIOS, which stores all of the biological data collected on the Big Elk Creek as part of the Pennsylvania Department of Environmental Protection's Water Quality Network. USEPA also administers the Federal Clean Water Act, which requires the Commonwealth of Pennsylvania to monitor and maintain the quality of streams such as the Big Elk Creek.

United States Geologic Survey
The United States Geologic Survey (USGS) maintains several water quality and water quantity monitoring stations along streams in the watershed and is conducting a 2-year jointly-funded project with the Chester County Water Resources Authority to evaluate groundwater resources in the Big and Little Elk Creek watersheds. The USGS monitors stream discharge on the West Branch of the Big Elk Creek.

Pennsylvania Department of Environmental Protection
The Pennsylvania Department of Environmental Protection (PADEP) assesses stream quality, monitors discharge from sewage treatment plants and evaluates streams for stream and quality designation upgrades in the watershed. The Clean Streams Law, enacted by the Commonwealth of Pennsylvania in 1937, has been updated and amended over the years as the main regulatory tool for water quality protection in Pennsylvania. Since 1972, PADEP has physical, chemical and biological data at a water sampling station on the Big Elk Creek at the Strickersrville Road bridge in Franklin Township as part of its Water Quality Network. The Big Elk Creek basin was redesignated from Warm Water Fishery (WWF) to High Quality – Trout Stocking Fishery (HQ-TSF) following a 1990 PADEP survey (see Map 3). The Barren Run and Jordan Run tributaries of the Little Elk Creek are designated as Exceptional Value (EV) streams by PADEP. As required by the Federal Clean Water Act, PADEP also maintains a list of impaired waters (known as the "Section 303d List"), which are negatively impacted by point sources and nonpoint sources of pollution. At this time, none of the streams in the Elk Creeks Watershed have been included on this list. It should be noted that this list is compiled from an incomplete process of data collection and review, therefore it is possible that "impaired waters" do exist in the watershed.

The Pennsylvania Fish and Boat Commission
The Pennsylvania Fish and Boat Commission, Bureau of Fisheries has been assessing stream quality and monitoring stream impacts in the watershed since the 1970's, and conducts annual trout-stocking in sections of stream.

In addition, state agencies such as PADEP and the Fish and Boat Commission are charged with overseeing activities that involve potential encroachment on streams and wetlands throughout the watershed. PADEP oversees permitting programs under the Clean Streams Law for activities such as stream crossings, disturbance and mitigation of wetlands, dam and pond construction and maintenance, stormwater management, and sewage treatment facilities. The United States Army Corps of Engineers has jurisdiction over wetland delineations, and can rule on the accuracy of wetland boundaries and may oversee permitting on large scale (5 acres or greater) projects involving wetlands. The Conservation Officers of the Fish and Boat Commission regularly patrol streams

throughout the watershed to ensure compliance with fishing license regulations and to levy fines against individuals illegally encroaching on streams without a permit. While these permitting programs add an important level of review to minimize impacts of such activities, they do not represent a safeguard against the cumulative, watershed-wide impacts of smaller wetland losses and stream degradation over time.

Federal and County Soil Conservation Programs
The United States Department of Agriculture, Natural Resources Conservation Service (NRCS) and the Chester County Conservation District (CCCD) have worked with farmers to promote agricultural best management practices for reducing soil erosion and stream impacts. In addition, CCCD plays a critical role in reviewing land development plans to ensure compliance with regulations for erosion and sedimentation control plans.

Private Nonprofits
The Stroud Water Research Center has been conducting ongoing assessment and monitoring of stream ecosystems from sample stations on the Big Elk Creek. Studies have focused on stream-dwelling organisms such as fish and aquatic insects, known as benthic macroinvertebrates.

III. Existing Conditions

To develop a thorough understanding of the current state of the Elk Creeks Watershed, it is important to document the fundamental environmental, land use, and cultural forces at work in shaping its unique landscape and hydrology. This knowledge of existing conditions provides a basis for well-informed recommendations to communities throughout the watershed regarding future land use and water use decisions, and conservation and restoration actions.

Geography & Topography
The Elk Creeks Watershed, defined by the topographic features (see Map 4) that direct surface water to the Little Elk Creek, the Big Elk Creek and their tributaries, comprises 55.02 square miles in relatively rural portions of Chester County, Pennsylvania, and Cecil County Maryland. The Town of Elkton, Maryland draws drinking water from the Big Elk Creek. Downstream from this intake, the Big and Little Elk Creeks join. From there the Elk Creeks flows into the head of the Chesapeake Bay.

The Elk Creeks Watershed constitutes a small fraction (less than 1 percent) of the Chesapeake Bay Drainage, a 64,000 square mile natural system of freshwater wetlands, streams, rivers and groundwater feeding the Chesapeake Bay estuary, one of the largest and most productive estuaries in North America. The Chesapeake Bay Program's 1999 State of the Chesapeake Bay report documents that the gradual restoration of the Bay is well underway from its low point of degradation in the 1970's. Many of the Chesapeake Bay Program's recovery goals have been met or are close to being met – reducing nutrient and toxic pollution, protection and restoration of habitat, the return of Bay grasses and species such as striped bass. The report also documents the changing problems associated with a watershed that is home to more than 15.1 million people (growing by 300 people each day) – sprawling development, sedimentation, sewage

treatment, the loss of forests and wetlands, and the decline of several species of valuable fish, shellfish and waterfowl. The burgeoning human population in the Chesapeake Bay drainage basin threatens the vitality of the estuary, and without a concerted effort to minimize its adverse environmental effects, is capable of reversing the strides that have been made in recent years towards restoration. As part of the Chesapeake Bay Watershed, the Elk Creeks Watershed plays a part in an even bigger conservation effort.

The topography of the Elk Creeks Watershed can be described as gently rolling, and typical of the Piedmont Uplands region of southeastern Pennsylvania. The Piedmont, literally the "foot of the mountain" in Italian, is a fairly narrow band of clay soils underlain by hard crystalline bedrock extending from Georgia to Connecticut. The Piedmont is bounded to the southeast by the Atlantic Coastal Plain, and to the west by the Valley and Ridge Province – the beginning of the Appalachian Mountains. The drainage pattern in the watershed, controlled by geologic features, is considered dendritic, or resembling the veins of a leaf. This drainage pattern tends to indicate a relatively uniform weathering pattern of the underlying rocks.

The surface elevation of the watershed ranges from approximately 630 feet national geodetic vertical datum (NGVD) in the northwestern part, near Faggs Manor, to about 250 feet NGVD in the southeastern corner, south of Kemblesville. The total relief in the watershed is about 380 feet. The most dramatic, steeply sloping areas occur along the main stem of the Big Elk Creek in Elk, New London and East Nottingham Township. In these areas the elevation often drops dramatically from upland knolls of 450 to 500 feet down to the Big Elk Creek at 300 feet in distances of one-half mile. This area is underlain by the same Wissahickon Schist bedrock as the majority of the watershed, but may have subtle variations which have resulted in higher, less eroded uplands and allowed the stream to carve a deeper channel through relatively softer bedrock. Steep slopes and elevations are mapped as part of the GIS inventory (Map 4).

The largest stream, the Big Elk Creek, roughly bisects the watershed, following a meandering course from the northwestern corner to the southeastern corner. The slope of the stream is relatively gentle, which gives it less erosive power than a similarly sized stream in a region with greater topographic relief. However, the banks of the stream in many places are very steep, exceeding 25%. Because these slopes are prohibitive for agricultural purposes, a significant portion of the banks remain wooded, and this vegetative cover helps protect the banks from erosion. The Little Elk Creek and the smaller tributaries in the watershed have been more extensively deforested.

Geology

The Elk Creeks Watershed is located in the Piedmont physiographic province, which is a northeast-southwest trending belt of folded, faulted, and highly eroded crystalline rocks, bracketed by the unconsolidated sediments of the Atlantic Coastal Plain to the southeast and the Valley and Ridge province to the northwest. These majority of these rocks were deposited as sedimentary layers and later metamorphosed through tectonic collisions hundreds of millions of years ago during the Paleozoic Period. The subsequent eons of weathering and erosion have resulted in the gentle undulations of the topography. Due to the alignment of the Piedmont hills, and water's tendency to flow downhill, the overall dendritic surface drainage pattern tends to assume a southeastward orientation.

Most of the Elk Creeks Watershed occurs within one major structural group, the Glenarm Supergroup, which consists of the Peters Creek Schist, the Octoraro Phyllite, the Wissahickon Schist, the Cockeysville Marble, and the Setters Quartzite. The Wissahickon Formation (see Map 5), an Oligoclase-mica schist, with some pegmatite and Triassic diabase dikes and faults is predominant, although a substantial area of Serpentenite of the Baltimore Mafic Complex occurs in the southwest part of the watershed, adjacent to Gabbroic gneiss and gabbro. Geology is mapped as part of the GIS database (see Map 5 - Source: Chester County Planning Commission, GIS geology layer, 1993, which is based on mapping performed by Pennsylvania Geological Survey, 1980).

This pattern of bedrock influences the topography, landforms, groundwater, streams, soils and vegetation throughout the watershed. The gently rolling landscape, the steep areas along the main stem of the Big Elk Creek, the clean, dependable well water, the clear flowing streams, the productive clay soils and the rich oak-hickory forests are all strongly influenced by the presence of this bedrock.

Wissahickon Schist

The schist is a result of metamorphosed soft clay shales and contains hornblende gneiss, augen gneiss and some quartz-rich and feldspar-rich members. This bedrock is moderately hard but tends to weather deeply, resulting in a predominance of soils with a relatively good depth to bedrock of up to 5 feet or greater. This tendency shapes a landscape that appears more level and gently rolling than areas of northern Chester County underlain by granitic gneiss. The exceptions to this are the steep cuts and ravines along the main stem of the Elk Creek from the forks of the East and West Branches south to the Rudolph and Arthur covered bridge at Camp Bonsall Road. In this section of Elk, East Nottingham, and New London Townships, the creek cuts through a deep valley where much of the surrounding uplands are less weathered, with thinner soils, indicating a harder schist with greater representation of quartz or feldspar.

Many of the stone farmhouses and barns in the watershed were constructed from Wissahickon Schist fieldstone.

Pegmatite and Diabase

Two igneous rock types, pegmatite and diabase, occur infrequently in the watershed as a series of dikes trending generally in a southwest-to-northeast direction. Pegmatite is a type of granite containing large crystals of feldspar and quartz. Diabase, the hardest rock type in Chester County, only occurs in small faults and dikes in the watershed.

Serpentinite

Serpentinite is an unusual, metamorphic rock type that contrasts sharply with the dominant schist bedrock in the watershed. This dense rock is composed primarily of the mineral, serpentine. The serpentinite is evenly-eroded and is situated at the headwaters area of Jordan Run and Barren Run in the Little Elk Creek drainage. It helps to form the relatively level terrain of this area.

Serpentinite provides the parent material for a thin, relatively unproductive chrome soil that occurs in the Chrome Serpentine Barrens. The bedrock contributes large amounts of chromium, nickel and magnesium to the soil, making it undesirable for farming and inhospitable to all but a unique, globally rare community of plants. The term "barrens" stems from this poor agricultural productivity, the thin soil, and the fact that much of this area has historically supported an open grassland or stunted woodland due to the combination of chrome soils and frequent natural fires.

While serpentinite was quarried in the 18th and 19th centuries in eastern Chester County for use in a number of farmhouses and buildings, it appears that the Chrome barrens were not actively quarried for commercial use.

Gabbroic Gneiss and Gabbro

A thin band of Gabbroic gneiss and gabbro borders the south side of the Serpentinite area in the Little Elk Creek watershed along the state line near Chrome. This bedrock is known as a hybrid granitic gneiss, a metamorphic rock more commonly found in the northern and eastern part of Chester County. It is among the hardest rock types in the region and is typically resistant to erosion, weathering to an average depth of 8 feet and forming clayey soils (mostly Glenelg and Neshaminy).

Soils

Soils are characterized by the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS). Based on properties such as grain size, chemical composition, range of depth, consistency and moisture content, the NRCS groups soils into classes of suitability for agricultural and engineering uses. Agricultural classes range from I-VIII, and building suitability classes range from 1-13 with lower numbered classes generally corresponding to greater suitability for a given use.

The soils of the Elk Creeks Watershed are within the Glenelg-Manor-Chester association, the predominant soil group within southern (and much of northern) Chester County (see map 7). The majority of the soil types in the watershed are classified as Prime Agricultural Soils due to their productivity. These soils are also generally rated as having good permeability for groundwater recharge and septic systems. Closer to springs, wetlands and streams, hydric soils such as Glenville (Gn) and Wehadkeee (We) soils are prevalent. Floodplains in the watershed support alluvial soils such as Worsham (Wo) and Chewacla (Ch). Soils throughout the watershed are formed by weathering parent material (stones, gravel, silts, clays, sediments) and the fallen organic matter (leaves, branches, logs) from the predominantly oak-hickory and oak-chestnut forests that covered the region for thousands of years. The following is a description of the most common soils of the watershed.

Upland Soils (data from Soil Survey, Chester and Delaware Counties, Pennsylvania, U.S. Department of Agriculture Soil Conservation Service (now Natural Resources Conservation Service), Series 1959, No. 19, Issued May 1963.)

Glenelg (Ge)
The most common upland soil type in the watershed is Glenelg. The Glenelg soil series is divided into several sub-classifications, or phases, that are associated with different degrees of slope. All are considered "silt loams," and are moderately deep (up to 42 inches), well-drained soils. The Soil Survey indicates that the Glenelg soils that occur on gentler slopes are suitable for septic system infiltration. The Soil Survey generally indicates poor suitability of the Glenelg soils that occur on steeper slopes for most engineering uses, such as road construction and septic systems. Therefore, Glenelg soils are classified as Groups 5,6, 9 and 10 for building sites. Glenelg soils are considered moderately to highly productive for agriculture, and are classified as I and II, depending on the slopes of occurrence.

Manor (Mg)
Manor (Mg) is the second most common upland soil type. These soils are found throughout the watershed, but also appear in the steep topography of the lower Big Elk and Little Elk Creeks, just above the state line. Manor soils range in depth from 15 inches to 8 feet, and are considered suitable for use for septic systems or engineering purposes, such as road building, and are listed in Groups 5,6 and 9 for building purposes. On gentler slopes (up to 3%), these soils are considered Class II, for agricultural purposes, while those occurring on steeper slopes are Classes II-VII.

Chrome (Co)
Chrome soils are concentrated around the southwest part of the watershed area and generally exist as a thin layer (6 to 30 inches) over the serpentinite bedrock. They tend to support shallow-rooted plants, including corn and small grain crops, and dwarfed trees in uncultivated areas. Agricultural classes range from II, on shallow slopes, to VII on steep slopes. Because they are well drained and permeable, they are considered suitable for septic system drainage, where they occur to an adequate depth, and are listed in Groups 7, 8 and 9 for building sites.

Neshaminy (Na)
Neshaminy soils are also concentrated in the southwest part of the watershed area over serpentinite and gabbroic gneiss and gabbro geology. Neshaminy soils are deep (to 48 inches) and well-drained. They are considered generally suitable for most engineering and agricultural purposes, belonging to Classes I-VII, depending on slope. The Soil Survey ranking of these soils for building sites range from 3-9, again, depending on slope.

Calvert (Ca)
The Calvert Soil Series consists of deep (3 to 5 feet), poorly-drained soils of the uplands. Calvert soils are considered unsuitable for virtually all the uses listed in the Soil Survey, classified as Group 12 for building sites and Groups V and VI for agricultural purposes. Calvert soils are also considered poor material for road building.

Hydric or Hydric Inclusion Soils (see Map 6)
Glenville (Gn)
The Glenville Soil Series includes deep (3 to 6 feet), moderately well-drained, upland soils, developed from weathered schist, gneiss and granite. Glenville soils rank from

Class II to Class VI for agricultural uses, and are listed in Groups 10 and 11 for building sites, due to their characteristically "high water table."

Conowingo (Co)
The Conowingo Soil Series consists of moderately-deep to deep (18 to 40 inches), moderately well-drained to somewhat poorly-drained silt loams, whose parent rock is serpentine. Often, the serpentine is highly weathered near the surface. These soils are classified as III for agricultural purposes and belong to Group 10 for building sites, owing to their association with a high seasonal water table that is unsuitable for both septic system operation and the maintenance of dry basements. The Soil Survey encourages their use for commercial, industrial and institutional sites.

Worsham (Wo)
The Worsham Soil Series are deep and poorly drained, occurring at the bases of slopes. Therefore, they are associated with headwaters, springs and small streams. They range from silt to clay loam, and from 5 to 10 feet deep. They are generally unsuitable for agricultural uses, belonging to Classes V to VII, and are also poor for building sites, being classified as Group 12.

Alluvial Soils
Chewacla (Ch) and *Wehadkee (We)* are alluvial soils associated with floodplain areas in the watershed. These soils consist of alluvium (sediment, sands, silts, clays and gravels) deposited during periodic flood events from soils eroded off of land areas situated farther upstream or upslope in the watershed. Both soils are unsuitable for engineering uses listed in the Soil Survey, being classed as Group 13 for building sites. However, Chewacla soils are listed as Class II for agricultural purposes.

Planning Implications:
Not surprisingly, the Elk Creeks Watershed contains widespread areas of prime agricultural soils (Classes I and II). Unfortunately, these soils also tend to be fairly deep and well drained, and therefore amenable to suburban developments using septic systems for wastewater disposal. From the standpoint of wise land use, the area is a classically high priority for a concentrated agricultural preservation effort. In addition, the ability for the most common soils in the watershed to sustain mature hardwood forests, as they did historically, suggests that restoring and preserving forests would be a worthwhile, and possibly even profitable, endeavor.

The use of deep, well drained soils that predominate the cover of the watershed, for development presents several threats to the health of the watershed. Suburban subdivisions typically involve the construction of a paved road network that is impervious to water, not to mention the houses themselves. Impervious surfaces reduce the infiltration of rainwater, which reduces groundwater recharge, thereby reducing the supply of groundwater available for both drinking water and stream baseflow.

Many developments tend to be subject to heavy grading processes, which compact the soils, lowering their natural permeabilities. The increased runoff and velocity of runoff caused by impermeable surfaces hastens erosion once the flow reaches more natural soils. Increased erosion not only robs the earth of nutrients needed to sustain vegetation, but it

also degrades streams. When a stream receives a sudden increase in sediment load, it responds with changes in its channels, bars, slopes and meanders. These changes alter the nature of the habitat for aquatic biota, which already are contending with the primary effects of erosion, namely the sudden appearance of excess sediment that covers the streambed and clouds the water column.

The longstanding agricultural use of the watershed, without consistent application of best management practices has resulted in the loss of topsoil to streams. Many of the soils in the watershed are highly erodable, and the importance of retaining and restoring the soil cover is paramount. This is critical not only to the environmental health of the area, but also the economic health, as it relates to the maintenance of a viable agricultural community.

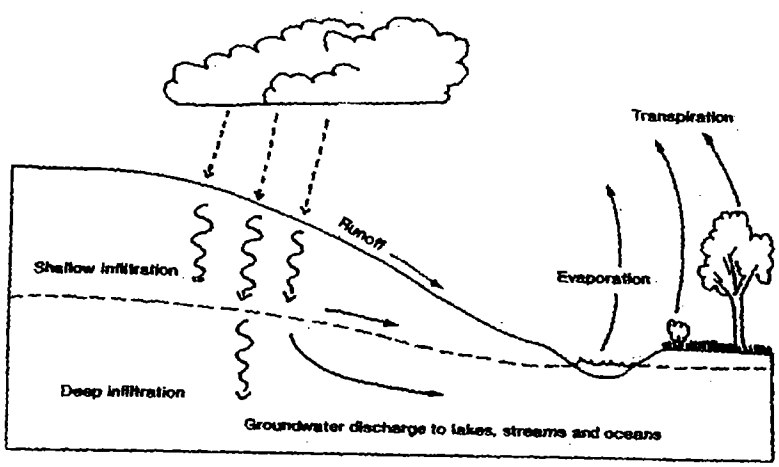
A number of the soil types in the watershed present significant barriers to development, due either to their association with steep slopes or their hydric natures. Areas containing these soils obviously are also less important to preserve in relation to the health of the watershed, since they tend not to permit productive agricultural use or significant groundwater recharge.

Hydrologic Conditions

The Hydrologic Cycle

Any study of a watershed should account for the natural hydrologic cycle of water, including precipitation, runoff, recharge, evapotranspiration (see Figure 1). Water condenses in the atmosphere and falls to the earth as precipitation. The Elk Creeks Watershed is within a temperate climate zone that receives nearly 44 inches of precipitation annually, spread out fairly evenly over the year. All of this water is eventually recycled to the atmosphere, either directly from the surface of the earth or vegetation, or from bodies of surface water. Streams drain to the ocean, from the ocean, the water is evaporated once again, thus completing the hydrologic cycle.

Figure 1
The Hydrologic Cycle



Prior to European settlement, forests dominated the landscape by far, with only minor portions existing as meadows and crop fields, cultivated by the native Lenni Lenape. Less than 1% of the precipitation likely would have run off and eroded the soil, therefore the streams ran clear. Because nearly 60% of the watershed is now in agricultural use, and the amount of impervious surface is approaching 10%, stormwater is now a significant concern. Without the consistent use of best management practices to prevent erosion, farm fields lose topsoil to runoff, choking streams and their inhabitants. Developed lands typically contain high percentages of pavement, or impervious surfaces, which fail to infiltrate the precipitation into the ground, and which accelerate the runoff's velocity over the surface of the earth. Increased velocity intensifies erosion. Since groundwater, generally ranging in temperature in the mid 50's Fahrenheit, supplies the bulk of the stream flow at hotter, drier times of year, lowered infiltration results in less flow and higher temperature streams. This can have a "domino effect" on aquatic biological systems, with different suites of plant and animal species supplanting the natives.

The Elk Creeks Watershed is expected to host a growing human population over the next 20 to 30 years. The ultimate effects on the ecosystem are difficult to predict, but the time is now to plan that growth in a way that allows the hydrologic cycle to continue in a manner that mimics the natural system as closely as possible. Without it, the environmental health and quality of life in the Elk Creeks Watershed can be expected to decline. By contrast, reaching this goal will mean that all residents of the watershed (humans, plants and animals) will enjoy clean, plentiful ground and surface water now and into the future.

Groundwater & Aquifers

Groundwater occurs naturally in the open spaces of rocks, specifically between grains in sedimentary rocks, and in joints, fractures and pores of crystalline rocks. Generally, two zones within the upper portion of the earth's crust contain moisture - a saturated and an unsaturated zone. The upper, unsaturated zone contains some moisture between soil grains, whereas the voids between rock particles is completely filled with water in the saturated zone.

The upper, two-dimensional surface of the saturated zone is known as the water table. The elevation of the water table varies in space and time. Surface water bodies such as ponds, lakes and streams occur where the water table is above the earth's surface, while groundwater occurs below the surface. The water table experiences both seasonal and long-term fluctuations in elevation. The water table will generally occur at its highest elevation during late winter or early spring and its lowest elevation during late summer or early fall. This is because evapotranspiration at or near the earth's surface reduces the infiltration of precipitation to the saturated zone during the summer. By contrast, evapotranspiration is at its lowest during the colder seasons, and groundwater recharge is at its maximum. By the end of the warmer season, the water table is relatively depressed, and at the end of the cooler season, the water table is elevated. Finally, the water table will tend to fall after a drought, due to the lack of recharge through precipitation.

Groundwater flows from recharge areas, where precipitation infiltrates, to discharge areas, such as surface water bodies. Aquifers are geologic units or portions of geologic units that not are not only saturated with water, but have enough interconnected spaces to

yield groundwater in useable quantities. In the Mid-Atlantic region, the temperature of the groundwater remains fairly steady.

In the Elk Creeks Watershed, one primary aquifer is recognized by hydrogeologists: crystalline rocks composed of schist and gneiss. Below the weathered zone, the basic crystalline rocks do not bear water very readily because the individual grains comprising the rock are fused together and the fractures that do contain water are generally not large and well enough connected to yield water in useable quantities. However, the shallower (approximately the upper 100 feet) portion of this aquifer, known as saprolite, has been altered by weathering processes such that it contains voids. The depth to water in this aquifer is generally about 20 to 30 feet. At this depth, the groundwater is available for domestic use, and is generally not shallow enough to prohibit the proper functioning of septic systems. Therefore, the watershed exhibits groundwater characteristics that make it attractive for development.

Groundwater Quantity and Recharge

The USGS has performed a great deal of investigation of the water resources throughout Chester County. Many of their findings are published in the publication, "Geology, Hydrology and Ground-Water Quality" of Chester County, Pennsylvania (1994). According to the report, groundwater is used as a source of drinking water for approximately 60 percent of the residents of Chester County. In the watershed, only Oxford Borough and the Oxford Mobile Home Park, are listed as sources of public water. Other residents derive their drinking water, presumably, from individual wells or smaller, community systems.

In general, the Wissahickon Schist is able to support domestic and community wells, but the Peters Creek Schist is not a reliable source of supply over the long term. Well yields in gabbro tend to be low due to the hardness and lack of fractures, averaging only 2 to 10 gallons per minute (gpm), while the gneiss may average 5 to 10 gpm.

One major interbasin transfer is documented by the U.S.G.S. It is a net import (consisting of 120 million gallons in 1986) into the Big Elk Creek watershed from the Octoraro Creek.

Because groundwater in the watershed generally flows from high to low topographic areas, it serves as a consistent source of flow into streams as baseflow. Stream flows tend to peak shortly after high-volume precipitation events, because they receive an influx of cumulative overland flow, or stormwater in addition to the groundwater baseflow. During times when precipitation is low and when a large portion of the precipitation is evapotranspired, the stormwater component of stream flow is relatively low. The major, or maybe even the only component of stream flow is from groundwater. *If the volume of groundwater in aquifers supplying stream baseflow is not maintained through the infiltration of precipitation in recharge areas, then stream baseflow declines.*

Declines in stream baseflow present many problems. Obviously, if the stream is used for drinking water supply less water may be available to the users. But less obvious may be the fact that the quality of the water can also be expected to decline along with the quantity. This is because we use streams both to withdraw water and to discharge

wastewater. When issuing permits for wastewater discharges to streams, regulators rely on the volume of water in a stream to dilute the pollutants of the wastewater. When the volume of uncontaminated water declines, the relative proportion of pollution rises, thereby decreasing the "assimilative capacity" of the stream. The result can be exposure of consumers to higher concentrations of pollutants or higher treatment costs to the downstream users.

Obviously, a decline in water quality also affects aquatic biota. Since these creatures rely on the water not only to drink, but also for a "breathing" atmosphere, the effects on them may be even greater than on humans, whose greatest amount of exposure is typically from drinking the water. In addition, lower surface water volumes can reduce the size of the aquatic habitat, since the area of the stream that is actually submerged may be reduced. Obviously, higher mortality rates for aquatic biota can be expected under such conditions.

Finally, the amount of baseflow affects the temperature of the water in a stream because the groundwater supplying that baseflow is of a relatively constant and cool temperature. By contrast, surface water temperatures tend to fluctuate with changes in air temperature. Water temperature affects aquatic organisms in many ways, the most well known of which is probably related to the concentration of oxygen that the water can hold. Generally, colder water holds more oxygen and warmer water holds less oxygen. Therefore, if a stream loses important amounts of cool baseflow in the summertime, the temperature may rise significantly. For animals that need high concentrations of oxygen, decreases in baseflow can significantly affect the habitability of a stream.

Groundwater recharge generally occurs in areas that have relatively:

- flat topography
- highly permeable soils
- highly permeable bedrock geology

Groundwater recharge is not only affected by natural conditions, such as climate and topography. Humans also affect groundwater recharge through farming activities, grading, road construction, and commercial, industrial and residential development. Among other effects, most construction activities involve the introduction or expansion of impermeable surface. *Removing natural vegetation, compacting permeable soils, paving and constructing impermeable surfaces, directing stormwater to detention ponds and pipes, and other such activities can reduce groundwater recharge with both direct and indirect effects on streams and biological systems. By clustering buildings, reducing cartway widths, preserving natural open space, avoiding the use of curbs and other approaches, groundwater recharge can be maintained.*

Groundwater quantity can also be affected by overdevelopment. In order to plan for sustainable land use, it is important to understand the hydrologic system, including the nature of the aquifers, the relationship between groundwater and surface water, the nature of soils and the recharge capacity of the earth's surface in various locations. Every location's natural resources, including water, are limited, and responsible growth management demands an understanding of those limitations. Once the limitations are

defined, methods for recycling resources can be employed and a plan for future development within the boundaries of the resource limitations can be created.

Groundwater Quality

The natural quality of groundwater in the Elk Creeks Watershed varies; the Peters Creek Schist and the Wissahickon Schist tend to yield slightly acidic water that bears iron from the mafic minerals of these formations. Water from the Peters Creek Schist is generally somewhat harder (usually caused by the presence of calcium or magnesium) than water from the Wissahickon Schist. The serpentinite generally does not produce high yields of groundwater, but what there is tends to be hard, due to its magnesium content.

The major anthopogenic sources of groundwater contamination in Pennsylvania, according to the Pennsylvania PADEP, include pesticide application, aboveground and underground storage tanks, surface impoundments, landfills, hazardous waste sites, industrial facilities, mining and mine drainage, pipelines and sewer lines, and spills. Polluted groundwater is a serious concern especially as it affects drinking water sources and baseflow supply for recharging wetlands and streams.

In the Elk Creeks Watershed, groundwater quality is most profoundly influenced by the prevailing land use-agriculture. Nutrients in groundwater of the watershed are higher than background, or natural concentrations, with nitrate appearing above or just barely below the drinking water standard in the majority of wells sampled by the USGS in their 1994 study. The results of the study did not reveal the significant presence of organic or metal pollutants, on a widespread basis.

With the ongoing conversion of agricultural land to residential use, groundwater quality can be expected to remain relatively constant or to decline. As discussed previously, the soils that have made the Elk Creeks Watershed so successful for agriculture are also generally able to absorb wastewater from septic systems. Due to the nature and distribution of these soils, and to the random pattern of residential development, septic systems could become a significant source of groundwater contamination. Traditional on-site septic systems store household waste in underground holding tanks and then distribute the waste through underground pipes in a "drain field." The system develops a suite of microorganisms that consume the wastes, and convert organic nitrogen into other nitrogen-containing compounds, including nitrate (N03). Improperly maintained septic systems can contribute other contaminants, such as pathogens. *Residents should be made aware of local regulations and, perhaps more importantly, the dependence of their own good health, on the proper maintenance of septic systems.*

In some cases, planned communities have turned to "package treatment systems" to process household waste. Some of these systems add a processing step to the basic biological treatment process used in on-site septic systems. This step can reduce much of the nitrate and reduce groundwater contamination. However, package treatment systems require long-term maintenance, therefore it is important to make sure that a responsible entity will be in a position, technically and financially, to maintain these treatment systems over the long term.

Although agricultural land use can cause groundwater contamination, much of that can be controlled through the use of best management practices. Virtually all land uses generate some level of contamination. The degree of contamination can be minimized through the prescription of certain pollution prevention and treatment methods. To date, no prevention or treatment methods that eliminate all contamination from agriculture or household waste have been developed. Therefore, we depend upon dilution as a means of reducing our exposure to contamination. Dilution, in turn, depends on precipitation and recharge of clean water, and on some amount of land that does not contribute contaminants from human activities. If random sprawl were contained, if best management practices were consistently applied, if domestic wastewater systems were all properly maintained and if enough open, natural areas were preserved, groundwater quality could be expected to improve.

Streams

Map 3 shows the Commonwealth-designated uses of streams in the watershed.

Physical Stream Characteristics

A survey of physical stream characteristics was conducted in June of 1999 and covered a total of 105 points throughout the watershed where roads crossed a stream channel. In addition, physical stream characteristics were surveyed in 1977 and again in 1997 by the Pennsylvania Fish and Boat Commission.

Many of the headwaters areas have a similar appearance, with small streams flowing through fields and pastures, or yards, often with no riparian buffer or else narrow riparian buffers of young trees and shrubs. Certain headwaters areas have more extensive mature forested buffers, possibly due to the amount of wet soil, rocky soil, or steep slopes that limited cultivation or pasturing. *These forested buffers serve important ecological functions. With respect to water resources, they provide shade that helps keep the surface water cooler. They act as filters, intercepting eroded sediments that might be carried over by the overland flow of water during storm events and in some cases even removing pollutants from the soil zone. Their roots help hold the soils of the streambanks in place, which can keep the banks from eroding and the sediments from invading the water. With respect to biological functions, keeping excess soil out of the stream is important because sediment-laden water can clog fish gills, expose aquatic organisms to chemical toxins, impair various animals' abilities to detect food and can consume oxygen. Forested buffers also permit birds, reptiles, amphibians and mammals to travel from various habitat areas and territories under cover.*

Most small streams cross under roads in single or double culverts, which present at least three concerns: constriction of floodwaters; barriers to wildlife migration (turtles, fish, frogs, weasels, salamanders), and downstream pools created by channelized water gouging out the streambed. *In order to avoid these problems, township development ordinances could establish more "ecologically friendly" ordinances that encourage the use of properly designed bridges and culverts.*

Very few sections of stream (other than the main stems of the Big and Little Elk Creeks) are protected by a continuous wooded riparian buffer of 75 feet or greater on either side, recommended for proper sediment screening and shading. Many of the smaller

headwaters tributaries have either herbaceous vegetation on streambanks, limited trees and shrubs (less than 25 feet in width along each bank), or a mix. Multiflora rose, an alien, invasive plant with little to no nutritional value for most native wildlife, is common in abandoned streamside pastures. The pattern of pools and riffles in the streambed appears to correspond directly with sections of stream flowing through forested cover. Open, eroded sections of streambed are typically silted-in and have noticeable cut-banks and sediment islands. Algae blooms and aquatic plants are noticeable in a number of areas. Increased turbidity following storms is very obvious.

Farm ponds and (increasingly) development ponds are a common occurrence. Comparisons of aerial photographs from the 1970 to the 1990's reveals a marked increase in the number of ponds in the watershed, particularly along headwaters streams. Unfortunately, this increase generally is not a positive sign for Watershed resources. While residents may enjoy some localized improvement in their access to aquatic resources associated with ponds, the overall effect of artificial ponds is usually to increase water temperatures and expose water that would otherwise be filtered by a protective layer of soil and rock, to pollution from runoff. In general, the construction of artificial ponds should not be encouraged.

Stream Water Quality

Section 305(b) of the Federal Clean Water Act requires the Commonwealth of Pennsylvania to regularly assess and report water quality of streams such as the Big Elk Creek. The Pennsylvania Water Quality Assessment, prepared every 2 years, reports on current water quality data for streams throughout the state, and provides an update of surface and groundwater quality programs, pollution control measures, monitoring programs, and special concerns such as exotic species (zebra mussels, etc.) *Once this Plan has been implemented, this "Section 305(b) report" can be used as one way to measure of progress toward to any water quality improvement goals.*

Agriculture can generate nonpoint source pollution problems including erosion and sedimentation, improper manure disposal, and unintended effects of pesticide use.

The Pennsylvania Water Quality Network operated by PADEP includes the collection of physical, chemical and biological data at 153 stream locations, including one on the Big Elk Creek at the Strickersville Road bridge. Populations of aquatic stream organisms (benthic macroinvertebrates) are monitored for species diversity as an indicator of stream quality, and fish tissue samples are analyzed to check the accumulation of organics and heavy metals. A major goal of this program is to determine whether water quality standards under the Federal Clean Water Act and the State Clean Streams Law are being met.

The PFBC issued a fish advisory for American Eel from the main stem of the Big Elk Creek in April 2001. A limit of two meals per month was established because of mercury. To counter these effects, agricultural best management practices have been developed.

Erosion and Sedimentation
Conventional agricultural operations generally include cultivated fields in which practices such as plowing and discing, applying pesticides and drill seeding (no till) are utilized. Operations involving livestock require grazing, feeding and watering of livestock in pasture areas, which may occur on steep slopes, or in or near streams and wetlands. Each of these activities involves some amount of soil disturbance and vegetation removal at various times of year. Depending on the time of year, the type of soil, the extent and location of the disturbance, and weather conditions, significant quantities of soil can erode from fields, pastures and streambanks and end up as sedimentation in wetlands and streams.

Best Management Practices (BMP's) include such activities as:
- contour farming
- cover cropping
- terracing
- use of grassed swales
- streambank and wetland fencing
- riparian buffer planting

Without the implementation of BMP's, erosion and sedimentation from conventional agricultural operations can lead to a number of problems for the Elk Creeks Watershed, including:
- loss of irreplaceable prime agricultural soils
- increased turbidity of stream water
- silting-in of streambeds
- covering fish eggs and reducing habitat for aquatic organisms
- altering the natural dynamics of streamflow (increased sediment bars and islands, fewer pools and riffles)
- creating slower moving streams with less dissolved oxygen for aquatic life
- greater potential for algae blooms (eutrophication) due to excess nutrients, like nitrates
- downstream impacts to the public water supply of the Big Elk Creek
- estuary impacts resulting from reduced populations of bay grasses in the Chesapeake Bay, which are critical habitat and spawning areas for many species of fish and other aquatic life in the estuary.

Headwaters Areas
Stream headwaters are important conservation targets for a number of reasons. First, they contain intermittent and smaller stream segments, which, because of their low volume, are sensitive to reductions of water in the overall hydraulic system. Significant withdrawals from baseflow-providing aquifers or from surface water bodies translate into reductions in aquatic habitat. Second, these reductions in water quantity affect streams' abilities to withstand other environmental impacts, such as chemical and thermal pollution. Lowering the volume of water in a stream lowers its ability to dilute chemical constituents from agricultural runoff, for example, as well as its ability to resist increases in temperature from solar radiation where vegetative cover is lacking. Since the native inhabitants evolved to prefer the cooler conditions of shaded streams, such increases in

temperature make a stream system less hospitable to native species. Finally, because the water from headwaters areas flows to downstream areas, degradation in water quality or quantity can affect downstream areas as well as the actual headwaters.

Planning Implications
Headwaters, composed of first and second order streams, comprise about 59% of the total stream miles in the Elk Creeks Watershed. Cultivation activities are obviously most easily undertaken on more level, headwaters terrain, rather than in the steeper-banked valleys carved by the larger streams. Much of the residential development has occurred in formerly agricultural areas. Therefore, most of the headwaters are surrounded by agricultural or residential land uses. Relatively few farmers and homeowners take measures to buffer these sensitive streams by fencing off livestock or allowing natural vegetation to grow along the banks. *Consequently, one of the greatest opportunities for effecting improvements in the health of the Elk Creeks Watershed is to pursue conservation projects in headwaters areas.*

Natural Areas
The Elk Creeks Watershed includes a rich natural landscape of woodlands, meadows, hedgerows, wetlands, ponds, and streams that support literally thousands of species of native plants and wildlife (see Map 7). This biological diversity ("biodiversity") can be described as "the rich variety of native vegetation and wildlife and the habitats on which they depend." The diversity of native species and natural areas function together as ecosystems that provide numerous benefits and "ecosystem services" to the residents of the watershed and should be evaluated for protection as part of the necessary "green infrastructure" of a healthy, sustainable community. The diverse natural systems of plants, animals, soils and water are nature's life-support systems, providing clean air and water, and regulating climate extremes and flooding. Local biodiversity directly supports timber production and provides opportunities for residents and others to enjoy scenery, recreation, environmental education, hunting, fishing, bird-watching and outdoor activities. From the smallest insects and lichens to top predators, the diversity of native plants and animals and their habitats play an important role in keeping the environmental health of the Elk Creeks Watershed in balance.

This section evaluates the vegetation and wildlife and their habitats in the Elk Creeks Watershed, the community benefits they provide, and the issues affecting them, and prescribes strategies for ensuring their protection as part of balanced growth.

The Elk Creeks Watershed is situated in the northern Piedmont section of the Eastern Deciduous Forest. Its dominant natural vegetation is mixed-oak and oak-hickory forest, with 4 main habitat types:

1. Woodlands
2. Successional Lands (meadows, old fields, thickets)
3. Wetlands
4. Streams (from small tributaries to the Big Elk Creek)

These natural areas provide habitat for a wide variety of native vegetation and wildlife, particularly where they occur in large, interconnected networks. The most functional

habitat networks for native species can best be understood as "core reserve" natural areas linked together by "natural corridors" These natural areas and corridors are not distinct; they often overlap in places such as forested wetlands, forested stream corridors, wetland meadows. In fact, some of the most diverse natural areas in the watershed are those areas where two habitat types come together.

These natural areas occur throughout the watershed in the following overall pattern: Approximately 56% of the headwaters streams areas in the watershed have wooded or partially wooded streams/seeps/springs (some young thickets of pole sized trees and multiflora rose, some older woodlots of 50, 75, 100 years in age). Hedgerow networks are common. Meadows are uncommon, although some headwaters areas support broad wet meadows and marshes.

The southern part of the watershed area has dramatic, steep, wooded slopes, wooded ravines, boulders, rock outcrops, forested floodplains, some emergent wetlands. The steep ravines along the Big Elk near the two covered bridges (the Big Elk Creek Woods) are a very distinct natural landscape, with wide stretches of creek meandering through steep, densely forested slopes. *The area from forks of the East and West Branches southward to Fair Hill at state line should be prioritized as "core reserve" and "natural corridor" areas, since they contain large, mature woodlands along steep ravines, a large section of the main stem of Big Elk Creek, at least one sizeable wetland area, and two historic covered bridges.*

The Nature Conservancy's Chrome Barrens preserve protects one of the largest, most intact serpentine barrens, a globally rare ecosystem located along Jordan Run and Barren Run on the Little Elk Creek. The Chrome serpentine barrens have a distinct presence in the landscape, with a shift to more eastern red cedar in fields and pastures, with more broomsedge and little bluestem grasses, and woodlands with blackjack oak, post oak, greenbrier. *This is another important "core reserve" to consider.*

Hedgerows are present on many farms, with the typical pioneer trees (sassafras, black cherry, black walnut, ash, red maple, tulip poplar) and multiflora rose common. A fair number of farms maintain their road frontage as mowed grass rather than hedgerow vegetation. *Hedgerow networks throughout the watershed should be assessed in terms of their function as wildlife corridors linking other natural areas.*

Woodlands

Woodlands in the Elk Creeks Watershed occur as a scattered patchwork of various sizes, shapes, ages and types. Where the forest remains, it belongs to the Oak-Hickory forest community, which ranges throughout most of the Appalachian Mountain system. These forests are home to various species of oak and hickory as well as dogwood, sassafras, tuliptree, elm and maple. The shrub layer of these forests is characterized by the presence of mountain laurel, blueberry and viburnum, while the herb layer typically contains a variety of ferns and wildflowers.

One of the most important characteristics of a woodland is its interior habitat, defined as that portion in the center of a woodland that lies at least 300 feet from its outer edge. These interior areas are protected the most from most sources of habitat disturbance.

They are less susceptible to alien invasive plant seeds dispersed by wind or to vines that plague the forest edges, and the tree canopy shades the lower strata of the forest vegetative layers, which is a condition that prevailed prior to European settlement. Also, certain species of plants and animals require interior zones for habitat.

Using a Geographic Information System (GIS) an analysis of forest interior habitats was performed (see Map 7). This analysis involved the ranking of woodlands with interior habitat, based on the relative size of the interior zones. This ranking has been included as a factor in the prioritization of areas in the watershed where preservation efforts should be most keenly focused.

Topography, hydrology and soils are the most influential natural factors in determining the six different forest types that make up the woodlands in the watershed. The six forest types (with dominant species) are:

1) dry woodlands on ridges/steep slopes (white, red, chestnut oak);
2) north-facing woodlands on moderate slopes (beech, oak, hickory, tulip poplar);
3) south-facing woodlands on moderate slopes (tulip poplar, red maple, hickory, oak);
4) forested wetlands/floodplain woodlands (white, pin oak, sycamore, red, silver maple);
5) woodlands in "coves" or ravines along major streams;
6) serpentine woodlands (blackjack oak, post oak, sassafras, eastern redcedar).

These variations are important in supporting the watershed's rich diversity of plant and animal species. The different types will be described below as they occur in landscapes throughout the watershed.

Woodlands play a vital role in recharging groundwater and reducing stormwater runoff and flooding in the watershed through their ability to intercept rainfall and direct it down toward aquifers through root systems and forest soils. Local woodlands promote clean air by producing oxygen and reducing carbon dioxide, and also moderate temperature and wind extremes experienced by residents. *Some of the most scenic areas and popular recreational and educational sites in the watershed are found in woodlands.*

Large Upland Forest (> 100 acres)

Big Elk Creek Woodland and Forks Woodland

The wooded slopes and floodplains in the central part of the Elk Creeks Watershed support some of the largest and most interconnected tracts of forest remaining in southern Chester County. Though fragmented by roads, utility lines and residential developments, the series of woodlands of 50 to 100 acres or more along this section of the valley forms a nearly continuous natural corridor linking up with the 5,000+ acre Fair Hill Natural Resources Management Area in Maryland. *The Natural Areas Inventory of Chester County* ("the Inventory") identifies the "Big Elk Creek Woods" as being "Locally Significant", with a County Rank of Medium. The Big Elk Creek Woods is further described in a recent naturalists survey prepared by the Brandywine Conservancy as follows:

> The site provides buffering and habitat protection for species identified in a 1995 plant survey of the northeast quadrant of Big Elk Creek Woods, including one (1) PA Endangered plant species, tawny

ironweed (*Vernonia glauca*), and three (3) PA rare plant species, including a large population of cranefly orchid (*Tipularia discolor*), golden club (*Orontium aquaticum*), and riverweed (*Podestemum ceratophyllum*). A total of five (5) orchid species were identified in the Big Elk Creek Woods site. The Big Elk Creek Woods is ranked as Locally Significant with a County Rank of Medium in the Chester County Natural Areas Inventory of 1994. The Inventory preceeded the plant survey, but noted the size and maturity of the Big Elk Creek Woods as having countywide significance.

The site is rich in biological diveristy, with a variety of forest types from upland to floodplain, and represents a prime example of the Natural Landscapes identified in Landscapes, adopted by Chester County in 1996. The upland forest on the site includes two distinct stands of different ages and is contiguous with the forested stream valley which is sufficiently large to provide forest-interior habitat for neotropical birds and other deep-woods species. Younger upland forest on the site supports 40-50 year old stands of red maple, tulip poplar, and black birch with flowering dogwood, sassafras and spicebush understory. The western boundary of the site is bordered by a wide, maturing hedgerow of tulip poplar, ash, red maple, and flowering dogwood, with a thick shrub layer of spicebush and viburnum. This portion of the woodland was a former pasture bordered by hedgerows, as indicated by a younger (30 - 40 year old) upland stand of tulip poplar, red maple, ash and black birch, with eastern redcedar scattered throughout and some larger "wolf trees", primarily tulip poplar and black birch, representing older (75 - 100 year old) hedgerows along fencelines. Black walnut is a common tree in younger stands and woodland edges, with patches of quaking aspen and eastern redcedar near the top of the slope.

Downslope, more mature stands of tulip poplar, red oak, white oak, black oak, and hickories characterize the woodland, with some trees reaching 25 - 35 inches in diameter-at-breast-height (dbh). The southeastern ridge and slope supports dry, acid soil conditions characterized by white oaks and an understory of mountain laurel, lowbush blueberry, and viburnums. Numerous species of mosses, lichens, clubmosses and ferns are found throughout the woodland, particularly in wet areas along the tributary stream and seeps and springs, which also support wetland species such as skunk cabbage. Most of the forest exhibits relatively good tree regeneration, with young red and white oak saplings, tulip poplar, and hickory in most areas.

The site provides buffering and habitat protection for species identified in a 1995 plant survey of the northeast quadrant of Big Elk Creek Woods, including one (1) PA Endangered plant species and three (3) PA rare plant species. A total of five (5) orchid species were identified in the Big Elk Creek Woods site. A May 1997 bird survey of the Big Elk Creek Woods identified over 15 neotropical migratory bird species, indicating that the area provides significant migratory and breeding habitat for these species. With the addition of the project site to the Lenhart easement, the total area of protected forest in the Big Elk Creek Woods will be expanded to over 110 acres, or 36% of the total area.

The site includes over 2,400 feet of the east bank of the Big Elk Creek, designated as a High Quality - Trout Stocking Fishery under the Special Protection Waters category of the PA Department of Environmental Protection's Chapter 93 stream classification system. Protection of the site will extend the linear feet of protected Big Elk Creek stream frontage to over 3,300 feet on the east bank, or 46% of the total of 7,200 feet in the Big Elk Creek Woods. The limited floodplain habitat and stream bank along Big Elk Creek support a mixture of oaks, tulip poplars and hickories, with ironwood, arrowwood and spicebush common in the understory. Pinxter azalea is also found near the stream bank. The site also includes seeps and springs and 3 unnamed tributary streams. The woodland provides a riparian buffer for the Big Elk Creek of between 600 and 800 feet in width.

Plant surveys conducted in the Big Elk Creek Woods verified the outstanding quality and diversity of its forest-interior habitat, with five species of orchids, including a large number of crane-fly orchid (*Tipularia discolor*), listed as Rare in Pennsylvania. A purple wildflower known as tawny ironweed (*Vernonia glauca*), listed as Endangered in Pennsylvania, is also found in the younger woodland areas and edges.

The Forks Woodland
A second major block of upland forest, which was present at the outset of this planning process, was situated at the confluence of the East and West Branches of the Big Elk Creek. The Forks Woodland covered about 375 acres, and included a diverse mix of dry, north-facing and south-facing moderate slopes, floodplain forest, and even cove or ravine forest. This woodland was valuable as part the northern anchor of woodland along the Big Elk Creek Corridor, providing excellent habitat and an important stopover point for migratory birds. These refuges from intensive human activity are critically important habitats for many species of native plants and wildlife, including migratory songbirds such as warblers and wildflowers such as orchids.

Unfortunately, the Forks Woodland has been subdivided since this planning process began in 1999, and will no longer serve as the number one priority for protection as it did in the first draft of this report. The loss of the Forks Woodland magnifies the role of the remaining Big Elk Woods and adds urgency to any protection effort that might be considered.

The Big Elk Creek Woods area should be considered as a potential "core reserve" for conservation planning efforts. The wooded and partially wooded Big Elk Creek Corridor extending down to Fair Hill, Maryland should be considered a potential "natural corridor."

Forested Stream Corridors
The Elk Creek watershed's natural landscape includes several of the most pristine forested stream valleys in southern Chester County and a number of streams bordered by more narrow woodland corridors (see Map 9 – Riparian Buffers). These forested stream corridors vary greatly in width and length, yet they constitute some of the most important habitat for native plants and animals living within and along streams in the watershed.

There is a direct correlation between presence of streamside (or riparian) woodlands and the quality of the stream ecosystem. Riparian woodlands provide shade and organic matter to support aquatic organisms such as larvae and nymphs that form the base of the food web in a stream. They also provide important "ecosystem services" to the community by stabilizing streambanks, reducing erosion and sedimentation, moderating flooding, and filtering out pollutants from runoff. Forested stream corridors also provide important habitats to support stable populations of species such as mink, Louisiana waterthrush, freshwater mollusks, native brook trout and spotted salamander.

Forested wetlands of white oak, pin oak, sycamore, black walnut and red maple are frequently found in the broader headwaters wetlands, and floodplains along the Big Elk, Little Elk, and larger tributaries, whereas the steeper stream valleys have narrow floodplains and support more of a mixed-hardwood forest type common on slopes.

Even with the loss of the Forks Woodland, a natural corridor of significant forests lines the banks of the main stem of the Big Elk Creek (in East Nottingham, New London, Franklin and Elk Townships). This should also be considered a "natural corridor" for protection.

The Jordan Run and Barren Run corridors in the Little Elk Creek subwatershed each support healthy, diverse forested slopes and narrow ravines with Exceptional Value stream ecosystems. These and other forested streams and sloping woodlands in the watershed provide habitat supporting at a variety of bird species including a number of rare breeding bird species. A variety of amphibians including salamanders, frogs and toads rely on these forested stream corridors and wetlands. Of particular importance to amphibians are the vernal pools that form in floodplains each spring, which provide important breeding and egg laying habitat.

Conservation planning efforts should recognize all stream corridors in the Elk Creeks Watershed as potential natural corridors providing ecologically important linkages between a variety of natural areas.

Small Woodland Networks

The majority of the woodlands in the Elk Creeks Watershed are small (2 to 20 acre) woodlands commonly found in the northern, western and eastern sections of the watershed. Many of these are woodlots managed for lumber and firewood by local landowners for many years. These woodlots have noticeably square boundaries that follow roads and property lines, and are often interconnected by hedgerows following fencelines. While trees have been regularly harvested in these woodlots, these may be among the oldest continuously-managed woodlands in the watershed. The network of small woodlands linked by hedgerows and streams plays an important role in connecting the natural "fabric" of habitat found in larger woodland networks. Without them, even larger woodland networks become more isolated and their diversity can be expected to decline.

Small woodlands in the watershed should be considered core reserve areas for conservation planning, while the hedgerows and streams linking them should be considered natural corridors. Where practical, these woodlots should also be recognized as candidates for expansion, by allowing woodland perimeters to grow outword.

Wetlands

Wetlands are areas that contain soils with certain characteristics and certain types of plants and animals because they tend to be saturated with water on a frequent basis. The importance of wetlands cannot be overstated. Not only do they serve as nurseries for many plant and animal species at the bottom of the food chain, but they also absorb and dampen peak floodwaters and absorb contaminants, thereby providing a water purification process.

The network of emergent wetlands, wet meadows, scrub-shrub wetlands, forested wetlands and ponds in the Elk Creeks Watershed represents a variety of habitats for plants and animals created by the intersection of soil and water, and a living system the provides critical water supply and flood control functions for the entire watershed. Over 50% of the wildlife species inhabiting Pennsylvania depend on wetland habitats for at least a portion of their food, cover, or reproduction requirements, yet in excess of 50% of the wetlands in the state have been lost to agriculture and development. The diversity of

birds, reptiles and amphibians in the watershed would be greatly diminished without a healthy number of wetlands of all types.

Other wetland habitats can be found where seeps and springs emerge at the headwaters of streams, or along broader floodplains. Forested wetlands tend to grow in areas without recent disturbance, whereas open wet meadows or emergent marshes tend to occur in areas that have been historically cleared and drained for agriculture. The recolonization of beavers in the area reintroduces one of the original natural creators of open wetland habitats. By cutting trees and building dams, beavers remove riparian woodlands and create flooded environments which favor herbaceous plants such as sedges, rushes and wetland wildflowers. Beaver dams may also create wet meadows in streamside areas previously supporting pasture, cropland or lawn areas.

Because of both their great importance, and the alarming rate at which wetlands have been destroyed, wetlands have become the subject of focused protection efforts within the last thirty years. Congress emphasized wetland protection in the Clean Water Act of 1972, including requiring that projects impacting wetlands undergo review by the Army Corps of Engineers. Since then, many states, including Pennsylvania have fortified protection efforts. Even so, regulatory programs do not necessarily afford adequate protection to wetlands. For example, the federal Clean Water Act does not prohibit the de-watering of wetlands even though the water is the very feature that distinguishes wetlands from other areas. Consequently, the Army Corps of Engineers regulates only those activities in wetlands that constitute "filling" the wetlands. The Pennsylvania Department of Environmental Protection does not consider the potential impacts of stream flow reduction on downstream riparian wetlands and many municipalities do not regulate wetlands per se. *Since the regulatory programs fall short of adequate wetland protection this Plan recognizes the importance of wetlands to the health of the watershed by containing specific recommendations for their preservation.*

Broad wetland areas in the watershed tend to be fairly isolated, and linear, streamside wetlands are more common. Broader wetlands and square or rounded wetlands of one acre or more should be considered <u>core reserve</u> areas for conservation planning purposes, whereas narrow, linear wetlands should be considered along with streams as <u>natural corridors</u>.

Successional Lands/Meadows

Successional lands in the Elk Creeks Watershed can generally be described as areas that have recently been abandoned from agricultural use and that have reached various stages of regrowth. If permitted to reach maturity under natural conditions, these areas would eventually become part of the Eastern Deciduous Forest habitat. Successional lands ranging from meadows to old fields to thickets are all important habitats for vegetation and wildlife, particularly where they provide buffers or corridors between other natural areas. They add to the variety of ecosystem services provided by other habitat types, particularly as natural alternatives to lawn or paved areas, and act as valuable groundwater recharges areas.

Open space areas in the early stage (1 to 5 years) of succession are generally considered meadows or grasslands. Some landowners prefer to manage these areas by once or

twice annual mowing, to encourage grassland habitat for species such as wildflowers, butterflies and grassland nesting birds, and to maintain the aesthetics of an open, rural landscape without the cost and environmental impacts associated with lawn care.

Without disturbance such as mowing or burning over a 5 to 10 year period, abandoned fields will reach the old field stage of succession. While this stage may not be considered as aesthetically pleasing as a wildflower meadow, the mixture of grassland vegetation, shrubs and young trees supports a wide diversity of wildlife species and provides excellent bird habitat.

Between 10 and 15 years the woody trees and shrubs become dominant, forming thickets as the last stage before becoming a young woodland. These thickets include fast growing "pioneer trees" such as black walnut, black cherry, ash, sassafras and red maple that help to establish a young woodland. Unfortunately, many thickets are dominated by non-native invasive vines and shrubs such as oriental bittersweet, Japanese honeysuckle, mile-a-minute weed, and multiflora rose, as well as native, but invasive wild grape. Without selective management, these species will out-compete young trees and prevent establishment of woodlands.

For conservation planning purposes, the broadest successional areas of 3 acres or greater should be considered core reserve areas, while narrow strips of successional habitat along utility line corridors should be defined as natural corridors.

Serpentine Barrens
Serpentine barrens are technically a type of successional lands which will revert to an unusual woodland type if not subject to natural or human disturbance such as fire, cutting, or grazing.

Wildlife
The namesake for the Elk Creeks Watershed is the native woodland elk or wapiti (*Cervus elaphus*), a large herbivore that once ranged throughout North America but was extirpated over most of its former range due to overhunting and conversion of forests to farmland following European settlement. The elk is just one of a number of wildlife species that once were but no longer are part of the Elk Creeks Watershed. The large herbivores and the top predators were exterminated by the early 1800's in southeastern Pennsylvania due to overhunting and loss of natural habitat. Mountain lion (*Felis concolor*), gray wolf (*Canis lupus*), woodland bison (*Bison bison*) and elk were all present in the forests of the region for thousands of years. It is difficult to estimate how the absence of these and other plant and animal species has changed the ecological balance of the remaining woodlands, wetlands, streams and grasslands.

The Pennsylvania Game Commission has reintroduced a small population of elk from the Rocky Mountains to a remote 80 square mile area in the northcentral part of the state, raising an interesting question -- could elk ever be reintroduced to the Elk Creeks Watershed? While elk reintroduction (or mountain lion or gray wolf reintroduction) is highly unlikely given the lack of habitat and the relatively dense network of roads and expanding development in the watershed, reintroductions of species such as beaver (*Castor canadensis*) and wild turkey (*Meleagris gallopavo*) have been successful in other

locations that share these characteristics. With careful protection and restoration of natural habitat, other species such as river otter (*Lutra canadensis*), ruffed grouse (Bonasa umbellus), and bog turtle (Clemmys muhlenberghii) could return to the watershed as well.

The wildlife of the Elk Creek watershed includes at least 135 species of breeding birds and 117 species of transient or occasional visiting birds; 10 species of turtles; 15 species of snakes; 11 species of frogs and toads; 12 salamander species; 2 lizard species; over 40 species of large and small mammals; a variety of cold-water and warm-water fish species; and a vast number of microorganisms and invertebrates (e.g., at least 30 species of butterflies, other insects, freshwater mussels). A survey of all wildlife has not been undertaken, but Appendix II includes a list of birds known to occur in the Elk Creeks Watershed.

Planning implications

The greatest threat to biodiversity and the natural areas of the Elk Creeks Watershed is development, which results in:

- destruction, fragmentation, and degradation of habitat;
- altered hydrology;
- pollution;
- invasive exotic species;
- excessive browsing of deer.

The natural landscape of forests, streams and wetlands and the species it supports has undergone centuries of intensive alteration —from the initial wave of hunting wildlife, clearing forests, draining wetlands, and damming of streams from the 1670's through the 1820's, to the rapid population growth and major shift to dairy farming (1830's to 1930's).

For the past 50 years, however, the Elk Creek watershed's natural areas have been experiencing a dual trend – a process of regeneration and fragmentation. Much of the land cleared for farming has been left to regenerate as woodland and wetland areas. Abandoned agricultural fields are growing up with grasses, wildflowers, trees and shrubs. Wetlands once drained for agriculture are reverting back to wetlands. Old mill and pond dams are no longer in use, allowing streams to once again flow freely. Yet amidst all of this regeneration, suburban development has been steadily fragmenting and isolating those newly expanded natural areas. *While it may take a woodland or wetland 20 years to grow back following abandonment from cattle grazing, it only takes a construction company a matter of weeks to clear the native vegetation and begin building roads and houses.*

Suburban roads, large, cleared residential lots, highway commercial shopping areas and office/industrial parks are rapidly fragmenting the habitats that have rebounded over the last half century. Increasing numbers of woodlands, successional lands, streams and wetlands are becoming fragmented by development, resulting in isolated pockets of

habitat that are too small, too isolated, too irregular in shape, and too poor in quality to support viable populations of the native plants and animals that once inhabited the area.

Lawns and pavement are "biological deserts" compared to the rich habitats they replace. The resulting environment favors the hearty "habitat generalist" species such as white tailed deer, Japanese honeysuckle and Canada geese that can adapt to urbanized areas, and excludes the more vulnerable "habitat specialists" such as minks, bald eagles, and native orchids that depend on specific, undisturbed habitats. An ecosystem cannot function over the long term without natural species diversity beyond these specialists.

Forest fragmentation is becoming evident, leaving some forested areas too small and isolated to serve as valuable ecological areas. Therefore, the focus of the Plan is on larger, mature tracts, especially where linked by streams. In order for existing woodlands to function effectively, preservation efforts must focus on:

- re-establishing forested areas where possible;
- restoring existing, but poor quality forests;
- expansion of existing forests;
- connection of forested areas;
- buffering of forested areas.

Agriculture

Approximately 62% of the land in the Elk Creeks Watershed is in some form of agricultural use (see Map 8). The watershed supports a range of successful farm operations – including dairy farms, crop farms growing corn and soybeans, produce farms growing vegetables and fruits, mushroom farms, and equestrian operations.

With some of the most naturally-productive farmland anywhere in the country, an extensive land base of historic working family farms dating back to the 18th and early 19th century, the farming communities of the Elk Creeks Watershed should be well positioned to maintain their important role in Chester County's agricultural economy both now and in the future. However, as with forests and other land uses, fragmentation threatens the viability of farmland.

Within Agricultural Security Districts, farms are protected from nuisance complaints that often accompany residential encroachment. However, in areas where suburban homeowners dwell in close proximity to agricultural lands, farmers complain that they feel unwelcome because neighbors complain about noise and odors, farm machinery on roadways, and they trespass over cultivated grounds with regularity. Not only does the loss of farms create a less hospitable atmosphere, it creates a less economically viable scenario as farm-related industries and infrastructure recede toward the remaining areas of higher agricultural density. Other forces that affect the decision to continue farming in the watershed range from development pressure to taxes to unsteady crop and livestock prices to the high cost of land and equipment. These forces are serious and are a major factor in driving many farms out of existence, but are largely beyond the scope of this Plan. The complexity of the farmland preservation situation underscores the need for a concerted preservation effort to accompany other needed measures, such as tax reform.

Agriculture's contribution to the watershed is a mixed one: while the use of agricultural chemicals and the poor management of farm animals and waste can adversely affect water quality, agricultural fields can serve as important groundwater recharge areas. They also may serve as valuable habitat, providing feeding and resting areas for migratory birds, cover for mammals, nesting territory, and homes to rodents, reptiles and insects upon which foxes and raptors feed. *Because agricultural operations can be conducted in an environmentally sound way and water quantity is as important as water quality, the focuses within this Plan are on responsible agriculture and agricultural preservation. Responsible agriculture emphasizes the use of best management practices, including integrated pest management, manure containment, riparian vegetative buffering and livestock exclusion fencing around streams. If conducted in accordance with best management practices, agriculture can be a valuable contributor to the health of the watershed, providing both important recharge areas and wildlife habitat.*

Land Use Pattern

The overall land use pattern is predominantly agricultural with scattered residential development (see Map 8). Farms range in size from about 20 to several hundred acres. Very few farms appear to be growing produce such as vegetables and fruits, and there are few farm stands or farm markets. Equestrian uses are also present, scattered somewhat randomly throughout the watershed, with a small number of larger (100+ acre) horse farms, but the majority being smaller (5 to 50 acres) properties. Several nurseries and Christmas tree farms are also present. Most farms are family-owned rather than corporate and a small but growing percentage are operated by Amish owners. Approximately 26% of the watershed is publicly owned land.

Most new development is either road front lots carved off by farmers (a widespread trend dating from 1950s to present), small subdivisions of 20 or fewer 1-acre lots, or a relatively small number of large-scale residential subdivisions (20 to 100 lots). While some of the residential development is concentrated in the southeast part of the watershed along Route 896 outside of Newark, and along US Route 1, most of it follows a fairly random pattern of scattered sprawl. Most commercial/industrial development appears to be centered around existing towns such as Oxford, New London, or spread along major roads such as US Route 1, PA Route 10, PA Route 896, and PA Route 472.

Route 796 south from Route 926 follows the eastern boundary of the watershed. The road passes through Londonderry and Penn Townships and merges with Route 896, which continues along the eastern boundary. Most of this northeastern headwaters section of the watershed is dominated by agricultural land (primarily crops such as corn and soybeans with scattered dairy operations), with consistent, older "frontage lots" (1940's through 1970's) and occasional small new (1980's or 1990's) residential subdivisions of 10 to 20 houses. Mobile home parks are not prevalent (one in Londonderry for 50 units), and the large Oxford Village park along US Route 1 and Old Baltimore Pike at Pusey Mill Road. The Jenners Pond retirement community represents a growing land use pattern serving a "baby-boomer" population that is living longer. The Southern Chester County Medical Center is the main hospital serving residents in the watershed. Lincoln University includes a 65 acre campus and a collection of mid-1800's to early 1900's brick buildings.

Demographics
According to the Delaware Valley Regional Planning Commission (DVRCP), the projected average population growth for all ten municipalities in the Elk Creeks Watershed between 1980 to 2025 is 126% (see Table 1). Of the ten municipalities, New London has the greatest projected growth rate, at 422%, which is likely unprecedented in the watershed, even given Oxford Borough's explosion from 482 to 1151 residents between 1860 and 1870. *The Borough of Oxford is expected to experience 10% growth, the lowest rate of all the municipalities in the watershed. Unfortunately, the projection is nearly the opposite of a growth pattern that would most effectively accomplish conservation goals of the watershed.*

In order to accommodate the projected population growth in a way that is compatible with resource conservation goals, the growth rates for Oxford Borough and New London Township would be essentially reversed. That is, growth would be concentrated in the Borough, where water and transportation infrastructure either already exists, or would merely need to be augmented. By contrast, virtually any additional population growth in New London Township would require the creation or addition of new infrastructure. Not only is this situation representative of the most costly way of allowing population growth, it is also generally the most environmentally harmful. Denser development in and around existing villages makes for more compact (and therefore more profitable) service territories, lower use of automobiles and gasoline consumption, and preservation of farmland and wildlife habitat.

Development outside of villages and boroughs often brings suburban dwellers close to agricultural land uses that are incompatible, sometimes involves the extension of pipelines through less developed areas and the placement of infrastructure in areas that formerly served as good wildlife habitat. For example, the Forks Woodland in New London Township was initially identified as the highest ranking conservation priority of the watershed during the early analysis stage of this Watershed Conservation planning process, primarily because it contained a large interior forest habitat of great value to wildlife and contributes recharge and water quality improvements to both the East and West branches of the Big Elk Creek. The woodland has since been subdivided, and with this subdivision, a substantial portion of one of the most valuable environmental features of the entire watershed was lost.

Because the effects of suburban sprawl can be so detrimental and costly, some localities have undertaken focused actions to reverse its trends. For example, the State of Maryland adopted a Smart Growth policy in 1997 that advances three stated goals:

1) *to* ***save the most valuable remaining natural resources;***
2) to ***support existing communities and neighborhoods*** *by targeting state resources to support development in areas where the infrastructure is already in place or planned to support it; and*
3) to ***save taxpayers millions of dollars in the unnecessary cost of building the infrastructure required to support sprawl.***

The Smart Growth program also contains provisions that pertain specifically to local land use authorities:

- **Impact Fees**
  Municipalities in a county with a residential development impact fee to finance the costs of school construction must help counties collect that fee for new residential construction in the municipality. The map identifies counties, as of June 1997, where this provision applies. The municipality may either collect the fee and remit it to the county, or require the fee be paid to the county. This provision does not affect any existing agreements between a municipality and a county concerning the levying and collection of impact fees.
- **Adequate Public Facilities Standards**
  Municipalities exercising zoning authority in a county with adequate public facility standards for school capacity must adopt their own adequacy standards before the State can fund growth related projects. This requirement is waived for municipalities that collect an impact fee or have other provisions to defray the local cost of school construction attributed to new residential development.
- **Annexation**
  Areas annexed by a municipality after January 1, 1997 must meet the following residential density standards to qualify as Priority Funding Areas:
  - Land that was developed before January 1, 1997 must have community sewer service and an average density of 2 or more units per acre.
  - Land that was undeveloped as of January 1997 must have community water and sewer service and an average permitted residential density of 3.5 or more units per acre.

Of course, the strength of Maryland's Smart Growth program derives from its adoption by the state, which has the resources and power to implement many of the policies in a way that local governments, without state support, cannot.

Nevertheless, higher levels of government in Pennsylvania have also adopted policies and developed programs that are intended to help curb some of the adverse impacts of unplanned growth as well, including the Commonwealth's Growing Greener Program. In addition, Chester County has adopted and implemented a "smart growth" policy through its comprehensive plan, *Landscapes*. In addition to designating more appropriate geographic areas for development, Chester County offers support to municipalities in the form of grants.

By taking advantage of resources offered by county and state government, and by adopting new land use provisions specifically designed to conserve natural resources through better land use planning, municipalities in the Elk Creeks Watershed can control some of the harmful effects of past development trends as well as correcting these trends for the future.

Water Supply

Water supplies are derived from a combination of surface water and groundwater in the watershed. The Borough of Oxford originally operated a reservoir, now occupied by a water tank, which was filled with water from the West Branch of the Big Elk Creek. The Borough augments this supply with groundwater from wells around its perimeter and ties into the Chester Water Authority's supply line that pipes water from the Octoraro Reservoir along the southern end of town.

The vast majority of subdivisions rely upon individual wells for water supply. As mentioned previously, the Peters Creek Schist is not reliable for widespread, sustainable use. Although the predominant Wissahickon Schist is a relatively stable supply of groundwater, all sources of water involve some ultimate limitation. Without preserving recharge areas, the precipitation that infiltrates to the groundwater used by residents, and that supplies baseflow to streams will not be sustained. Therefore, the proper management of stormwater and the preservation of open space for recharge are critical to the maintenance of adequate water supply.

Whereas surface water reservoirs are often identified as a solution to water supply questions, they are not a panacea. Creating a reservoir involves land acquisition and the displacement of other uses as well as significant investments in engineering and infrastructure. They represent long-term commitments to maintenance and operational costs. Finally, reservoirs fail to take advantage of the natural efficiency that the earth provides for groundwater: filtration by the soil. The soil serves as a buffer mechanism that helps keep many contaminants out of groundwater. By contrast, surface water supplies must be heavily disinfected. The most inexpensive disinfection method is the introduction of chlorine, which kills harmful bacteria, but also combines with natural, ubiquitous organic materials to form small amounts of carcinogens.

The development of all water supplies entails some costs. In the Elk Creeks Watershed, groundwater is the predominant source of supply. New surface water sources would not be viable because of the associated costs and inefficiencies, especially given the dispersal of existing water consumers in residential subdivisions.

In order to maintain the current groundwater-based system, several actions are imperative.

- *A study should be undertaken to determine the amount of water available for various uses throughout the watershed;*
- *Land use plans should be revisited and revised, if necessary, based on the findings of the study;*
- *Measures must be taken to maintain groundwater recharge, and to prevent contamination, including:*
  - *Proper management of stormwater for maximum infiltration;*
  - *Preservation of open space for recharge of clean precipitation;*
  - *Increased use of best management practices and;*
  - *Proper maintenance of septic systems.*

Cultural and Historic Resources

The Elk Creeks Watershed has a rich local history that spans thousands of years of settlement by the Lenni Lenape people, settlement nearly 300 years ago by (primarily) English Quakers and Scotch-Irish Presbyterians, a long agricultural history, a role in the Civil War and Underground Railroad, and one of the first African American colleges in the nation.

Interestingly, the Little and Big Elk Creeks and several of their tributaries play an important role in the cultural geography of the area, serving as boundaries between the

municipalities, and having supplied many mills with energy during the 18th and 19th centuries. Some of these old mill buildings still stand today, but most others have long since succumbed to disuse and deterioration.

During the initial British settlement of the area, both Lord Baltimore and William Penn claimed title to land in the watershed. The following is an excerpt from a website (http://geography.about.com/library/weekly/aa041999.html) focused on the Mason-Dixon line.

> Though the Mason-Dixon line is most commonly associated with the division between the northern and southern (free and slave, respectively) states during the 1800s and American Civil War-era, the line was delineated in the mid-1700s to settle a property dispute. The two surveyors who mapped the line, Charles Mason and Jeremiah Dixon, will always be known for their famous boundary.
> In 1632, King Charles I of England gave the first Lord Baltimore, George Calvert, the colony of Maryland. Fifty years later, in 1682, King Charles II gave William Penn the territory to the north, which later became Pennsylvania. A year later, Charles II gave Penn land on the Delmarva Peninsula (the peninsula that includes the eastern portion of modern Maryland and all of Delaware).

The description of the boundaries in the grants to Calvert and Penn did not match and there was a great deal of confusion as to where the boundary (supposedly along 40° north) lay. The Calvert and Penn families took the matter to the British court and England's chief justice declared in 1750 that the boundary between southern Pennsylvania and northern Maryland should lie 15 miles south

of Philadelphia. A decade later, the two families agreed on the compromise and set out to have the new boundary surveyed. Unfortunately, colonial surveyors were no match for the difficult job and two experts from England had to be recruited.

Charles Mason and Jeremiah Dixon arrived in Philadelphia in November 1763. Mason was an astronomer who had worked at the Royal Observatory at Greenwich and Dixon was a renowned surveyor. The two had worked together as a team prior to their assignment to the colonies.

Once the Lord Baltimore-William Penn ownership dispute was settled, the area's modern political boundaries began to take shape. Many of the historical structures in the watershed today are linked to the area's agricultural and early industrial economy. Some of the remnants of the following industries remain today:

- Manufacturing of
  - Bricks
  - Tobacco Products
  - Candy
  - Augers
  - Pottery
- Mills (flour, sorghum, wool, wood, paper, cider)

- Mines
  - Chrome

It seems the earlier residents of Oxford realized the need for community recreational and gathering opportunities, having operated both an annual, regional agricultural fair, and an eight-acre amusement park (Lacey's Park, opened in 1895), complete with picnic grounds, a 1-acre lake, paths, playgrounds and other amusement amenities.

The communities and landscapes of the watershed are directly influenced by this history and carry on many of its threads today. The following list provides a summary of cultural and historic resources, which help to define the unique character of the Elk Creeks Watershed:

Villages, hamlets, towns
Small, historic villages and hamlets in the area include:
- Daleville
- Elkview
- Jennersville
- Kelton
- New London
- Russelville
- Hayesville
- Forestville
- Lincoln University
- Kemblesville
- Elkdale

- Maple Grove
- Chrome
- Hickory Hill
- Peacedale
- Lewisville, and
- The Borough of Oxford

Farmsteads
Brick (some stone) 18th and 19th century farmhouses (and barns – some brick and wood, some stone and wood).

Churches, meeting houses, cemeteries
Brick 18th and 19th century buildings in villages:
- Historic churches (United Methodist, Church of Christ, Presbyterian) and cemeteries
- Faggs Manor
- Penns Grove church near Forestville
- Mt. Olivet Chruch east of Chrome
- Little Elk Chapel west of Hickory Hill and Mennonite meetings in the Little Elk headwaters south of Oxford
- African Methodist Episcopal cemetery ("Flatfoot") on west side of Thunderhill Road in New London (adjoins Lenhart section of Big Elk Creek Woods)

Schoolhouses
One-room schoolhouses:
- Charlton School north of Jennersville
- Buena Vista school north of Russelville
- Union School south of Hickory Hill

Taverns/inns
- Hoods Tavern in Oxford
- Chrome Tavern
- Red Rose Inn

Farm markets
Scattered produce markets and dairy stores.

Bridges
At least 3 covered bridges:
- The Lincoln Stephens
- The Rudolph and Arthur
- The Glen Hope

Smaller stone bridges:
- Pusey Mill Road
- Fox hunting underpasses/overpasses on Fair Hill land (Springlawn) just north of Maryland state line

Lincoln University
Formerly known as "Hinsonville," the town that became the site of Lincoln University was established by the settlement of several African-American families. One established a refuge for southern, former slaves, and several others were responsible for founding the "Ashmun Institute," and now (since 1866) known as Lincoln University. Official credit for the founding of Lincoln University is given to Reverend John Miller Dickey, who intended to train black men to become missionaries to Africa. In so doing, Reverend Dickey established the first institution of higher learning for African Americans in the nation. The college's charter was revised to allow the enrollment of women in 1952. Among other distinguished leaders, Lincoln University educated the first black Supreme Court Justice, Thurgood Marshall.

IV. Land Use and Water Regulations

Currently, the watershed holds onto its agricultural heritage, with a predominance of farmland throughout. However, a patchwork of residential developments reflects the area's growing characterization as a residential community.

Until recently, the watershed was relatively removed from the development pressures exerted by the nearby metropolitan centers to the east, especially Wilmington and Newark, Delaware, and West Chester and Philadelphia in Pennsylvania. Development prior to the 20th century occurred largely in support of agricultural operations and in relation to the area's location proximal to Baltimore Pike (now U.S Route 1), the original, main thoroughfare linking Philadelphia and Baltimore. Additional traffic resulted from railway development in the 19th century, when both the Lancaster, Oxford and Southern Railroad (the "Peachy") and the Philadelphia-Baltimore Central Railroad were constructed. However, all passenger service to the area was discontinued by the 1940's.

Land and water regulations are among the most effective means of controlling the impacts of our society on the environment. Under the Municipalities Planning Code, the townships and boroughs in the watershed have primary control over virtually all major land use decisions. Water regulation authority is dispersed among local, state and federal entities, however, municipalities have traditionally opted not to use their authority for the regulation of water to its full extent.

With regard to land use laws, municipalities use comprehensive plans, zoning, land use and subdivision ordinances, and other ordinances to control the use of land in their jurisdictions.

Zoning Ordinances may include a range of options to guide growth while protecting critical land, water and cultural resources, including such provisions as:

- Agricultural zoning (20-30 acre minimum)
- Water-quantity-based zoning
- Steep slope restrictions
- Large-lot zoning (5-40 acre minimum)
- Transfer of Development Rights (TDR)
- Mixed-use village areas

- Village extension preferences
- Open Space Design Option (using conditional use process)
- Natural Area Overlay zones
  - e.g., riparian buffer zoning along streams and wetlands
  - woodland management zoning

Subdivision and Land Development Ordinances can benefit Watershed resources through:

- Comprehensive stormwater management requirements to promote effective groundwater recharge (including locations of infiltration areas) and mitigate peak discharges;
- Encouraging the use of wetland basins as filters for runoff;
- Requiring sediment and erosion controls for grading and soil disturbance activities;
- Encouraging natural landscaping and reforestation.

The following is a summary of municipal land use ordinances used throughout the watershed to regulate development.

(1) East Nottingham Township

East Nottingham's Zoning Ordinance does not require natural landscaping, reforestation or open space reservations. A 1992 amendment to the ordinance emphasizes that the township has "no Planned Residential Development procedure." However, the township does require all development to provide for stormwater drainage toward natural swales and streams, with flow capacities based upon 100 – year storm models, limiting paved surfaces to 50% of a lot's area.

In order to prevent excessive soil erosion and deposition into waterways, East Nottingham requires agricultural lands to maintain at least 8 inches of soil in disturbed areas, with replanting occurring within one year. In a departure from most townships surveyed, East Nottingham will allow residences to be constructed, in some circumstances, on slopes of greater than 25% so long as existing soil and grade conditions are not altered.

(2) Elk Township

Elk Township classifies its lands into two residential districts, a village commercial district and a flood hazard district. The lower density residential district starts with 2-acre bulk density, which can be increased pursuant to a "flexible development option," for single-family dwellings as a conditional use, depending on the Township's review of an environmental impact assessment that addresses steep slopes, floodplains, groundwater recharge, soil conditions, wildlife and vegetation. Multi-family dwellings are permitted in the village commercial district, where bulk density requirements allow greater density than in the R-1 and R-2 districts. At least 40% of a multi-family development tract must be left as open space.

In 100-year floodplains, primary-use structures may not be erected, except when their primary uses are temporary and recreational, agricultural or accessory in nature.

Chemical storage facilities are also prohibited. Mineral extraction may be performed by special exception.

Impervious cover limitations are applied in recreational areas only, and restrictions on building on steep slopes are limited to those 25% or greater. There are no specific rules governing stormwater.

(3) Franklin Township
(Zoning Ordinance reviewed-missing Subdivision and Land development Ordinance)
Clustering (and "residential lot averaging") is permitted as a conditional use in the R-1 and R-2 zoning districts as a means of protecting natural resources. At least 40% of these developments must be set aside as open space, pursuant to the transfer of an interest in the property to Franklin Township or a land trust. A high density residential district is provided for (in Kemblesville), although there is currently no provision for transfer of development rights to this district.

Primary-use-type structures and chemical storage facilities are prohibited in floodplains. The uses of steep slopes of both 15% and greater and 25% or greater are limited, with more stringent requirements applied to steeper slopes. Drainage ditches are permissible and specifications for culverts do not include special design provisions for low flows. Driveways accessing public roads must be paved for a minimum distance of 20 feet from the right-of-way.

Stormwater from rooftops must be handled through "roof drain dry-wells" and natural swales. Drainage calculations are based on 50-year frequency storms, which must be undertaken as part of the insurance that pre-development rates and volumes of discharge will not be exceeded.

Residents of subdivisions are subject to a $200 fine for growing "weeds and other vegetation" over 15 inches in height between May 15th and October 15th of any year. It is not entirely clear from the language of this ordinance whether it outlaws meadows containing indigenous plants.

(4) Londonderry Township
Londonderry Township devotes significant space within its zoning ordinance to cluster development, promoting open space to protect steep slopes and "wet soils." At least 40% of land on a developable tract must be preserved as open space through conservation easements. The ordinance specifically restricts structures built within 100 feet of any waterway to single-family residences or agricultural buildings in order to reduce the impact on riparian corridors. Storm and sewer systems are permitted within 100 – year floodplains provided they prevent infiltration of floodwaters into those systems or vice-versa. In order to control stormwater runoff, impervious surfaces may only cover 15% of a lot in agricultural districts, rising to only 35% in higher density districts.

The ordinance defines steep slopes within its boundaries as having a greater than 15% percent slope "prior to engineering." Maximum lot sizes in "buildable" areas of steep slopes are limited to three acres, and no construction is permitted on slopes exceeding

25%. Roads, drives, parking lots and access paths are permitted only when "no viable alternative alignment or location is feasible."

Londonderry has the distinction of directly regulating open pit mining within its borders. These regulations offer the only reference in the ordinance to reforestation activities by requiring a mining operation to replant the entire disturbed area to inhibit soil erosion.

(5) Lower Oxford Township
Several attempts were made to contact officials from Lower Oxford Township, but none were successful. Therefore, the Lower Oxford Township zoning ordinance has not been reviewed.

(6) New London Township
New London Township divides its districts into Commercial, Industrial, Limited Industrial, Rural Agricultural, Village, Flood Hazard, Steep Slope Conservation, and R-1 through 3 Residential Districts. Residential clustering is a design option available for subdivisions of 20 acres or greater, and 40% open space must be retained.

The uses of steep slopes are restricted, with the limitations in 25% or greater slopes increasing over those of 15% or greater slopes. Primary use structures may not be constructed and listed substances may not be stored in 100-year floodplains. Stormwater is to be discharged into natural swales, and volume and velocity must be limited to pre-development magnitudes (drainage calculations are based on a 50-year frequency storm).

Provisions are specifically addressed to the keeping of large animals, including fencing and acreage requirements. Grazing is specifically prohibited over "shallow and mound type" septic systems, yet none of these restrictions apply to streams or steep slopes.

(7) Oxford Borough
The Borough did not have any zoning ordinances available, therefore, the Oxford Borough zoning ordinance was not reviewed.

(8) Penn Township
Penn Township divides its zoning into residential, commercial, industrial, institutional, and flood hazard districts. In order to promote open space and natural resource conservation, a density bonus is awarded for subdivisions that have common open space set aside. Proper management of the common open space is ensured through the imposition of a performance bond requirement. Impervious coverage is limited for various lot and parcel sizes.
Restrictions are imposed on the use of slopes equal to or exceeding 25%, but in contrast with many other municipalities, construction of single family dwellings are permitted if they meet design standards.

New structures may not be erected in 100-year floodplains, except as permitted by special exception, specified substances may not be stored, and trees generally may not be clearcut. Herbaceous vegetation is not permitted above the height of 12 inches, except in floodplains, meadows and other specified areas pursuant to waiver by the Zoning Officer.

(9) Upper Oxford Township
To encourage a sense of continuity, Upper Oxford Township asks developers to position proposed open spaces at a logical points along property lines, allowing for an "open space network" within the community. At least 50% of the total proposed development must be preserved as open space, with deed restrictions designed to protect this space from future encroachment. Structures within these areas are limited to those supporting recreational opportunities for residents. Land set aside as open space may only be used for agriculture, the protection of wetlands and other natural areas, outdoor recreation, and sewage and stormwater management facilities. These must be integrated into the natural landscape by utilizing natural swales and retention facilities. In Residential Agricultural districts at least 20% of the land in a designated open space must originate outside of identified natural areas.

The township requires proposed residential developments to provide an analysis of natural drainage patterns and water resources, including streams, drainage swales, ponds, floodplains and groundwater. All properties must demonstrate proper drainage along streets and away from structures.

Steep Slope districts are divided into moderate (15% - 25%) and severe (25%+) slopes. The Township's ordinance specifies that any activities on steep slopes must minimize grading, protect and preserve wildlife and plant habitats and protect water quality on and around the site. Soil, rock and mineral extraction is strictly prohibited in these areas. Structures and "cut and fill" operations are not permissible on steep slopes (there may be special exceptions), though stormwater management facilities may be placed on moderate slopes. On severe slopes, no more than 5% of vegetation may be removed, and it is prohibited to significantly alter the existing grade or to construct roads, parking lots or install sanitary sewers with subsurface disposal fields.

Construction operations must take appropriate conservation measures at sites to prevent excessive stormwater runoff and erosion during any soil stripping operation. The ordinance further specifies that no more than 20,000 square feet of soil may be stripped from a site at a single time.

(10) West Fallowfield
West Fallowfield has developed a zoning ordinance that is clearly intended to preserve its agricultural heritage, and has been thoughtfully designed also to preserve natural resources.
With the exception of Cochranville and the Route 41 corridor, West Fallowfield is zoned for agricultural use. Where residential use is permitted, cluster development is by right. At least 50% open space is required for developments in Village Development designs.

West Fallowfield maintains natural resource protection overlay districts for floodplains (100-year), wetlands, steep slopes, and woodlands.

Other Land Use Issues
As the Elk Creeks Watershed continues to experience growth and development at both a scale and a rate that is unprecedented, careful thought should be given as to how each building impacts air, water, land, and natural environment. Each new building adds to

the burden of water consumption, wastewater production, stormwater management, energy consumption from polluting/non-renewable sources, disturbance of soil, agricultural land and natural habitats, light pollution and traffic.

But the "ecological footprint" that new buildings have on the Elk Creeks Watershed can be reduced. Local governments, local residents, architects, developers and builders can design and build in ways that lessen impacts on the environment. Both current and new methods can be used to produce buildings that use less energy, consume fewer resources, and restore, rather than degrade, both natural land and agricultural land.

Recreational Resources

Public recreational resources in the Elks Creeks watershed are somewhat limited, as there are no large parks or regional trails within the watershed. Even smaller recreational areas are underrepresented. Currently, the greater bulk of outdoor recreational opportunities lie in neighboring areas, and include the White Clay Creek Preserve to the east and the Fair Hill Natural Resources Area to the south in Maryland. *The public will be likely to develop an appreciation for the watershed only if the opportunities to develop a personal connection to the natural world are developed through direct interaction. Since the need to direct public resources to the conservation of the Watershed resources depends on public enthusiasm, the need to develop these opportunities is compelling.*

V. Priorities for Land and Water Conservation and Restoration

Watershed resources serve our communities in many ways. Not only are rivers sources of life-sustaining water, but they also serve as habitat, as wildlife thoroughfares, as recreational resources and industrial infrastructure. Rivers also bear evidence of our history and culture.

Ironically, our society invests heavily in the creation and maintenance of non-natural infrastructure, such as roads, pipelines, parks, golf course and energy generation and transmission facilities. Even though rivers serve many of the same types of functions as these other elements, we tend to neglect the maintenance of river resources. Our daily activities degrade these resources, and our failure to invest in their maintenance today only forestalls the inevitable, shifting the associated costs to future generations and lowering the quality of life in the interim.

In the Elk Creeks Watershed, Watershed resources are especially threatened by poorly designed, random, rapid development and the failure to apply best agricultural management practices on a broad scale. But most of these ills can be corrected and even reversed. The following is a summary of actions that can be taken to conserve the resources of the Elk Creeks Watershed.

Streams

- Restore Riparian Buffers (see Map 9);
- Restore native brook trout and benthic invertebrate diversity (target species) – set quality/quantity goals;
- Limit road impacts, development impacts, point source/non point source;
- Limit withdrawals;

- Prevent dams – restore shad migration.

Wetlands
- Restore;
- Create;
- Remove old tile fields and ditches.

Woodlands
- Protect;
- Restore;
- Reforest;
- Interconnect;
- Expand.

VI. Elk Creeks Watershed Conservation Plan Implementation Strategies

Strategy 1 - Protect and Preserve Natural and Cultural Resources and Farmland

As noted in the discussions of the existing conditions, the watershed contains abundant, interdependent natural and cultural resources. Agriculture is a foundation of the community. Both the natural resources and the farmland are threatened by random development. In order to preserve the watershed, its natural and cultural resources, and the farmland that serves as an economic anchor for the community, a focused effort is needed. This effort will consist of at least the following projects.

A. Formation of an Elk Creeks Land Trust

The Elk Creeks Watershed constitutes a rapidly-growing, semi-rural area of southern Chester County that is underrepresented by land conservation activity. Several hundred acres of land are protected by conservation easements held by the Brandywine Conservancy and the Chester County Agricultural Land Preservation Board, with additional land in the Chrome Barrens Preserve protected by The Nature Conservancy and a small preserve owned by Natural Lands Trust. This relatively low level of activity can be explained in part by the fact that these organizations are regionally focused and there is currently no local conservation group representing the Elk Creeks Watershed. The Elk Creeks Watershed Association, land trusts active in the watershed, the Pennsylvania Land Trust Association and the Land Trust Alliance should collaborate on the formation of an Elk Creeks Land Trust. The purpose of this land trust would be to work individually with key landowners throughout the watershed to provide conservation solutions for their properties. Maintaining contacts with key landowners and cultivating strategies for acquisition of land and conservation easements are primary functions this type of watershed-scale land trust.

In order to promote a collaborative effort, a regular forum to coordinate and focus conservation activities in the watershed should be held.

An example of a conservation project that should be pursued under this initiative is the preservation of a wooded corridor along the Big Elk Creek in Londonderry Township on

Ewing Road. This location contains a riparian woodland, high quality farmland and an old mill site. Locations like this, where there is an intersection of important natural and cultural resources, warrant high priority preservation efforts.

Major Core Reserves and Major Natural Corridors are recommended as Highest Priority conservation areas that should be protected as nature preserves as part of a long-term Elk Creeks Natural Areas Initiative. High Priority farmland, (i.e. farms with significant stream frontage and large parcels in headwaters areas) should be protected as agricultural preservation areas that help to achieve the dual goals of supporting the viability of the agricultural economy in southern Chester County and the quality and quantity of ground and surface water systems in the Elk Creeks Watershed.

This Initiative should involve direct conservation techniques such as acquisition of land or conservation easements by a public/private partnership of municipalities, land trusts/conservancies, county or state parks agencies, or other conservation groups. Acquisition of land or easements in these areas will likely involve a long-term process of negotiating with landowners and will include both purchase, donation, or a combination (bargain sale). Funding sources may include township open space funds, Pennsylvania Keystone grants for municipalities and land trusts, the Pennsylvania Agricultural Conservation Easement Program, and grants from private foundations, businesses and individuals.

Lead Organization: Elk Creeks Watershed Association (with support from the Brandywine Conservancy, and potentially, the Pennsylvania Land Trust Association, and the Land Trust Alliance).

B. Establish Natural Areas Networks as priority networks of natural areas and corridors for protection to support the Elk Creeks Watershed's diversity of native plants and wildlife.

These Natural Area Networks are listed as Core Reserves and Natural Corridors, and generally represent the largest, most interconnected, highest quality, most mature, diverse, or least common habitats. While these recommendations represent a thorough assessment of available information, a more detailed and comprehensive assessment and prioritization of Natural Areas Networks should be considered, combining a Geographic Information Systems (GIS) mapping and database with detailed field surveys of vegetation and wildlife populations and habitats.

The recommended Natural Areas Networks are:

Core Reserves (Major):
- Big Elk Creek Woodland
- Big Elk Creek Wetland
- Chrome Barrens

Core Reserves (Minor):
- Forest-Interior Habitats (> 30 acres in area, round/square in shape)
- Broad Successional Areas (> 3 acres in area)
- Broad Wetland Areas (> 1 acre in area)

Natural Corridors (Major):
- Big Elk
- Little Elk

Natural Corridors (Minor):

- Smaller stream corridors
- Utility/transportation rights-of-way (electric, gas, fiber optic, railroad)

Lead Organization: Elk Creeks Watershed Association.

Strategy 2 – Conduct Education and Outreach

As noted in the discussion of conditions the activities of watershed residents as individuals, as businesses, and as institutions have profound effects on the quality and quantity of groundwater, surface water and other resources. By providing information to residents, major improvements in the health of the watershed can be made. In addition, knowledge sometimes leads people to care more, to become more involved , and ultimately more likely to support broader efforts to protect resources. The following is a list of projects intended to increase understanding and appreciation of the watershed's resources.

A. *An Elk Creeks BMP Initiative should be launched as a means of coordinating the various outreach and implementation efforts of agencies and organizations throughout the watershed.*

   Develop and disseminate agricultural handbook – "Agricultural BMP's & Who Can Help?" The detrimental impacts that conventional farming practices have on the health of streams and wetlands in watersheds such as the Elk and, ultimately, estuaries such as the Chesapeake Bay are well-documented. With the growing understanding that widespread soil erosion, pollution from pesticides and fertilizers, and degradation due to conventional livestock management are taking their toll on aquatic ecosystems, an increasing number of options and funding sources are available to reverse this trend. Streambank fencing, riparian buffers, manure management systems, conservation reserve/wetland reserve strategies, and cover cropping are all examples of agricultural BMP's that can be applied on any farm to reduce its watershed impacts. A myriad of Federal, State, County, and non-profit organizations and programs are involved in landowner outreach and are pursuing funding for BMP implementation on individual properties. The Elk Creeks Watershed Association, the Chester County Conservation District, the USDA-NRCS, the Pennsylvania Fish and Boat Commission, the Alliance for the Chesapeake Bay, and the Chesapeake Bay Foundation all have some level of involvement with outreach and implementation regarding BMP's in the watershed.

B. *Create and post watershed signs.*

C. *Develop and disseminate watershed-oriented information pamphlet & homeowner handbook.*

C. *Develop and disseminate homeowner's association handbooks (i.e., welcome to your neighborhood).*

D. *Develop and disseminate industry handbook.*

E. *Hold semi-annual field days for public education.*

F. *Conduct education about septic system operation and & testing (utilize PADEP info kits & videos).*

G. *Focus ongoing watershed education on schools and school districts within watershed (Octoraro, Oxford, Avon Grove, George Fox, Bethany, etc.), using walks and other programs.*

H. *Restoration projects (riparian forest, wetlands, meadow, forest).*

I. *Develop and administer school adoption of grounds for restoration, maintenance, learning (Oxford & others?).*

J. Summarize the Plan for residents of the watershed in a 6 – 8 page, color "State of the Watershed" handout to be printed for distribution.

K. Bayscapes, wooded filter strips, rain barrel program, rain gardens, vegetated swales, bio-retention cul de sac islands, dry wells.

L. Promote Green Building/Sustainable Designs.

To reduce the "ecological footprint" of buildings and landscapes within the Elk Creeks Watershed, educational materials should be distributed throughout the watershed to educate residents and business owners about the benefits of solar energy, wind power, water-saving technologies, geothermal heating and cooling systems, recycled and salvaged building materials, traditional building methods, innovative wastewater treatment systems, natural landscaping, site-design standards, community-supported-agriculture (CSA). Local ordinances should include "green building requirements," or a code that specifies measures to be taken or standards to be achieved.

A model project (such as a new school, municipal or institutional building, business, or custom home) could be planned and designed as a Sustainable Design demonstration site, exhibiting good examples of low-impact building. The Elk Creeks Watershed of the future could support communities consisting of energy-efficient, water-efficient, non-polluting buildings that fit the landscape and preserve the quality and quantity of water.

Lead Organization: Elk Creeks Watershed Association.

Strategy 3 – Add Watershed -Oriented Aspects to Municipal Plans and Regulations

As a minimum, all Core Reserves and Natural Corridors (Major and Minor) are recommended for protection with options for promoting conservation-oriented land development through the Zoning Ordinance and Subdivision and Land Development Ordinances adopted by municipalities in the watershed. All municipalities should have open space and recreation plans.

A. Initiate a Municipal Assistance Program in the Watershed and Promote the Adoption of Resource Protection Ordinances and Plans

Environmental Impact Assessment

Zoning Ordinances should include a requirement for an Environmental Impact Assessment (EIA) on any site proposed for a subdivision and land development. This EIA should also include a Biological Resources Inventory component, listing existing habitat areas and the native plants and wildlife documented or likely to exist on the site. *Municipalities in the watershed should use the EIA to require identification of any Core Reserves or Natural Corridors (Major or Minor), as identified in this Plan, that occur on any tract of land proposed for development. Once identified, the applicant should be required to reserve these areas as part of the protected open space for the plan.* Applicants who successfully demonstrate that protection of a major or minor Core Reserve or Natural Corridor is not feasible must propose *Mitigation Measures* that accommodate the development plan while maximizing the ecological function of the natural area as habitat for native vegetation and wildlife. Examples of Mitigation Measures for natural areas may include reducing forest fragmentation by limiting development in a woodland to an area within 100 feet of a woodland edge with minimal tree clearing, or protecting a stream corridor by reforesting a minimum of 75 feet on either side of the stream.

Open Space Design Option

Municipalities throughout the watershed should have Zoning Ordinances that allow developers an option for designing residential subdivisions with lots that are smaller than the by-right ordinance allows, while requiring protected open space on at least 50% of the tract. Plans submitted under this type of "Open Space Design Option" or "Growing Greener" approach should identify any major or minor Core Reserves or Natural Corridors on the tract as part of the designated open space. Applicants who successfully demonstrate that the site contains more area of Core Reserve

or Natural Corridor than is required to meet the criteria for required open space must propose *Mitigation Measures* that accommodate the development plan while maximizing the ecological function of the natural area as habitat for native vegetation and wildlife.

Open Space Management Plan as part of Open Space Design Option.
As part of their Zoning Ordinance allowing an option for conservation-oriented subdivisions, municipalities in the watershed should require applicants submitting plans involving Core Reserve or Natural Corridor areas to demonstrate that the proposed management strategies will maximize the ecological function of these areas as habitat for native vegetation and wildlife. Management strategies may include meadow management programs, reforestation of riparian corridors and upland corridors, reforestation to expand existing woodlands, restoration and enhancement of wetlands, and construction of wetlands as part of stormwater management facilities.

Riparian Forest Buffer Ordinance
Protection and/or restoration of riparian forest buffers of at least 75 feet on each side of a stream is one of the most valuable strategies for enhancing surface water quality and quantity in the Elk Creeks Watershed. *Municipalities throughout the watershed should adopt Riparian Forest Buffer Ordinances to require protection and restoration of riparian forest buffers as a necessary part of the "green infrastructure" in major subdivision and land development plans.* By adopting a Riparian Forest Buffer ordinance, municipalities can require developers to demonstrate protection and management of existing riparian forest buffers, and reforestation and management along streams that are currently cleared of woody vegetation. Particularly when these buffers are integrated with Innovative Stormwater Management systems (described in the following paragraph) these steps contribute to the long-term health of the watershed while helping to mitigate the potential impacts of new development.

Innovative Stormwater Management Requirements
Stormwater management requirements in municipalities throughout the watershed can be enhanced to incorporate the protection and creation of native vegetation and wildlife habitat as part of innovative stormwater management systems. For example, land development plans that are designed to minimize grading and clearing of natural vegetation, utilize plants and soil to increase recharge of groundwater and generate less stormwater runoff than conventional developments. Subdivision regulations can require minimization of stream crossings, the use of bridges and culverts that are designed for better wildlife protection and for less stream damage. The addition of native trees, shrubs, grasses and wildflowers (instead of turf grasses) in swales, berms, filter strips, riparian buffers and recharge beds, and the construction of stormwater management wetlands can turn the hard engineering of conventional stormwater management into a "green infrastructure" that protects water resources and expands natural habitat. As a minimum, ordinances should encourage the use of stormwater BMPs listed in the Pennsylvania Handbook of Best management Practices for Developing Areas (Pennsylvania Association of Conservation Districts, Inc., November 1997).

Forest Management Program
While woodlands are one of the most important community resources in the watershed, they are largely privately owned and are subject to periodic timber harvesting activities. Regulation of forestry activities is often limited to permits required for stream crossings or timbering on steep slopes, leaving municipalities out of the loop in terms of promoting best management practices for timber harvesting. Municipalities in Pennsylvania are empowered under the Municipalities Planning Code (MPC) to adopt ordinances for the protection and preservation of natural resources and agricultural land activities. *As such, municipalities in the Elk Creeks Watershed should consider adopting a free-standing Forest Management Ordinance to govern the proper management of woodlands and ensure consistency with Best Management Practices (BMP's) for forestry during timber harvesting and land development activities.* The major standards that can be addressed in this type of ordinance include:

- The commercial harvesting of timber should only be permitted subject to a Forest Management Permit issued by the Township or Borough. The Township or Borough should require the landowner to submit a Forest Management Plan prepared by a registered forester for review by a Township/Borough Forester or Arborist. A permit would be issued based on approval of a Forest Management Plan that demonstrates compliance with Best Management Practices for forestry as established by the Township/Borough in conjunction with the Pennsylvania Bureau of Forestry. These practices should include, among other things, selective thinning without high-grading or diameter-limit cutting, retaining substantial (75 feet or greater) undisturbed riparian and wetland buffers, minimizing the width and location of roads, stream crossings, storage areas for logs and equipment, replanting of native trees, etc.

- The Forest Management Plan should include a Declaration of Intent signed by the landowner stating that the Plan has been prepared for the sole purpose of harvesting timber and not for any other purpose, including submission of a Subdivision and Land Development plan or Building Permit application. The Declaration acknowledges that no land development plan will be submitted within a 5 year period following the proposed timber harvest. This helps to avoid the possibility of a developer or builder clear-cutting all or part of a woodland and then submitting a Subdivision and Land Development plan or Building Permit application for a non-wooded area.

- No Subdivision and Land Development Plan or Building Permit will be permitted for a property containing a woodland in which timber was harvested in the last five (5) years according to a Forest Management Plan (including a signed declaration of intent) and permit.

Natural Landscaping Ordinance.
Municipalities throughout the watershed can encourage residents to increase biodiversity, protect streams and groundwater and reduce the amount of lawn by adopting Natural Landscaping Ordinances as alternatives to the conventional "weed law." A Natural Landscaping Ordinance starts from the premise that lawns cannot be mandated, and that residents have the right to landscape their properties with wildflower meadows, native plantings, hedgerows, reforestation areas, ponds and wetland creation projects provided they are not causing a nuisance to their neighbors. Natural landscapes provide more wildlife habitat and groundwater recharge than lawns and require virtually no watering, regular mowing, chemical fertilizers or pesticides.

Such ordinances would include requirements for planting schedules, mowing schedules, removal of invasive species, buffers along property lines, and avoiding fire hazards that must be followed. Municipalities can further encourage residents to intentionally manage their properties to provide natural habitat by establishing a Backyard Habitat registry and by organizing community native plant sales (including plants rescued from development sites).

Open Space and Recreation Plans
In recognition of the need for residents to have areas where they can recreate, many municipalities have open space and recreation plans that contain a survey of recreational resources as well as a plan for the creation of new recreational opportunities, if necessary. Those municipalities that have not already developed these plans should consider doing so.

Source Water Protection Ordinances
Source water protection has been mandated by the federal government through the Safe Drinking Water Act. The U.S. EPA delegated the source water protection program to the states, and Pennsylvania, in turn, has largely delegated responsibility to the local governments. The Safe Drinking Water Act Program governs public water systems, but not individual or domestic wells systems. Nevertheless, municipalities could possibly explore the availability of funds for the development of a local source water protection program, designed to protect domestic well users.

In addition the few public water systems that are in use within the watershed should be assessed and a plan for their protection through the program should be devised.

Lead Organization(s): The Elk Creeks Watershed Association, with support from the Brandywine Conservancy, would conduct initial outreach. Leadership in follow-up efforts would have to come from individual municipalities.

Strategy 4 – Continue Research and Analysis Needed to Enhance Watershed Conservation

Seek grants for and conduct the following activities:

A. *Prioritize habitat lands, agricultural lands.*
B. *Analyze water balance in watershed.*
C. *Conduct screening level assessment for restoration – stream channel analysis.*
D. *Map proposed open space, recreational, protected lands.*

Lead Organization: Elk Creeks Watershed Association

Strategy 5 – Continue and Initiate Grass Root Stewardship Activities

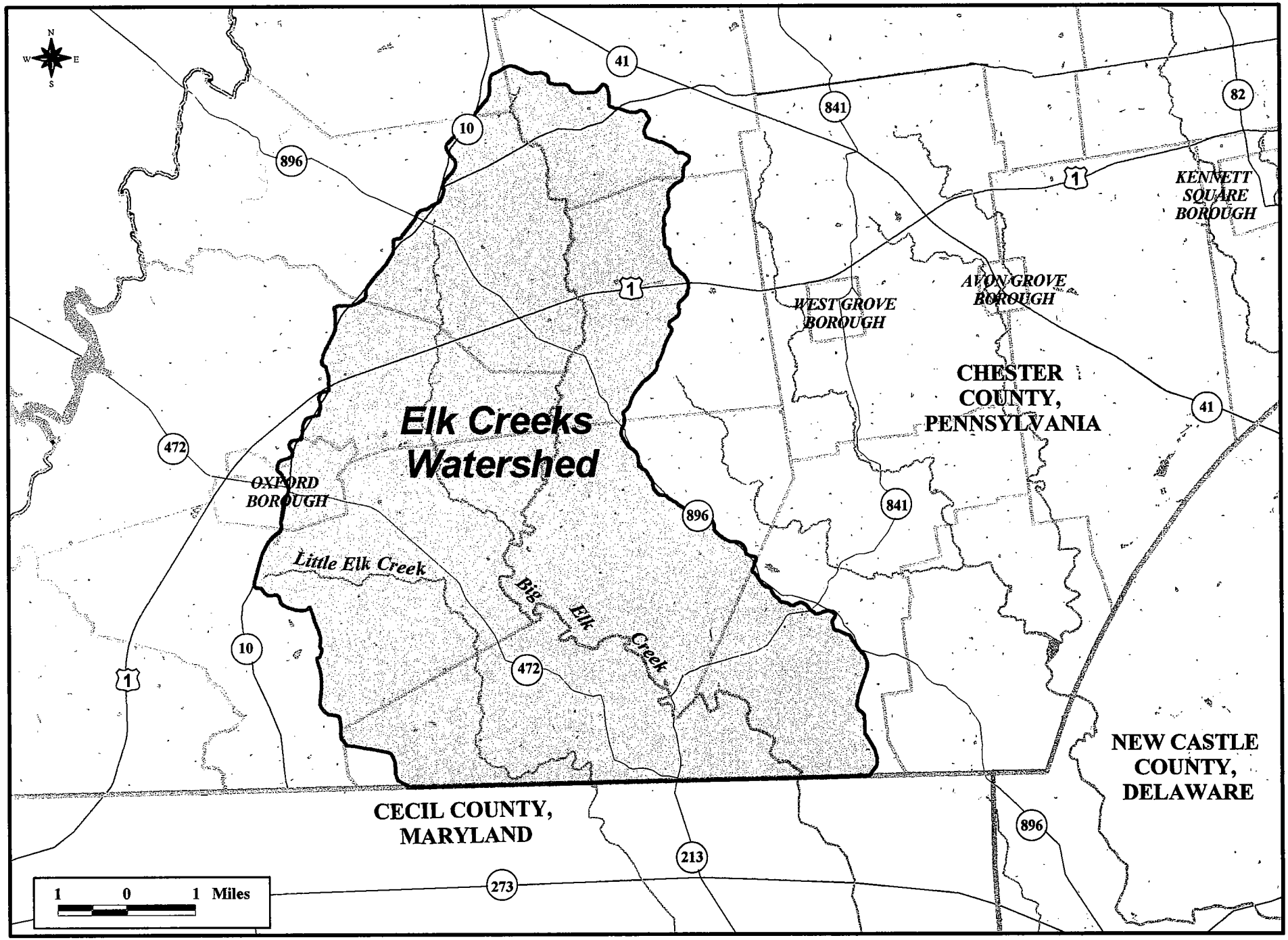
A. *Establish a Community Involvement Network* – include:
   - Streamwatch System
     This effort should involve local residents and school groups in a grassroots monitoring program to gauge the quality and quantity of stream water and the health of aquatic ecosystems. The Streamwatch Program can also supplement ECWA's watchdog function for existing or potential contamination problems such as point source pollutants and discharge permits, non-point source pollutants, NPDES permits, Superfund sites, dam proposals, wetland impacts, water withdrawals and other threats to stream water quality and quantity.
   - Clubs to encourage people to gather and appreciate watershed resources through
     - hiking
     - photography
     - bird-watching
     - other

B. *Expand purview of ECWA to an interstate watershed association*

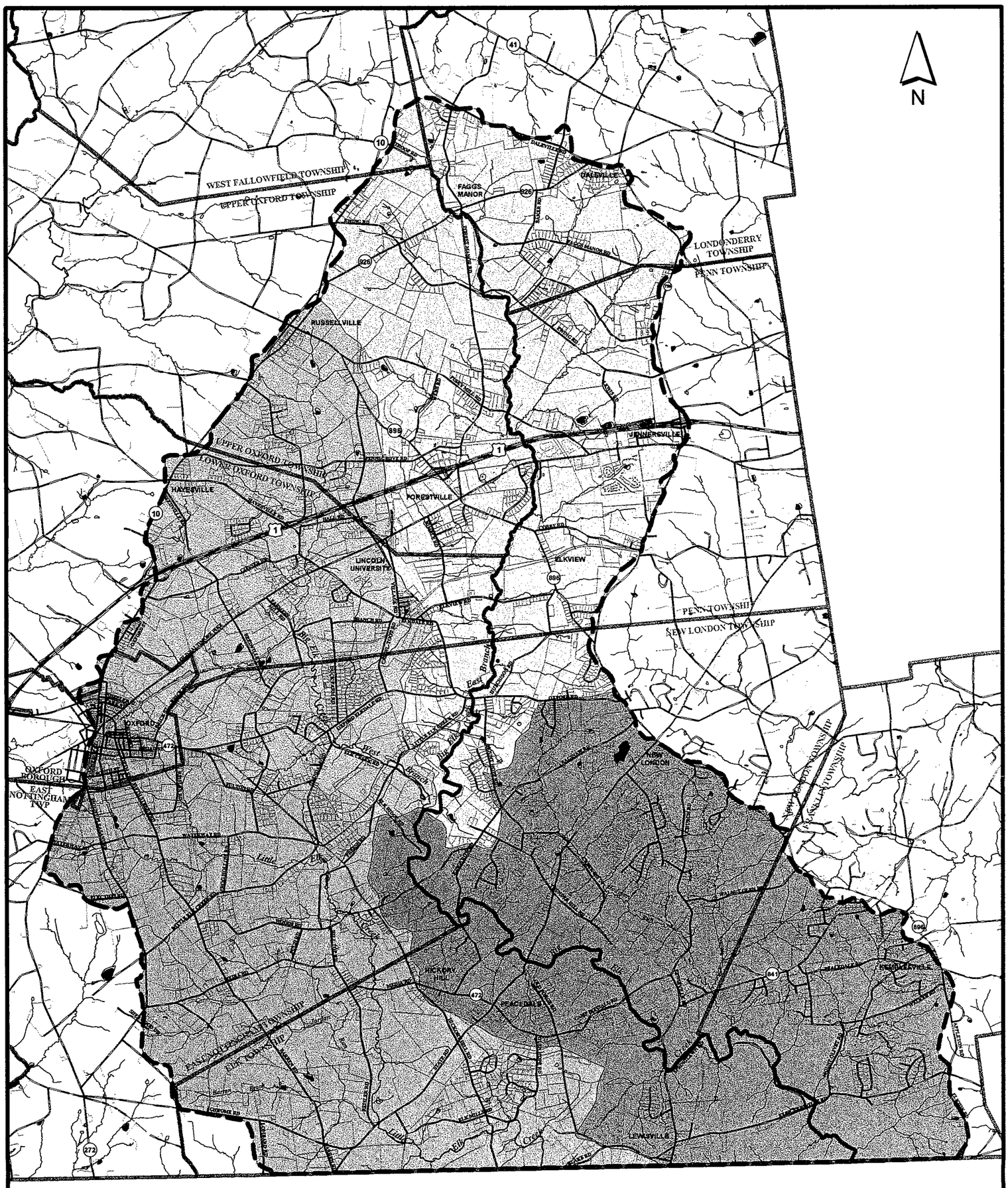
Lead Organization: Elk Creeks Watershed Association with eventual transfer of responsibility to any resulting entities or clubs.

Map 1 – Watershed Location

Elk Creeks Watershed Location Map



Map 2 – Watershed Boundaries



LEGEND

- Elk Creeks Watershed Boundary
- Municipal Boundaries
- Tax Parcels

Roads

- Limited Access Highway
- Major Roads
- Minor Roads
- Driveways

- Streams
- Ponds

Watersheds

- Big Elk Creek - Main Branch
- East Branch Big Elk Creek
- West Branch Big Elk Creek
- Little Elk Creek

5000 0 5000 Feet

Watershed Boundaries

Elk Creeks Watershed Conservation Plan Chester County, Pennsylvania

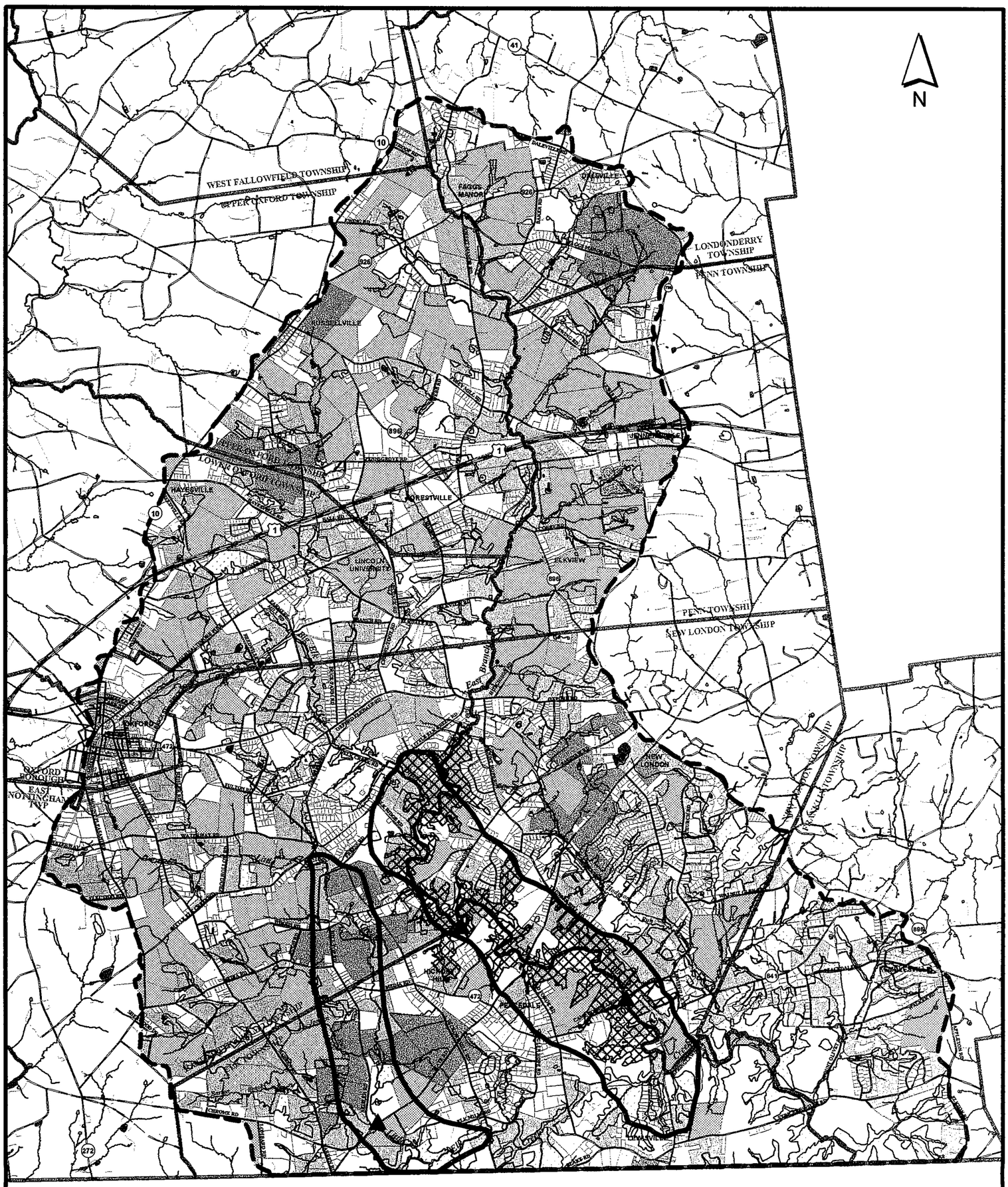
Elk Creeks Watershed Association

Environmental Management Center
BRANDYWINE CONSERVANCY
P.O. Box 141 Chadds Ford, Pennsylvania 19317 (610) 388-2700

Pennsylvania Environmental Council

Source: Watersheds from PA GAP Analysis program, 1998.

Date: November 16, 2001



LEGEND

- Elk Creeks Watershed Boundary
- Municipal Boundaries
- Tax Parcels

Roads

- Limited Access Highway
- Major Roads
- Minor Roads
- Driveways
- Streams
- Ponds
- Covered Bridges
- Proposed Core Reserves
- Natural Corridor
- Woodlands and Hedgerows
- Conservation Easements
- Agricultural Land Preservation Program Easements
- Tax Parcels Greater or Equal to 50 Acres with Greater or Equal to 50% Class I and II Prime Agricultural Soils
- Tax Parcels Greater or Equal to 50 Acres
- Riparian Parcels 10 Acres or Greater

5000 0 5000 Feet

Targeted Parcels

Elk Creeks Watershed Conservation Plan Chester County, Pennsylvania

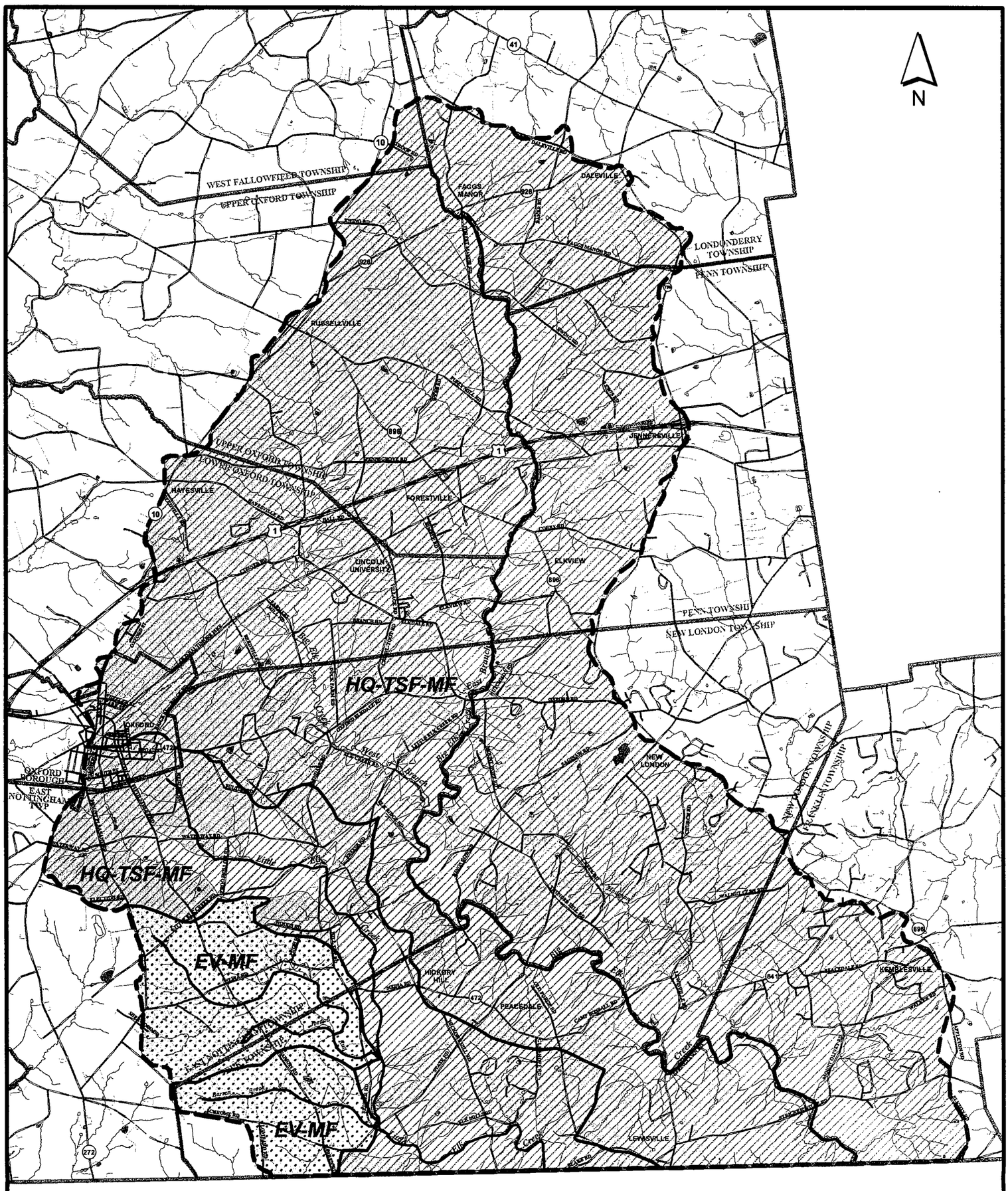
Elk Creeks Watershed Association

Environmental Management Center
BRANDYWINE CONSERVANCY
P.O. Box 141 Chadds Ford, Pennsylvania 19317 (610) 388-2700

Pennsylvania Environmental Council

Source: Prime Ag. Soils from NRCS, 1995; Conservation Easements from Brandywine Conservancy, 2001; Ag. Easements from Chester County Ag. Preservation Board, 2001.

Date: November 16, 2001



LEGEND

- Elk Creeks Watershed Boundary
- Municipal Boundaries
- Tax Parcels

Roads

- Limited Access Highway
- Major Roads
- Minor Roads
- Driveways

- Streams
- Ponds
- Designated Streams

PA Stream Use Designations

- Exceptional Value Waters--Migratory Fish (EV-MF)
- High Quality Waters--Trout Stocking--Migratory Fish (HQ-TSF-MF)
- First and Second Order Headwaters

5000 0 5000 Feet

Water Quality Designations and Headwater Areas

Elk Creeks Watershed Conservation Plan Chester County, Pennsylvania

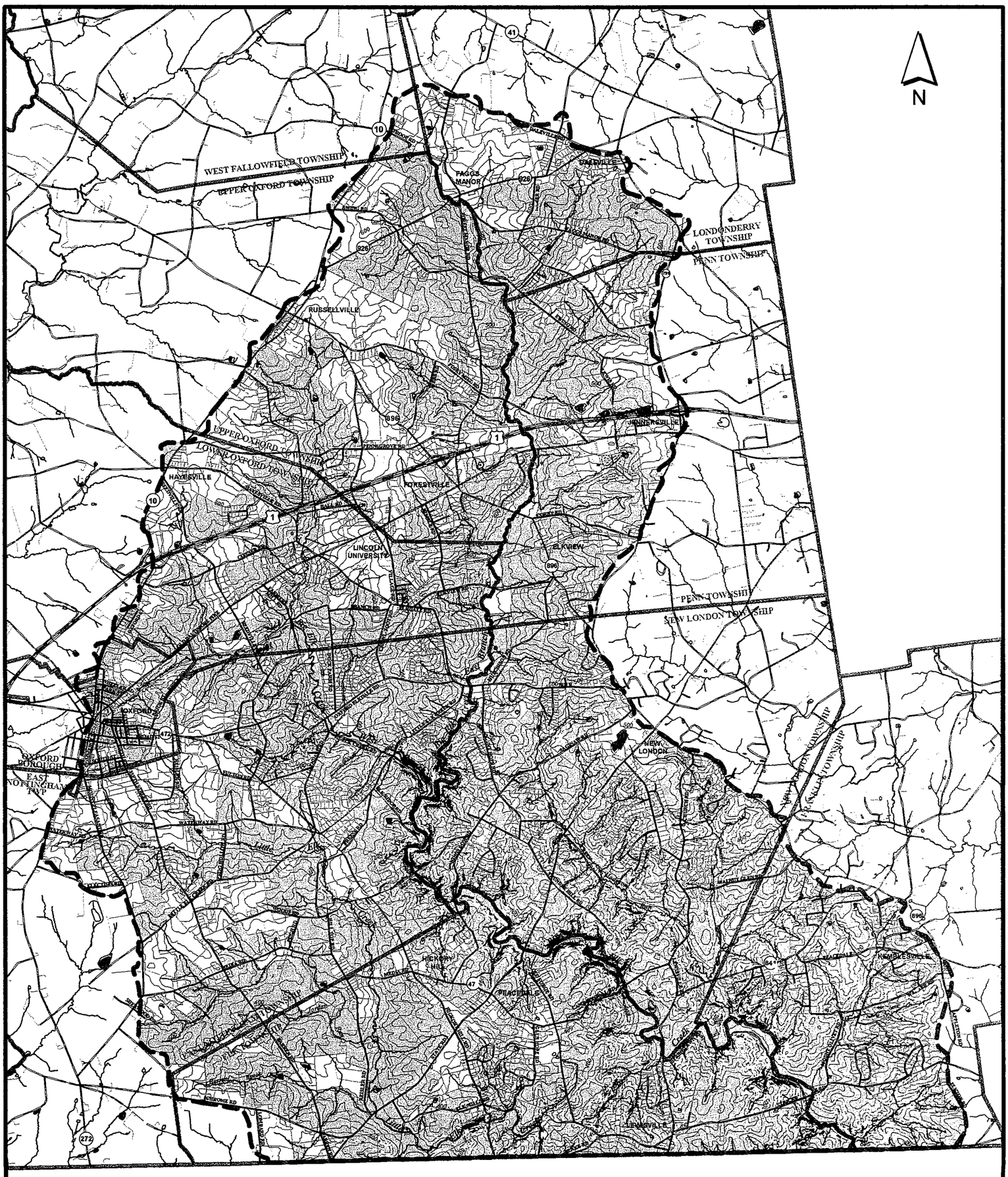
Elk Creeks Watershed Association

Environmental Management Center
BRANDYWINE CONSERVANCY
P.O. Box 141 Chadds Ford, Pennsylvania 19317 (610) 388-2700

Pennsylvania Environmental Council

Source: Stream designation from Chester County, PA Water Resources Compendium; Headwaters digitized by Brandywine Conservancy, 2000; EV and HQ streams from PADEP, 2000.

Date: November 16, 2001



LEGEND

- Elk Creeks Watershed Boundary
- Municipal Boundaries
- Tax Parcels

Roads

- Limited Access Highway
- Major Roads
- Minor Roads

- Driveways
- Streams
- Ponds
- Contours (20 ft. Interval)
- Steep Slopes 15 - 25%
- Steep Slopes 25% or Greater
- Parcels with Moderate to Steep Topography

Note: National Geodetic Vertical Datum of 1983.

5000 0 5000 Feet

Topography

Elk Creeks Watershed Conservation Plan Chester County, Pennsylvania

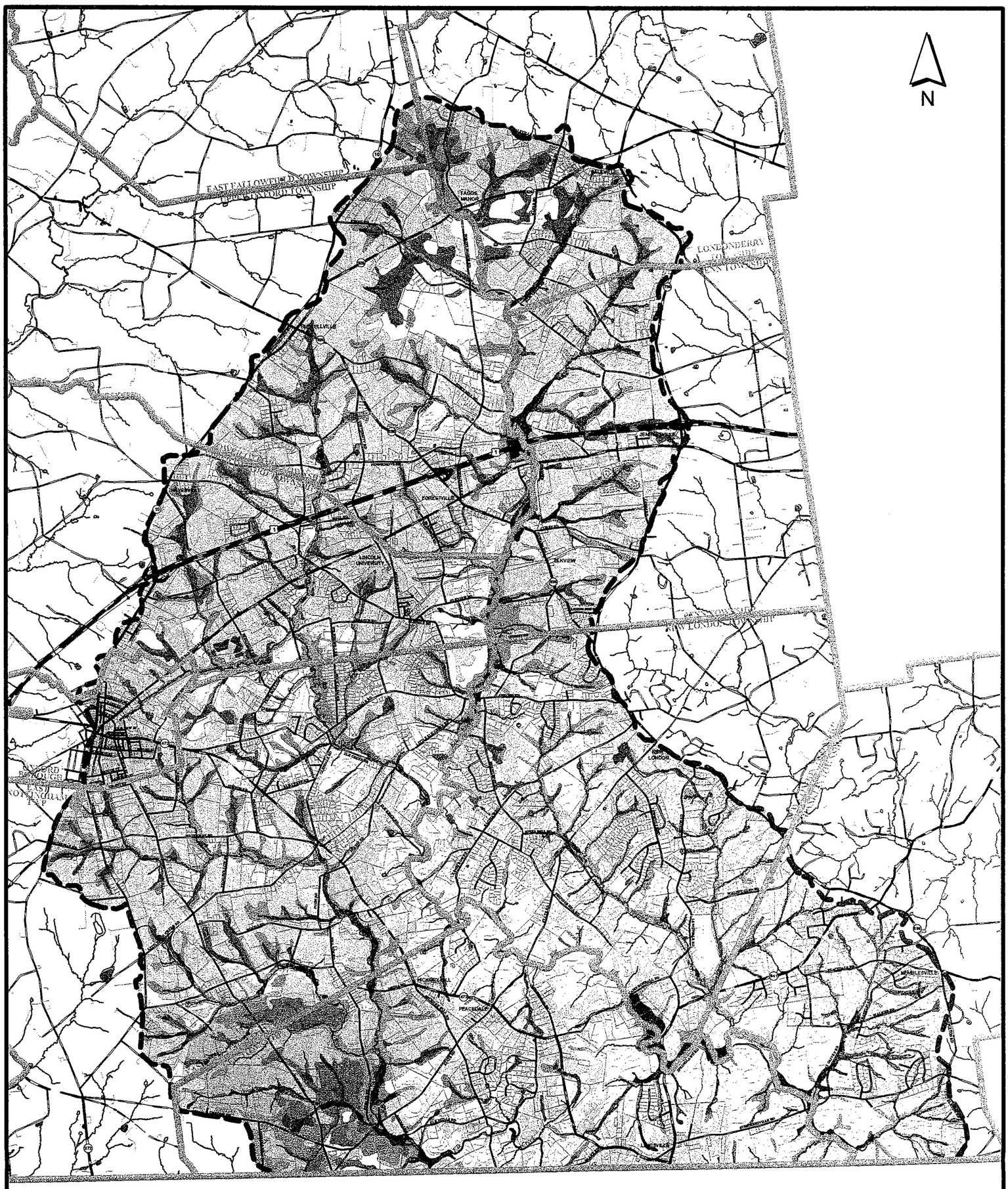
Elk Creeks Watershed Association

Environmental Management Center
BRANDYWINE CONSERVANCY
P.O. Box 141 Chadds Ford, Pennsylvania 19317 (610) 388-2700

Pennsylvania Environmental Council

Source: Contours from Geographic Information Systems, 1999; Slopes created by the Brandywine Conservancy, 1999.

Date: November 16, 2001



LEGEND

Elk Creeks Watershed Boundary
Municipal Boundaries
Tax Parcels

Roads
Limited Access Highway
Major Roads
Minor Roads
Driveways
Streams
Ponds

Soils
Aldino
Baile
Calvert
Chester
Chewacla
Chrome
Congaree
Conowingo
Edgemont
Glenelg
Glenville
Manor
Montalto
Neshaminy
Urban Land
Watchung
Water
Wehadkee
Worsham

5000 0 5000 Feet

Soils

Elk Creeks Watershed Conservation Plan Chester County, Pennsylvania

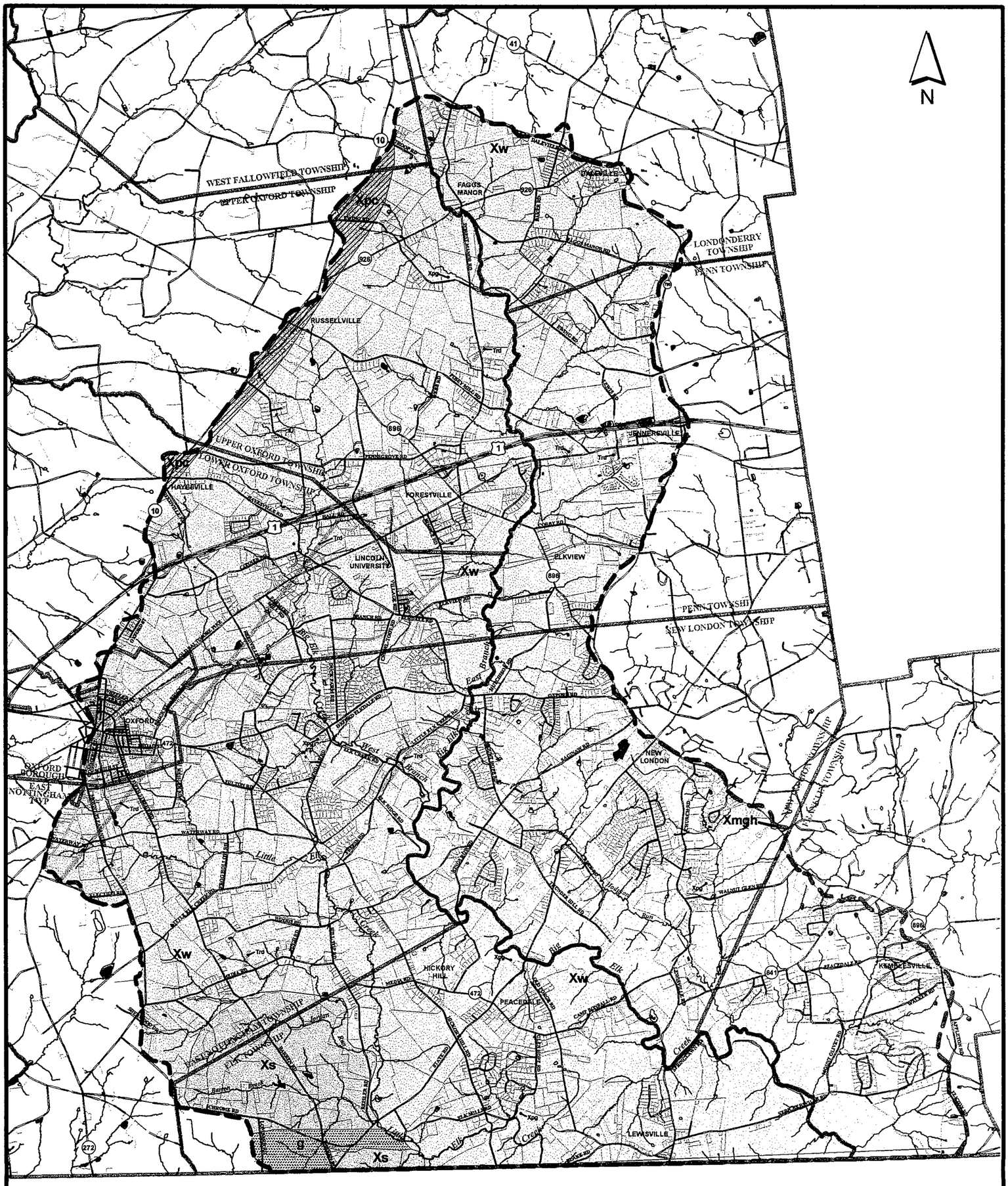
Elk Creeks Watershed Association

Environmental Management Center
BRANDYWINE CONSERVANCY
P.O. Box 141 Chadds Ford, Pennsylvania 19317 (610) 388-2700

Pennsylvania Environmental Council

Source: Geology from PA Geological Survey, 1980.

Date: November 16, 2001



LEGEND

- Elk Creeks Watershed Boundary
- Municipal Boundaries
- Tax Parcels

Roads

- Limited Access Highway
- Major Roads
- Minor Roads
- Driveways
- Streams
- Ponds

Dikes and Faults

- Trd – Triassic Diabase
- Xpg – Pegmatite

Geology

- g – Gabbroic Gneiss and Gabbro
- Xmgh – Mafic Gneiss, Hornblende bearing
- Xpc – Peters Creek Schist
- Xs – Serpentine
- Xw – Wissahickon Fm (Oligioclase Mica Schist)

5000 0 5000 Feet

Geology

Elk Creeks Watershed Conservation Plan Chester County, Pennsylvania

Elk Creeks Watershed Association

Environmental Management Center
BRANDYWINE CONSERVANCY
P.O. Box 141 Chadds Ford, Pennsylvania 19317 (610) 388-2700

Pennsylvania Environmental Council

Source: Geology from PA Geological Survey, 1980.

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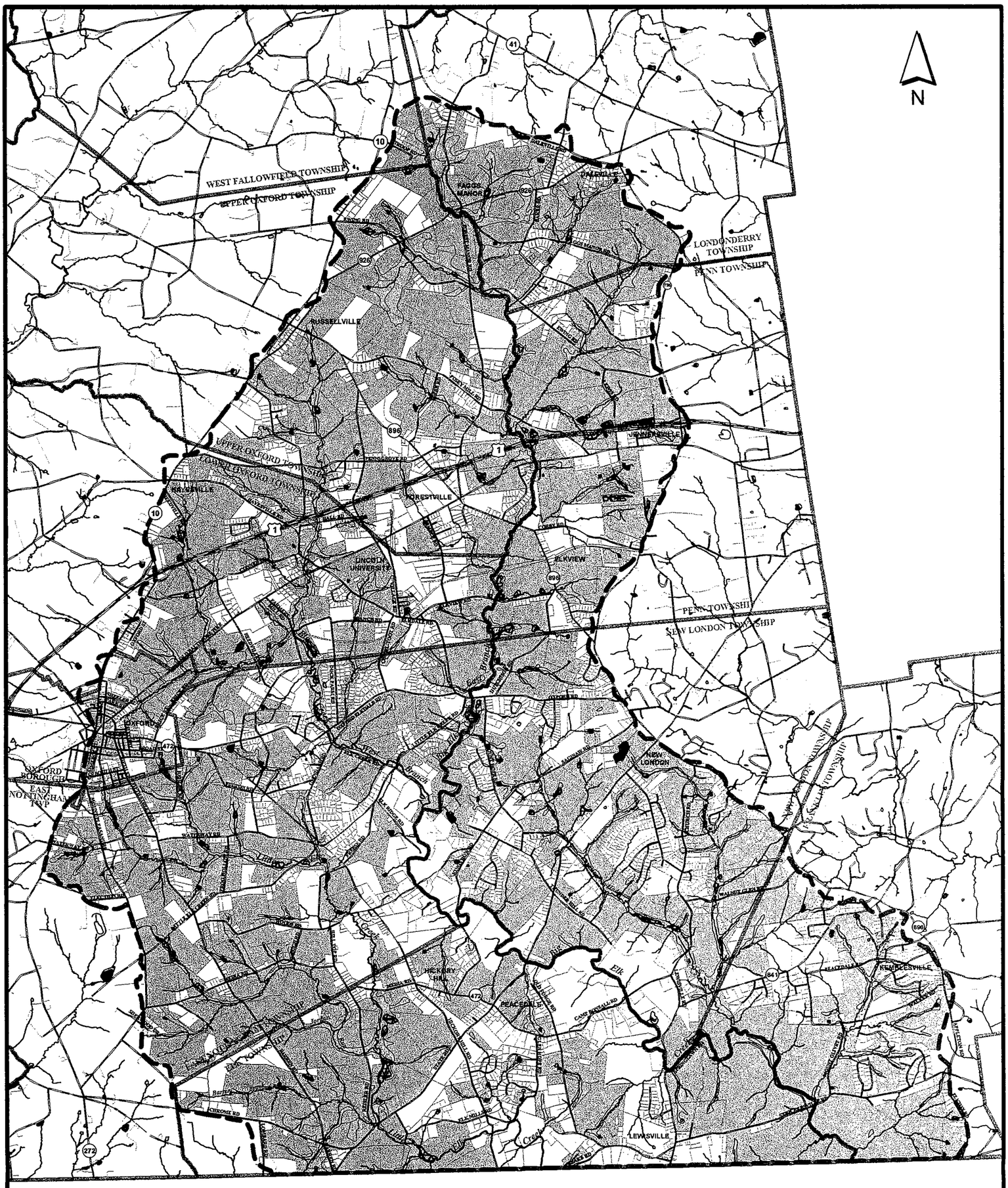


LEGEND

- Elk Creeks Watershed Boundary
- Municipal Boundaries
- Tax Parcels

Roads

- Limited Access Highway
- Major Roads
- Minor Roads

- Driveways
- Streams
- Ponds
- National Wetlands Inventory for Elk Creeks
- Hydric Soils
- Riparian Parcels

5000 0 5000 Feet

National Wetlands Inventory and Hydric Soils

Elk Creeks Watershed Conservation Plan Chester County, Pennsylvania

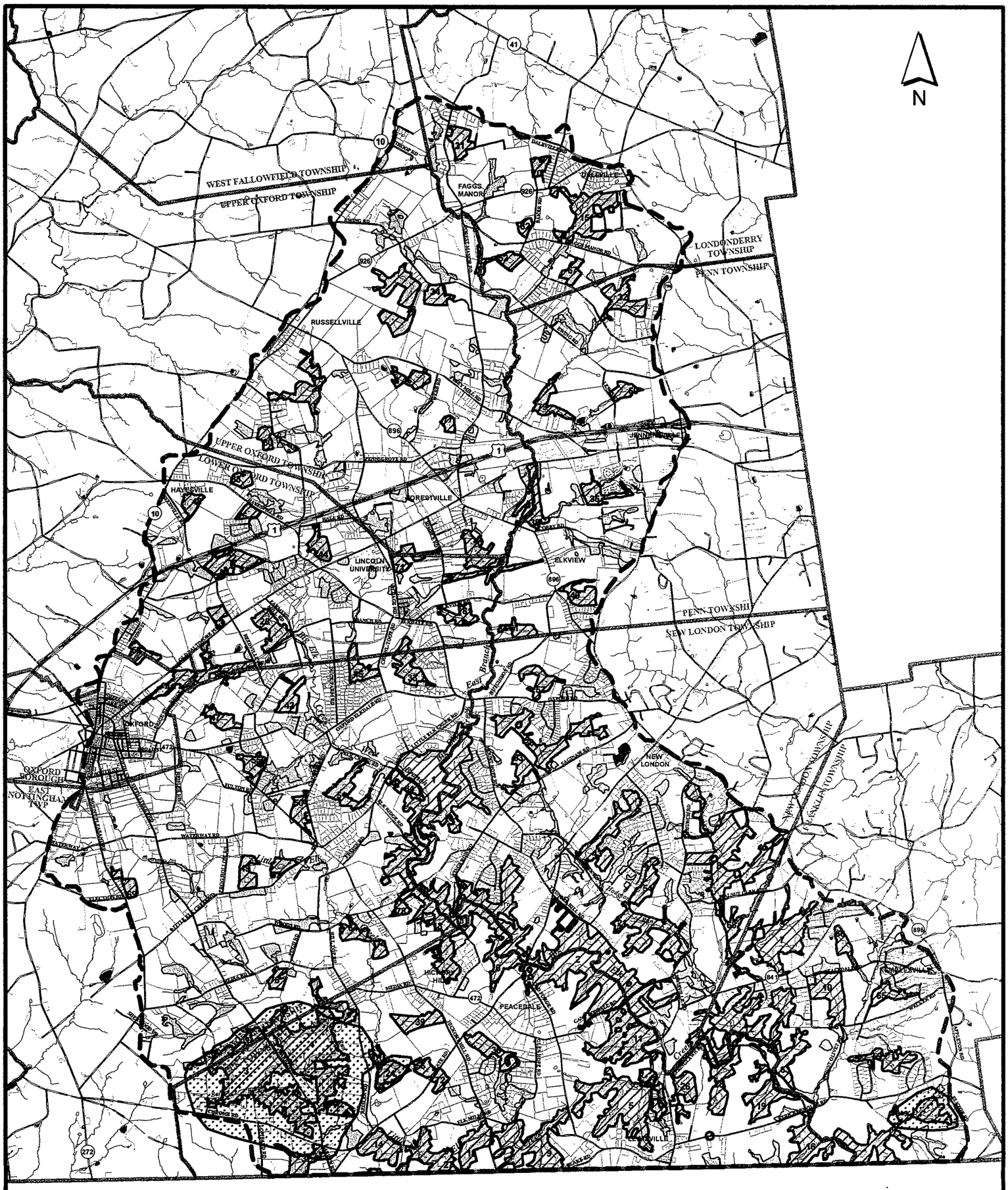
Elk Creeks Watershed Association

Environmental Management Center
BRANDYWINE CONSERVANCY
P.O. Box 141 Chadds Ford, Pennsylvania 19317 (610) 388-2700

Pennsylvania Environmental Council

Source: National Wetlands Inventory, 1993; National Resource Conservation Service Soil Survey, 1995.

Date: November 16, 2001



LEGEND

- Elk Creeks Watershed Boundary
- Municipal Boundaries
- Tax Parcels

Roads

- Limited Access Highway
- Major Roads
- Minor Roads
- Driveways
- Streams
- Ponds
- Pennsylvania Natural Diversity Inventory (PNDI)
- Woodlands and Hedgerows
- Interior Woodlands (300 ft. from edge)
- Discrete Woodland Polygons

5000 0 5000 Feet

Biodiversity: Forest Interior Habitat and PNDI Sites

Elk Creeks Watershed Conservation Plan Chester County, Pennsylvania

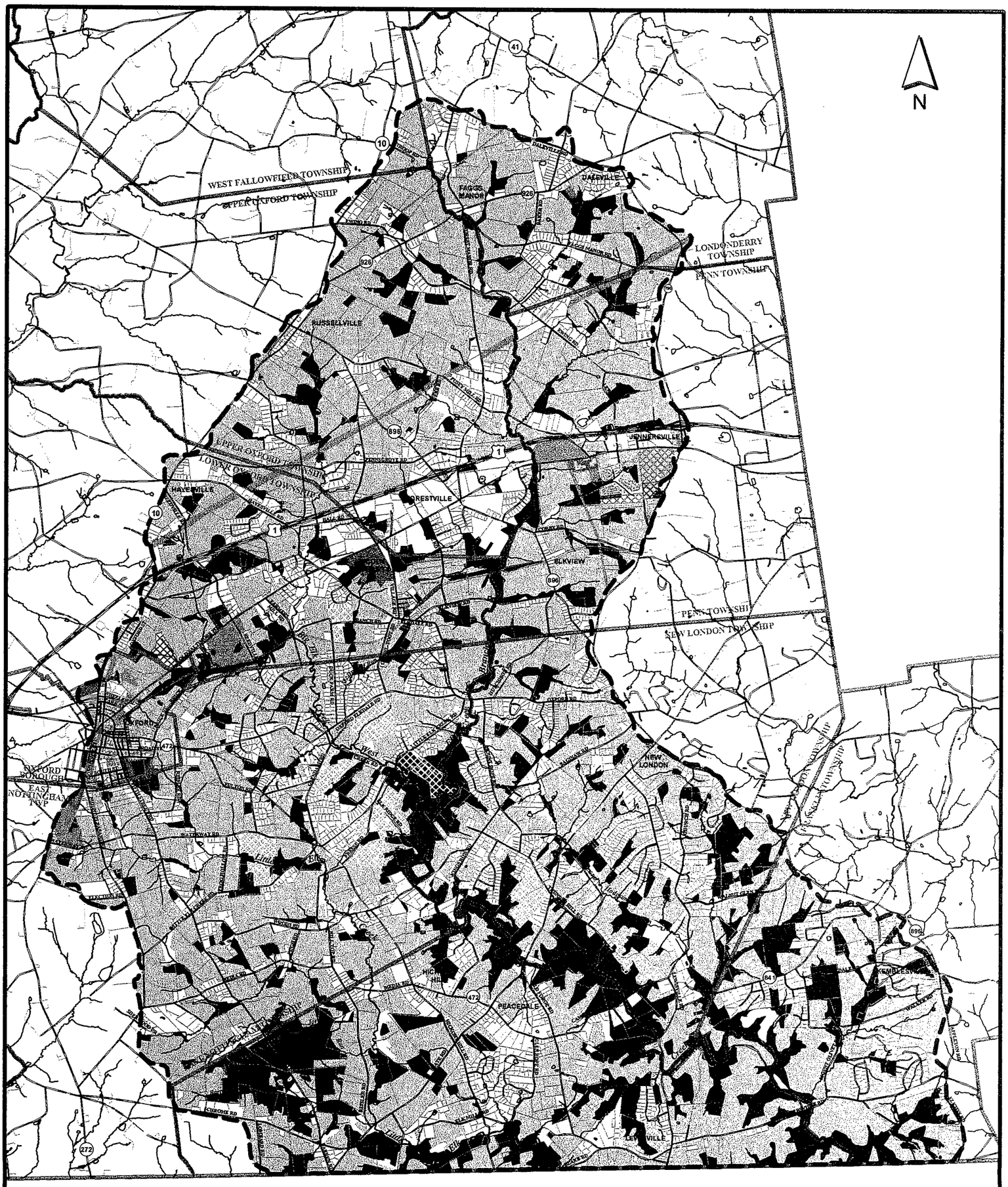
Elk Creeks Watershed Association

Environmental Management Center
BRANDYWINE CONSERVANCY
P.O. Box 141 Chadds Ford, Pennsylvania 19317 (610) 388-2700

Pennsylvania Environmental Council

Source: Woodlands digitized by Brandywine Conservancy, 1999; PNDI from Chester County Natural Areas Inventory, 1994.

Date: November 2, 2001



LEGEND

- Elk Creeks Watershed Boundary
- Municipal Boundaries
- Tax Parcels

Roads

- Limited Access Highway
- Major Roads
- Minor Roads
- Driveways
- Streams
- Proposed Core Reserves

1990 Land Use

- Agriculture
- Single Family
- Multi-family
- Commercial
- Manufacturing
- Mining
- Transportation
- Utility
- Institutional
- Wooded
- Recreation
- Water
- Vacant

Changes in Land Use Since 1990

- Single Family
- Commercial
- Utility
- Institutional

5000 0 5000 Feet

1990 Land Use and Proposed Core Reserves

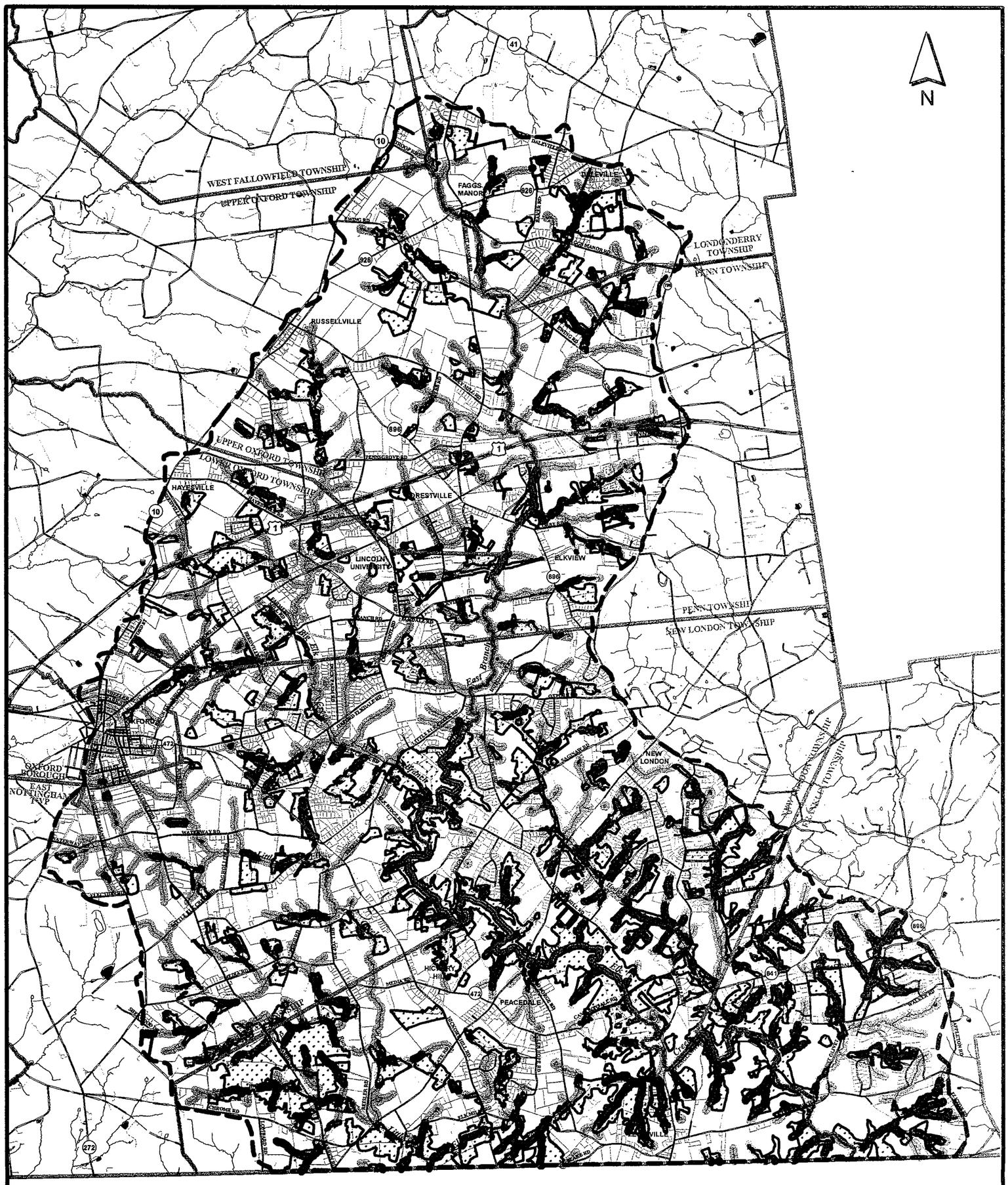
Elk Creeks Watershed Conservation Plan Chester County, Pennsylvania

Elk Creeks Watershed Association

Environmental Management Center
BRANDYWINE CONSERVANCY
P.O. Box 141 Chadds Ford, Pennsylvania 19317 (610) 388-2700

Pennsylvania Environmental Council

Source: "Livable Landscapes for Chester County", 1990.
Date: November 16, 2001



LEGEND

- Elk Creeks Watershed Boundary
- Municipal Boundaries
- Tax Parcels

Roads

- Limited Access Highway
- Major Roads
- Minor Roads
- Driveways

- Streams
- Ponds

Riparian buffers

- Full Buffers
- Partial Buffers
- Opportunity Buffers
- Woodlands and Hedgerows

5000 0 5000 Feet

Riparian Buffers

Elk Creeks Watershed Conservation Plan Chester County, Pennsylvania

Elk Creeks Watershed Association

Environmental Management Center
BRANDYWINE CONSERVANCY
P.O. Box 141 Chadds Ford, Pennsylvania 19317 (610) 388-2700

Pennsylvania Environmental Council

Source: Woodlands digitized by Brandywine Conservancy, 1999; Riparian Buffers created from the Chester County LRS Stream coverage, 1998.

Date: November 16, 2001

APPENDIX I

Survey of Plants of the Elk Creeks Watershed
Conducted in 1999 by Janet Ebert

Name	Status
Aplectrum hyemale	Rare
Aster dumosus	Undetermined
Carex tetanica	Endangered
Chlonathus virginicus	PA Threatened
Cirsium horridulum	Endangered
Gentiana saponaria	Endangered
Iris prismatica	Endangered
Juncus biflorus	PA Threatened
Lobelia puberula	Endangered
Oxypolis rigidior	Undetermined
Poa autumnalis	Endangered
Prenanthas serpentaria	Undetermined
Rubus coneifolius	Endangered
Rudbeckin fulgida	Undetermined
Strophostylis umbellata	Endangered
Tipularia discolor	Rare
Trillium cernuum	Undetermined

APPENDIX II

Survey of Birds of the Elk Creeks Watershed
Conducted in 1997

Acadian Flycatcher
American Black Duck
American Crow
American Goldfinch
American Krestrel
American Redstart
American Robin
American Tree Sparrow
Barn Swallow
Bay-Breasted Warbler
Belted Kingfisher
Black Turkey Vulture
Black-and-White Warbler
Black-Billed Cuckoo
Blackburn Warbler
Blackpoll Warbler
Blue Black-Throat Warbler
Blue Grosbeak
Blue Jay
Blue-Gray Gnatcatcher
Blue-Winged Warbler
Bobolink
Broad-Winged Hawk
Brown Creeper
Brown Thrasher
Brown-Headed Cowbird
Canada Goose
Canada Warbler
Cape May Warbler
Carolina Chickadee
Carolina Wren
Cattle Egret
Cedar Waxwing
Cerulean Warbler
Chestnut-Sided Warbler
Chimney Swift
Chipping Sparrow
Common Grackle
Common Snipe
Common Yellowthroat
Dark-Eyed Junco
Downy Woodpecker
Eastern Bluebird
Eastern Kingbird
Eastern Meadowlark
Eastern Phoebe
Eastern Screech-Owl
Eastern Wood-Pewee
European Starling
Field Sparrow
Fish Crow
Fox Sparrow
Golden-Crowned Kinglet
Grasshopper Sparrow
Gray Catbird
Gray-Cheeked Thrush
Great Blue Heron
Great Crested Flycatcher
Great Horned Owl
Greater Yellowlegs
Green Black-Throat Warbler
Green-Backed Heron
Hairy Woodpecker
Hermit Thrush
Hooded Merganser
Hooded Warbler
House Finch
House Sparrow
House Wren
Indigo Bunting
Kentucky Warbler
Killdeer
Least Flycatcher
Louisianna Waterthrush
Magnolia Warbler
Mallard
Mourning Dove
Nashville Warbler

Northern Bobwhite
Northern Cardinal
Northern Flicker
Northern Mockingbird
Northern Oriole
Northern Parula Warbler
Northern Waterthrush
Orchard Oriole
Osprey
Ovenbird
Palm Warbler
Pine Siskin
Pine Warbler
Priarie Warbler
Purple Finch
Red-Bellied Woodpecker
Red-Breasted Nuthatch
Rea-Eyed Vireo
Red-Headed Woodpecker
Red-Shouldered Hawk
Red-Tailed Hawk
Red-Winged Blackbird
Ring-Necked Pheasant
Rock Dove
Rose-Breasted Grosbeak
Rough-Winged Northern
Swallow
Ruby-Crowned Kinglet
Ruby-Throated Hummingbird
Rufous-Sided Towhee
Savannah
Scarlet Tanager
Sharp-Shinned Hawk
Solitary Sandpiper
Solitary Vireo
Song Sparrow
Sparrow
Spotted Sandpiper
Swainson's Thrush
Swamp Sparrow
Tennessee Warbler
Tree Swallow
Tufted Titmouse
Veery
Warbling Vireo
White-Breasted Nuthatch
White-Crowned Sparrow
White-eyed Vireo
White-Throated Sparrow
Willow Flycatcher
Wilson's Warbler
Winter Wren
Wood Duck
Wood Thrush
Worm-Eating Warbler
Yellow Warbler
Yellow-Bellied Sapsucker
Yellow-Billed Cuckoo
Yellow-Breasted Chat
Yellow-Rumped Warbler
Yellow-Throated Vireo
Yellow-Throated Warbler

APPENDIX III

List of Information Sources

Frey, Robert F., 1996. (*Commonwealth of Pennsylvania 1996 Water Quality Assessment.*) Commonwealth of Pennsylvania Department of Environmental Protection. Bureau of Water Quality Management, Division of Assessment and Standards.

Hall, George M., 1934. (*Ground Water in Southeastern Pennsylvania.*) Commonwealth of Pennsylvania Bureau of Topographic and Geologic Survey, Ground Water Report W 2.

Kricher, John and Gordon Morisson, 1988. (*Eastern Forests.*) Peterson Field Guide. Houghton Mifflin.

Shertzer, Richard H. and Schreffler, Tammy L., 1996. (*Pennsylvania's Surface Water Quality Monitoring Network {WQN}.*) Commonwealth of Pennsylvania Department of Environmental Protection, Bureau of Water Quality Management. #3600-BK-DEP0636.

Sloto, Ronald, 1994. Geology (*Hydrology and Ground -Water Quality of Chester County, Pennsylvania.*) Chester County Water Resources Authority. Water Resources Report 2. Prepared in cooperation with the U.S. Geological Survey. West Chester, Pennsylvania.

The Borough of Oxford, East Nottingham Township, West Nottingham Township, Upper Oxford Township, Lower Oxford Township, Elk Township, reprinted March 1999. Friends of the Oxford Public Library. *Around the Oak.*

APPENDIX IV

Funding Sources

- **Department of Conservation and Natural Resources, Growing Greener Grants**
  - Community Grants – Local recreation, park and conservation projects, including rehabilitation, development, land acquisition, and technical assistance.
  - River Conservation Implementation Grants – Carry out projects defined in approved RCP.
  - Rails – to – Trails Grants – Planning, acquisition or development of rail-trail corridors.
  - Land Trust Grants – Acquisition and planning of open space and natural areas facing imminent loss.
  - Heritage Parks Grants – Preserve and enhance natural, cultural, historic and recreation resources through heritage tourism.

Contacts: Dan Gephart and Fran Rupert (215)560-1812, dgephart@state.pa.us or frupert@state.pa.us

- **Keystone Planning and Technical Assistance Grants**
  - Circuit Riders - Hiring park directors through intergovernmental cooperative efforts between two or more municipalities.
  - Comprehensive Recreation, Park and Open Space Plans – For municipalities to develop open space plans.
  - Conservation/Sound Land Use – Study conservation and sound land use strategies.
  - Feasibility Studies – Feasibility strategies to require, develop or rehabilitate recreational facilities.
  - Greenways – Exploration of greenways as recreational trails or environmental protection corridors.
  - Land and Water Conservation Fund Program - Available to municipalities for public recreation and conservation projects.

- **Chester County Vision Partnership Planning Grants**
  - Tier I – Plan Consistency Initiatives – Updating local plans and ordinances.
  - Tier II – Plan Implementation Projects – Promoting implementation of the policies of *Landscapes*

APPENDIX V

Elk Creeks River Conservation Plan
Summary of Plan Development Process

According to guidance supplied by the Pennsylvania Department of Conservation and Natural Resources, River Conservation Plans are to be developed using a process that is described in the Manual for Keystone Planning, Implementation & Technical Assistance Grant Programs, as well as in the General Information and Scope of Work and Public Participation Guide.

These guidance documents describe a four-step planning process, including (1) determining initial interest through a public meeting, (2) collecting and analyzing resource data, (3) preparation of a draft River Conservation Plan and a public meeting, and (4) preparation of a final River Conservation Plan and a public meeting.

(1) Determining Initial Interest
The initial "kick-off" meeting for the plan was held on October 19, 1998 in conjunction with the Elk Creeks Watershed Association. Approximately 30 people attended.

(2) Collect and Analyze Resource Data
We collected resource data from February 1999 through October 2001, including field notes and photographs, GIS data, such as tax map parcels, aerial photographs, land use and ownership, watershed characteristics, topography and geology, and biological surveys were conducted. After initial observations were collected, GIS database was queried for facts about impervious surface, percentages of various lands uses, etc. Township zoning ordinances were acquired, reviewed and summarized, and a draft of Chester County's Water Resource Management Plan section on the Elk Creeks watershed was previewed. We also began holding discussions with private landowners regarding easements and other protection techniques, including one called "Money for Farmers." After public meetings were held, additional field data were collected for confirmation of certain observations.

(3) River Conservation Plan Draft and Public Review
Based on the first round of data analyses, a draft plan was prepared. The plan was presented to the Steering Committee and revised several times over the course of the summer of 2001.
A Public Review meeting was held at the Oxford Friends Meetinghouse in Oxford, Pennsylvania on November 29, 2001. Changes were made to the draft in response to comments made at this meeting, and over the following 30 days. The plan was revised again and letters and resolutions of support were collected.

(4) The final draft was presented to the public on January 16, 2002.

APPENDIX VI

Letters/Resolutions of Support

ELK CREEKS WATERSHED ASSOCIATION

P.O. Box 111, Oxford, PA 19363
610 998.9900 (voice) ecwa@elkwatershed.org

January 9, 2002

Judith H. Jordan, Associate Director
Environmental Management Center
Brandywine Conservancy
P.O. Box 141
Chadds Ford, PA 19317

Dear Ms. Jordan,

The Elk Creeks Watershed Association would like to express our thanks to the Brandywine Conservancy for their efforts in completing the Elk Creeks River Conservation Plan. Our watershed possesses wonderful natural and cultural features but faces many issues which effect the quality of the watershed. We face issues arising from traditional agriculture at the same time as issues from incredibly rapid development. We have eagerly awaited finalization of this plan so that publication and implementation can begin.

During completion of this plan, the Brandywine Conservancy comprehensively studied, analyzed, and compiled information about our watershed. For this reason alone, the plan is valuable. Moreover, the plan makes recommendations tailored to the unique issues of our watershed and lays out some of the action steps we can take to begin to realize the broader strategies as a watershed association, as individuals, and as a community.

Moving forward, the Elk Creeks Watershed Association will direct our efforts toward achieving the goals of the plan and working within its spirit. We have appreciated your hard work and the assistance of the Pennsylvania Department of Conservation and Natural Resources in helping us to protect our watershed.

Sincerely,

The Board of the
Elk Creeks
Watershed
Association

NEW LONDON TOWNSHIP
P.O. BOX 1002
NEW LONDON, PA 19360

Telephone: 610-869-8658 Fax: 610-869-3386

NLT-01-073

December 26, 2001

Judith H. Jordan
Associate Director
Environmental Management Center
Brandywine Conservancy
PO Box 141
Chadds Ford, PA 19317

Dear Ms. Jordan:

New London Township wishes to congratulate the Conservancy and the Elk Creeks Watershed Association on the completion of the Elk Creeks River Conservation Plan.

As noted in the plan, New London Township is experiencing more residential growth than any of the other townships in the watershed. This growth can adversely impact the natural resources of the Township if not handled carefully. In addition, it requires the Township to emphasize the importance of planning for the recreational needs of our residents. We think the plan contains useful and appropriate recommendations regarding these issues.

Please extend our appreciation to the Elk Creeks Watershed Association for its invaluable work on this Plan and for its future commitment to implementation. We look forward to working with the Association for the benefit of our Township and the watershed.

Sincerely,

Trish Fagan

Trish Fagan
Secretary/Treasurer

Cc: Letter File

ELK TOWNSHIP
P.O. BOX 153
LEWISVILLE, PA 19251

December 26, 2001

Judith H. Jordan
Associate Director
Environmental Management Center
Brandywine Conservancy
PO Box 141
Chadds Ford, PA 19317

Dear Ms. Jordan:

Elk Township would like to express its support for the Elk Creeks River Conservation Plan, recently provided to the watershed townships and presented at a November 29 public meeting. As a township that lies almost 100% in the watershed, conservation of the river resources as recommended in the plan is very important to the future of the Township and its residents.

We note that a great deal of the natural area networks recommended for preservation are located in Elk Township, and further, that we ourselves have spent a significant amount of time and energy in the effort to conserve these natural resources as well. In particular, we currently anticipate seeking assistance with the establishment of a recreational trail along the Big Elk Creek, which we think will advance both the Natural Resources Preservation and Outreach and Education strategies in the plan. We also note that Elk Township's location on the Maryland border, adjacent to the Fair Hill Natural Resources Area, provides a unique opportunity not only to accomplish conservation objectives, but also to serve the recreational needs of the area.

Congratulations on the completion of this plan; we look forward to working to implement the recommendations in order to preserve this extraordinary watershed.

Sincerely,

Trish Fagan

Trish Fagan
Supervisor

Resolution No. 2002-3
Elk Creeks River Conservation Plan
Prepared by the Brandywine Conservancy for the Elk Creeks Watershed Association

WHEREAS, the Penn Township Board of Supervisors has observed the importance of certain natural resource and cultural values, and recognizes the necessity to maintain and improve water quality within the Elk Creeks watershed, thereby affecting the quality of life for its citizens; and

WHEREAS, the Penn Township Board of Supervisors individually has taken steps to protect such values, through adoption and administration of zoning and other development guidelines within its jurisdiction; and

WHEREAS, the Penn Township Board of Supervisors recognizes that joint, cooperative action by all communities within the Elk Creeks watershed will be necessary in order to protect and enhance the watershed's natural resource and cultural values for all of its citizens; and

WHEREAS, the draft Elk Creeks Watershed Plan is a reasonable approach to cooperative watershed management that recognizes the importance of the various roles of landowners, government, business and industry, and other citizens in protection of the watershed's many values; therefore

BE IT RESOLVED THAT the Penn Township Board of Supervisors supports the Elk Creeks River Conservation Plan and urges its adoption by all affected communities.

Resolved this 7 day of JANUARY, 2002

Penn Township
Board of Supervisors

By: _____
Chairman

By: _____
Vice Chairman

By: _____

By: _____

Attest: _____ By: _____
Secretary

ELK CREEKS WATERSHED CONSERVATION PLAN
ADDENDUM 1

Fish of the Elk Creeks Watershed
(by E.L. Cooper and C.C. Wagner, from surveys in 1977, 1978)

Big Elk Creek 1 mile upstream from Pa. Rt. 841
Anguilla rostrata
Clinostomus funduloides
Exoglossum maxillingua
Notropis cornutus
Nocomis micropogon
Rhinichthys atratulus
Rhinichthys cataractae
Semotilus atromaculatus
Catostomus commersoni
Hypentelium nigricans
Noturus insignis
Etheostoma olmstedi
Cottus bairdi

Hodgsons Run
Lampetra aepyptera
Anguilla rostrata
Clinostomus funduloides
Exoglossum maxillingua
Rhinichthys atratulus
Rhinichthys cataractae
Semotilus atromaculatus
Catostomas commersoni
Etheostoma olmstedi
Cottus bairdi

East Branch of Elk Creek at old Rt. 1 bridge
Lampetra aepyptera
Anguilla rostrata
Clinostomus funduloides
Exoglossum maxillingua
Notropis cornutus
Notropis analostanus
Notropis procne
Rhinichthys atratulus
Rhinichthys cataractae
Semotilus atromaculatus
Catostomas commersoni
Lepomis auritus
Lepomus gibbosus
Lepomis macrochirus
Etheostoma olmstedi
Cottus bairdi

ELK CREEKS WATERSHED CONSERVATION PLAN
ADDENDUM 2

Benthic Macroinvertebrates

(from USGS Open-File Report 99-216, Physical, Chemical, and Biological Data for Selected Streams in Chester County, Pennsylvania, 1981-94, A. Reif, 1999)

East Branch Big Elk Creek at Elkview

Platyhelminthes (flatworms)
- Turbellaria
  - Tricladida
    - Planariidae

Nematoda (nematodes)

Nemertea (proboscis worms)
- Enopia
  - Hoplonemertea
    - Tetrastemmatidae
      - *Prostoma*

Mollusca (molluscs)
- Gastropoda
  - Mesogastropoda
    - Pleuroceridae
      - *Goniobasis*
  - Basommataphora
    - Ancylidae
      - *Ferrissia*
    - Physidae
      - *Physa*

Annelida (segmented works)
- Oligochaeta
- Lumbriculida
  - Lumbriculidae
- Tubificida
  - Naididae

Arthropoda (arthropods)
- Acariformes
  - Hydrachnidia
- Crustacea
  - Podocopa
- Insecta
  - Ephemeraoptera
    - Baetidae
      - *Baetis*
      - *Pseudocloeon*

- Caenidae
  - *Caenis*
- Ephemerelidae
  - *Ephemerella*
- Heptagniidae
  - *Stenacron*
  - *Stenonema*
- Isonychiidae
  - *Isonychia*
- Leptohyphidae
  - *Trichorythodes*
- Leptophlebiidae

Odonata
- Ashnidae
  - *Boyeria*

Plecoptera
- Capnidae
  - *Allocapnia*
- Nemouridae

Hemiptera
- Vellidae
  - *Microvelia*
  - *Rhagovelia*

Megaloptera
- Corydalidae
  - *Nigronia*

Trichoptera
- Glossosomatidaea
  - *Glossosoma*
- Hydropsychidae
  - *Ceratopsyche*
  - *Cheumatopsyche*
  - *Hydropsyche*
- Hydroptilidae
  - *Hydroptila*
  - *Leucotrichea*
- Leptoceridae
  - *Oecetis*
- Philopotamidae
  - *Chimarra*
  - *Dolophilodes*
- Polycentropolidae
  - *Polycentropus*
- Rhyacophilidae
  - *Rhyacophilia*
    - *R. fuscula*

Uenoidae
Neophylax
Coleoptera
Circulionidae
Dryopidae
Helichus
Elmidae
Ancyronyx
Dubiraphia
Macronychus
M. glabratus
Optioservus
Oulimnius
Stenelmis
Gyrinidae
Dineutus
Hydrophilidae
Hydrobius
Psephenidae
Psephenus
Diptera
Chironomidae
Empididae
Hemerodromia
Simuliidae
Simulium
Tipulidae
Antocha
Tipula

<u>West Branch Big Elk Creek (near Oxford)</u>

Platyhelminthes (flatworms)
Turbellaria
Tricladida
Planariidae
Nematoda (nematodes)
Nemertea (proboscis worms)
Enopia
Hoplonemertea
Tetrastemmatidae
Prostoma
Mollusca (molluscs)
Gastropoda

Basommataphora

- Ancylidae
  - *Ferrissia*
- Physidae
  - *Physa*

Annelida (segmented works)
- Oligochaeta
- Lumbriculida
  - Lumbriculidae
- Tubificida
  - Naididae

Arthropoda (arthropods)
- Acariformes
  - Hydrachnidia
- Crustacea
  - Cyclopoida
  - Podocopa
- Insecta
  - Ephemeraoptera
    - Baetidae
      - *Baetis*
      - *Pseudocloeon*
    - Caenidae
      - *Caenis*
    - Ephemerelidae
      - *Ephemerella*
    - Heptagniidae
      - *Stenonema*
    - Isonychiidae
      - *Isonychia*
    - Leptohyphidae
      - *Trichorythodes*
    - Leptophlebiidae
  - Odonata
    - Coenagrionidae
      - *Argia*
  - Plecoptera
    - Capniidae
      - *Allocapnia*
    - Chloroperlidae
    - Taeniopterygidae
      - *Taeniopteryx*
  - Hemiptera
    - Vellidae
      - *Rhagovelia*
  - Megaloptera
    - Corydalidae

Corydalus
Nigronia
Trichoptera
Apataniidae
Apatania
Brachycentradae
Brachycentrus
Glossosomatidaea
Glossosoma
Hydropsychidae
Ceratopsyche
Cheumatopsyche
Hydropsyche
Macrostemum
Hydroptilidae
Hydroptila
Leucotrichea
Leptoceridae
Oecetis
Philopotamidae
Chimarra
Dolophilodes
Polycentropolidae
Neureclipsis
Polycentropus
Rhyacophilidae
Rhyacophilia
Uenoidae
Neophylax
Lepidoptera
Pyralidae
Coleoptera
Ptilodactylidae
Anchytarsus
A. bicolor
Hymenoptera
Diptera
Chironomidae
Empididae
Chelifera
Hemerodromia
Simuliidae
Simulium
Tipulidae
Antocha
Tipula

ELK CREEKS WATERSHED CONSERVATION PLAN
ADDENDUM 3

Major Streams and Tributaries of the Elk Creeks Watershed

Stream	Length (miles)
Barren Brook	2.19
Big Elk Creek East Branch	9.24
Big Elk Creek West Branch	9.14
Big Elk Creek Main Branch (confluence to state line)	9.61
Hodgson Run	4.20
Jordan Run	2.10
Little Elk Creek	9.50
McDonald Run	1.83