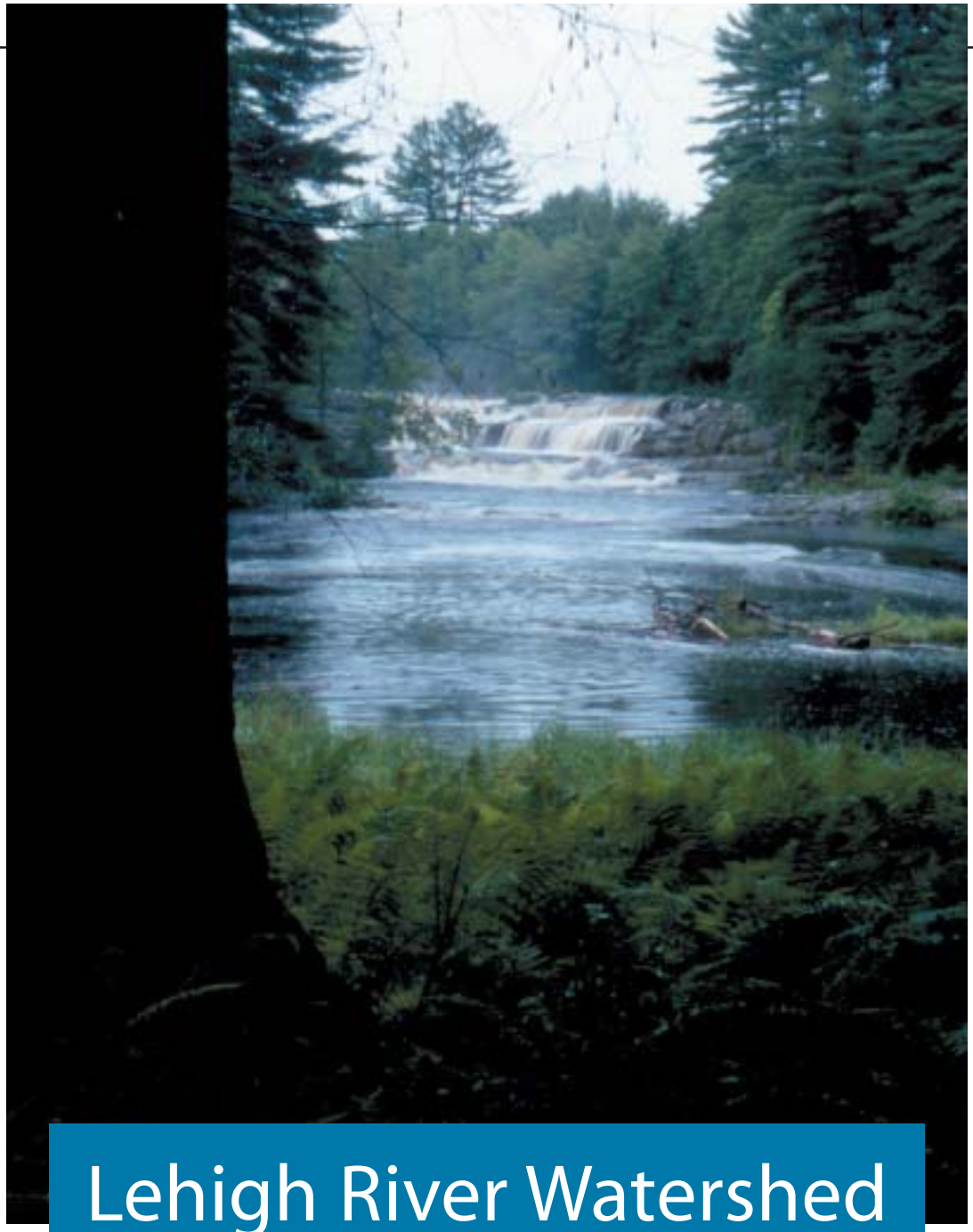


Lehigh River Watershed
Conservation Management Plan

Wildlands Conservancy 2003

Wildlands Conservancy

Message from the President of Wildlands Conservancy

This *Lehigh River Watershed Conservation Management Plan* is a gift to the communities of the Lehigh River watershed – its people, its institutions, its businesses.

It is presented in the spirit of cooperation by Wildlands Conservancy and its many partners, sponsors, and friends, as well as by the principle funders of the effort: Pennsylvania Department of Conservation and Natural Resources (DCNR) and The William Penn Foundation. This document provides many benefits, one of which is that it is the lens through which the state, and others, will look when asked to fund projects relating to the natural, ecological, cultural, recreational, and historical assets of our beautiful watershed.

You might wonder who is "responsible" for the quality of this watershed. What entity cares for its precious natural and recreational aspects? What governmental department is watching over its parks and trails, its wetland and woodlands? What agency monitors its mountains, valleys, rivers, and open spaces? Who is charged with teaching the next generation – not to mention the current one – about its responsible stewardship?

The answer is not simple. Beyond our personal responsibilities in these matters, and beyond our personal reach, there remains an enormous amount to be dealt with. Some of these tasks are covered by various agencies of federal, state, county, and local governments. It's interesting – and perhaps even alarming to some – to realize that not everything is covered by such agencies. One might also argue that government should *not* be involved with every issue. In any case, not everything that needs attention is getting it.

It occurred to the leadership of Wildlands Conservancy several years ago that, if there is to be a coordinated effort to maintain – or remedy, where needed – the health of the Lehigh River watershed, we will need a comprehensive plan. "Oh, good," we heard, "just what we need: another plan." Skepticism notwithstanding, we set about to create one … and this plan is it.

Many plans, we are told, just look nice sitting on a shelf. Wildlands Conservancy is an organiza-

tion of doers. Our long-term goal is to implement this plan … starting right now. It will take all we have – and more – to do it. As I said before, this plan is a gift to the community, and indeed it is. There is so much to do, so many needs, that it will take the entire watershed community to complete it.

In one sense, it will never be completed – certainly not just by Wildlands Conservancy alone. Among the plan's many valuable aspects is that it assembles, in one place, several useful tools. It provides a fundamental reference or orientation, as well as a platform from which one can view the larger needs. It is a compendium of assets, problems, and solutions. It is a motivator, providing impetus to tackling issues and problems.

The staff and board of Wildlands Conservancy are willing to do whatever our abilities and resources permit. Beyond that, we are willing to help foster and facilitate action among others. If you have read this far, perhaps you are one of those who will work with us – or independently of us – in implementing the recommendations of this plan. This is important work. The health and well-being of this community, this region, this state and country is dependent upon action of the type described in this plan.

Thanks to the many who worked to put this document together over the last three years. Many from Wildlands Conservancy staff and elsewhere spent untold hours helping to shape the document. The visionaries at The William Penn Foundation have for years been willing to invest in forward-looking projects like this one. The personnel at the Pennsylvania Department of Conservation and Natural Resources have been creatively supportive of this project from the outset. We appreciate the opportunity to work with these talented and progressive people.

Tom Kerr
December 2003

Introduction

The Lehigh River

The Lehigh River has been used and enjoyed by countless generations. From the first Native Americans to settle upon its banks, to the developers of the canals, locks, and dams which harnessed the power of the river, to the many industrialists who brought us iron, cement, and steel, to the many recreational users, to the resident wildlife – all of whom did – or do – depend on this important resource. The Lehigh River is part of our lives, part of our community. Over the span of years, this great resource has served us well. This plan and its recommendations, along with the support of the watershed community, will help us return the favor to our wonderful river and its unique watershed. While it may never again be labeled "pristine," it can be returned to its former glory as the life-blood of our communities.

The Lehigh River watershed drains 1,345 square miles, encompasses 108 municipalities, and drains portions of ten counties in eastern Pennsylvania, including Lehigh, Northampton, Berks, Bucks, Carbon, Monroe, Luzerne, Schuylkill, Lackawanna, and Wayne in eastern Pennsylvania. The Lehigh River is approximately 103 miles long and is the second largest tributary to the Delaware River. The headwaters of the Lehigh River are located at Lehigh Marshes just north of Gouldsboro, Wayne County. The mouth of the river is located in the city of Easton, Northampton County.

The reach of the Lehigh River encompassing the Francis E. Walter Dam to Jim Thorpe has been designated a Pennsylvania Scenic River. This 32-mile section includes the Lehigh Gorge State Park, which is one of the most popular Class II and Class III whitewater-boating sections in the country. This attraction provides annual economic benefits to the state and local economy, and offers recreational opportunities to tens of thousands of people each year. The Lehigh River is also used as a raw water supply for hundreds of thousands of watershed residents in four riverside communities.

The river has historically functioned as a transportation route to markets in Philadelphia, New York, and elsewhere, for the coal from the Eastern Middle and Southern coalfields of Carbon and Luzerne counties. America's Industrial Revolution was cradled in the valley of the Lehigh River, which is the only river in America to be privately owned. From 1827 to 1966 it was owned by the Lehigh Coal & Navigation Company. Since then, it has largely emerged from its industrial past to become much more naturally beautiful. Now, along the banks of the river, mountain

bikers and hikers are seen where there were once mules and canal boats hauling coal and other material to fuel the Industrial Revolution. Where dams once contained the mighty Lehigh, fishermen in great numbers are now seen reaping the harvest of a more-healthy stream. Since the passage of the Clean Water acts in the early 1970s, the water quality of the Lehigh River has dramatically improved, and our communities are starting to develop a sense of stewardship for the resource.

However, today the river still faces many challenges. Rapid growth – know as "suburban sprawl," non-point source pollution, loss of critical wildlife habitat, loss of open space, loss of productive farmland, and abandoned mine drainage all impact the watershed adversely.

PROJECT GOALS

In 2000, with funding from the Pennsylvania Department of Conservation and Natural Resources (DCNR) and The William Penn Foundation, Wildlands Conservancy and its project partners began a three-year process to develop the Lehigh River Watershed Conservation Management Plan. In the broadest sense, this work will be the focus of Wildlands Conservancy and its many partners for the next decade, at least. In this sense, the plan will be a community asset. The ultimate goal of the project is the official acceptance of the plan by DCNR, and for the Lehigh River to be listed on the Pennsylvania Rivers Conservation Registry, making the entire Lehigh River watershed eligible for additional state funding to carry out the recommendations made in this plan.

Generally, the Lehigh River Watershed Conservation Management Plan:

- identifies the cultural, natural, biological, historical, and recreational resources of the Lehigh River and its watershed;
- identifies problems, as well as solutions to these problems; and
- provides a listing of prioritized recommendations that will preserve, protect, and enhance this important natural resource.

More specifically, the plan will guide the watershed community in:

- identifying and preserving critical natural habitat and open space;
- identifying and developing recreational features and corridors;
- assessing and addressing the region's most critical environmental problems; and
- educating its citizens.

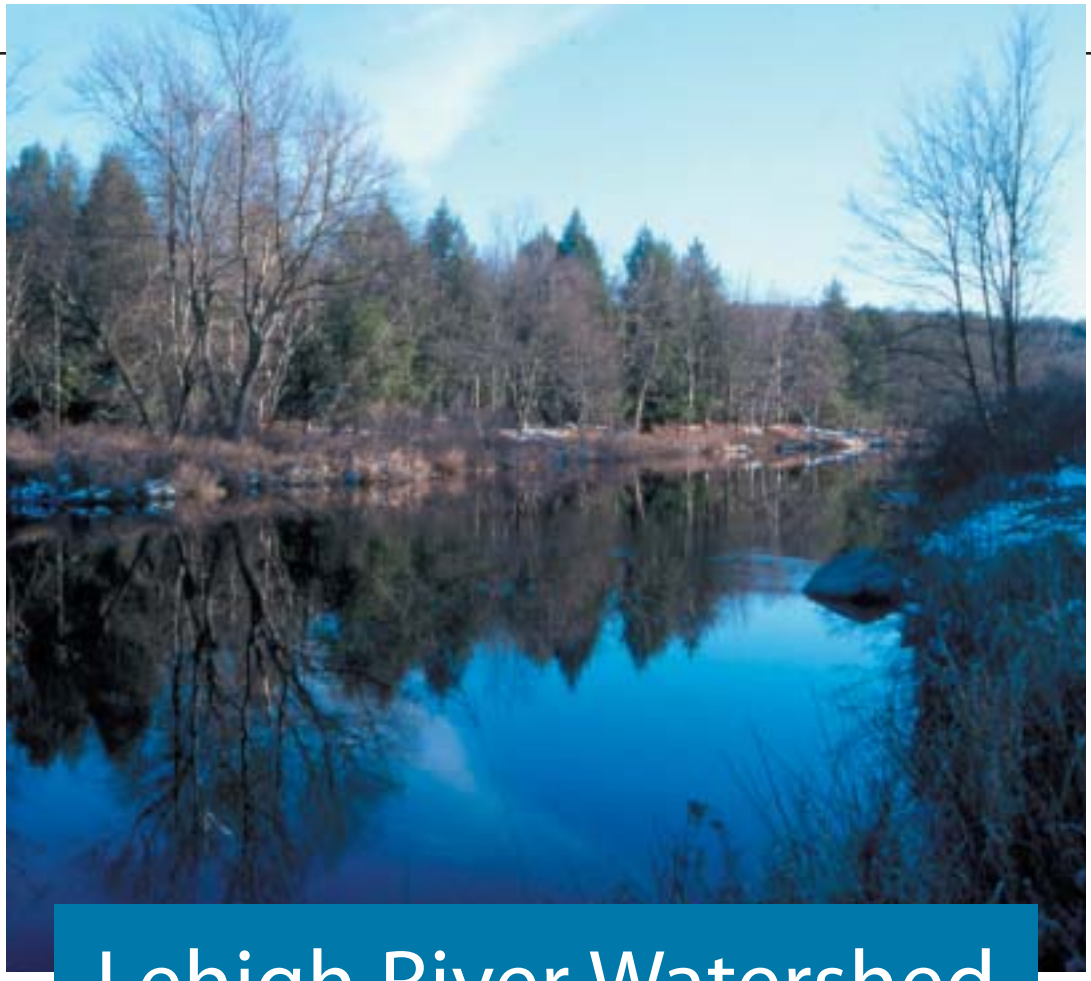
The plan is a result of several years of work and public interaction. The public input component included four public meetings, three steering committee meetings, three partnership meetings, and countless meetings and interviews with individuals, committees, municipalities, watershed organizations, watershed specialists, and agencies involved in the Lehigh River watershed.

With Implementation of key aspects of the Lehigh River Watershed Conservation Management Plan, the watershed community can work towards the future protection, preservation, and enhancement of the Lehigh River and its watershed.

REPORT LAYOUT

The Lehigh River Watershed Conservation Management Plan is divided into several separate, but integrated, sections. They include an introduction, descriptions of the various components of the watershed including physical, cultural, historical, aquatic, land, biological, and recreational. These sections constitute the main body of the document, and characterize the resources within the watershed.

In addition, the report contains a section on conservation resources and tools, which outlines programs, funding, and tools available to help the watershed community implement the plan. The final section of the plan, entitled "Recommendations," details future projects and activities designed to enhance and protect the valuable and unique resources of the watershed.



Lehigh River Watershed
Conservation Management Plan

Wildlands Conservancy 2003

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Wildlands Conservancy

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Wildlands Conservancy's Contributing Authors

Ms. Kate Brandes
Environmental Scientist

Mr. Dennis G. Collins
Director of Land Protection

Mr. Brian Flores
Stream Restoration Specialist

Mr. Thomas L. Gettings
Director of Advancement

Mr. Thomas J. Kerr
President

Ms. Sharla Kistler
Database Manager

Mr. Chris Kocher
Director, Rivers Program
Chief Program Officer

Ms. Debra Lermitte
Director of Land Conservation & Planning

Ms. Diane Matthews-Gehringer
Land Conservation Manager

Ms. Abigail Pattishall
Environmental Biologist

Mr. Brian Vadino
Stream Restoration Manager

Mr. Gregg Woodruff
Environmental Scientist

Project Steering Committee

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Mr. Philip Burtner
President
Monocacy Creek Watershed Association

Mr. James Clauser
District Manager
Carbon County Conservation District

Ms. Kate Crowley
Environmental Program Manager
Pennsylvania Department of Environmental Protection

Mr. Doug Fogal
Pocono Whitewater Adventures

Mr. William Manner
Watershed Manager
Pennsylvania Department of Environmental Protection

Dr. Carl Moses
Dean, College of Arts and Sciences
Lehigh University

Dr. Kenneth Najjar
Branch Head, Planning and Implementation
Delaware River Basin Commission

Dr. Carl Oplinger
Associate Professor of Biology
Biology Department, Muhlenberg College

Mr. Geoff Reese
Chief Planner
Lehigh Valley Planning Commission

Mr. Todd Wood
Pennsylvania Department of Environmental Protection, Bureau of Abandoned Mine Reclamation

PROJECT PARTNERSHIP COMMITTEE

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Mr. Jeffrey Andrews
Superintendent, Water Supply & Treatment, City of Bethlehem

Mr. Aurel Arndt
Lehigh County Authority

Mr. Eric Bartolacci
Environmental Planner
Monroe County Planning Commission

Mr. Frank Bostick
Lehigh River Stocking Association

Michele Breslin
Regional Recreation and Park Advisor, Pennsylvania Department of Conservation and Natural Resources

Mr. Jed Brown
U.S. Fish and Wildlife Service

Mr. Walter Chamberlin
Luzerne County Conservation District

Mr. Scott Christman
Wildlife Conservation Officer, Pennsylvania Fish & Boat Commission

Mr. John William Clune
Watershed Specialist, Lackawanna County Conservation District

Dr. Joe Colosi
Natural Science Department
DeSales University

Mr. Lee Creyer
Wildlife Conservation Officer, Pennsylvania Fish & Boat Commission

Mr. Andrew Curtis
Penn State Cooperative Extension

Mr. Dennis Demara
Regional Recreation and Park Advisor
Pennsylvania Department of Conservation and Natural Resources

Ms. Karen Dolan
Illick's Mill Project

Dr. Percy Dougherty
Lehigh County Commissioner

Mr. Bob Eddy
Arrowhead Lakes

Mr. Kevin Fazzini
Park Manager
Lehigh Gorge/Hickory Run State Park

Ms. Rebecca Hayden
Watershed Specialist
Lehigh County Conservation District

Mr. Gordon Heller
Superintendent, Department of Parks & Recreation, County of Northampton

Ms. Pat Hill
Lake Harmony, Kidder Township

Mr. Heath Hines
Watershed Specialist
Luzerne County Conservation District

Mr. Robert Hughes
Eastern Pennsylvania Coalition for Abandoned Mine Reclamation, Luzerne County Conservation District

Mr. & Mrs. Everett Kaul
Walnutport Canal Association

Mr. Steve Kerbacher
Northampton Borough Municipal Authority

Ms. Janice Lathrop
Historic Catasauqua

Lehigh Valley Canoe Club

Mr. Rick Loomis
Executive Director, Clean Water Action

Mr. Josh Longmore
Watershed Specialist
Luzerne County Conservation District

Mr. John Mauser
Northampton Greenway Partnership

Mr. Joe McMahon
Manager of Operations
City of Allentown, Water Resources

Mr. Lance Metz
Hugh Moore Historical Park and Museums

Mr. Robert Miller
Lehigh River Watch

Mr. Craig Morgan
District Manager, Schuylkill County Conservation District

Mr. Robert Muller
Wayne County Conservation District

Mr. Richard Myers
Program Assistant
Delaware Riverkeeper Network

Mr. Larry Newswanger
Management Forester
Pennsylvania Department of Conservation and Natural Resources, Bureau of Forestry

Mr. Lincoln Parmer
Little Lehigh Trout Unlimited

Dr. Frank Pazzaglia
Earth and Environmental Sciences
Lehigh University

Mr. Bruce Pysher
Northampton County Conservation District

Mr. Scott Reinhart
Program Biologist
Ducks Unlimited, Inc.

Mr. Paul Sell
Lehigh County Conservation District

Mr. Leroy Skinner
Carbon County Groundwater Guardians

Mr. Howard Slifkin
Arrowhead Lakes

Ms. Barbara Smith
North Pocono C.A.R.E.

Mr. Paul Snyder
Tobyhanna Creek/ Tunkhannock Creek Watershed Association

Mr. Glenn Solt
Township Executive
Whitehall Township

Ms. Pamela Spayd
Watershed Specialist
Berks County Conservation District

Mr. Darryl Speicher
Watershed Specialist
Monroe County Conservation District

Mr. Bill Sweeney
Environmental Educator
Jacobsburg State Park

Ms. Jane Thomassen
Big Bass Lake

Mr. Anthony Tur
U.S. Fish and Wildlife Service

Mr. Steve Vanya
Monocacy Creek Trout Unlimited

Mr. Gregory Wacik
U.S. Army Corps of Engineers

REGIONAL ADVISORY COUNCILS

Southern Region – Lehigh and Northampton Counties

Mr. Richard Cary
Forestry Consultant
ForestLand Consulting

Ms. Karen Dolan
Illick's Mill Project

Dr. Percy Dougherty
Lehigh County Commissioner

Mr. Matt Glennon
Real Estate Consultant
Plainfield Township

Ms. Rebecca Hayden
Watershed Specialist
Lehigh County Conservation District

Mr. Gordon Heller
Superintendent, Department of Parks & Recreation, County of Northampton

Mr. Chad Helmer
Director, Lehigh Valley Land Recycling Initiative

Mr. Dennis Jones
Township Supervisor
Upper Mt. Bethel Township

Mr. Lee Lichtenwalner
Public Works Project Manager
Lower Macungie Township

Mr. Glenn Solt
Township Executive
Whitehall Township

Mr. Tom Wehr
Decorator

Mr. Forrest A.Wessner Jr.
Supervisor, Heidelberg Township

Dr. Geoff Wright
Veterinarian

REGIONAL ADVISORY COUNCILS

Northeast Region – Monroe, Wayne, and Lackawanna Counties

Mr. Dave Albright
Open Space Coordinator
Monroe County Planning Commission

Mr. Jeff Andrews
Superintendent
Water Supply and Treatment

Mr. Eric Bartolacci
Environmental Planner
Monroe Planning Commission

Mr. Jared Brandwein
U.S. Fish and Wildlife Service

Mr. Sal Checho
Conservation Easement Donor
Delaware Township

Mr. John William Clune
Watershed Specialist
Lackawanna County Conservation District

Mr. Ralph "Bud" Cook
The Nature Conservancy, Northeast Pennsylvania Office

Mr. Tim Ladner
Assistant District Forester
Delaware State Forest

Mr. Tighe Scott
President
Scott Enterprises contractors

Ms. Linda Snyder
Resident, Eldred Township

Mr. Paul Snyder
Tobyhanna Creek/ Tunkhannock Creek Watershed Association

Mr. Darryl Speicher
Watershed Specialist
Monroe County Conservation District

Ms. Edie Stevens
League of Women Voters, Brodhead Creek Watershed Association

Mr. Dominic Strohlein
President
Aquashicola & Pohopoco Watershed Conservancy

Mr. Anthony Tur
U.S. Fish and Wildlife Service

REGIONAL ADVISORY COUNCILS

Northwest Region – Carbon and Luzerne Counties

Mr. Walter Chamberlin
District Manager
Luzerne County Conservation District

Mr. Duane Dellecker
Director, Carbon County
Department of Solid Waste

Mr. Robert Dobash
Code Enforcement Officer
Kidder Township

Mr. Kevin Fazzini
Park Manager
Lehigh Gorge/Hickory Run State Park

Mr. Thomas J. Gerhard
Carbon County Commissioner

Mr. Alan Gregory
Journalist

Mr. Conyngham William Haas
Landowner, Bear Creek

Mr. Glen Hahn
Supervisor
Lower Towamensing Township

Ms. Robin King
Resident/Past Supervisor
Buck Township

Mr. Josh Longmore
Watershed Specialist
Luzerne County Conservation District

The Honorable Keith McCall
Representative
Commonwealth of Pennsylvania

Ms. Judy McCarthy
North Pocono C.A.R.E.

Mr. Larry Newswanger
Service Forester
Pennsylvania Department of Conservation and Natural Resources, Bureau of Forestry

Mr. Harold J. Pudliner, Jr.
Manager, Weatherly Borough

Mr. Carl Schmitt, Jr.
Retired Architect-AIA

Ms. Linda Thoma
Executive Director
North Branch Land Trust

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Part I

PHYSICAL COMPONENTS

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A. Location and Size

The Lehigh River Watershed is located within the Delaware River Basin as shown in Map 1-1. The Lehigh River (Map 1-2) originates in a series of glacial bogs and marshes in the area of Pocono Peak Lake near Gouldsboro (about 15 miles southeast of Scranton). The elevation at the Lehigh River headwaters is approximately 2,200 feet above sea level and drops nearly 1,000 feet during its 103-mile journey to the Delaware River (see Map 1-3). The river flows through ten counties, shown in Table 1-1, and drains 108 municipalities; in many places the river forms the municipal (political, county) boundary.

TABLE 1-1. COUNTIES IN THE LEHIGH RIVER WATERSHED

County	***Area, mi2***
Berks	21.64
Bucks	0.93
Carbon	379.19
Lackawanna	40.10
Lehigh	275.94
Luzerne	126.38
Monroe	257.08
Northampton	174.98
Schuylkill	55.30
Wayne	12.49
Total	***1,345***

At White Haven, the Lehigh River and its banks become the Lehigh Gorge State Park. Over the next 30 miles, the river flows through a wilderness area that is a haven for whitewater boaters and mountain bikers. Within the boundaries of the park, access on paved roads is limited to White Haven on the north, the park headquarters at Rock Port, near the center, and the Glen Onoko take-out at the south. The Lehigh River exits the Lehigh Gorge State Park north of the town of Jim Thorpe. From Jim Thorpe to Bowmanstown, the Lehigh River contains less rapids and is enjoyed by summer boaters.

The Lehigh River then crosses Blue Mountain at the Lehigh Gap near Palmerton. Blue Mountain separates the Upper Lehigh region from the Lehigh Valley. The Lehigh River continues south through Walnutport and into Allentown. At Allentown, South Mountain impedes the Lehigh River's southward flow and turns it to the east and into Bethlehem.

At Bethlehem, the Lehigh River's speed continues to slow until it merges with the Delaware River at the dam in Easton. The Lehigh's watershed is approximately 1,345 square-miles in area and consists of approximately 2,006 miles of streams. The Delaware River, with a 13,539 square-mile watershed, flows south past Trenton, Philadelphia, and Wilmington-ultimately emptying into the Atlantic Ocean.

B. Physiography and Topography

As shown in Map 1-4, the majority of the Lehigh River basin lies mainly within two physiographic provinces. The Appalachian Plateaus Physiographic Province to the north is characterized by a high rolling plateau, dissected by many narrow and steep-walled stream valleys, as well as numerous lakes and wetlands at elevations ranging from 1,500 to 2,200 feet above sea level. The Glaciated Pocono Plateau section of the Appalachian Plateau province contains the headwaters of the Lehigh River. The Valley and Ridge province to the south, below White Haven, is recognized as consisting of two sections, the Appalachian Mountain Section and the Great Valley Section. The Appalachian Mountain Section, which adjoins the Plateaus province, is a broad band of long narrow ridges and intermediate valleys whose axes lie in the northeast-southwest direction, transverse to the general course of the river. The ridges and steep slopes are moderately wooded. Elevation of the terrain ranges from 400 to 1,400 feet above sea level. The southern-most ridge, Blue Mountain, is cut by the river at Lehigh Gap. The Great Valley Section, characterized by broad rolling terrain, extends northeast to the mouth of the Lehigh at

Easton. This section is bounded on the north and west by Blue Mountain and on the east and south sides by the South Mountain. The northern portion of the valley, is underlain by shale. These shale uplands are commonly 400 to 700 feet in elevation, and stream valleys cut 100 to 150 feet below that surface. In the eastern part of the valley, north of Allentown in Lehigh County, where there is slate rather than shale, the elevations and relief are 100 to 200 feet greater. These shale uplands commonly stand as much as 100 feet above the carbonate terrain to the south.

South of the Great Valley Section, minor portions of the Lehigh basin are within the New England and Piedmont provinces. The portion of the watershed within the New England province is entirely within the Reading Prong Section. It lies between the Great Valley and the Gettysburg-Newark Lowland. The Reading Prong consists of Precambrian granitic gneiss and Cambrian Hardyston quartzite. Elevations in the Reading Prong are as great as 1,000 to 1,300 feet. The portion of the watershed that extends into the Piedmont province is entirely within the Gettysburg-Newark Lowland Section. This section consists of red sedimentary rocks of the Mesozoic basins that include sandstones, siltstones, shales, and, locally, conglomerates. The Mesozoic rocks are intruded by numerous thick sills and thin dikes of diabase that almost invariably stand out in relief above the adjacent sedimentary rocks. Elevations can reach 1,000 to 1,300 feet and commonly are at least 900 feet.

C. Geology

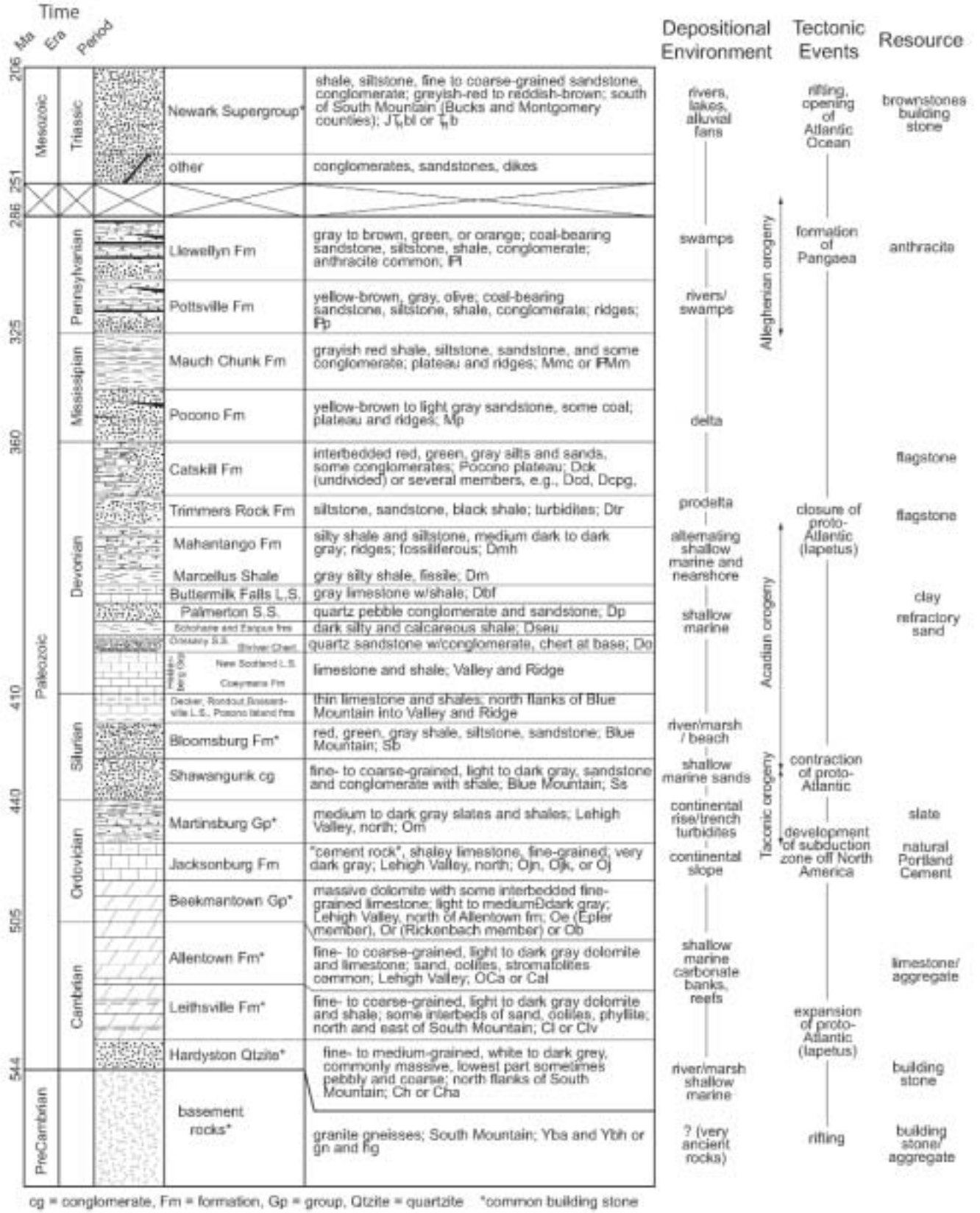
The stratigraphy and structure of bedrock underlying the land surface plays an important role in the physical, chemical, and biological interactions of the watershed. The mineral composition of geologic formations determines, in large part, the quality, and chemical makeup of both surface and groundwaters throughout the watershed. The resulting chemical composition may be a determining factor in what species of flora and fauna live and thrive in the watershed. Factors of geologic structure such as degree of fracturing, folding, or dissolution of bedrock may all be relevant to the quantities of water available for withdrawal by public wells or for irrigation or recreational purposes.

1. Geologic History

The earth is about 4.5 billion years old and has a long geologic history. The major events that have shaped the Lehigh River watershed are described here and are shown in Figure 1-1.

During PreCambrian times, (before about 550 million years ago (mya)), the granitic-gneisse rock which makes up South Mountain was formed. During the Cambrian period (550-500 mya) and Ordovician period (500-440 mya), many of the carbonate rocks in the watershed were created such as the Jacksonburg ("cement rock"), Beekmantown, and Allentown limestones. During the Ordovician period, the Martinsburg shale was formed. Blue Mountain was shaped during the Silurian and Devonian periods (440-360 mya) when the Taconic and Acadian mountain building events were taking place. The Shawangunk, Bloomsburg, Marcellus Shale, Trimmers Rock, and Catskill formations were also formed during this time. From about 360-290 mya (the Mississippian and Pennsylvania Periods), the Lehigh River watershed area looked like a large plain with swamps and peat bogs that formed the source of the present day anthracite coal seams in Pennsylvania. The Pocono, Mauch Chunk, Pottsville, and Llewellyn formations were formed during this time. In the late part of this period, a great mountain building event occurred called the Alleghenian orogeny resulting from the collision of the North American and

FIGURE 1-1 STRATIGRAPHIC COLUMN FOR BUCKS/MONTGOMERY/LEHIGH VALLEY/POCONO REGION (Source: Frank Pazzaglia, Lehigh University, 2003)



African continents. This mountain building event raised the Allegheny Mountain Range about 2 1/2 miles high. Following this period, the North American and African continents separated and a basin formed between the two continents that is the present day Atlantic Ocean; this basin continues to widen today.

During the Mesozoic Era (250-65 million years ago), the region was transformed due to erosion that formed many of the land features we see today. Erosion from the Allegheny orogeny continued during much of the Cenozoic (the last 65 million years ago) and most of the area in the watershed was lowered by hundreds of feet, with the more resistant rocks becoming the higher ridge tops and the softer rocks becoming the valleys.

Two episodes of glaciation left marks on the Lehigh River watershed. The first glaciation, the Illinoian, receded about 150,000 years ago and the second, called the Wisconsian, receded about 13,000 years ago. The Illinoian glaciers spread more southward than the Wisconsian glaciers, which stopped just north of the Lehigh Valley. The Illinoian Glaciers flowed southward until encountering the ridge of the South and Blue Mountains, which caused the glacial flow to turn southeastward between the Blue and South Mountains. The Illinoian glaciers filled most of the Lehigh Valley and terminated at South Mountain. Glacial actions have produced marked effects mostly upon the northern segment of the watershed including the smoothing down of summits, the scouring of valley walls, and the deep accumulation of glacial till at irregular intervals.

2. Geologic Formations of the Lehigh River Watershed

The primary geologic formations of the Lehigh River watershed are sandstones, shales, and carbonates. These are shown in Map 1-5 and are described below.

a. North of Blue Mountain

This area is within the Appalachian Plateau Province and the Anthracite Upland or Appalachian Mountain Section of the Ridge and Valley Province. This area is mostly underlain by the Catskill, Pocono, and Mauch Chunk Formations, generally consisting of shale, sandstone, and conglomerate. Most of the consolidated rocks are covered by glacial deposits of non-uniform thickness. The Duncannon Member of the Catskill Formation comprises approximately three hundred square miles of the watershed north of the Blue Mountain. The Duncannon Member has a moderate infiltration capacity and a moderate aquifer potential. The Hickory Run Boulder field has resulted from weathering of the Duncannon Member conglomerate during glaciation.

The Polar Gap Member of the Catskill Formation has a similar consistency to that of the Duncannon Member. The watershed area covered by the Polar Gap Member is approximately eighty-five square miles. The Long Run Member of the Catskill Formation covers an area of approximately 55 square miles and consists primarily of sandstone and siltstone. The Pocono Formation covers about seventy-five square miles of the headwaters area. This formation also has a moderate aquifer potential. The Mauch Chunk Formation is approximately 110 square miles and is located in the Anthracite region. This formation has a low to moderate aquifer potential.

As shown in Map 1-6, the northern portion of the Lehigh River watershed contains two anthracite coal fields including the Eastern Middle field and the east end of the Southern field between Jim Thorpe and Tamaqua. Anthracite is a hard coal that is nearly pure carbon. The high carbon content makes anthracite difficult to ignite, but it burns longer and cleaner than bituminous coal, which is a softer type of coal with less carbon. When fully ignited it burns with a short, very hot,

The discovery of high-quality anthracite coal in the watershed fueled America's Industrial Revolution in the18th century.

almost colorless, smokeless flame and yields a small quantity of ash. Pennsylvania's anthracite deposits comprise four geographically distinct fields totaling about 480 square miles. The deposits generally run in a northeast-southwest direction along the line of the Appalachian Mountains.

The coal beds or veins were folded and faulted by the geological formation of the Appalachian Mountains. The intense pressures associated with this process produced the high carbon content that characterizes anthracite. Where the veins intersect the surface they can be mined using surface mining techniques without expensive equipment or any technical knowledge of mining principals. However, where the steeply pitched veins descend below the surface, frequently extending beneath the water table, underground mining is required.

1. Eastern Middle Anthracite Field

The Eastern Middle Anthracite field, the smallest of the four major anthracite fields of northeastern Pennsylvania, is situated in Luzerne, Carbon, Schuylkill, and Columbia counties. Its maximum length is 26 miles, and its maximum width is 10 miles. Coal-bearing rocks underlie approximately 30 square miles. Most of the Eastern Middle field occupies a high plateau centered near the city of Hazleton. The highest elevations (1,600 to 1,800 feet) occur on the steep escarpments bordering the plateau and along several northeast-southwest trending ridges that have local relief of 200 to 300 feet (Hollowell, 1999).

Bedrock units exposed within and directly adjacent to the Eastern Middle field range from the Late Mississippian Mauch Chunk Formation to the Middle to Late Pennsylvanian Llewellyn Formation. The Pottsville Formation in the Eastern Middle field is composed of predominantly thick-bedded, light gray, oligomictic quartzose conglomerates that total 250 to 300 feet in thickness. Throughout the remainder of the Eastern Middle field, "white" quartz conglomerate, typical of the Schuylkill-Sharp Mountain Members, disconformably overlies the upper member of the Mauch Chunk. One or two coal beds (the Alpha and/or the Little Buck Mountain) occur in the finer-grained upper part of the Pottsville Formation. The Llewellyn Formation is about 1,500 feet thick and contains all of the major coal beds of the Eastern Middle field. Aside from its numerous anthracite seams, it consists predominantly of interbedded, dark-gray, carbonaceous sandstones (and some conglomerates), siltstones, claystones, and shales that are often arranged in fining-upward cycles, 50 to 60 feet thick (Inners, 1988). The Llewellyn contains an abundance of pyrite and siderite, attesting to a predominance of reducing and acidic conditions during deposition and diagenesis. Pyrite occurs interstitially in many of the coarser-grained sandstones adjacent to the anthracite seams, in stringers and blebs within the coal beds, and as large "sulfur balls" in claystone and siltstone seat rocks.

The geologic structure of the coal field is typical of the geology in the anthracite region. The Eastern Middle field lies in the east-central part of the great structural depression in the

Appalachian fold belt that forms the Pennsylvania Anthracite region. The coal-bearing areas of the Eastern Middle field consist of numerous relatively shallow, elongate, 2nd-order synclines that lie mainly on the crestal area of the Selinsgrove-Shade Mountain anticlinorium (Inners, 1988). These synclines are commonly chevron-shaped and complexly faulted, and the intervening anticlines are more open. The major structural fold in the field is the Hazleton basin, whose axis parallels the major regional folds trending northeast to southwest. The basin becomes broader and shallower in the eastern and western margins.

Faults are minor structural features in this area; most are small wedge faults that transect one or more beds and have displacements of three feet or less. Joints are developed in all lithologies but are particularly well expressed in sandstones and siltstones. Dominant joint sets strike either northwest southeast or northeast southwest (Nasilowski and Owen, 1998).

The Eastern Middle Anthracite field consists mainly of comparatively small, discontinuous coal basins, most of which lie above the natural drainage system of nearby watersheds. According to Ash and others (1949), the area covered by anthracite measures in this field is approximately 33 square miles. The synclinal coal basins are relatively long and narrow and separated by broad areas immediately underlain by members of the Pottsville conglomerate, which contains no anthracite. The anthracite measures are discontinuous because the crests of the anticlines have been eroded away.

The Mammoth and Buck Mountain beds were the most productive, respectively. Production from the other seams has been relatively less, both because of their usual lesser thickness and somewhat poorer quality and because of the limited extent of outcrop of the beds above the Mammoth. The Mammoth bed in the Eastern Middle field generally consists of a single bed that averages about 30 feet in thickness but has up to three splits in some basins. The Buck Mountain (#5) is mined in all the basins and averages about five feet of good coal; however, in many places the "Buck" consists of two splits 10 to 20 feet apart (Inners, 1988).

2. SOUTHERN ANTHRACITE FIELD

The Southern Anthracite Coalfield, the largest coalfield in northeastern Pennsylvania, is situated in Dauphin, Schuylkill, Northumberland, Columbia, and Carbon counties. It extends 56 miles from Jim Thorpe to Lykens. The larger part of the coalfield drains about 77 square miles toward the Delaware River while the remaining 64 square miles flows toward the Susquehanna River. The coal bearing rock of the Southern Coal basin covers approximately 141 square miles. The field drains approximately 270 square miles (Edmunds et al., 1998).

Much of the Southern field has been geologically mapped by Wood and associates, and the geologic structure and stratigraphy of the Southern field are described in *Geology of the Southern Part of the Pennsylvania Anthracite Region*, (Wood et al. 1969). The basin is made up of three distinct rock formations: the Mauch Chunk Formation, the Pottsville Formation, and the Llewellyn Formation.

Mauch Chunk Formation includes all of the strata between the Pocono and Pottsville Formations, and its rocks are poorly exposed and structurally complicated by faulting and folding. Lacking stratigraphic markers, they have been subdivided into three informal members: lower, middle, and upper. The lower and upper members contain more sandstone and siltstone and underlie moderate to steep slopes adjacent to the underlying Pocono and the overlying Pottsville Formations; the middle member, which contains mostly fine-grained sandstone, siltstone, and shale, underlies valleys where the relief is generally less than 300 feet (Wood et al., 1969).

The Pottsville Formation has a maximum thickness of approximately 1,600 feet in the Southern field. The Pottsville Formation consists of the Tumbling Run Member, the Schuylkill Member, and the Sharp Mountain Member. The Tumbling Run Member is composed of approximately 55% conglomerate and conglomeratic sandstone, about 30% fine- to coarse-grained sandstone, and about 15% shale and sandstone (Wood et al., 1969). The Schuylkill Member is comprised of about 50% conglomerate and conglomeratic sandstone, and the sandstone in the member ranges from very fine to very coarse, constituting about 30% of the member (Wood et al., 1969). The Sharp Mountain Member in most of the Southern Anthracite field is composed of about 45% conglomerate, 25% conglomeratic sandstone, 15% sandstone, 5% siltstone, 9.5 % shale, and 0.5% anthracite (Wood et al. 1969).

The Llewellyn Formation is as much as 3,500 feet thick, with a maximum thickness of 4,400 feet in Schuylkill County. The Llewellyn Formation contains up to 40 mineable coals (Edmunds et al., 1998). The dominant lithology of this formation is sandstone, including conglomerate units, as in the Pottsville Formation.

The Southern Coal field of the Anthracite Region is a complexly folded and faulted synclinorium. Deformation is most complex toward the southeast, where it is characterized by hundreds of thrust, reverse, tear and bedding-plane faults, and tightly compressed, commonly overturned folds (Wood and Arndt, 1960).

Wood and Bergin (1970) noted that not only does the structural complexity vary geographically, but it also varies stratigraphically. They defined five lithotechtonic units in the region, each of which occupies a particular stratigraphic zone. These units each control the vectoral resolution of stresses, resulting in assemblages of structural features in each unit. The relatively competent rocks of the upper member of the Mauch Chunk Formation are commonly deformed into long, concentric, symmetric, open folds broken by low-angle thrust and bedding faults and fewer reverse faults. In contrast, rocks of the Llewellyn Formation range from competent to incompetent, are folded more tightly into numerous shorter, narrower, lower amplitude, commonly disharmonic anticlines, and synclines broken by reverse faults and low-angle thrust and bedding faults.

Coal in the Southern field has been thickened by flowage associated with folding and faulting. Commonly, the coal thickens in the axis of synclines and is increased as much as three- to fourfold, but this thickening is not predictable. Thrust faults often create local thickening of the coal by dragging of the less competent coal and of the enclosing strata. Structural thickening can be seen in stripmine highwalls and has also been reported in underground mining and in drill hole data (Wood and Bergin, 1970).

Several mine discharges in the Southern Anthracite field have significant alkalinity concentrations, including Wadesville, Eagle Hill, and Kaska discharges. It is almost certain that a detailed study of stratigraphy in this area would reveal calcareous strata or calcareous secondary mineralization. Several Southern field discharges have significant acidity concentrations (Brady et. al., 1999).

b. Blue Mountain Region

The Blue Mountain area is within the Blue Mountain Section of the Ridge and Valley Physiographic Province. The Blue Mountain area consists of a large number of formations. The mountain region contains streams, seeps, springs, vernal pools, and wetland areas that are important habitat for a wide diversity of plant and animal species. The Mahantango and

Marcellus Formations cover a large area of this region. The areas are, respectively, 37 and 22 square miles. The Mahantango Formation consists primarily of shale and siltstone and contains fossils. Shale makes up the Marcellus Formation. The Walcksville Member of the Catskill Formation covers the second largest area in this region covering approximately 35 square miles. It consists primarily of sandstone and siltstone with smaller areas of claystone. The Beaverdam Member of the Catskill Formation covers an area in this region of approximately 21 square miles. It consists of sandstone and siltstone as well as containing some marine fossils. The Bloomsburg Formation covers about 21 square miles of this area and consists of shale, siltstone, and sandstone. The Lehigh River crosses this formation at Palmerton. The southern most part of the Blue Mountain region is bordered by the Shawangunk Formation consisting of sandstone, conglomerate, and shale. This formation covers approximately 20 square miles in this area. The Long Run Member of the Catskill Formation is present in both the headwaters region and the Blue Mountain region. This particular section is located approximately in the center of the Blue Mountain area. It consists of sandstone, siltstone, and claystone.

c. South of Blue Mountain

The lower half of the watershed is located primarily in the Great Valley section of the Ridge and Valley Physiographic Province and is bounded to the south by South Mountain, which is part of the New England Physiographic Province. This area is underlain from north to south by a shale and slate region (Martinsburg Formation), a valley composed of carbonate rocks (Jacksonburg, Beekmantown, Allentown limestones), and South Mountain, which is composed of metamorphic crystalline rock. The carbonate areas in the watershed are shown in Map 1-7.

The groundwater that seeps into streams from the carbonate rocks is alkaline and capable of buffering some of the acid coal mine drainage that enters the Lehigh River above Lehighton. In Lehigh and Northampton counties, the subterranean structure can contain cavities and caverns where soluble limestone deposits were dissolved by groundwater flow. Cavities may form sinkholes when the roof of the cavity collapses.

The southern-most region of the Lehigh River watershed is composed primarily of the Allentown Formation. This region has a significant impact on the water quality of the Lehigh River due to its high content of limestone (calcium carbonate). The Allentown Formation itself covers an area of eighty-three square miles and consists of broad-banded magnesium limestone. The Jacksonburg Formation creates a northern border to this region, covers approximately twenty-two square miles, and is composed of dark-colored limestone. The Jacksonburg limestone formation is used for the manufacturing of cement. The Epler Formation covers sixty square miles with limestone and dolomite. South Mountain at the southern border of the Lehigh River watershed is generally made up of granitic gneiss and is part of the Reading Prong Physiographic Section.

The most significant landform in the lower watershed – the Blue (or North) Mountain.

These rocks are some of the oldest found in Pennsylvania and date back to about a billion years ago. The Granitic Gneiss covers thirty-six square miles of divided smaller areas and is composed primarily of quartz and feldspar.

D. Soil Characteristics

Soil characteristics directly influence many natural functions and interactions of a watershed, as well as many activities occurring within and values placed on a watershed. For instance, different types of soils allow different rates of precipitation infiltration, thus affecting soil moisture content, groundwater recharge, and base flows in creeks. People may also value one soil type over another because it has more nutrients, making it more favorable for agricultural use, or because the depth of one is more conducive to development than another. The parent materials of a soil type may also lead to significant impacts on water quality.

Soil surveys are available for each county and should be consulted for detailed soil information. Maps 1-8 through 1-16 show soil maps for each county in the watershed, with the exception of Bucks County, since Bucks County represents a very small area in the watershed. Soil names, soil texture or classification information, hydric soils, and drainage characteristics are shown on the maps. In general, South and Blue Mountains have thin, rocky, somewhat infertile soil, with mesic to xeric moisture regimes (middle moisture to dry conditions). The valley areas tend to have thick soil that can be very fertile with good infiltration rates and mesic to hydric moisture regimes (middle to wet moisture conditions). The northern portions of the study area that lie in the Appalachian Plateau province contain soils formed in glacial till, which generally have very slow infiltration rates and hydric moisture regimes. Most of the watershed is classified as having moderately-well to well-drained soils; however, the area north of Blue Mountain has a more mixed distribution of drainage characteristics ranging from poorly to excessively drained.

E. Climatology

The climatology of the watershed is largely characteristic of continental areas despite its proximity to the Atlantic Coast. Generally, west to southwest airflows are responsible for the hot, dry weather that causes occasional summer droughts.

Mean annual precipitation in the Lehigh River basin ranges from 42 inches at Bethlehem to 48 inches at Jim Thorpe and averages about 45 inches for the basin. The lowest monthly average, 2.6 inches, normally occurs in February, and the highest monthly average, 4.9 inches, normally occurs in July. Mean annual air temperature is 8° C near Allentown and ranges from an average low of -2° C in winter to an average high of 22° C in the summer (U.S. Weather Bureau).

1. Air Quality

Over the past 30 years, scientists have collected a large amount of convincing information demonstrating that air pollutants can be deposited on land and water, sometimes at great distances from their original sources, and can be an important contributor to declining water quality. These air pollutants can have undesirable health and environmental impacts, such as contaminated fish, harmful algal blooms, and unsafe drinking water.

According to the Department of Environmental Protection, air pollution is the largest environmental health risk in the nation. In order to combat air quality problems, Congress passed a Clean Air Act in 1963; our air pollution standards are based on the 1970 version of the law. In 1990, the Clean Air Act was amended to strengthen many of the provisions. In accordance with the law, the Environmental Protection Agency established standards for six major air pollutants: ozone, nitrogen oxides, carbon monoxide, sulfur dioxide, particulates, and lead. The Clean Air Act requires each state to reduce air pollution through a state implementation plan (SIP), which must be approved by the EPA.

In Pennsylvania, air pollution results from industry, power plants, cars, and numerous consumer products. Emissions from automobiles contribute to approximately one-third of Pennsylvania's air pollution. Although the emissions given off by one car are low, the combined emissions from millions of automobiles make the personal vehicle the single greatest air polluter in many of Pennsylvania's cities and towns. Carbon monoxide and ozone-forming compounds such as hydrocarbons and nitrogen oxides are the components of car emissions that are especially environmentally harmful. In Pennsylvania, highway vehicles create two-thirds of carbon monoxide pollution, and wood stoves and industry are accountable for the other one-third. If inhaled, carbon monoxide takes the place of oxygen in the blood and results in impairment of many mental and physical processes

Ozone, which consists of three oxygen atoms bound together, exists naturally in the stratosphere and helps block ultraviolet radiation. However, in the lower atmosphere, the existence of ozone is not natural and contributes to poor air quality. Ozone at ground level forms from a series of reactions involving sunlight, hydrocarbons, and nitrogen oxides. The hydrocarbons and nitrogen oxides are the result of various industrial and combustion processes, one-half of which comes from automobiles, trucks, buses, and airplanes. Ozone can cause significant damage to crops and forests since high levels in the lower atmosphere hinder the growth of plants. In addition, inhaled ozone affects breathing due to its reaction with tissue in our lungs

Various other air pollutants contribute to poor air quality in Pennsylvania. Nitrogen oxides and sulfur dioxide, a gas produced by power plants and furnaces, are the two main components of acid rain. Sulfuric acid forms when sulfur dioxide and water vapor react, resulting in formation of extremely corrosive acid rain, snow, or fog. Both nitrogen oxides and sulfur dioxide can cause restriction of air passages and difficulty breathing.

Carbon dioxide and methane are other prevalent air pollutants and are considered heat-trapping gases. Scientists believe that excess amounts of either compound in the atmosphere may cause trapping of the sun's heat, which can contribute to global warming. Carbon dioxide forms from the burning of fossil fuel, while methane enters the air from swamps, landfills, oil and gas exploration, and coal mines.

Particulate pollution consists of dust, metal, liquid, or other materials that exist as small particles in the air. A variety of sources produce particulate pollution including volcanoes, forest fires, steel mills, municipal waste incinerators, coal mines, and power plants fueled by coal-burning. Breathing problems result when these particles enter the lungs, and severe health problems will result if toxic and cancerous chemicals attach themselves to the particulate matter (DEP 2002).

All of the aforementioned air pollutants have deleterious effects on Pennsylvania's stream and river system. Poor air quality causes degradation of the Lehigh River watershed through contribution of nutrients and other matter. Across every square inch of their surface, the Lehigh River

and its tributaries are in constant contact with the atmosphere. Just as the health of its waters is dictated by the health of its watershed, so is the Lehigh River impacted by the health of its "airshed." The airshed has no precise borders; it changes with the direction of the wind. Since airflow occurs from west to east, the watershed receives fallout from air pollutants originating in urban areas to the west. The air moves eastward from those highly polluted areas and air pollutants are emptied into the water system when rainstorms wash them from the air – and as "dryfall," the steady, slow sifting down from above during the rest of the year. Additionally, at least part of the air pollutants that fall on the lands of the watershed also wash into the water during rainstorms.

The state and the nation have been working for decades with mixed success to control air pollution. The true amounts of nutrients and other pollutants deposited from the air onto the Lehigh and its tributaries are not well understood, but indications from studies done on the Chesapeake Bay watershed (more than one-third of which is in Pennsylvania) suggest they may be substantial. As early as 1982 scientists with the EPA Chesapeake Bay Program speculated that as much as 15 percent of the nitrogen reaching the main bay resulted from direct deposits on the water's surface from the air. More recently, studies by the Environmental Defense Fund and EPA have suggested that the air contribution may be up to 25 percent. Some rough calculations by the Washington Council of Governments estimated that nearly six million tons of nitrogen and a quarter million tons of phosphorous fall on the waters of the Potomac River basin each year from the air.

Excess nutrients emptied into the watershed can cause low-oxygen levels and decreased plant growth. Acid rain and toxic air pollutants can negatively impact fish populations in the watershed. Increasing acidity in the water may kill small fish and fish eggs along with other aquatic species that are sources of food for fish. In addition, acid rain releases aluminum from the earth's crust. When washed into streams and rivers, very small amounts of aluminum are lethal for various forms of aquatic life (Horton, 1990).

The outlook for reducing many airborne nutrients has improved in recent years with passage of the 1990 revisions to the federal Clean Air Act. Projections up until 1990 showed nothing but a steady increase in emissions of nitrogen oxides, a source of acid rain and nutrients. The new revisions have altered the scenario for the better, but the newest act still does not put an ultimate limit on nitrogen oxides, the bulk of which come from automobiles. "Unless we change our driving habits and patterns of sprawling land development, we are certain to repeat our previous history—offsetting any positive impacts of cleaner cars with increases in driving and auto ownership." (Horton, 1990). Pennsylvania has seen a 10 percent increase in the total number of vehicle miles traveled in the last decade. Continued increases like this—and all projections show the current trends continuing—will outstrip new air quality regulations in less than a few decades (Horton, 1990).

2. Acid Rain

Acid deposition is primarily the result of human-made emissions from burning fossil fuel, automotive exhausts, and other industrial processes, which emit sulfur dioxide (SO2) and nitrogen oxide (NOx) gases. These pollutants are transported in the atmosphere, chemically transformed, and deposited either as wet deposition (such as rain, sleet or snow) or in the form of sulfuric and nitric acids, or as dry deposition in the form of sulfate and nitrate particles. These acids can be carried hundreds of miles by the wind before they eventually drop or wash down. The emis-

sions that cause acid rain are not distributed evenly in the United States. SO2 and NOx emissions are concentrated in the coal-burning Ohio River Valley and its surrounding area. The wind carries the gases in a northeasterly direction toward the Mid-Atlantic States, New England, and Canada (DEP, 2002).

Scientists measure the amount of acidity in the water using the pH scale. Monitoring since 1982 has shown that the pH of some Pennsylvania rainfall averaged 4.1 to 4.3, which is around 25 times the acidity of "pure" rain (DEP, 2002). Different areas of the state may respond differently to acid deposition, depending on the region's natural ability to "buffer" or neutralize the incoming acidity. This ability of a body of water to neutralize acids is called its "acid neutralizing capacity," and depends on the dissolved mineral content in the water, which, in turn, depends on the composition of the soils and bedrock in the watershed. If the watershed is primarily underlain by sandstone or igneous rocks such as granite or basalt, then the streams and lakes in the region will have low acid-neutralizing capacity. Limestone rocks in the watershed will have more acid-neutralizing capacity. If soils and waters of an area continually receive acid deposition, their neutralizing capacity will decrease. With little or no neutralizing capacity, the water will gradually acidify and fish and other aquatic life forms will be adversely affected.

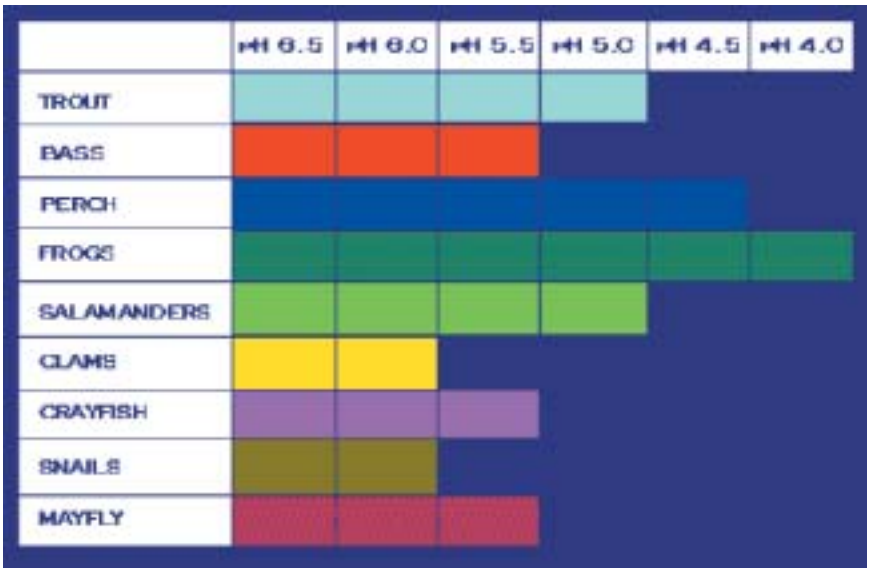
As a waterway becomes acidified, algae and rooted aquatic plants die off, reducing the available food supply for aquatic insects and fish. Healthy aquatic insect communities are replaced by acid-tolerant individuals, which are not as desirable or abundant a food supply for higher organisms such as certain species of fish. More tolerant fish species may begin to replace the original populations, or the fish may disappear entirely from a waterway.

Fish populations can also be directly affected in several ways. Acidity can stress a fish's basic body function, because it upsets the fish's ability to regulate its blood chemistry. Toxic metals, such as aluminum, can be leached from the soils and delivered to the lakes and streams by acidic rainfall. For example, small amounts of dissolved aluminum can cause mortality in fish by damaging their gills and decreasing sodium in their bloodstream. Finally, fish eggs and fry are very susceptible to high acidity and toxic metals. Partial or entire year classes can perish, leaving older, more resistant individuals to maintain a remnant population. At pH 5, most fish eggs cannot hatch (http://www.epa.gov/airmarkets/acidrain/effects/surfacewater.html). At lower pH levels, some adult fish die. Some acid lakes have no fish. Figure 1-2 below shows that not all fish, shellfish, or the insects that they eat can tolerate the same amount of acid; for example, frogs can tolerate water that is more acidic (has lower pH) than trout.

Experts also believe that acid rain contributes to the reduction of crop and forest yields. Instead of adding nourishment to fields and forests, acid rain leaches nutrients (as well as toxic aluminum) that causes sensitive trees and plants to grow slowly or even die. Scientific reports suggest widespread forest damage in the northeastern United State and Canada due to acid rain (DEP, 2002).

Numerous acid rain government and university studies have been conducted in Pennsylvania. Studies conducted by the U.S. Environmental Protection Agency indicate that the Pocono lakes region is the second most negatively affected lakes region in the country. A Lehigh University study determined that out of 160 lakes in the Pocono region for which there were data, 70 percent were sensitive to acid deposition, and 8 percent were already acidified. Scientists from the Pennsylvania State University and from California University of Pennsylvania conducted many watershed studies on the Laurel Hill area, which contains the majority of the natural trout streams

FIGURE 1-2: ACID TOLERANCE OF SOME FISH, SHELLFISH, AND INSECTS
(http://www.epa.gov/airmarkets/acidrain/effects/surfacewater.html)



in southwestern Pennsylvania. One of their studies revealed that 10 of the 61 watershed samples were fishless and concluded "26 percent of the headwater streams on the Laurel Hill are severely impacted by acidification episodes." The National Academy of Science has stated that protection or recovery would occur on 80 percent of the nation's affected waters if sulfate deposition were reduced to 17 kg/ha/year (15 pounds/acre/year). In Pennsylvania, sulfate deposition ranges from 25 to 45 kg/ha/year (23 to 41 pounds/acre/year), so a reduction of approximately 50 percent would be required.

Acid rain may have a serious toxic impact on the fish of the Lehigh River. During the last twenty years, rain falling across much of the northeast has become substantially more acidic. Pennsylvania has recorded acid rain with a pH as low as 3.69. Severe storms can cause pulses of highly acidic water to enter streams and rivers, stressing or killing small fish and fish eggs as well as aquatic species important as food for young fish. Pennsylvania has documented extreme vulnerability of freshwater trout streams to acid rain.

Acid rain is one of the many air pollution issues addresses by Title IV of the Clean Air Act Amendments of 1990. The amendments required a 10 million ton reduction of sulfur dioxide emissions by industry from 1980 baseline levels (nearly one-half). This reduction had two phases. The first phase, effective January 1, 1995, required the largest power plants in the United States to reduce sulfur dioxide emissions. The second phase, effective January 1, 2000, required additional smaller power plants to also reduce their emissions. Statistics show that as a result of both phase, sulfate concentrations in Pennsylvania's rain from 1995-2000 were 27.3 % lower than observed from 1982-1994. The NO_x control program under Title IV also had two phases – the first one was effective January 1, 1996 and the second on January 1, 2000. The overall goal was a national reduction of NO_x emissions from power plants of two million tons form 1980 baseline levels. As a result of both phases, the emissions from affected units in 2000 decreased 23 % from 1990 levels. However, the total NO_x emissions from all sources, including automobiles (the other major source), have increased. Therefore, overall NO_x emissions have not changed significantly from 1980 (DEP, 2002).

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Part II

CULTURAL AND HISTORICAL COMPONENTS

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The Lehigh River watershed has a long and rich cultural history, from Native Americans to European Settlement, throughout the Age of Agriculture and the rise and fall of the Anthracite Industry and into the Contemporary Era. The historical events of the watershed have shaped both its landscape and its peoples.

A. Pre-History and the Paleo-Indians

Stone hammer heads were used by the Lenape as weapons and tools for more than 10,000 years.

During the last ice age, ending about 11,000 years ago, the sea level was lowered because much of the planet's water had turned into snow and ice. As the level of the seas declined, the area of land connecting Alaska and Siberia, the Bering Strait, was exposed. Some scientists believe that animals, particularly caribou, bison, and the woolly mammoth, which thrived on the plant life at the glacier's edge, crossed this land bridge. Following them were bands of hunters whose food and clothing came from the hides and flesh of the mammoth and other big game.

Little is known about the Paleo-Indians, as the earliest human inhabitants of the region are called. Some scholars believe they entered the area about 10,000 years ago when the last ice age was ending. The mastodon remains, one of the animals hunted by the Paleo-Indians, have been found at Marshall's Creek, near the Delaware Water Gap. They are estimated to have been there since 10,210 B.C. Recent excavations at Vera Cruz in southern Lehigh County suggest that people were mining the jasper there and making tools as early as 12,000 years ago. If so, it is likely that the Paleo-Indians were living right on the edge of the Wisconsin Glacier, which terminated just south of Allentown.

Physically, the Paleo-Indians were similar to present-day humans. Living along the line of glaciation in a tundra-like environment that could not support human settlements of any great size, these people hunted big game. Their monuments—the bones of the animals they killed, scattered tools, and the ashes of their campfires—still lie hidden and unexplored under the earth of the Lehigh Valley (Hall, 1982).

About 10,000 years ago, the climate began to warm. The Wisconsin Glacier, which had covered most of the northeast for 60,000 years, began to recede. The mass of ice turned into rivers and streams that ate into the newly exposed land. As the climate warmed, the environment altered radically. The cold-weather plant life on which the mammoth and the mastodon had subsisted was replaced by conifer and deciduous forests. The large animals, unable to survive under these conditions, died off or were hunted to extinction.

1. THE LENNI-LENAPE

The retreat of the ice and the alteration of the Indian way of life seem to be described in the historical chronicle *Walam Olam*, the one surviving piece of Lenni-Lenape literature:

The ancestors of the Lenni-Lenape eventually ended their wanderings. They learned to fish, taking food from not only the Jordan, Lehigh and Delaware, but also, in patterns of seasonal migration, from the Atlantic Ocean. While not yet farmers, these Archaic Indians had begun gathering certain grains and grinding them in stone mills. "Tools became more sophisticated. While the details of Indian history are forever lost, the artifacts that they have left behind suggest a notable complexity and adaptability to changing conditions." (Hall, 1982). The appearance of polished stone tools and weapons suggests that the Indians of the area were, 3000 years ago, in contact with the highly developed civilizations of Central America. Recent discoveries at the Vera Cruz jasper mines seem to indicate that Indians came from all over the east coast to obtain fine-quality stone for tool making.

> After the rushing waters, the Lenape of the turtle were closer together, in hollow houses, living together there.
>
> It freezes where they abode, it snows where they abode, it storms where they abode, and it is cold where they abode.
>
> At this northern place, they speak favorably of mild, cool lands, with many deer and buffaloes.
>
> As they journeyed, some being strong, some rich, they separated into house-builders and hunters. . .
>
> Those from the north being free, without care, went forth from the land of snow, in different directions.
>
> The fathers of the Bald Eagle and the White Wolf remain along the sea rich in fish and mussels.
>
> Floating up the streams in their canoes, our fathers were rich; they were in the light.
>
> Source: unknown

By 1,000 B.C., the Indians of the Lehigh River Watershed were doing more than merely imitating the tool forms of their highly sophisticated cousins of Mexico. "They were also profoundly influenced by Meso-American religion, engaging in a series of localized adaptations of burial and temple mound-building practices that were a woodland variant of the great stone temples of the Central American Indians." (Hall, 1982). Certainly, the most important contribution of this southern contact was the introduction of maize (corn) as an agricultural crop and the introduction of technologies related to maize agriculture, most notably the use of pottery vessels for cooking and storage. "By the beginning of the first millennium, the Indians of this region had broken distinctly with their hunting and gathering past and were evolving relatively stable patterns of life." (Hall, 1982). They still hunted and fished, moving between inland areas and the shore with the seasons. However, their movements were governed by their need to sow and harvest the maize, beans, sunflowers and other crops that had become essential parts of their pattern of survival.

The Lenni-Lenape possessed a civilization with developed concepts and procedures of government, religion, education, social responsibility, morality and personal honor. Although Indian chiefs, or "kings" as the Europeans called them, nominally ruled the tribes, they governed more by consensus than by edict. The whole tribe often met in council, the chief in the center, surrounded by elders, young warriors, women and, in the outermost circle, children. William Penn remarked, "how powerful kings are, yet how they move by the breath of their people." The Indians had the rudiments of representative government and developed procedures for policymaking, diplomacy, declaring war, making peace, and handling personal misconduct.

The Lehigh River was vitally important to Native Americans as a food source, and as a means of transportation.

> *"Rivers must have been the guides which conducted the footsteps of the first travelers..."*
>
> *— Henry David Thoreau*

Although the Lenape had no religion in the European sense of a organized theology, they based their lives on certain beliefs about their creator and the expectancy of judgment in an afterlife. The Indians had phrased the ideal of the Golden Rule long before they ever heard of the Bible, and found no difficulty accepting many Christian concepts (Klein, 1973).

These people would eventually contribute much to the early colonists. They shared their knowledge of agriculture and introduced Europeans to such crops as potatoes, corn, beans, squash, tomatoes, and tobacco. They provided the pelts for colonial ventures in the fur trade. They eased access to the interior of Pennsylvania not only by their canoes, but also by a network of well-defined Indian paths, so numerous and well placed that many of the routes still serve their original purpose, functioning as modern day highways. Their language, though unwritten, lives on in hundreds of picturesque names for counties, towns, mountains, and rivers.

Many of the names of places in the Lehigh River watershed are derived from names given by the Lenni-Lenape. Most of the settlement of the region was initially along the Delaware River. The Lehigh River flows into what is now the town of Easton. In the 1600s, it was called the Forks of the Delaware. The river was originally known by the Lenape name "Lechauwekink," meaning, "where the forks are." The Pennsylvania Germans shortened the name to "Lecha" and the English anglicized it as "Lehigh."

Centuries before the first European settlers carved a roadway out of the virgin forest of Pennsylvania, the Native Americans had created an elaborate network of trails throughout the eastern half of the state. In Carbon County, three distinct trails—the Nescopeck Path and its two branches—have been traced by the Pennsylvania Historical and Museum Commission. The trail ran north of the Delaware River near Philadelphia through Bethlehem. Above Lehigh Gap, near Parryville, the trail passed through the Indian village of Pochapauchkug. A second trail branched off and ran about 20 miles east of Lehigh Gap through the Indian village of Wechquetank and joined the Wyoming Path that ran through the "Shades of Death," a thick wilderness forest that once covered Monroe County. The Nescopeck Path again divided near Nesquehoning. One section ran north near Lehigh Tannery. The other section led travelers to the town of Nescopeck, a well-known Indian gathering place.

The routes reveal a keen knowledge of the land. The Indians who planned the paths made sure the trails ran on level ground where possible. Many modern highways follow the routes of these pathways. In addition to this, a system of road signs was created using bent trees to point travelers in the right direction. Almost a century after the first European arrivals in Pennsylvania, Indian paths were the only roadways available.

As Indian life stabilized in the northeast, particular groups, usually defined by language and kinship, came to occupy or have rights to certain geographical areas. Originally, the Indian languages were probably very similar. However, as each group settled into particular locations and developed lifestyles appropriate to different settings, the languages diverged. By the year Christopher Columbus arrived, it is estimated that Native Americans spoke some 2,000 mutually unintelligible languages (Sipe, 1927).

While it is true that all Lenape recognized one another as members of the same people, there was no tribal government. Instead, the Lenape were organized into village communities based

on common descent through the female ancestor. There were 30 or more of these communities. Authority within the communities was administered not by a powerful chief, but, according to historian C. A. Weslager, by a council of "older and spiritually powerful men." Decisions were arrived at through discussion and debate among these older men.

Perhaps the best description of the decentralized character of Lenape society has been written by C. A. Weslager, author of a definitive work on the Lenape. He wrote that one might compare their society

> *"to a number of small rural towns in modern America, scattered across the landscape, but lacking county, state or federal affiliation, each responsible for its own government and the welfare of it's citizens. The main difference was that in the Lenape towns, there were a high percentage of persons related to one another, and the frequent movements of the people and the perambulations of their communities gave the population a group mobility generally lacking in modern American towns. The inhabitants of Lenape towns spoke dialects of the common language and had a sufficient feeling of common identity to call themselves Lenni-Lenape, just as modern dwellers in small towns refer to themselves as Americans."*

The loose organization of the Lenape society would cause the Indians many problems, both with other Indian groups and ultimately in their dealings with European settlers. Scattered over a wide area, including portions of the present states of New York, New Jersey, Pennsylvania, and Delaware, and lacking a clearly defined system of political leadership, it was difficult for the Lenape to act as a unified group, even in war (Sipe, 1927).

2. The Lenape and the Mengwe

According to the Lenape national legend (the *Walum Olum)*, the Lenape, who once lived in the vast region west of the Mississippi, migrated east. For reasons unknown they left their western home, and, after many years of wandering eastward, reached the Namaesi Sipu, or Mississippi, where they fell in with the Mengwe (who would later be called Iroquois by the French), who had also migrated from the distant west in search of a new home. The spies sent forward by the Lenape for reconnoitering, had discovered, before the arrival of the main body, that the region east of the Mississippi was inhabited by a powerful nation called the Alligewi. When the Lenape arrived at the Mississippi, they sent a message to the Alligewi requesting that they be permitted to settle among them. This request was refused, but the Lenape obtained permission to pass through the territory of the Alligewi and seek a settlement farther to the east. They accordingly began to cross the Mississippi; but the Alligewi, seeing that their numbers were vastly greater than they had supposed, made a furious attack upon those who had crossed, and threatened the whole tribe with destruction, if they dared to persist in crossing to the eastern side of the river (Sipe, 1927).

Angered by the treachery of the Alligewi and not being prepared for the conflict, the Lenape consulted together as to whether they should make a trial of strength, and were convinced that the enemy was too powerful for them. Then the Mengwe, who had been spectators from a distance, offered to join the Lenape, on the condition that, after conquering the Alligewi, they should be entitled to share the benefits of the conquest.

Having united their forces, the Lenape and the Mengwe declared war against the Alligewi, and started their onward march eastward across the continent, gradually driving out the Alligewi, who fled down the Mississippi Valley never to return. This conquest lasted many years, during which the Lenape lost great numbers of their best warriors.

For a long period, possibly many centuries, according to the *Walum Olum*, the Mengwe and Lenape resided peacefully and increased rapidly in population. Some of their hunters and warriors crossed the Allegheny Mountains, and, arriving at the streams flowing eastward, followed them to the Susquehanna River. Other enterprising pathfinders penetrated the wilderness to the Delaware River, and exploring still eastward, arrived at the Hudson. Some of these explorers returned to their nation and reported the discoveries they had made, describing the country as abounding in game and the streams as having an abundance of waterfowl and fish with no enemy to be dreaded (Sipe, 1927).

"The Lenape considered these discoveries as fortunate for them, and believed the newly found region to be the country destined for them by the Great Spirit as their permanent abode" (Sipe, 1927). Consequently they began to migrate, settling on the four great rivers—the Susquehanna, the Potomac, the Delaware and the Hudson. The *Walum Olum* states, however, that not all of the Lenape reached the eastern part of the United States, many of them having remained behind to assist a great body of their people who had not crossed the Mississippi, but had retreated into the interior of the country on the other side, upon hearing of the attack on those who had crossed the river. Another part of the Lenape remained near the eastern bank of the Mississippi. According to this traditional history, the Lenape nation finally became divided into three separate bodies.

The Lenape who settled on the eastern rivers divided into the Wolf tribe, or Minsi, who lived along the eastern ridges of the mountains; the Turtle tribe, or Unamis, who hunted and farmed in the lower Delaware valley; and the Turkey tribe, or Unalachtigos, who occupied the area between Delaware Bay and the Atlantic Ocean (Klein, 1973).

When the Lenape and the Mengwe divided the county of the Alligewi between them, the Mengwe took the part near the Great Lakes and their tributary streams, north of the part taken by the Lenape. The Mengwe later proceeded farther and settled below the Great Lakes and along the Saint Lawrence River, so that when the Lenape had moved to the eastern part of the United States, the Mengwe became their northern neighbors. "The Mengwe now became jealous of the growing power of the Lenape, and finally assumed dominion over them" (Sipe, 1927).

To the Moravian missionary, Reverend John Heckewelder, who had lived among the Lenape for more than thirty years, they related how this dominion came about. The great chiefs of the Lenape stated to Heckewelder that the Mengwe "clandestinely sought to start quarrels between the Lenape and the distant tribes, hoping thus to break the might of the Lenape. The treachery of the Mengwe having been at length discovered, the Lenape resolved upon the extermination of this deceitful tribe. War was declared against the Mengwe, and carried on with vigor, when the Mengwe, finding that they were no match for the powerful Lenape and their kindred tribes, resolved upon uniting their clans into a confederacy" (Sipe, 1927). Up until this time, each tribe of the Mengwe had acted independently of the others, and they had not been inclined to come under any supreme authority. Accordingly, about the year 1570, the Mengwe formed the great confederacy of their five kindred tribes, the Mohawks, the Oneidas, the Onondagas, the Cayugas and the Senecas, known as the Five (later six) Nations.

The Lenape claimed that the confederacy was formed for preventing the extermination of the Mengwe by the Lenape. "Other authorities say that the purpose was to end inter-tribal feud and war among the Mengwe, themselves; to enable the allied tribes to make mutual offense and defense, and to advance their general warfare." (Sipe, 1927). Thannawage, it is claimed, was the aged Mohawk chief who first proposed the alliance. Other authorities say that Dekanawida,

the Iroquois statesman, prophet, and lawgiver, planned and formed the historic confederation; and that his disciple, Hiawatha, assisted him. The following chiefs, also, assisted in forming the confederacy: Toganawita, representing the Onondagas; Togahayon, representing the Cayugas; and Ganiatario and Satagaruyes, representing the Senecas. This confederacy is known in history as the Five Nations, until the Tuscaroras, a tribe having been expelled from North Carolina and Virginia in 1712 or 1713, and having sought an asylum among the Mengwe of Pennsylvania and New York, were formally admitted to the alliance in 1722, after which time the confederacy is known as the Six Nations. The French gave the Indians of the confederacy the name of Iroquois, while the Lenape continued to call them Mengwe.

To resume the story, the Lenape told Heckewelder that, after the forming of the confederacy, very bloody wars were carried on between the Mengwe and themselves in which they were generally successful, and while these wars were in progress, the French landed in Canada and combined with the Mengwe. "At last the Mengwe, or Iroquois, seeing themselves between two fires, and not seeing any prospect of conquering the Lenape by arms, resorted to a stratagem to secure dominion over them" (Sipe, 1927).

The plan was to persuade the Lenape to abstain from the use of arms, and to assume the station of mediators and umpires among their war-like neighbors. It was not considered becoming for a warrior to ask for peace. He must fight to the end. The women of the tribe were encouraged to make moving speeches and persuade the enraged combatants to bury their hatchets and make peace. On these occasions, they were very eloquent. They would describe the sorrows of widowed wives, and, above all, of bereaved mothers. Speeches like this usually had the desired effect, and the women, by the honorable function of peacemakers, held a very dignified position.

These were the arguments used by the artful Iroquois to ensnare the Lenape, according to Heckewelder. Unfortunately, the Lenape listened to the voice of their enemies, and consented to subjugation.

The Iroquois denied that such an intrigue ever took place. They alleged that they had conquered the Lenape in battle and had thus compelled them to cease fighting,—to submit to the greatest humiliation a spirited and war-like nation can suffer (Sipe, 1927). "Many historians believe that the Delawares (Lenape) imposed upon the venerable Rev. Heckewelder by inventing a cunning tale in explanation of the humiliation under which they were smarting." (Sipe, 1927). In addition, President William Henrey Harrison, in his "Aborigines of the Ohio Valley," gives the story of the Lenape little credence. He says that the Lenape were "too sagacious a race to fall into such a snare as they allege the Iroquois claim they conquered the Lenape by force of arms and not be stratagem, yet the Iroquois have no tradition among them of the particulars of the conquest."

Many authorities state, however, that the time of the subjugation of the Delawares was much later than the date given Heckewelder. "Some have stated that the Delawares were not made tributaries of the Iroquois until after the coming of William Penn; but the celebrated Delaware chief, King Beaver, told Conrad Weiser at Aughwick on September 4, 1754, that the subjugation took place before Penn's arrival" (Sipe, 1927). At the first extended conference between the Pennsylvania Authorities and the Indians, of which a record had been preserved, held at Philadelphia on July 6, 1694, the Delaware chief, Hithquoquoan, advised the Colonial Authorities that he and his associate chiefs had shortly before this time received a message from the Onondagas and Senecas containing the following statement: "You Delaware Indians do noth-

Chief Teedyuskung was the "king" of the Lenape tribe. His name means "He who makes the earth tremble."

ing but stay at home and boil your pots, and are like women; while we Onondagas and Senecas go ahead and fight the enemy." We therefore conclude that it can not be stated with exactness, just when the subjugation of the Delawares took place; and, inasmuch as there is no record of any conquest after the time of Penn's arrival, it may be that the subjugation took place through fear and intimidation rather than by war (Sipe, 1927).

"Whatever may be the facts as to how the Iroquois reduced the Delawares to a state of vassalage—whether by artifice, intimidation or warfare—the fact remains that about the year 1720, this powerful northern confederacy assumed active dominion over them, forbidding them to make war or sales of lands" (Sipe, 1927), a condition that existed until the time of the French and Indian War. During the summer of 1755, the Delawares declared that they were no longer subjects of the Six Nations, and, at Tioga, in the year 1756, their great chieftain, Teedyuscung, extorted from the chiefs of the Iroquois an acknowledgment of Delaware independence. However, from time to time, after 1756, the Iroquois persisted in claiming the Lenape were their vassals, until shortly before the treaty of Greenville, Darke County, Ohio, in August 1795. This was a famous treaty between the United States Government, represented by General Anthony Wayne, who had defeated the western tribes at the battle of the Fallen Timbers, on August 20 of the preceding year, and the Shawnees, Delawares, Wyandots, Ottawas, Potawattomies, Miamis and smaller tribes, by the terms of which treaty about two-thirds of the present state of Ohio was ceded to the United States. "The subjection of the Delawares to the Six Nations greatly complicated negotiations on the part of the colony of Pennsylvania for the purchase of the lands of the Delawares, inasmuch as the Iroquois' seat of government was the colony of New York" (Sipe, 1927).

During this time, the domain of the Five Nations extended from the borders of Vermont to Lake Erie, and from Lake Ontario to the headwaters of the Delaware, Susquehanna, and Allegheny. This territory they called their "long house." The Senecas, who lived on the headwaters of the Allegheny, and many whose settlements were in Pennsylvania, guarded the western door of the house, the Mohawks, the eastern and the Cayugas, the southern, or that which opened on the Susquehanna (Sipe, 1927).

The Smithsonian Institution, in its "Handbook of American Indians," says the following of the Iroquois:

> *"Around the Great Council Fire of the League of the Iroquois at Onondaga, with punctilious observance of the parliamentary properties recognized in Indian diplomacy and statescraft, and with a decorum that would add grace to many legislative assemblies of the white man, the federal senators of the Iroquois tribes devised plans, formulated policies, and defined principals of government and political action, which not only strengthened their state and promoted their common welfare, but also deeply affected the contemporary history of the whites in North America. To this body of half-clad federal chieftains were repeatedly made overtures of peace and friendship by two of the most powerful kingdoms in Europe, whose statesman often waited with apprehension the decisions of this senate of North American Savages."*

In addition, Colden in his "History of the Five Nations," says:

> *"The Five Nations are a poor and generally called barbarious people; and yet a bright and noble genius shines through these black clouds. None of the greatest Roman heroes discovered a greater love to their county, or a greater contempt of death, than these people called barbarians have done when liberty came in competition. . . . They carried their arms as far southward as Carolina, to the northward of New England, and as far west as the River Mississippi, over a vast country, which extends twelve hundred miles in length, and about six hundred miles in breadth; where they entirely destroyed many nations, of whom there are now no accounts remaining among the English."*

So great was the scourge of the Iroquois that, during the closing decades of the seventeenth century and the first two decades of the eighteenth century, the region south of Lake Erie on both sides of the upper Ohio and Allegheny contained practically no Indian population; and the Iroquois looked upon the vast territory as their hunting ground (Sipe, 1927).

Speaking of the warfare of the Iroquois, DeWitt Clinton said:

> *"They reduced war to a science, and all their movements were directed by system and policy. They never attacked a hostile country until they had sent out spies to explore and designate its vulnerable points, and when they encamped, they observed the greatest circumspection to guard against spies. Whatever superiority of force they might have, they never neglected the use of stratagem, employing all the crafty wiles of the Carthagenians."*

B. The Rise of Indian-European Conflict

The political fragmentation characteristic of Indian society would also lead to confusion and bitterness between the Lenape and the Europeans. European settlers assumed that Indian societies were organized like European ones, with recognized leaders who could speak for their subjects. Thus they mistakenly thought that when they purchased a particular piece of land from one particular chief, that the chief was acting with the consent of all of his people. Europeans frequently purchased land, only to find other Indian groups claiming that the land sale had no validity. By the late 17th century, a migrant Indian band might arrive on the shore at the end of a trek from the Forks of the Delaware only to find that their cousins at Brandywine or Tulpehocken had sold their land rights to the Swedes, the Dutch, or the English (Hall, 1982).

The problem of social and political organization was only one source of misunderstanding between the Lenape and the Europeans. More fundamental were radically different concepts of property ownership. For the Indians, property ownership meant the right to use the fruits of the land—to hunt, to fish, to plant. It did not imply absolute and exclusive possession. Thus, while the Indians amicably signed treaties granting tracts of thousands of acres to the Europeans, they were shocked to discover that they could no longer hunt or even traverse the lands that they had used for thousands of years. To them, the European gifts of cloth, beads, tools, and liquor were merely tokens of hospitality and friendship, not purchase prices for pieces of real estate, "but these conflicts between concepts of political authority and property were only symptomatic of a far more significant clash between Native American and European cultures" (Hall, 1982).

1. 1700-1790, EUROPEAN SETTLEMENT OF PENNSYLVANIA

When the first Europeans appeared in the Middle Atlantic area, Indians of the Algonquian language occupied the Delaware River Valley. They called themselves Lenni-Lenape, signifying "the real people" or "the original people," with a connotation of superiority and special destiny (Klein, 1973). The English later gave these Indians along the banks of the Delaware River the name "Delawares" (named after the Governor of Virginia Thomas West, Baron De La Warr).

Throughout most of the 17th century, the region was almost uninhabited. The quiet woodlands were disturbed only by the seasonal movements of the Lenape as they moved upriver to their hunting grounds in the mountains or downriver to the plains around present day Allentown and Bethlehem where they annually burned off brush and scrub to clear land for planting maize, beans and pumpkins. Even though their plantations were large enough to produce thousands of bushels of grain, their largest hardly intruded on the primordial forests and streams (Hall, 1982). The Lenape numbered no more than 8000 to 10,000 people scattered across four states.

Neither the settlement of the Scandinavian colony of New Sweden on the lower Delaware in the 1640s nor the incursions of New York-based Dutch traders affected the Lehigh Valley. Rich as its soil, timberlands and mineral deposits were, it was remote and isolated, protected by steep hills that rose west of the Delaware and by its distance from the coast (Hall, 1982).

The 17th century was a time of great religious and political turmoil in Germany, France and England, and peoples lives were changing in every aspect. Dissatisfaction with the Roman Catholic Church led to the Protestant Reformation and civil war. In 1618, war swept across Germany and resulted in the deaths of millions over the course of the Thirty Years' War. By the 1640s, as the war was ending, the Protestants were threatened with extermination in France and were frantically searching for religious asylum (Hall, 1982).

This statue of William Penn is located at Pennsbury Manor, his home and farm near Bristol, Bucks County.

America was not necessarily a safe haven for these exiles. Neither the Southern colonies (Virginia and the Carolinas) nor New England were particularly tolerant of religious dissent. "Of all the regions of the New World only Pennsylvania offered both economic and religious freedoms" (Hall, 1982). This was due in very large part to William Penn.

William Penn was the son of a prosperous merchant who, having survived the difficulties of the English Civil War, emerged after the restoration as a distinguished admiral in the English wars with the Dutch in the 1660s. In the course of his naval career, King Charles II had become deeply indebted to Admiral Penn. When Penn died in 1670, his son (William), who had become a dissenter from the Church of England, offered to settle the debt in exchange for a grant of land in the New World. In 1681, William Penn became the largest single landowner in the world. In September of 1682, William Penn set sail for the Delaware to examine his new land and to make plans for its settlement. The territory measured about 54,000 square miles or 35 million acres overall (Eckhart, 1992). The province contained about 2,000 white inhabitants comprised pri-

marily of English, Dutch and Swedes and approximately 8,000 Lenni Lenape. English and Welsh Quakers were the first immigrants. In 1701, a Charter of Pennsylvania was issued which remained in effect until the drafting of the State Constitution in 1776. William Penn had three sons, Thomas, Richard, and John, who succeeded him as heirs.

William Penn learned much from the troubled times he lived in. He came to believe in religious tolerance as a matter of conviction. As a Quaker, he believed that God revealed himself to men not through the pronouncements of bishops or the edicts of kings, but through intense personal experience. Because of this, he and the other Quakers opposed the intrusion of the state or of powerful religious organizations into the private relationship between man and God. "He thus envisioned Pennsylvania as a Commonwealth open to all, whatever their way of worshiping their creator" (Hall, 1982).

He recognized that the immense land grant given to him was only valuable if it was inhabited by people willing to purchase or rent portions of his vast estate. In addition, because he was a merchant, he recognized that settlers meant markets for important goods, sources of valuable raw materials, as well as tenants for his property. "To open Pennsylvania to the thousands of Europeans displace by war, intolerance and economic disorder would serve both his religious convictions and his pocketbook" (Hall, 1982).

When William Penn and his party arrived on the site of Philadelphia in 1683, the colony consisted of over 2000 people, but it would be decades before the first European settlements appeared in the Lehigh Valley. In addition to the formidable physical barriers to the valley, another obstacle to its settlement was the fact that the Indians, King Charles not withstanding, regarded the lands granted in Penn's charter as their own. "Penn, motivated by his Quaker pacifism and profiting from the mistakes made by the English settlers of New England, who had waged bloody warfare with the natives for three decades, decided the Lenape should be paid for their lands and their mutual rights established by written treaties." (Hall, 1982). Finally, as a merchant with an eye for profit, Penn wished his lands to be settled in an orderly fashion. His model of order was a feudal one: the grant would be divided into manors, the basic English unit of rural government. He also established a general government with an executive (the governor), to be appointed by the Proprietor, and a legislature (the assembly), to which representatives would be elected from the various civil divisions, townships and boroughs of the colony. "Pennsylvania may have been an early model of political democracy and religious tolerance, but it was also, first and foremost, a private land speculation" (Hall, 1982).

2. Settlement of the Lehigh Valley and the Walking Purchase

Few Europeans ventured into the Lehigh River Watershed before the 1720s. Not only was the area still regarded as Indian Territory, but migration was also impeded by the formidable barrier of the South Mountain. Far more accessible and fertile lands lay to the south, in Chester, Lancaster, Berks, and York counties.

By the 1730s, William Penn had died and the entire European population was estimated at fewer than 10,000. As his sons struggled to pay their father's debts and as immigrants, particularly from Germany and Ireland, began to arrive in the colony in ever-increasing numbers, attention turned to the lands at the Forks of the Delaware and beyond. Eventually immigrants began to move into the Lehigh Valley region. Following rivers, creeks and Native American trails, they located along the banks of streams or near springs. As settlement continued, immigrants selected readily accessible and obviously fertile sites near a fresh water supply (Fletcher, 1950).

Trout Hall, Allentown's oldest residence, was built in 1770 as a summer residence by James Allen.

Thomas Penn, son of William, enforced the infamous "Walking Purchase" agreement in 1737 that was forged by his father 40 years earlier. The trick of using trained runners for the "walking" task prompted the end of good relations between the Lenape and the Europeans.

By 1738, families of similar religions began to settle in the same areas. These included such notables as Casper Wistar, James Bingham, James Hamilton, and William Allen. Allen, for example, acquired his lands at Allentown from his business partner, Joseph Turner, who, in turn, had received them from the Penns in settlement of a debt. These land speculators were anxious to earn profits from their Lehigh properties and their anxieties increased as they watched a growing number of squatters moving onto their lands. Added pressures to these landowners were the protests of the Indians, who resented the squatters' unauthorized incursions into their territories. The landowners felt it was clearly time to open the area to orderly development and civil government. The first step would need to be the negotiation of a treaty with the Lenni-Lenape.

"Although William Penn's pacific and legalistic approach to Indian affairs had largely spared Pennsylvania colonists from the murderous struggles that had typified New England's relations with the Indians, European incursions into the Lehigh Valley presented a host of difficulties." (Fletcher, 1950). As the Lenape had ceded their lands on the coast and the lower Delaware, they had moved in large numbers to the Tulpehocken, the region along the Lehigh between the South and Kittatinny Mountains. Lamenting the loss of their once vast domain, the Lenape were especially reluctant to permit further cessions of their possessions to the English.

William Penn's sons and their friends were insistent. They cheated the Lenape in the Philadelphia Treaty or Walking Purchase of 1737. The sons produced a copy of a document that had the signatures of three dead Lenape chiefs. It stated that the Lenape had agreed to sell a parcel of land up to the Blue Mountains or, as they agreed, equal to the distance a man could walk in one and a half days. At the end of this walk, a line would be drawn eastward to the Delaware River then down the river to the starting point. This section of land would then be available to the colonists for settlement. On September 19, 1737 from a Chestnut tree in present day Wrightstown, Bucks County, Pennsylvania the walk began. The walkers were James Yates, Solomon Jennings, and Edward Marshall. All three were very athletic and experienced hunters. To make certain the walk would go well an advance party spent nine days blazing a trail and clearing brush to speed the walkers. To insure the total commitment of the walkers, five pounds and 500 acres of land

were offered to the man who traveled the farthest.

Jennings stopped at the Lehigh River between Allentown and Bethlehem exhausted at the end of the first day. At the beginning of the second day, Yates collapsed in a stream coming off Blue Mountain, was stricken by blindness and died three days later. Finally, after 36 hours the last walker, Edward Marshall, threw himself full length on the ground at noon just outside present day Jim Thorpe. He had traveled over 65 miles from the starting point.

The route of the "Walking Purchase" was much longer than the Lenape anticipated – 65 miles in total. At the end of the walk, a line was to be drawn to the Delaware River. Penn drew the line at 45 degrees, rather than due east as the Lenape had understood to be the agreement.

After going 35 miles farther than the Lenape had anticipated the Colonial authorities proceeded to draw the line to the Delaware River at a right angle to the river a distance of 66 miles. This fraudulent measurement then took in all the MiniSink land and thousands of acres more than if the line had been run to the nearest course to the Delaware. The Lenape refused to move from the Walking Purchase lands. Thomas Penn persuaded the Lenape to sign a document to confirm the Walking Purchase but guaranteed them that they would not be removed from the MiniSink lands. However, as soon as the Lenape had signed the Penns arranged for the Iroquois Indians, who were the dominant Indian nation in the region, to force the Lenape removal because they did not honor the agreement held in the original Walking Purchase.

Realizing that they had perhaps gone too far and that the resulting Lenape resentment might impair the value of their properties, James Logan, the Penns' representative, made some significant concessions to the Indians. He relinquished all claims to lands north of the Kittatinny Mountains and granted the Lenape a 10-square-mile tract south of the mountains, which included major Lenape villages. However, the Lenape would continue to resent the unfairness of the Walking Purchase. The events of 1737 marked the end of the friendly and trusting relations between the Indians and the English. What had begun in 1683 with the declaration in Penn's treaty with the Lenape, that the two peoples should live together "in love as long as the sun and the moon endure," was, by the 1760s, characterized by Lord Jeffrey Amherst's request that his officers contrived "to send the Small Pox among these disaffected tribes of Indians" (Sipe, 1927).

As a result of this incident, the Lenape declared war on the settlements. There was bloodshed on both sides. Through battles and treaties, the Lenni-Lenape continued to lose land. After the thirteen colonies became the United States, a treaty was written on September 19, 1778 to establish an Indian Territory in the Ohio area and make it the fourteenth state. However, congress did not ratify this treaty and the Indian leader, White Eyes, who signed the treaty, was believed to have been murdered by the militia on November 10, 1778. By 1778, most Native American tribes had been forced out of Pennsylvania. Some moved north into New York and finally settled in Canada. Others moved into the Ohio area and over time moved to Kansas, Louisiana, Oklahoma, and Mexico. Many died due to starvation and European diseases. Some were converted to Christianity and lived with the Moravians in Bethlehem.

Although a few European families had been living in the Lehigh Valley since the 1720s, they represented only scattered settlements until the next decade when groups of Germans, Scotch-Irish, and Huguenots (French Calvinists) began to build churches and set out farms on the frontier. Most of these early settlements lay below South Mountain, near Saucon and Milford townships. However, the largest groups of settlers did not begin to arrive in the region until after 1737, when the Walking Purchase had settled ownership of the valley.

The 18th-century settlers of the Lehigh Valley belonged to four large groups. The first consisted of individual German Protestants, members of the reformed and Lutheran churches, who purchased land in various parts of the county, and considerable numbers of French and Swiss farmers who made common cause with German members of the Calvinist Reformed Church.

The second group was also largely German, but unlike the rugged individualists of the Reformed and Lutheran churches, these settlers (Moravians, Mennonites, Dunkers, Amish, and Schwenkfelders) were "religious radicals, and they combined to varying degrees intense piety with doctrines of civic and family organization that set them apart not only from the English, but from their fellow Germans" (Hall, 1982).

The third group, the Scotch-Irish, was composed of Protestant families from the north of Ireland. Their ancestors had been brought to north of Ireland by a succession of English monarchs, beginning with Elizabeth I, in order to dilute the power of the native Irish Catholics. Although not communitarians, the Scotch-Irish tended to gather for religious and social reasons. The areas of the valley where they settled with particular density lay along the eastern bank of the Lehigh River between Hokendauqua and Catasauqua and eastward to the town of Bath.

The fourth group, the English, never settled in great numbers in the Lehigh Valley during the 18th century. Nevertheless, they were particularly important because they were the largest landowners in the region. Even where the English were numerically insignificant, their influence was pronounced, for they decided where the major townships would be, they laid out the house lots of Easton in the 1750s, and those in Allentown in 1762. They were responsible for attracting settlers to those places as part of their plan to develop the region and profit from their investments.

3. British-French Conflict and the Pennamite Wars

The orderly settlement of the Lehigh Valley was interrupted between 1755 and 1763 by a series of bloody Indian uprisings. These were part of the larger struggle between the French and the English for control of the New World. The English were allied with the Iroquois tribes of New York, who held the Lenape in subjection for nearly a century. The Lenape saw in the French-English conflict an opportunity to regain their ancient domain and to settle old scores with their Iroquois enemies. In addition, they were inspired by an Indian religious movement which had begun in the West and through which the "culturally broken natives hoped to revive their morale and resume their former dominance of the continent." (Hall, 1982). Finally, there were very concrete economic and political grievances underlying the uprisings. In 1749, the Iroquois sold all the remaining Lenape lands to the Penns, including those north of the Kittatinny Mountains. They claimed a right to do so by virtue of their 17th century conquest of the Lenape.

By the early 1760s, the British military had assumed control of Indian affairs. Knowing the sympathy of certain tribes for the French and wishing to nip any uprisings in the bud, Lord Jeffrey Amherst, governor general of British North America, effectively blocked the sale of trade goods

to the Indians. The Indians, having no market for their furs and no means of obtaining the tools, firearms and clothing on which their lives depended, were faced with starvation. From Pennsylvania into New York and as far west as Ohio, desperate Indians began to arm for war.

Complicating the deterioration of relations between the English and the Indians were conflicts among the Europeans themselves, which rendered the situation of settlers in the Lehigh Valley very uncertain. The first involved land claims made by the colony of Connecticut on the northern part of the Pennsylvania.

In 1662, when Charles II granted Connecticut its charter, its southern boundary was 41° north latitude. Nineteen years later, when William Penn received his charter, King Charles granted him lands whose northern boundary lay along 43° north latitude. The Connecticut grant included all lands north of the Delaware Water Gap—a considerable portion of Pennsylvania and New York. As the colonies' populations swelled and as land speculators in Connecticut and Pennsylvania sought new sources of profits, King Charles' vagueness about North American geography developed into a major crisis, the Pennamite Wars.

The major antagonists in the war were the Province of Pennsylvania and two Connecticut –chartered private corporations, the Susquehanna Company and the Delaware Company. These companies were granted lands in the disputed territory by the Connecticut General Assembly. The Connecticut people, regarding the land as their own, did not feel bound by an arrangement made by the Penns with the Lenape, who, by the 1750s, had retreated into the Wyoming Valley north and west of the Lehigh. The representatives of the Susquehanna Company met with the Iroquois chiefs at Albany in 1754 and purchased what they regarded as legitimate title to these lands. Within the year, families from Connecticut began to arrive.

By 1760, Teedyuscung, the Lenape leader, was warning the governor of Pennsylvania that if he would do nothing about "those intruding people" that "the Indians would put a stop to it," which would, he threatened, "certainly bring on another Indian war" (Sipe, 1927). In addition to the danger of an Indian uprising, the Connecticut incursion was stirring up political discontent among the European settlers on the frontier. Many of them, unhappy with the Penns' feudal system of land tenure through which they were only permitted to lease land rather than buy it outright, were attracted by the possibilities of fee-simple ownership offered by the Connecticut companies (Sipe, 1927). They also looked to the opportunities offered by the opening of the Wyoming Valley to white settlement, a move that had been forbidden by the Penns' treaties with the Lenape and Iroquois.

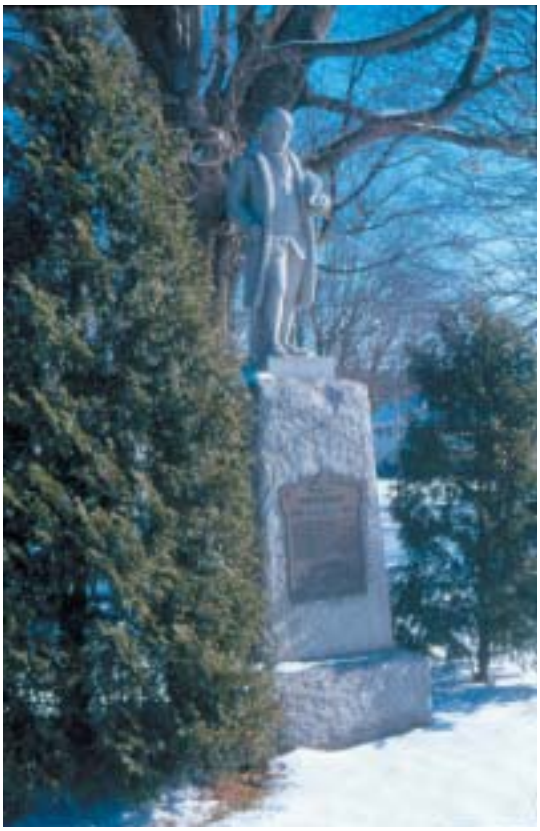
"The conflict between Pennsylvania and Connecticut, the anger of the Indians, and the dissatisfaction of the frontiersmen were further aggravated by the development of a fundamental split in Pennsylvania politics between those who supported the Proprietaries (the Penns and their friends) and those who supported the Quaker merchants of Philadelphia." This cleavage anticipated the conflict between Tories and Whigs that would emerge in the 1760s and would bear fruit in resistance to the Stamp Act and culminate in the American Revolution (Hall, 1982).

The Proprietaries' interests were closely tied to those of the British government. They favored enforcement of the Navigation Acts, which limited where and in what commodities Americans could trade and which curtailed manufacturing in many areas. The Quakers on the other hand, favored free trade, avoided British efforts to enforce trading laws whenever possible, and favored the enforcement of Lenape claims on disputed lands, especially in the Wyoming Valley.

"This conflict had serious consequences, for it rendered the governor of Pennsylvania virtually powerless to deal with either the Connecticut incursion on the Susquehanna or Teedyuscung's threat to call his braves to arms" (Sipe, 1927). The Indians, recognizing that the whites no longer spoke with one voice, were quick to attempt to play off one party against the other.

On July 9, 1755, 400 miles west of the Lehigh Valley, a band of several hundred Indians, including many refugee Lenape, joined battle against the British Regulars under General Edward Braddock near Fort Duquesne, the present site of Pittsburgh. The brightly uniformed and highly trained professional soldiers, unfamiliar with the guerilla techniques of frontier warfare, were routed. British authority collapsed in the Ohio valley and the French began to move in, taking over British trading posts and military strongholds.

Gnadenhuetten (present day Weissport), in the Mahoning Valley was the first settlement of Europeans in the area now embraced in Carbon County. It was established by the Moravians as an Indian mission in 1746. Each Indian was given his own plot of ground and lived in seeming harmony with the white spiritual advisors. For a short time, Chief Teedyuscung lived there. However, as the Indians began to waiver in their allegiance to the English and prepare to take up the hatchet on the side of the French, it became a matter of concern to them that many of their people were living in the Moravian settlement as Christians. Teedyuscung urged them to withdraw from Gnadenhuetten. For a time the Christian Indians refused to move, but Teedyuscung's influence was eventually great enough to draw many away from the settlement. The Indians that had joined the French were incensed that any remained with the Moravians and began to plan revenge.



This statue of Ben Franklin is located in a public park in Weissport, Carbon County. In 1756, Governor Morris sent Franklin to the Lehigh Valley to see to its defense. As a result, Fort Allen was erected in the Lehigh Gap, along with numerous other block-house forts on Blue Mountain.

By October, the Lenape were on the warpath. By November, settlers were gripped with fear. Moravian missionaries wrote to their Bishop in Bethlehem begging that their Indian converts be escorted to safety and that guards be sent to protect the village against imminent attack. On November 24, 1755, the Indians attacked Gnadenhuetten, killing eleven of the fifteen inhabitants, and burning their barns and houses. The Indian attacks continued into December, moving ever closer to the centers of settlement along the Delaware and Lehigh rivers. The residents of the frontier counties repeatedly asked Governor Morris for aid in defending themselves, but he could do nothing, since the Quakers controlled the assembly and refused to grant him funds for such a purpose.

Finally, in January of 1756, Benjamin Franklin, agent of Governor Morris was sent to the area to see to its defense. He arrived in Bethlehem on January 7th to find the town crowded with terrified refugees from the surrounding countryside, including the remnants of the Northampton County militia, who had been soundly defeated by the Indians on the road to Gnadenhuetten. Franklin, a notable organizer, took command of the confused situation. Rallying 500 troops, he left on January 15th for Gnadenhuetten, where he began construction of Fort Allen. It was completed ten days later, establishing a major military stronghold at the strate-

gically important Lehigh Water Gap. Within the next few weeks, Franklin and his men constructed half a dozen other forts and blockhouses along the frontier in Schuylkill, Monroe, and Carbon counties.

By April of 1756, Governor Morris, although still opposed by the Quakers, declared war on the Lenape, offering cash rewards of $130 for the scalp of every male Indian over 10 years of age and $50 for the scalp of every women or girl. At the same time, he opened negotiations with the Indians in a series of conferences at Easton, which would meet intermittently between 1756 and 1762.

These conferences were the Lenape's last stand. Caught up in an international power struggle between two great world empires, the English and the French, their rights overlooked in a boundary dispute between Connecticut and Pennsylvania, and outrun in the jockeying for imperial favor among other Indian tribes, "they could do little more than vacillate between impotent threats and pathetic appeals" (Hall, 1982). The Lenape's situation was summed up by Teedyuscung when he declared:

> *"I sit here as a Bird on a Bow—I look about, and do not know where to go; let me therefore come down upon the Ground, and make that my own by a good Deed, and I shall have a Home forever."*

Landless, demoralized, and scattered, the Lenape stood little chance of recovering what they had lost. The failure of the French to hold the Ohio Valley deprived them of their strongest ally. Continuing raids on isolated white settlers not only alienated their Quaker friends in the Pennsylvania Assembly, but also aroused such hostility among frontiersmen that "no Indian, whether Christian or pagan, was safe even in broad daylight" (Sipe, 1927). The last Easton conference, in the summer of 1762, left the status of the Lenape unresolved. They were free to live in the Wyoming Valley as far as Pennsylvania authorities were concerned. However, the Wyoming was occupied by Connecticut settlers the government at Philadelphia was powerless to displace.

In the summer and fall of 1763, the long struggle of the Lenape finally ended. On April 19th, Teedyuscung, who had remained with his people in the Wyoming Valley, was burned to death as he slept in his cabin. The fire had been set by agents of the Susquehanna Company who, at the same time, put the entire Indian village to torch, burning more than 20 houses and chasing their inhabitants into the woods. The destruction of Wyoming was accompanied by countless other outrages against the Lenape.

By fall, the Lenape were ready for revenge. Early in October, Captain Bull, Teedyuscung's son, descended with a war party on Northampton County, killing 54 persons. Shortly after, they struck the Connecticut settlement at Wyoming, where the thirty to forty people who remained were tortured and murdered.

These attacks sealed the fate of the Indians. The government could not protect them as groups like the Paxton Boys at Lancaster were killing every Indian they could find—man, women or child. By the 19th century, the remnants of the tribe were scattered throughout Oklahoma, Indiana, and Canada.

The Pennamite Wars between Connecticut and Pennsylvania were not finally settled until the 1770s. Although no actual fighting took place between the two colonies, it was a struggle of major consequence. First, the aggressiveness of the Connecticut settlers sparked a conflict between the whites and Indians, which not only caused enormous bloodshed, but also, by its

conclusion, had eradicated the Indian presence in Pennsylvania. Secondly, the impotence of the British government and its agents in dealings with the Connecticut invaders and the Indians permanently discredited English officialdom in the eyes of the settlers. This alienation would have had much to do with the enthusiasm with which the inhabitants of the Lehigh Valley would greet the outbreak of the American Revolution (Hall, 1982).

4. European Proliferation and the Revolution

With the eradication of the Lenape in the early 1760s, the people of the area passed beyond the frontier stage and began to build their own distinctive version of what would later be termed the American Dream. Virtually every corner of Lehigh and Northampton counties was dotted with farms, taverns, and mills by the last quarter of the 18th century.

Bethlehem was the metropolis of the Lehigh Valley during this period. It owed its growth to its strategic location at the juncture of the Lehigh and Delaware rivers. The Moravians, or Unity of Brethren, were descended from a reformation movement that antedated the preachings of Martin Luther by almost a century. The Moravian settlement in Pennsylvania occurred by accident. The sect had originally hoped to settle in Georgia, and a party of ten arrived in Savannah in 1735. The non-Moravians proved unfriendly—especially after the Moravians refused to bear arms against Spanish marauders from Florida. In Georgia however, the Moravians encountered George Whitefield, the Presbyterian evangelist. Whitefield, who owned a large tract of land that included present day Bethlehem and Nazareth, had hoped to establish in the Pennsylvania wilderness school for Negroes and a sanctuary for English debtors. He proposed that the Moravians come to his "Barony of Nazareth" to begin building houses for his beneficiaries. The Moravians arrived in Nazareth in 1741 and made friends among the other settlers, including Nathanial Irish, land agent for William Allen. The Moravians cast their lot for a tract of Allen's land at the junction of the Lehigh River and the Monocacy Creek. By the next year, when Whitefield found himself in financial distress, they were able to purchase his holdings.

The Moravian settlement in Bethlehem, and elsewhere in the lower Lehigh River valley, brought a sturdy religious orientation to the region, as well as a level of culture not typically found in the frontier.

The Moravian settlement grew rapidly from that point on. The ownership of the real estate in the towns that they controlled—Bethlehem, Emmaus, and Nazareth—remained restricted to the Moravian Church until the 1840s. The pooling of resources and the coordination of activities enabled the Moravians to mount educational, cultural, and missionary ventures. "Within months of their first settlement, the strains of fugues and cantatas could be heard on the banks of the Lehigh" (Hall,1982).

The Moravians encouraged the visual arts. John Valentine Haidt, who arrived in Bethlehem in 1754, was one of the most skilled portraitists in colonial America. He and his successors created a visual record of life in an early American community that is unrivalled, even by major cities like New York and Boston. The Moravians did not confine their interests to aesthetic and religious matters. They were accomplished engineers and architects. Their pumped water systems at Bethlehem, the first in North

America, began operation in1754. Moravian architects built large structures of stone and brick that still stand today, unimpaired by two and a half centuries of use. In addition, Moravian engineers laid out the roads that made Bethlehem the hub of the region.

The American Revolution left tiny Allentown, busy Easton and cosmopolitan Bethlehem physically untouched; the centers of fighting lay to the north in New England, New York and New Jersey, and to the south in Virginia and the Carolinas. While most of the Moravians were pacifists and did not fight in the war, they maintained a stance of friendly neutrality toward the patriots. Among the non-Moravians, however, support for the cause of independence was almost universal. When the people of the county (which included present day Lehigh and Northampton) were called upon to swear oaths of allegiance to the Continental Congress in 1777, 4,821 subscribed to the declarations. Only 59 refused. By May of 1775, over 2,000 volunteers stood ready for military service. George Taylor, the pioneer manufacturer of Easton and Catasauqua, was one of those who stepped forward to sign the Declaration of Independence. (Hall, 1982)

The engineering skills of the Moravian settlers provided many amenities to frontier life, like the water works in Bethlehem built in 1754.

The Lehigh Valley had much to gain from the revolution. The unusually fertile and productive agricultural region was a major supplier of provisions to the Continental armies. The struggling government set up military hospitals at Easton, Bethlehem, and Allentown. Among the disabled soldiers who recuperated in the valley was the young Marquis de LaFayette, who had been wounded at the Battle of Brandywine in 1777. As Philadelphia fell to the British in the autumn of that year, the Lehigh Valley became a place of refuge for the patriots. The Liberty Bell, symbol of the nation's aspirations, was transported to Allentown and hidden in the basement of Zion's Reformed Church to prevent it from falling into the hands of the Tories. Bethlehem became an important meeting place for patriot leaders. The Founding Fathers—Washington, Adams, Jefferson and Hancock—and such military nobles as Casimir, Pulaski, Baron von Steuben, Henry Knox, Nathanael Greene and John Paul Jones, all spent time in Bethlehem during the war. However, the most important effect of the war on the Lehigh Valley involved the development of manufacturing, particularly of desperately needed armaments. Many of the German craftsmen in the area were descendants of ancient arms-making families in cen-

In 1777, the Liberty Bell was transported from Philadelphia to the Lehigh Valley, and stored for safe keeping in the basement of the Zion's Reformed United Church of Christ in Allentown. The Liberty Bell Shrine can be seen there today.

tral Europe. Bringing their skills and tools to the wilderness, they had been quick to adapt the European rifle to frontier uses, producing the remarkably accurate and dependable Pennsylvania rifle. "The stimulus of war laid the basis for the subsequent industrial development of the region, which would be largely devoted to the mining and manufacturing of ferrous metals" (Hall, 1982)."

With the end of the war, the artisans and farmers of the Lehigh Valley returned to their normal pursuits. The Lehigh Valley remained largely rural. Of the 25,000 inhabitants of the region in 1800, less than 2,000 lived in its three largest towns. In addition, it was even more Germanic than it had been before the war, for many of the Scotch-Irish of Northampton County, unwilling to support the struggle for independence, had departed for places where King George was more favorably regarded.

As the farms in the countryside grew more prosperous, producing surpluses of grain, dairy products, and cattle, the towns grew larger. They also became trading centers where the farmers went to sell their goods and purchase what they could not grow themselves. The towns were also centers of information. In the taverns the farmers, artisans, and merchants wrangled over state and national politics, exchanged gossip, and renewed old friendships. Their arguments as well as their sense of identity were no doubt fueled by German-language newspapers, which had been published in Philadelphia as early as the 1750s and which, by 1810, were being printed in Easton and Allentown (Hall, 1982).

After almost three-quarters of a century of being alternately flattered and neglected by the English-speaking politicians of Philadelphia, the Pennsylvania-Germans were beginning to recognize where their political interests lay. Profoundly conservative, tied by choice to the land and intensely suspicious of officialdom of any kind, the Germans were quick to oppose efforts to increase the power of both state and national governments (Hall, 1982).

The Pennsylvania Germans' devotion to self-government was so great that, in 1798, when Federalist President John Adams attempted to levy a direct federal tax on real estate in order to finance the unpopular undeclared war with France they rose in rebellion. Liberty poles were erected throughout the Lehigh Valley and the old revolutionary slogans about taxation without representation were heard in the taverns.

"This localism and cultural insularity did not, for the most part, cause the inhabitants of the Lehigh Valley to turn away from the greater world" (Hall, 1982). While it is true that the Moravians became increasingly withdrawn and isolated, outcasts even among their fellow Germans for their neutrality during the revolution, the majority of Pennsylvania Germans were actively interested in commerce and politics. Indeed, with Jefferson's election to the presidency in 1800 and the subsequent relaxing of the suffrage laws, they became major participants in state politics, promoting the movement of Pennsylvania's capital to Harrisburg and, after 1820, electing a series of Pennsylvania Germans to the governorship.

In many ways, the struggles of the Pennsylvania German pioneers in the 18th century were the same as those of any group settling on the American frontier before the revolution, but there were important differences. "The horrors of religious warfare in Europe, in which the possession of a single piece of territory might pass, within 30 years, between half a dozen governments, had made the Pennsylvania Germans intensely suspicious of all authority" (Hall, 1982). This suspicion was intensified by their experiences with the English colonial government and their encounters with aggressive New Englanders in the northern part of the valley.

"Thus, while the Yankees were quick to extract from their land what they could before moving on to the West or into commerce and manufacturing, the Pennsylvania Germans single-mindedly kept at the task of improving the land and replacing makeshift wooden structures with stout fieldstone farmhouses." (Hall, 1982).

In 1820, Allentown was a bastion of Pennsylvania-German pioneers. Rather than extract the region's wealth and move west, as others did, the "Pennsylvania Dutch" stayed to build and improve their land and buildings.

The fundamentally agrarian nature of the people of the Lehigh Valley gave the towns a unique character. Unlike towns situated in the heart of other agricultural regions, the Lehigh Valley towns of Allentown, Bethlehem and Easton did not drain off the wealth of the surrounding countryside. Although the population of urban areas in the nation increased at almost double the rate of rural areas between 1790 and 1830, the towns of the Lehigh Valley grew no faster than the rural townships around them. The earliest paintings of Easton, Allentown, and Bethlehem show them, in the 1820s and 1830s to be small clusters of buildings set amid pastures and fields.

"The strong ties between town and countryside were not coincidental. They were a product of the Pennsylvania German's profoundly traditional attitudes which regarded land as the only real source of security and the family and Scriptures as the only true sources of authority" (Hall, 1982).

"This ongoing relationship between county and town led to a perpetuation of rural conservatism. The towns, rather than becoming outposts for the spread of political, economic, and religious activities inimical to the preservation of Pennsylvania German culture were, rather, citadels of resistance to the English-speaking mainstream"(Hall, 1982).

By the 1820s and 1830s, the region presented rich possibilities to the enterprising. The entrepreneurs of Philadelphia, New York and Boston looked to its untapped iron, coal, timber, and agricultural resources with eagerness. The Pennsylvania Germans, however, having created and perpetuated their own distinctive way of life, were not about to permit the Lehigh Valley to be transformed into a colony of avaricious outsiders. Nor were they, like the Amish of Lancaster or Moravians of Bethlehem, willing to turn their backs on the new. Commerce and industry would develop in the Lehigh Valley along lines quite different than it did elsewhere. The social gulf between owners and laborers characteristic of many other industrial areas would be largely absent in the 19th century, for employers were reluctant to exploit their employees and laborers trusted their employers to act in their common interest. Because the Pennsylvania German community was so powerful and cohesive, industry would come to serve the community; the community would not exist merely for the convenience of industry.

C. Industrialization of the Lehigh River

Using swiftly moving water for transportation, the harvesting of trees was a relatively easy matter. These logs became fuel and building material for the Lehigh Valley's communities, as well as the boats, locks, and dams of the Lehigh Navigation.

Early settlers took advantage of the Lehigh River as a source of water, food, transportation, and power. The first industries included a tannery, mills, and logging. Logging was a big business. The virgin forests of the Lehigh were clear-cut to provide a source of fuel and building materials for the settlements. Later the logs were used to build canal boats and canal locks. The forests have re-grown in the upper Lehigh but in the lower Lehigh, the land remains deforested as farms, and more recently, building lots.

As time passed, deposits of coal, iron, slate, and limestone were discovered. Each became a major industry and made the Lehigh region the heart of America's Industrial Revolution.

1. Stoddartsville, an Example of Industrial Development on the River

Stoddartsville is situated at the Great Falls of the Lehigh River, 14 miles southeast of Wilkes-Barre and 30 miles northwest of Easton. It was built by John Stoddart, a poor English immigrant who rose to financial power. The town was to serve as the hub of Stoddart's business empire, which rested on a fortune built through dry goods merchandising, book publishing and speculation in real estate and stocks.

In the early 1800s, Stoddart joined others in investing in the Poconos. Most warrants for land in the Poconos were then purely speculative, as the names from the period indicate: Silverhill, Mine Hill, Moneymore, Grand Object, Expectation, Industry, and Hope. However, Stoddart had a long-range vision that reached beyond such get-rich-quick schemes. He wanted to use the land itself to create a transportation and industrial center—one that would funnel raw grain from Pennsylvania's fertile Wyoming Valley to his mill, and then pass the flour down to markets in Philadelphia. The Wyoming Valley is a 20-mile stretch of farmland along the Susquehanna River near present-day Wilkes-Barre; at that time, the valley's grain was moving down the Susquehanna to the city of Baltimore, which was engaged in a trade rivalry with Philadelphia via the Lehigh and Delaware Rivers.

Josiah White was another visionary businessman who would eventually become Stoddart's partner. White was a member of the powerful industrialists and pioneering developers who lived in Philadelphia and dominated the industrial growth of the Delaware Valley for several generations. One of White's passions was to develop coal as a source of reliable power; though rivals had closed him out of the coal trade on the Schuylkill River, he hoped to get coal to Philadelphia by way of the Delaware River. Both Stoddart and White were seeking to exploit resources for the Philadelphia markets, and both were looking to secure an edge over their competitors. These motives brought their fortunes together.

Stoddart was an original investor in the Easton-Wilkes-Barre Turnpike Company, which was chartered in 1802. Stoddart planned the route of the turnpike to pass through Stoddartsville, as

he planned to call his proposed milling center. By 1806, the first 29 miles of the turnpike had been completed, from Wilkes-Barre past the great falls of the Lehigh. Stoddartsville itself would not be finished until 1819, three years after the completion of the turnpike and construction of Stoddart's gristmill.

Protected recently by a local visionary, Commander John Butler, this historic grist mill at Stoddartsville, Luzerne County (near Blakeslee) was built to take advantage of the new Lehigh Navigation. Unfortunately, the northern terminus of the system was established 12 miles downstream in White Haven.

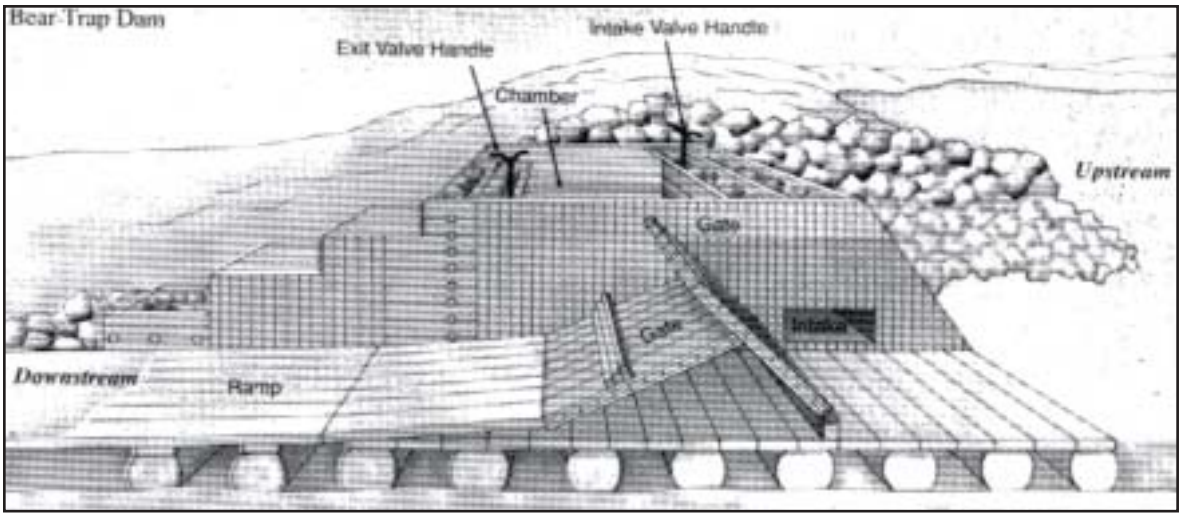
Josiah White's fortunes began to mesh with John Stoddart's in about 1815. Stoddart situated his community along the turnpike—where an old Indian trail known as the Wechquetank Path, improved by General Sulivan's army in the Revolution, crossed the Lehigh. The site was also at the most elevated point on the river that navigational improvements could ever be expected to reach. The Pennsylvania Commonwealth's assembly—later its legislature—had been periodically passing bills to encourage improvements to navigation along the Lehigh River since as early as 1771. This legislation had given Stoddart hope that navigation would eventually be possible.

In 1815, White tried to get Stoddart to invest in a plan to open up the Lehigh to navigation. Stoddart clearly understood how navigation on the Lehigh could be beneficial to him. Whoever controlled river traffic and the canal that was to come would naturally charge tolls; and he hoped that the turnpike and the Lehigh Coal and Navigation Company (LCN) could be played off against each other to keep tolls down. As a charter investor in the turnpike, he probably hoped to moderate its charges against his commerce, and he doubtlessly hoped for the same from the LCN.

Moreover, Stoddart hoped that his town's strategic location would help him take advantage of both modes of transportation. The turnpike from Wilkes-Barre to Stoddartsville would bring raw grain to Stoddart's gristmill, since only overland transport from farms in the Wyoming Valley to the mill was feasible. From the mill to the Delaware, he looked forward to descending navigation via the Lehigh and, in time, two-way navigation using the canal. Eventually, he could avoid the turnpike altogether.

Stoddart's industrial center at Stoddartsville was highly integrated. His gristmill was large and automated to conserve scarce frontier labor and minimize the need for workers' housing in the village. The same millrace that provided water for the gristmill also fed water, by way of a wooden aqueduct, into a sawmill, which was supplied with timber from Stoddart's surrounding lands. The lumber from this sawmill was used in the construction of the gristmill and the supporting village, including an inn to cater to the turnpike trade.

Stoddart's sawmill also provided the lumber for river barges, or "arks" as they were called, that carried his grain downriver toward Easton. In an apparent show of good faith, White had begun clearing the Lehigh River channel right below Stoddartsville, working downstream toward the Delaware. He did this as soon as his charter was granted, building dams as he moved down river.



Pre-dating the Lehigh Navigation, which was a lock-and-dam system, the "bear-trap lock" was an ingenious device that moved laden boats, or "arks," down the river on a released surge of water. From the collection of the National Canal Museum, Easton, PA.

White's dams were destined to play a significant role in this story. His initial wing dams were designed to impede, but not actually block, the flow of the river in such a way that high water flowed through the part where the wings failed to meet. However, a drought occurred in 1818 just before the wing dams were completed. White was at this time under pressure from the stockholders to fulfill his obligations under the LCN charter, which mandated a minimum channel depth set by the state legislature. In response, he invented a new type of hydraulic dam with a collapsible middle section that became known as a "bear-trap" lock.

Unlike the wing dams, this new type of dam spanned the entire river. The river, completely blocked, rose behind the dam, drought, or no drought. Once the pool had reached a sufficient height, the hydraulically moveable middle section was dropped, and river transport rode downstream on a miniature flood or freshet that poured through the breach. The dams had a damaging effect on fishing along the Lehigh eliminating the shad runs formerly harvested by the Moravian missionaries and their Indian converts.

The most financially damaging aspect of these downriver systems was that they were one-way; the arks or barges carrying either flour or coal southward had to be broken up and sold once they reached their destination. This problem contributed to the demise of Stoddart's fortunes. The cost of new arks was high, and his indebtedness grew with each passing year. His gristmill alone had cost him $20,000. However, his creditors remained enthusiastic, and by 1820, after the construction of Stoddartsville was completed, the entrepreneur was $250,000 in debt. Within eight short years, his debt grew to a staggering $650,000 and financial ruin was upon him.

White exploited Stoddart's situation to his advantage. White and the LCN needed wood from upriver of the coal fields to shore up the mines and build the arks to ship the coal, and the existing one-way bear-trap dams allowed for that. However, the cost was high, as it was for Stoddart.

In contrast, canal transport starting downstream from the coal fields would allow for two-way traffic and a return of coal barges loaded with supplies, thus recycling the arks and avoiding turnpike costs. White began construction of the canal, unlike the dams, at the Easton end of the Lehigh, with the foreseeable result that it would take some time—expensive time for Stoddart—for the canal to reach Stoddartsville.

It never got that far. In 1829, the canal reached White Haven, the closest point to White's upriver coal fields and 12 miles from Stoddartsville. There construction was stopped. Later the LCN lobbied the legislature into withdrawing the legal mandate for hooking in with Stoddartsville. John Stoddart's financial ruin was assured in the 1820s once it became likely that two-way navigation would never reach his mills because it presented no financial advantage to the LCN.

These canal boats – not barges, which have no steering mechanism – are laden with the matériel of an emerging nation. The Lehigh Navigation operated for over a hundred years, longer than any other canal in America.

Foreseeing his ruin, and recognizing that White had made a series of tough decisions that put the squeeze on him, Stoddart took advantage of his friendly relations with his creditors. He divested himself of certain properties and assets so that the members of his family would not be dragged to ruin with him. Josiah White was one of the people who bought Stoddart's land. Technically, Stoddart avoided bankruptcy. In the end, he took up work as a clerk in Philadelphia.

Stoddartsville was almost dead by the early 1830s. It enjoyed a resurgence between the mid-1830s and the early 1860s, supplying wood to the downstream coal industry. By sometime in the 1860s, the gristmill and sawmill were ruined and the upstream bear-trap dams had been destroyed by floods and abandoned by the LCN.

2. The Lehigh Canal and the Lehigh Coal and Navigation Company

In 1791, Phillip Ginter was hunting for a millstone at present Summit Hill when he noticed some "stone coal" which was later verified to be anthracite. The best way to get it to market, in, was via the Lehigh and Delaware Rivers. Placing it on rafts was not always successful, as the Lehigh was so shallow at times that the rafts were unable to float. A Philadelphia group, the Lehigh Coal and Mining Company, led by Colonel Jacob Weiss and Charles Cist, bought the rights to Ginter's mine and were deeded the land by the state of Pennsylvania. On March 9, 1791, the State Legislature approved an act for improving the Lehigh River, which consisted of the removal of boulders and other measures to make navigation easier. On February 27, 1792, the Lehigh Navigation Company was formed to improve the river. Through the early 1800s, they tried unsuccessfully to tame the Lehigh River and bring coal to Philadelphia.

In 1810, Josiah White and Erskine Hazard acquired ownership of the Schuylkill Falls at Philadelphia. Josiah White developed a dam and lock system for navigation purposes. Here, he built a nail manufacturing plant and a wire drawing plant. He used soft Virginia coal in his iron smelting operations.

During the War of 1812, Philadelphia was cut off from its supply of Virginia coal. Although there was high demand for wire and nails for the war effort, White and Hazard's operations had to be closed for lack of coal. They heard about the vast supplies of coal at Mauch Chunk and decided to inspect the town and study the Lehigh River as a source of navigation.

On August 10, 1818, Josiah White, Erskine Hazard and George Hauto formed the Lehigh Navigation Company. On October 20 of that year, they also formed the Lehigh Coal Company for exploitation of the anthracite deposits. On April 21, 1820, the two companies consolidated into the Lehigh Coal and Navigation Company. They first tried to control the Lehigh River by building a series of dams. When the spring thaw came, a powerful freshet (high waters due to snow melt or heavy rains) destroyed the dams.

On March 17, 1821, Erskine Hazard wrote in Poulson's American Daily Advisor:

> *"… It has been estimated that upwards of ten thousand tons of iron annually are imported into the United States. It is now ascertained from experience that iron can be made with Lehigh Coal at half the cost of imported iron. Upon the improvement of the River Lehigh, iron likely will become even a large article of export from the State of Pennsylvania."*

On March 6, 1821, Josiah White wrote in the Democratic Press:

> *"… On the waters of the Lehigh and the Schuylkill, about one hundred miles from Philadelphia, this species of coal resides. This fuel exists in a form more condensed than other species known. It is bulk one-tenth and in weight one-fifth that of oak wood for equal heat. It is consequently the fittest fuel for export. When transport by the Lehigh is improved, it is said the price of coal in the city of New York, along the seaboard to Boston, and including the seaboard south of Philadelphia, a population of four hundred thousand souls, easily will use two hundred fifty thousand tons of coal each year. In addition, estimating a profit of about two dollars a ton, such a market surely will awaken merchants out of their slumber and into a more active condition of enterprise."*

In 1827, Josiah White conceived of a canal linking the coalmines at Mauch Chunk (currently Jim Thorpe) to the markets at Philadelphia. By 1832, his Lehigh Canal was carrying 100-ton barges of coal from Jim Thorpe to Easton and down the Delaware River to Philadelphia. The canal system was later lengthened north to White Haven and, again, from south of Easton to Bristol.

Coal was first mined at Summit Hill, at the top of Pisgah Mountain about nine miles west of Jim Thorpe. In 1819, a route was graded which allowed anthracite coal to be hauled over the road bed in two ton capacity horse drawn wagons.

Josiah White first developed a lock-and-dam navigation system for the Schuylkill Falls in Philadelphia before putting his ideas to work on the Lehigh River. Coal from the Mauch Chunk area was needed to replace the soft Virginia coal cut off from Philadelphia by the invading British during the War of 1812.

In May of 1827, The Mauch Chunk, Summit Hill, and Switchback Railroad, the first coal railroad and the third railroad in the United States, began operations. This railroad, known as the Switchback, used the steep descent of the mountain to carry the coal cars to the Lehigh River. Mules or horses rode down with coal cars and pulled the empty cars back up the mountain.

In 1844, stationary steam engines replaced the mules and horses. Later, in 1872, direct railroad service came to Summit Hill and the Switchback was retired from coal hauling. It became a popular tourist attraction,

offering an 18-mile scenic ride through the mountains. The Switchback served as a model for the San Francisco cable car and the modern roller coaster. The railroad bed right of way was converted into a 16-mile recreational trail that begins at Summit Hill.

The Lehigh Coal and Navigation Company went before the Pennsylvania legislature and proposed to develop the Lehigh River for shipping. The LCN received a lease for 10,000 acres at Jim Thorpe for one ear of corn per year. Josiah White constructed a series of channels and Bear Trap locks to provide a sufficient water level for summer barge traffic. The Bear Trap locks provided a means of one-way travel. This succeeded in getting tens of thousands of tons of coal to Philadelphia and developing a market for anthracite (Zagofsky, 1993).

The Lehigh River had limitations as a shipping route. Under the best of conditions, it required great skill to steer the barges on the river and keep them off rocks and out of shallows. When the freshets came in the spring, the river became too swift to barge coal. In addition, the power of the water would damage the locks, sometimes totally destroying them. One-way travel created a constant demand for new barges, which, in turn, continued destroying the remaining forest (Zagofsky, 1993).

The first phase of the Lehigh Canal ran from Mauch Chunk to Easton. The canal measured 45 feet wide at the bottom, 60 wide feet at the top and drew five to six feet of water. The locks were designed to handle two barges traveling in opposite directions with each weighing up to 150 tons. The original section of the canal dropped 353.2 feet in 46.2 miles. In several places, where slackwater navigation was possible, the canal connected to the Lehigh River. It was made up of 10 miles of slackwater pools, 34.5 miles of canals, and 52 locks stretching 1.6 miles. It began operation in 1829 (Zagofsky, 1993).

During the construction of the canal, Josiah White discovered a source of hydraulic lime. He used the hydraulic lime to make waterproof joints in the canal lock masonry. This discovery

By 1832, these boats were each carrying 100 tons of "black diamonds" down the canal and river to Easton, and to the markets beyond.

Cars laden with coal were moved from the top of Pisgah Mountain in Carbon County down the Switchback Railroad to the Lehigh River and the Lehigh Navigation. From the collection of the National Canal Museum, Easton, PA.

Six feet deep, 60 feet wide at the top, and 45 feet wide at the bottom, the canals of the Lehigh Navigation were built to allow two boats to pass each other. From the collection of the National Canal Museum, Easton, PA.

Some locks in the 26-mile Upper Grand Section of the Lehigh Navigation were as high as 40 feet. In this section there were only eight short canals. Mostly it consisted of high-lift locks and dams. The boats traveled between the dams in the slack-water pools created by the dams. From the collection of the National Canal Museum, Easton, PA.

Forty-nine locks like this were built in the Lower Section of the Lehigh Navigation. From the collection of the National Canal Museum, Easton, PA.

started the cement industry in the Lehigh Valley. The second section of the canal connected Mauch Chunk to White Haven. It dropped almost 600 feet over 26 miles. This upper section consisted of 20.5 miles of slack-water pools, 4.7miles of canals and 29 locks stretching 0.856 miles. This section was destroyed by the flood of 1862. A third section of the Lehigh Navigation System was constructed from White Haven to Stoddartsville. At Easton, the Lehigh Canal connected to the Delaware and Morris canals (Zagofsky, 1993).

When the railroads came to the Mauch Chunk area, the Lehigh Canal began to lose business. Railroads ran faster than canal boats and were able to operate during the winter when the canal was frozen.

By 1890, commerce on the canals had for several decades been deteriorating. Yet, the final demise was delayed until well after the First World War. One reason for this lay in the insistence of state governments that the canal companies maintain their properties. The Lehigh Valley Railroad Company was unable to relinquish its responsibility for the Morris Canal to the State of New Jersey until 1922. The Lehigh Coal and Navigation Company was even less fortunate. In most years between 1890 to 1930, the company operated the canals at a loss (Joint Planning Commission, 1963) per year. During these years coal tonnage on the Lehigh canal declined from 356,639 to 91,227 (Joint Planning Commission, 1963). In 1953, property was leased in Walnutport from Lehigh Coal and Navigation for improving fishing and restoring the canal. In 1955, a flood destroyed 3.5 miles of this restored section of the canal. In 1964, LCN offered the canal property to the municipalities along the route. The Lehigh Canal has been significantly restored in Weissport, Walnutport, Freemansburg, Easton, and between Allentown and Bethlehem and is now used primarily for recreation.

In 1988, the United States Congress designated that the pathways of colonial development in eastern Pennsylvania be listed as a National Heritage Corridor. The corridor follows the railroad right of way beginning at Wilkes-Barre, meets with and continues along the Lehigh Canal to Easton and follows the Delaware Canal to its termination at Bristol. The Delaware and Lehigh Canal National Heritage Corridor Commission has been charged with helping towns along the corridor develop plans to maintain, restore and improve the lands, waterways and buildings.

3. Ownership of the Lehigh River

State Representative Samuel W. Frank, in 1966, engineered the return of the ownership of the Lehigh River to the public domain.

On July 19, 1965, Governor William W. Scranton signed into law a bill repealing a 143-year old legislative act that had given the Lehigh Coal and Navigation Company control of the Lehigh River, its tributaries and water rights by an act passed in the state legislature in 1822. Representative Samuel W. Frank, of Allentown, who offered a repealer, which had thirteen sponsors, uncovered the law granting this special privilege to the mining and coal company. The repeal bill passed the House 202-0 and the State Senate 40-0.

In the early years of development in Pennsylvania, special privilege laws were common to encourage the growth of industries such as mining, canals, transportation and toll bridges and highways. These rights were heavily relied on by the coal industry. These laws were valuable to the owners of the mines but also allowed for negative impacts to the environment. It was not until an aroused public opinion forced passage of the Clean Streams Act in 1965 in the State Legislature that corrective measures could be achieved by Pennsylvania officials in protecting the water quality of the Commonwealth without being totally hampered by unfavorable court rulings based on old laws (Beck, 1966).

4. The Rise and Fall of the Railroads

The very first railroad of significance in Pennsylvania had been the Switchback Gravity Railroad. It was built by Josiah White and Erskine Hazard to haul coal from the mine in Summit Hill to the Lehigh Canal at Mauch Chunk. The coal transported by this historic railroad fueled the Industrial Revolution in the United States.

At first, the railroad consisted of a single track that was used for the trip to and from the mine. Gravity was the power used to move the coal to the river, and mules were used to pull the cars back to the mine. In 1844, as coal became popular fuel and a quicker and more economical way was needed to move it, two inclined planes and a figure-8 track were installed to allow a continuous run between the mine and the river. The descending cars made the nine-mile journey in 20 minutes, an unbelievable speed for those times. They descended a total of 975 feet to the Lehigh River.

Josiah White's next railroad project was a 25-mile portage railroad, which he named the "Lehigh and Susquehanna Railroad" designed to bring coal from the northernmost extremity of his two-way navigation on the Lehigh River at White Haven, across the mountains from Wilkes-Barre in the Susquehanna River. Traffic became so heavy on the Lehigh and Susquehanna Railroad that the two tracks were taxed to capacity. Meanwhile, White's coal operation at Summit Hill had expanded into Panther Creek Valley to the north, and he developed a two-stage, four track inclined plane railroad to bring coal from Panther Creek to Summit Hill and from there to the Lehigh Canal at Mauch Chunk.

From the 1830s, steam locomotive railroads began to challenge the canals as the primary means of transporting anthracite coal and other industrial commodities. The first of these railroads, the

Beaver Meadow, began service in 1836. It was among the earliest steam locomotive railroads to operate in Pennsylvania's anthracite coal regions and the first to operate in the watershed.

The Beaver Meadow Railroad established the first railway service down the Lehigh River Valley. In the autumn of 1836, anthracite coal was carried from the mines at Beaver Meadow to Penn Haven along the Lehigh River through East Mauch Chunk to the Lehigh Canal docks across from Parryville. Originally planned to extend to Easton, The Lehigh Coal and Navigation Company persuaded railroad officials to end their railroad at Parryville and ship coal and freight via the canal. The 1841 flood destroyed much property between East Mauch Chunk and Parryville Coalport thus became the shipping terminus.

On April 21, 1846, a group of investors chartered the Delaware, Lehigh, Schuylkill, and Susquehanna Railroad Company. The petition for the charter was passed by the state legislature against strong opposition. During the winter, a route was surveyed from Mahoning Creek to Easton. In 1851, canal commissioners of the state appointed two men to determine if the railroad would be detrimental to the Lehigh Canal. They determined it would not be and construction of the railroad was authorized, but by that time, only 17 days remained before the expiration of the charter. The court sanctioned one mile of grading near Allentown to meet the requirements of the charter and thus the project was saved.

Asa Packer, railroad pioneer and founder of the Lehigh Valley Railroad Company (LVRR), dreamed of a continuous line from the Great Lakes at Buffalo, New York to the coastline of New Jersey. Packer's building of the Lehigh Valley Railroad between 1852 and 1855 marked the first major threat to the supremacy of the Lehigh Coal and Navigation Company. The Lehigh Valley Railroad initially stretched from Mauch Chunk to Easton and provided a more efficient and faster coal transportation route for anthracite than by canal. On June 11, 1855, the section connecting Allentown with South Easton formally opened with a locomotive named "General Wall" carrying passenger cars from South Easton to Allentown. Nearly the entire population of the communities along the route came out to see the train. By 1867, the Lehigh Valley Railroad was extended to the Susquehanna River at Wilkes-Barre, and in 1869 to New York State. In 1877, its tracks reached New York Harbor.

By 1855, immigrants from around the world flocked to the rich anthracite coal regions of Pennsylvania, and construction gangs laid track to hurry the shipment of coal to waiting factories. On September 15, 1855, sixty carloads of anthracite coal were carried from Beaver Meadow to East Mauch Chunk, and continued on the Lehigh Valley Railroad to South Easton and across the Delaware River on the new double-tier bridge to Phillipsburg, New Jersey. The coal transport was then continued on the tracks of the Central Railroad Company of New Jersey. On January 17, 1856, the first trainload of coal was shipped from Mauch Chunk to Trenton, NJ, covering the entire distance in only six hours. Lehigh Valley Railroad Company continued to expand with new construction and acquisition of existing companies.

Through a junction with the North Penn Railroad Company in 1856, the LVRR became the key link for both freight and passenger service between central Pennsylvania and New York. Although its main cargo was anthracite coal, not passengers, the LVRR prospered as all types of industries grew up along its route. A wealth of natural resources was diminished as large deposits of limestone, slate, clay and gypsum were carried to industries for refining.

By 1865 Packer owned 54 locomotives, nearly 4,000 coal cars, 11 passenger cars, four baggage cars, four house cars and 50 dump cars. "The LVRR was a tremendous success and a steady flow of traffic

rumbled up and down the river valley day and night." (Morning Call, 1997). The railroad industry throughout the upper watershed was also used in timber, tannery, and ice-cutting industries.

The Asa Packer Mansion in Jim Thorpe, Carbon County, is a well-preserved – and well-loved – example of a mid-19th century Italianate cubical villa. It is now a popular museum.

One publicity campaign that gained national attention came about when the LVRR held a contest to find a suitable name for its newest, most luxurious line. A hotel clerk from Toledo, Ohio was selected as the winner from among 35,000 contestants. His entry "The Black Diamond Express," symbolized the wealth of anthracite coal, often referred to as black diamonds. From the day of its first run in 1896, the Black Diamond became the symbol of the most modern in railroading. The streamliner was attended by a corps of chefs serving the finest delicacies of any railroad at the time. The interior of the train was decorated in polished mahogany with figured panels, domed ceilings, and French mirrors (Morning Call, 1997).

Asa Packer, whose 1860 home overlooks the town of Mauch Chunk, built the Lehigh Valley railroad that soon dominated the anthracite transportation. He went on to serve two terms in Congress and to fund Lehigh University in 1865. This latter contribution was part of a national trend following the Civil War. Men who had prospered during the war helped to foster higher education in America. Ario Pardee, coal magnate from Hazelton, financed Lafayette College. Joseph Wharton helped to finance both the University of Pennsylvania and Swarthmore College.

In reaction to both the threat posed by the Lehigh Valley Railroad and as a means of undoing the devastating effects of an 1862 flood that permanently destroyed the Upper Grand Section of the Lehigh Navigation, the Lehigh Coal, and Navigation Company extended the Lehigh and Susquehanna in 1871.

Although other rail lines, such as the North Pennsylvania and East Pennsylvania divisions of the Philadelphia and Reading Railroad, the Delaware, Lackawanna and Western Railroad, and later the Lehigh and New England Railroad, were all major carriers of anthracite coal in the region, it was the Lehigh Valley and the Lehigh and Susquehanna that were of the greatest importance to this region.

"It was a former boatman on the Lehigh Canal who recognized that the great "Iron Horses" would force the canal systems out of business, but it was years before anyone realized that railroads too could be pushed out of business by the painful loss of money year after year" (Morning Call, 1997).

Soon diesel engines were replacing steam engines across the country. In addition, as the demand for anthracite coal lessened, it became increasingly difficult for the LVRR to produce the money needed to replace engines and make improvements. The LVRR prospered temporarily during World War II, carrying coal for steel factories, supplies and homebound troops, but

once peace had been declared, labor strike after labor strike cut coal production, and the LVRR continued its steady decline.

The Lehigh Valley Railroad passed out of local hands into the control of J.P. Morgan in 1897. The railroads were hit with costly labor strikes in 1893 and 1902. The immigrant flow stopped when Ellis Island closed in 1924. By 1930, the economics of coal mining and railroading were in a steep decline. Coal was being replaced by oil. The numerous railroads serving the watershed went into mergers and bankruptcies until the federal government's Conrail and Amtrak finally acquired the remains in the 1970s. They have since consolidated operations and removed the track from obsolete routes.

One of the best places to gain perspective on the railroad competition after the 1870s is from Flagstaff on a hill south of Jim Thorpe. From this imposing promontory, one can see two ribbons of steel track snaking down either side of the Lehigh River. In that period, 100-car coal trains were seen daily.

D. The Anthracite Industry

1. Coal Mining and the Molly Maguires

Coal mining was a highly skilled occupation. The miner often worked alone as he freed the coal by picking and blasting. Knowledge of blasting, shoring, and safety had to be combined with strength and endurance. Risk was high from poisonous gasses, cave-ins, and black lung disease. Since 1900, over one hundred thousand people have died in mining accidents (Broehl, 1965).

Once the surface layers were mined, the mining continued underground. The miner wore an oil lamp on his cap, further increasing the danger of setting the methane gas on fire. Low pay, poor working conditions, lack of safety equipment, child labor, continuous health problems, high death rates, and a lack of control over working conditions made the miner a prime candidate for unionism (Broehl, 1965).

In the Mauch Chunk and Summit Hill areas, the mines were owned and managed by the English and Welsh Protestants and labored by the Irish Catholics. In addition to the mining life being physically hard, the workers had to work long hours. There were frequent accidents, and children had to help sort coal for the families to make enough money to survive. The mine owners took further advantage of their work by paying them in a script that was redeemable only at the company store. Further, the owners would require the mine workers to pay for their gear and supplies. Any men objecting to the low pay and hazardous conditions were fired.

Beginning in 1842, there were unsuccessful attempts to unionize the miners. During the Civil War, the miners rioted to protest the draft. In 1862, Jack Kehoe, a miner and opponent of the war, spat on the American flag. A mine foreman, F. W. Langdon objected to this act and was stoned to death. Over the following decade, this violence grew and developed into a secret society called the Molly Maguires.

In 1869, Franklin Benjamin Gowen, the district attorney of Schuylkill County, became head of the Reading Railroad Company. He led the railroad into the mining business with a policy of scaring the mine operators and destroying the unions. Gowen had the money, the power, and the police in his control. "His only opposition was the secret avenging group called the Molly Maguires" (Zagofsky, 1993). In order to break the Mollies, Gowen hired the private detective

services of Allen Pinkerton. Pinkerton decided to plant an agent, James McParlan, a native Irishman who immigrated to America in 1867, within the Mollies. In 1873, McParlan adopted the name Jim McKenna, and quickly established himself as a colorful, bright Irishman with sympathy for the Mollies (Zagofsky, 1993). In just three years, "McKenna" became a member of the innermost councils of the group. Over the following years, McParlan gathered evidence on the Mollies for several murders in Carbon County. The Mollies, including Jack Kehoe, were arrested, convicted, and hanged.

2. The National Significance of the Pennsylvania Coal Mining Industry

The following section on the national significance of the Northeastern Pennsylvania anthracite industry is taken from the report titled Anthracite Coal in Pennsylvania: An Industry and a Region by the Pennsylvania Historical and Museum Commission, 1997. Mining information specific to the watershed is discussed under Aquatic Components.

The anthracite coal industry of northeastern Pennsylvania, along with the closely related anthracite iron industry and the anthracite canals and railroads that delivered the output of the mines and factories to markets outside the region, is nationally significant.

The anthracite industry played a critical role in the expansion of the American economy during the second quarter of the nineteenth century. The decade between 1839 and 1849 marked the most rapid expansion of the economy's manufacturing sector in the nineteenth century. The opening of the anthracite fields directly influenced this critical development and helped "determine the timing and process of accelerated growth and institutional change in American manufacturing and mining" (Chandler,1972).

Anthracite coal fueled the modernization of the American iron industry east of the Alleghenies. It facilitated sharply increased production at rapidly falling prices. By 1844, anthracite produced the cheapest iron ever made in America. This iron became railroad rails, stoves, household furnaces, agricultural machinery, and a host of other products whose manufacture is considered central to the industrial revolution in the United States.

Anthracite offered manufacturers an inexpensive alternative to waterpower, facilitating the widespread adoption of steam power and the spread of factory production. The lack of coal was probably the most significant technological constraint holding back the spread of the factory in the United States. In Great Britain, the adoption of coal as the principal industrial fuel occurred earlier than in the United States, largely because of the deforestation of the British countryside and the need to develop a substitute fuel for wood and charcoal. As a result, the British led the United States in the adoption of steam engines, the development of automated machinery, the use of factory production methods, and the development of improved iron making techniques (Clark, 1949). The opening of the anthracite fields lifted this constraint upon American Industry and helped initiate a period of unprecedented growth within the manufacturing sector of the nation's economy beginning in the 1830s. Steam factories, placed in cities where coal was delivered by water, were closer to raw material supplies and markets. These factories provided work for the increasingly important new labor supply comprised of European immigrants.

Anthracite also occupied a prominent role within the non-industrial sectors of the economy. It became, starting in the 1830s, the major fuel source for residential heating and cooking in the northeastern portion of the nation. The adoption of anthracite solved the fuel crisis confronted by northeastern cities in the 1820s and helped make the rapid expansion of urban areas possible.

The locations of these anthracite fields, behind mountain barriers and a considerable distance from urban centers, necessitated heavy investments in transportation systems in order to deliver the coal to market. Owners of the coal lands first began building canals into the region in the 1820s. As these canals came into service the output of anthracite soared, from almost nothing before 1825 to 290,000 tons in 1830. Spurred by the developments of the iron industry, themselves a result of the expansion of the coal industry, railroads rapidly began to supplant the canals. The interrelationship between the mining industry, the iron industry and the transportation industry within the anthracite region are exceedingly complex and represent some of the earliest vertically integrated industrial enterprises in the United States.

The regions patterns of urban development, its recognition of the environmental and social costs of mining and the histories of the various immigrant groups who supplied the work force for the mines and factories all have national significance. The industry's role in the development of industrial unionism and the transformation of labor relations in the United States is central to the history of labor. Anthracite was one of the earliest industries to unionize by industry, rather than by trade or skill. Anthracite pioneered industrial unionism in this county. Events in the anthracite fields provided examples and lessons for labor organizers in other industries throughout the country.

The anthracite coal industry played a major role in the transformation of the American economy prior to World War I. The industry's decline offered one of the nation's earliest examples of de-industrialization. Throughout its history, developments in the anthracite region reached far beyond the seven counties in which the anthracite fields lay. From the perspective of economic, industrial, business, social, ethnic and labor history, the anthracite region and the anthracite industry are clearly of national significance.

E. Economic Development and the Industrial Revolution

The Industrial Revolution replaced craft production in homes and small shops with mass-production in the factories. The Industrial Revolution also increased agricultural production through improvements in farm machinery, quicker and safer means of transportation, and research in better methods of farming, pest control, crops, animals, and marketing techniques. These improvements elevated farmers' standards of living. Quarrying of slate, mining of anthracite, iron, and zinc, and the building of canals and railroads introduced new types of people, new ideas, and new problems.

1. Natural Resources

The first natural product to attract the attention of the colonists was lumber—immense stands of white pine, hemlock, and oak. These were once cut and floated down rivers in order to supply masts and spars for His Majesty's ships. Later these forests were cut to provide domestic firewood, building materials, and charcoal for the iron furnaces before the benefits of anthracite were recognized.

Large-scale lumbering took place with the opening of the canal system in the 1830s in order to supply the growing city markets. The area around Lehigh Gorge State Park in Carbon County was particularly active. As the original growth of pine and oak was stripped off, a secondary

industry developed in peeling the bark of spruce and hemlock trees to be used for tanning animal hides. The town name of Tannery in the Poconos attests to this industry.

The cement industry came to the region during the building of the Lehigh Canal, but it was the work of David O. Saylor at Coplay that gave cement making in the Lehigh Valley its major impetus. By 1877 Saylor had perfected a method of manufacturing Portland cement, which is both harder and stronger than the previously used hydraulic cement. The unique geological properties of the Lehigh Valley's Jacksonburg limestone formation provided an ideal raw material for the manufacture of Portland cement. By 1900, the Lehigh Valley had become the leading cement manufacturing center in America, a distinction it would hold for more than three decades.

A high-quality limestone was discovered in the Lehigh Valley during the construction of the Lehigh Navigation, and the American cement industry was spawned. These kilns, located in Saylor Park, Lehigh County, were used in the process of making limestone into Portland cement.

Limonite, also known as "brown ore," was found in such regions as the small, steep valleys east, southeast and northeast of Hellertown, Fogelsville, Guthsville, and Ironton. With the development of mining, came the process of smelting. The area's furnaces were small, had water wheels to provide power and used charcoal for fuel. Expansion was limited due to the expense of charcoal and availability of skilled labor and timber resources (Joint Planning Commission, 1963). At the same time, roads were beginning to deteriorate. The horse-driven wagon trains carrying ore turned the roads into dust in the summer and mud slicks in the winter (Joint Planning Commission, 1963).

With the discovery of zinc oxide made from ore and the completion of the Lehigh Canal, the slate industry began to rise (Joint Planning Commission, 1963). Large deposits of slate were found in a belt along the southern base of the Blue Mountain from the Delaware Water Gap to the western border of Lehigh County. Smaller amounts of slate were found in North Whitehall, South Whitehall and Lowhill townships.

From 1880 to 1930, the Lehigh Valley was the leading slate-quarrying center in America. Once again, it was the construction of the Lehigh Canal that provided a means of bringing this product to market. Beginning in 1845 at what is now Slatington, a major slate-quarrying and processing industry developed. Slate was made into blackboards, school slates, billiard tables, roofing materials and numerous products used in the building trades. The water-filled quarries and slate dumps of the slate belt, and the school slate factories of Slatington remain as visible evidence of this industry's former greatness.

The production of zinc played a significant role in the industrial history of the watershed. The zinc industry began with the discovery of large deposits of this metallic ore in the Saucon Creek Valley near Bethlehem. Soon a method of producing zinc oxide was discovered and a major market was created for using zinc as a paint pigment. Among the early investors and managers of the Lehigh Zinc Company was Joseph Wharton, a Philadelphia Quaker who later founded the Wharton Business School and the University of Pennsylvania, co-founded Swarthmore College,

and by the end of the century had become a major stockholder in the Bethlehem Steel Company. By 1870, the Lehigh Valley had become a center of the American zinc industry, but flooding at the Saucon Valley mines soon threatened it. Despite the installation of what was then the world's largest steam-operated pumping engine, the flooding problem drove up the cost of Saucon Valley ore. By the 1880s, most of the mines in the region had closed. However, in 1897 the zinc industry returned to the area when the New Jersey Zinc Company began the development of the planned industrial community of Palmerton in Carbon County.

As the mining industry grew, railroad production began to soar. This enabled communication and transportation of materials between major cities. With the spread of railroads in the valley, manufacturers increased exponentially, as did the number of people employed in manufacturing (Joint Planning Commission, 1963).

2. Iron and Steel

Iron and steel from the Lehigh River watershed fueled the growth of America and in the process made the Lehigh Valley extraordinarily prosperous. The very first iron furnace opened in 1727 at Durham Creek near the line between Bucks and Northampton counties, about a mile and a half inland from the Delaware River. Among its original owners were James Logan, Penn's colonial secretary, and William Allen, founder of Allentown. The Durham Furnace produced shot and shells for British colonial forces fighting in the French and Indian War and the American Revolution. During both of these conflicts, Durham Furnace was managed by George Taylor, who became a signer of the Declaration of Independence and a prominent patriot leader.

Another significant era in the watershed's industrial development began in 1840 when the Lehigh Crane Iron Company began operation at what is now Catasauqua. Since 1825, there had been keen competition to produce iron using anthracite as the blast furnace fuel. Many attempts were made in the anthracite regions of Pennsylvania, from Easton to Mauch Chunk. The Lehigh Crane enterprise was the first successful anthracite-fueled blast furnace in the United States. It was largely the creation of the Lehigh Coal and Navigation Company, which had brought Welsh ironmaster David Thomas to America. Thomas had discovered the secret of getting anthracite to burn in a blast furnace by heating the air blast in pipe stoves before it entered the furnace. The ruins of Thomas' iron works can still be seen among the weeds in Hokendauqua.

The remnants of the Thomas Iron Works in Hokendauqua, Lehigh County, are adjacent to the Lehigh River. This was the first plant in the country to burn anthracite coal successfully.

Since the Lehigh River watershed possessed abundant supplies of iron ore, limonite and coal, and the connecting Lehigh Navigation, Delaware Division and Morris canals gave ready access to both the Philadelphia and New York markets, other entrepreneurs emulated Thomas' success and built anthracite-fueled blast furnaces in the Lehigh Valley and in adjacent parts of Bucks and Carbon counties. By 1850, the Lehigh Valley had become the leading iron-producing region of

America, a distinction it held until 1880. The massive buildings of Lockridge Furnace Park at Alburtis are all that remains to represent the Lehigh Valley's former pre-eminence as an iron-producing region.

The Bethlehem Iron Company was the only Lehigh Valley iron maker to successfully make the transition from iron to steel, becoming Bethlehem Steel Corporation.

The iron boom had a profound effect on the Lehigh Valley. It transformed small towns, such as Allentown, into major urban areas and spawned many subsidiary industries, which in turn brought about further population growth.

In 1863, the Bethlehem Iron Company began production at what is now the city of Bethlehem. The Bethlehem Iron Company began as a railroad rail mill, and by 1873 it became the only Lehigh Valley iron maker to make a successful transition to the production of steel. In 1873, the "panic of '73" hit the nation and five years of depression followed. The company's directors were convinced that the infant company would have to expand its product base if it were to survive the years ahead. Its opportunity came in 1882 with the government's decision to rebuild the U.S. Navy, and to do it with steel.

During the 1880s and 1890s, the Bethlehem Iron Company, under the leadership of John Fritz, built the first super heavy forging plant in America. This marked the beginning of the modern American defense industry. From the 1890s onward Bethlehem produced guns, armor plate, propulsion machinery parts, and later nuclear reactor vessels, for American and foreign warships, including battleships beginning with the U.S.S. Maine of the Spanish-American War fame and ending with the U.S.S. Missouri, on whose decks World War II was ended.

During the early twentieth century, the Bethlehem Iron Company was transformed by Charles M. Schwab into the modern Bethlehem Steel Corporation. Schwab had long been one of Andrew Carnegie's lieutenants and was the first president of the United States Steel Corporation. In 1904, Bethlehem Steel Corporation consisted of a steel plant at Bethlehem, Pennsylvania; the Juraqua iron ore mines in Cuba; the Union Iron Works, with shipbuilding facilities at San Francisco; and a few other facilities of lesser importance.

The services of Eugene G. Grace came with Schwab's acquisition of the company. Schwab, with a broad background in steel and a keen understanding of salesmanship, and Grace, who proved to be a master of production and management, soon became a formidable team. "Clearly, the towering skylines of America's major cities are monuments to the vision and determination of Bethlehem Steel's first management team" (Metz, 1994). Grace became Bethlehem Steel's president in 1916, and Schwab remained chairman of the board until his death in 1939.

Before the outbreak of the First World War, Bethlehem bought Chilean iron ore properties from French interests. These South American properties put Bethlehem into the ocean transportation business. To transport the iron ore, Bethlehem built its own fleet of ocean-going carriers.

The war in Europe soon brought orders from the British navy for submarine assemblies to be built at Bethlehem's shipyard in Fore River, Mass. Meanwhile, from the French, the Russians, and the British came a flood of orders for guns and munitions, and naval vessels were ordered by several countries, including China.

Bethlehem's ability to turn out military material in large quantities contributed greatly to the Allied cause and gave the company a sound financial basis for future growth.

During the growth of the 1920s, Bethlehem acquired additional steel-making facilities. Bethlehem entered the Pacific Coast market in the late 1920s and early 1930s with the acquisition of facilities in Los Angeles and Seattle. Unfortunately, the booming 1920s led to the depression of the 1930s. Bethlehem was hit hard by the depression. Much of the business was dependent on construction and the railroads, and both of these industries operated at low levels during this period. Still Bethlehem managed to improve many of its facilities.

At this time, Bethlehem became a more broadly based producer of steel geographically and a major erector of bridges and buildings. Two of the nation's landmark suspension spans, the George Washington Bridge over the Hudson and San Francisco's Golden Gate Bridge were fabricated and erected by Bethlehem Steel. Notable buildings built by Bethlehem in this period are the Merchandise Mart in Chicago and the Waldorf-Astoria Hotel in New York City. In addition, Bethlehem supplied the steel for New York's Rockefeller Plaza, New York Coliseum and Madison Square Garden.

By 1939, as war clouds hovered over Europe, Bethlehem had the ability to turn out steel products on a scale much larger than that called for in World War I. By 1944, its peak production year, Bethlehem produced more than 13 million tons of raw steel.

After the attack on Pearl Harbor, every phase of Bethlehem's operations shifted to a war production basis. In the war years, Bethlehem yards built 1,121 naval and merchant vessels and repaired nearly 38,000 ships, with the help of 220,000 employees. Bethlehem's contributions to the U.S. Navy are impressive. In 1925, the company built the U.S.S. Lexington, America's first aircraft carrier.

By the close of the 1950s, Bethlehem had increased its steel-making capacity by more than 50 percent over what it had been at the end of World War II. During this same period, it also invested heavily in overseas sources of raw materials in Canada, Africa, and South America. The capital goods boom ended in 1958 and left Bethlehem with enlarged capacity and a market that had shrunk by a quarter. The situation was also complicated by the longest strike in the steels industry's history (116 days) and the invasion of the domestic market by low-priced foreign steel.

New patterns of growth characterized Bethlehem Steel's activities through the 1960s, 1970s and 1980s: the development of new technology, its application to shifting market demands; diversification into other fields; and the continuing modernization of production facilities. In the 1990s, the steel company discontinued operations locally and eventually became bankrupt.

3. Textiles

Textile manufacturing was one of the very few industries that were historically found in almost all parts of the watershed. As early as 1832, a major cotton-spinning mill was established at the Abbott Street industrial area in Easton. Silk became the predominant textile industry of the Lehigh Valley. The great Adelaide Silk Mill in Allentown, constructed in 1881, was the first of many. The Allentown Board of Trade, concerned about the city's dependence on iron, was actively looking for other industries at the same time that silk manufacturers in Paterson, New Jersey, were seeking new locations for mills. The Lehigh Valley's superb transportation facilities, lack of labor union activity, and large potential labor force of women made it a major center of silk production by 1900. By 1920, the Lehigh Valley had become the second most important silk

producing region in America. There were mills in almost every town in the region. The Wyoming Valley became a major producer of Nottingham lace during the same period.

The Phoenix Silk Manufacturing Company, operator of the Adelaide Mill was one of the forerunners in the "Safety First" movement in twentieth-century American industry. The company operated a cafeteria for its workers, hired a trained welfare worker to advise its female employees, and sponsored recreational activities. Men in the textile industry were paid more than women, but this was one industry where women were allowed to rise to supervisory positions. Because of the predominance of female workers in the textile industry, social organizations developed to assist single women in urban areas. The economic downturn of the Great Depression, coupled with the development of synthetic fibers such as nylon, largely destroyed the textile industry. However, great numbers of surviving mill buildings, such as the Simon complex in Easton, the giant Adelaide Mill in Allentown and the Wilkes-Barre Lace Manufacturing Company, give evidence of the former economic importance of textiles to the inhabitants of the towns and cities of the watershed.

4. Agricultural

As manufacturing increased and transportation and communication improved during the Industrial Revolution, the agriculture community began to benefit. The transportation improvements provided farmers with new markets outside the valley, and the newer farming techniques and equipment increased production yields per acre of new varieties of crops.

"During the period from 1840 to 1940," writes S.W. Fletcher in the second volume of Pennsylvania Agriculture and Country Life, "Pennsylvania agriculture was transformed gradually from a simple and largely self-sufficing occupation and way of life into a capitalistic, scientific, and highly commercial enterprise." Most of this development occurred after 1890.

In terms of relative importance to the economy of the Lehigh Valley region, agriculture declined after 1890. Between 1910 and 1959 the number of farm operators in Lehigh and Northampton counties diminished from 6,860 to 2,749 (Joint Planning Commission, 1963). Over the same span of years, the amount of land in farms decreased from approximately 85% of the area of the two counties to 60% (Joint Planning Commission, 1963).

Yet agriculture continued to be one of the principal industries affecting the development of the region. One reason for this lay in the willingness of farmers to accept technological improvements for increasing the efficiency of production and raising standards of living. Around the turn of the century, the silo began to make an appearance. About the time of the First World War, the Model T Ford gave farmers an improved means of locomotion. After 1920 labor-saving devices such as tractors, milking machines and brooders came into increasing use. By the end of World War II, most farms in the region were supplied with telephones, electricity, and modern household appliances. The majority had at least one tractor larger than a garden tractor. Most farmers possessed trucks. Improved equipment meant that a farmer could till more land in less time than his ancestors had found possible. In 1910, the average sizes of farms in Lehigh and Northampton counties were respectively 58.2 and 54.0 acres. By 1959, the average sizes of farms in the two counties had risen respectively to 99.9 and 102.9 acres (Joint Planning Commission, 1963).

In addition, farmers learned to apply methods of scientific farming. In the Lehigh Valley region, this meant increased yields of crops on which farmers principally depended for cash income.

Among these were corn, wheat, potatoes, dairy products, fruits, vegetables, poultry, and poultry products. In time, the farmers became small businessmen with considerable investments in land, buildings, and equipment. Upkeep and replenishing of their capital necessitated a continual reliance on government and an industrialized economy. Farmers in Lehigh and Northampton counties were brought increasingly into contact with governmental agencies and programs (Joint Planning Commission, 1963).

On the national front, the next 50 years saw a proliferation of agricultural programs that offered various sorts of benefits to farmers but, at the same time, subjected them to greater governmental controls. The administration of Theodore Roosevelt concentrated on soil and forest conservation. That of Woodrow Wilson emphasized education of farmers in scientific methods of agriculture. In 1914 the Smith-Lever Act was passed, which aided the establishment of a system of county agents and farm bureaus to demonstrate improved methods for tilling the soil, rotating crops, using fertilizers, controlling pests, preserving the soil and selecting seeds. About the time of the First World War, the organization of farm bureaus on state and national lines produced the most powerful agricultural pressure group in the country, the American Farm Bureau Federation (Joint Planning Commission, 1963). In the 1920s the A.F.B.F. and other groups assisted the farmer in obtaining a variety of laws favorable to agriculture, especially laws encouraging the formation of cooperatives. Although the cooperative movement had its origin in the late 19th century, the decades of the 1920s and 1930s mark its greatest period of growth (Joint Planning Commission, 1963).

In the nation as a whole the period of the Great Depression beginning in 1929 saw still further increases in government aid to agriculture. Farmers received improved facilities for credit, support for parity prices, crop insurance, and rural electrification. These and other programs appeared in the administration of Franklin D. Roosevelt and were, in revised forms, continued through the administrations of Harry S. Truman and Dwight D. Eisenhower respectively. Farm credit banks and federal agents for administering production and marketing controls and other programs appeared in the region (Joint Planning Commission, 1963).

In general, farmers in the Lehigh Valley opposed these programs. In the 1920s and 1930s the farmers in the region organized a number of cooperatives for insurance, marketing, and purchasing. Among the largest of these were the Lehigh Valley Cooperative Farmers, the Farm Bureau Cooperative Association of Lehigh County, and the Lehigh Valley Egg Producers Cooperative Association. However, the cooperatives were not forced on the farmers by government. Cooperatives represented a voluntary effort to obtain services that would have been too costly to obtain by other means (Joint Planning Commission, 1963). However, with respect to the agricultural policies of the New Deal, the farmers took a different attitude. Subsidies, production and marketing controls, and other programs of direct governmental aid and regulation were of less benefit to the farmers of southeastern Pennsylvania than they were to those of the midwestern and western section of the United States (Joint Planning Commission, 1963). The Rural Electrification Administration never appeared in the Lehigh Valley region. Many farmers refused to apply for subsidies.

The family farm remained the basic unit of production. A few large commercial farms appeared, for example, the Trexler Farms in Lehigh County. The Trexler farms were an enterprise of General Trexler, who started them in 1901 with the purchase of large tracts of land in Lowhill and North Whitehall townships. In 1905, he planted about 300 acres to peach and apple trees. Three years later, he set aside a thousand acres as a refuge for deer, buffalo, and elk. This tract became known as "Trexler's Deer Park" – later, as Trexler's Game Preserve.

Yet, for the most part, large farms, such as the properties of General Trexler, occupied a small proportion of the total land in farms in the Lehigh Valley region. A more pronounced trend was that of farming rented or leased land, because farmers were often able to rent land more easily than they could afford to buy it. Although the number of farmers in the region was severely reduced, farming as a way of life was preserved for the several thousand families who were responsible for the major part of the agricultural production of the region.

5. Utilities

The landscape of the Lehigh River watershed region was altered in the midst of the Industrial Revolution. The rural areas showed the least change. Telegraph poles and wires lined many roads, and trains passed constantly through almost every part of the region. The farms and rural villages appeared more prosperous as better machinery and produce lay in the fields (Fletcher, 1950).

On the other hand, towns and boroughs were completely transformed. Industry and manufacturing dominated the boroughs that had once been small towns. These areas had no protection against the power of development (Eckhart, 1992). Houses were small and often overcrowded. Noise, smoke, and smells from the factory were part of daily life. Often piles of slag or other refuse bordered the residential areas. Factory wastes usually went into rivers and streams, which consequently became polluted. Narrow and poorly maintained streets were inadequate for the increase in traffic resulting from business and industry (Eckhart, 1992). Water systems and volunteer fire companies fell short of the needs of an expanding population (Eckhart, 1992). Very few parks or public recreation services existed. Sanitation including sewage disposal were considered each family's responsibility. In addition, most boroughs had little to no hospital services.

Communications and power displayed rapid trends toward a high degree of centralization. Utilities became known as a group of industries and services that were awarded special privileges and strict regulation. The growth of various utilities in the Lehigh Valley region presents great contrasts (Joint Planning Commission, 1963). Water supply and sewage disposal remained decentralized. The abundance of water supply in the region principally accounts for the decentralization of supply (Joint Planning Commission, 1963). In rural areas water supply still came from a private well on each establishment. In urban areas, the municipalities controlled the supply. Private companies were the original controllers of water but as the population grew and the concern for clean water grew, the supply of water became a public affair (Joint Planning Commission, 1963). After the Civil War, many municipalities took over the responsibility for providing their inhabitants with fresh water. This trend continued, until by the First World War most cities and boroughs in the Lehigh Valley region had municipal water systems. Then, as suburban populations continued to expand, municipalities had to extend their facilities. After the Second World War, as suburbs expanded into the townships surrounding cities, municipal governments began furnishing water by sale or contract to outlying areas. In more recent time, the growth of sewage disposal parallels that of the water supply. Prior to that, the demand for municipal sewage systems did not develop until people began to understand the nature of contamination and its relation to disease (Somerset Publishers, 1996).

In the act of improving the communication and trade, the telegraph entered the Lehigh River region in 1848. One of the large companies organized in 1876 became known as the Lehigh Telegraph Company. Telegraph consolidation was largely completed by 1890; Western Union joined most parts of the country, including the Lehigh Valley. In the telephone industry, consoli-

This beautiful art deco building, completed in 1927 by the Pennsylvania Power and Light Company, significantly changed the skyline of Allentown.

dation came more slowly. The period before the First World War was marked by considerable competition among small companies. Many merchants had to install the telephones of several companies in order to communicate with all parts of the Valley (Joint Planning Commission, 1963). For many years after the First World War, three principal companies remained in operation in the valley, Bell, Keystone and Lehigh (one of the enterprises of General Trexler). By 1930, the three had merged into the Bell system, of which General Trexler was the director.

Power also remained in private hands and became highly centralized. In the 1880's, when electricity was first commercially used, small companies were necessary because the direct current employed could be transmitted only over short distances (Joint Planning Commission, 1963). With the introduction of alternating current in the 1890's the chief technological obstacle to large-scale operations was removed. Small companies that had formed in most of the urban and industrial areas of the region rapidly merged.

In the central and southern parts of the region, a similar process gave control over electric power to the Pennsylvania Power and Light Company. First, the Bethlehem Electric Light and the Allentown Electric Light and Power companies absorbed or put out of business electrical companies in their respective areas. These companies eventually merged and reorganized into the Lehigh Valley Light and Power Company. Finally, in 1920 the Lehigh Valley Light and Power Company and several other large companies in Pennsylvania were merged to form the Pennsylvania Power and Light Company.

The utility companies helped change the landscape of the valley (Joint Planning Commission, 1963). The companies had office buildings and manufacturing and storage facilities. Gas storage tanks existed in the cities, and reservoirs for water became larger and more numerous. In 1927 Pennsylvania Power and Light completed construction of the 23-story PP&L building at Ninth and Hamilton streets in Allentown, providing the area with its only skyscraper. In addition, the pipes and lines for carrying services to the people and to industry spread over the valley. Gas and water mains and sewer pipes were installed, repaired, and improved. In the several decades before the First World War, masses of telephone and telegraph poles and wires appeared in urban areas. In 1914, Allentown began experimenting with underground conduits. The extension of underground wires, together with improvements in poles and cables and stricter controls over routing, helped to reduce confusion and gradually many poles and wires disappeared from densely populated areas (Joint Planning Commission, 1963).

6. PRESENT DAY ECONOMICS AND DEMOGRAPHICS

At the time of the 1960 census slightly more than 434,000 persons lived in the Lehigh River watershed. Almost 60 percent of them lived in the industrial Allentown-Bethlehem-Easton area. The remainder resided either in small communities centered around coal mining or light industries, in trading centers, or in rural areas. In 1964 population for the same area was estimated at 446,000. Tables 2-1 through 2-6 and Figures 2-1 and 2- 2 summarize present day economic and demographic information for the Lehigh Valley and the Lehigh River watershed.

TABLE 2-1. LARGEST LEHIGH VALLEY EMPLOYERS
(Lehigh Valley Planning Commission, 2000 Lehigh Valley Profiles & Trends, Lehigh Valley Economic Development Corporation, 2000)

Rank	*Company Name*	*Type of Business*
1	Agere Systems	Electronic components manufacturing
2	Lehigh Valley Hospital and Health Network	Acute-care hospital
3	Air Products & Chemicals, Inc.	Industrial gases, chemicals and manufacturing
4	U.S. Government	U.S. Government
5	St. Luke's Hospital	Acute-care hospital
6	Mack Trucks, Inc.	Heavy duty trucks and related components
7	Manpower, Inc.	Employment placement and training
8	County of Lehigh	County Government
9	Pa. State Government	State Government
10	Wood Dining Services	Food Service
11	County of Northampton	County Government
12	Allentown School District	Public School
13	Guardian Life Insurance Co. of America	Life Insurance
14	KidsPeace	Children's Services
15	Bethlehem Area School District	Public School
16	PPL Corporation	Electric Utility
17	Dun & Bradstreet, Inc.	Business credit information
18	Victaulic Co. of America	Pipe couplings, fittings and castings
19	Sacred Heart Hospital of Allentown	Acute-care hospital
20	Easton Hospital	Acute-care hospital
21	Day-Timers	Private planners and organizers
22	B. Braun Medical, Inc.	Disposable surgical and medical supplies
23	First Union Corporation	National bank and banking services
24	Lehigh University	Private university and research institution
25	F.L. Smidth & Co.	Manufacturer of cement industry equipment
26	Rodale, Inc.	Health and Motivational Living Publishing
27	Binney & Smith, Inc.	Manufacturer of crayons, markers, etc.
28	Good Shepherd Home	Church services
29	Aetna, Inc.	Life Insurance
30	Parkland School District Authority	Public School

TABLE 2-2. LARGEST MANUFACTURERS IN THE LEHIGH VALLEY
(Lehigh Valley Planning Commission, 2000 Lehigh Valley Profiles & Trends, Lehigh Valley Economic Development Corporation, 2000)

Rank	Company Name	Type of Business
1	Agere Systems	Electronic components manufacturing
2	Air Products & Chemicals, Inc.	Industrial gases, chemicals and manufacturing
3	Mack Trucks, Inc.	Heavy duty trucks and related components
4	PPL Corporation	Electric Utility
5	Victaulic Co. of America	Pipe couplings, fittings and castings
6	Day-Timers	Private planners and organizers
7	B. Braun Medical, Inc.	Disposable surgical and medical supplies
8	F.L. Smidth & Co.	Manufacturer of cement industry equipment
9	Rodale, Inc.	Health and Motivational Living Publishing
10	Binney & Smith, Inc.	crayons, markers, etc.
11	Morning Call, Inc.	Newspaper Publishing
12	Kraft Foods, Inc.	Food production and distribution
13	Paris Accessories, Inc.	Women's sportswear and manufacturer
14	Sure Fit, Inc.	Manufacturer of furniture covers
15	C.F. Martin & Co., Inc.	Guitars and String Manufacturer
16	Cadmus Communications Corporation	Printing
17	Scotty's Fashion Cutting, Inc.	Women's skirts, slacks, blouses & jackets
18	A & H Sportswear Co., Inc.	Sportswear manufacturer
19	Mannesmann Rexroth AG	Manufacturer of industrial hydraulic parts & systems
20	Georgia-Pacific Corporation	Manufacturer of paper and building products
21	Pabst Brewing Company	Brewery
22	Lutron Electronics Co., Inc.	Electric and lighting controls
23	Allen Organ Company	Manufacturer of digital organs
24	H.T. Lyons, Inc.	Engineering, construction and maintenance services
25	Just Born, Inc.	Manufacturer of candy; Hot Tamales, Mike & Ikes

TABLE 2-3. NUMBER OF LEHIGH RIVER WATERSHED RESIDENTS EMPLOYED BY INDUSTRY
(Lehigh Valley Planning Commission, 2000 Lehigh Valley Profiles & Trends, Lehigh Valley Economic Development Corporation, 2000)

Agriculture, Forestry, Fishing	1,011	Mining	160
Contract Construction	15,635	Retail Trade	51,885
Farming	1,465	Services	98,832
Finance, Insurance, Real Estate	22,458	Transportation and Public Utilities	16,712
Government	28,986	Wholesale Trade	12,269
Manufacturing	54,125	***Total Employment***	***305,375***

TABLE 2-4. LEHIGH VALLEY RESIDENTS EMPLOYED BY OCCUPATION (Pa.A Department of Labor & Industry, bureau of Research and Statistics, 1990. Lehigh Valley Planning Commission Regional Economic Model, 1998)

Occupation	*2000*	*2020 (est.)*
Administrative Support/Clerical	46,040	61,518
Agriculture/Forestry/Fishing	2,480	5,298
Executive/Administrative	19,170	35,256
Marketing/Sales	29,820	36,680
Operators/Fabricators/Labelers	38,390	46,493
Production Product Craft/Repair	27,920	33,939
Professional/Paraprofessional	58,860	58,005
Service	41,290	56,541

TABLE 2-5. LEHIGH RIVER WATERSHED AVERAGE ANNUAL UNEMPLOYMENT RATES (Bureau of Research and Statistics, Pa. Department of Labor and Industry, Lehigh Valley Planning Commission, 2000 Lehigh Valley Profiles & Trends)

Year	*Lehigh Valley*	*Pa.*	*US*
1990	5.6	5.4	5.5
1991	6.9	6.9	6.7
1992	7.8	7.5	7.4
1993	7.1	7	6.8
1994	6.2	6.2	6.1
1995	5.4	5.9	5.6
1996	5.3	5.3	5.4
1997	4.7	5.1	5
1998	4.3	4.5	4.5
1999	3.8	4.3	4.2

FIGURE 2-1. LEHIGH VALLEY UNEMPLOYMENT TRENDS (Bureau of Research and Statistics, Pa. Department of Labor and Industry, Lehigh Valley Planning Commission, 2000 Lehigh Valley Profiles & Trends)

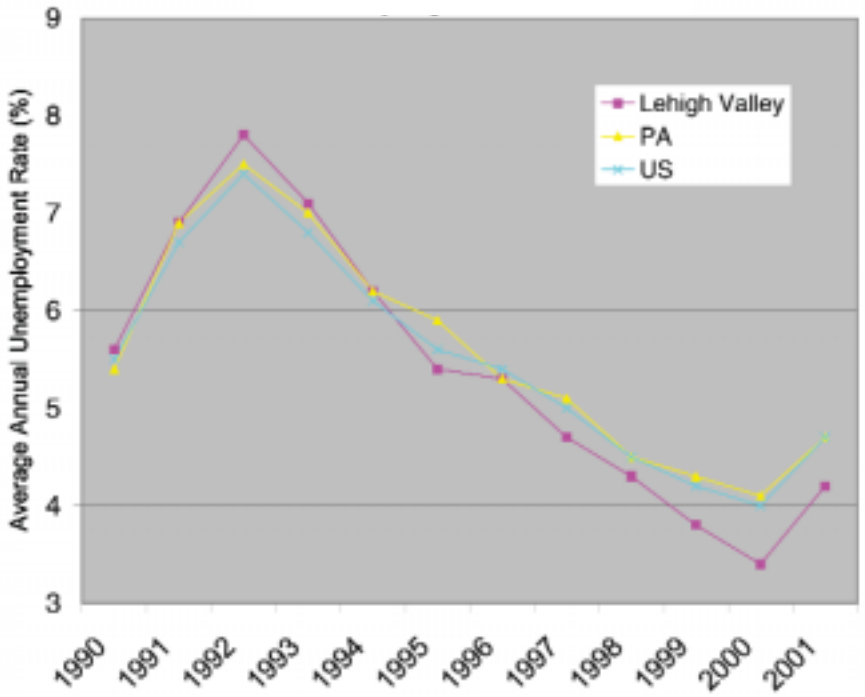


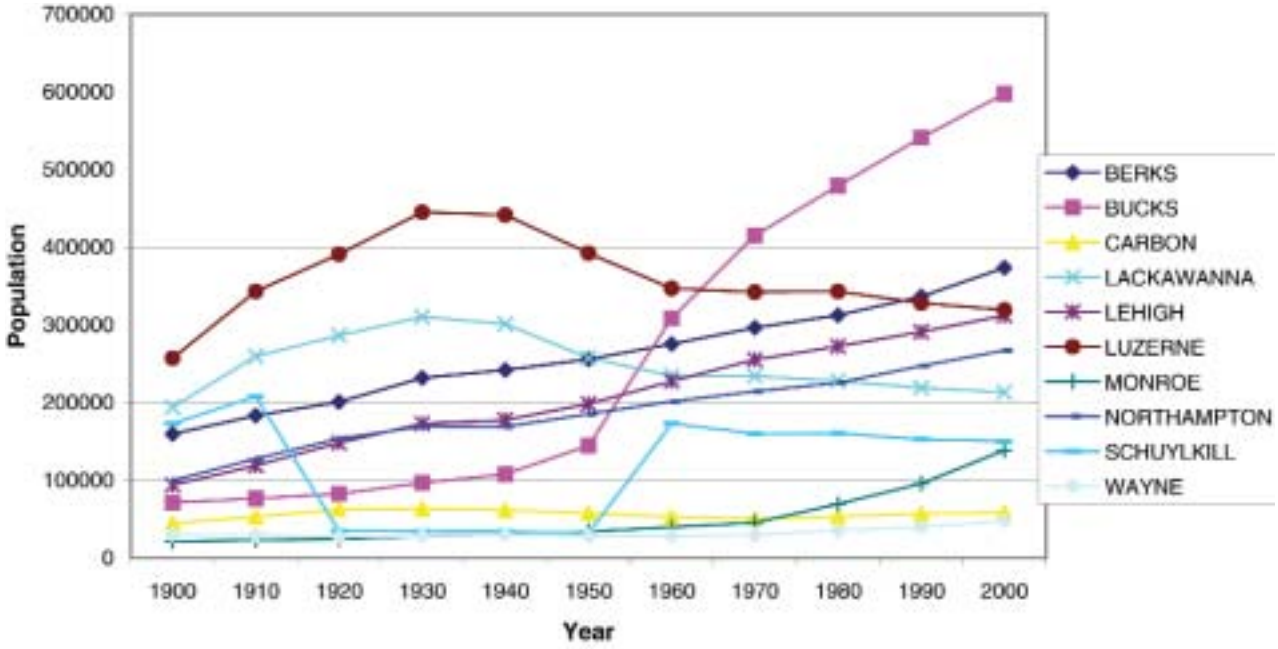
TABLE 2-6. DEMOGRAPHIC AND ECONOMIC DATA BY COUNTY (US Census Bureau)

	Berks	Bucks	Carbon	Lackawanna	Lehigh	Luzerne	Monroe	Northampton	Schuylkill	Wayne	Pennsylvania
POPULATION											
Population, 2001 estimate	377,679	605,379	59,506	211,829	314,204	315,754	144,676	269,779	149,176	48,392	12,287,150
Population percent change, April 1, 2000-July 1, 2001	1.10%	1.30%	1.20%	-0.70%	0.70%	-1.10%	4.30%	1.00%	-0.80%	1.40%	0.00%
Population, 2000	373,638	597,635	58,802	213,295	312,090	319,250	138,687	267,066	150,336	47,722	12,281,054
Population, percent change, 1990 to 2000	11.00%	10.40%	3.50%	-2.60%	7.20%	-2.70%	44.90%	8.10%	-1.50%	19.50%	3.40%
Persons under 5 years old, percent, 2000	6.20%	6.40%	5.10%	5.30%	6.00%	5.00%	6.00%	5.60%	4.90%	5.60%	5.90%
Persons under 18 years old, percent, 2000	24.60%	25.70%	22.20%	21.80%	23.90%	21.00%	26.80%	23.30%	20.90%	24.00%	23.80%
Persons 65 years old and over, percent, 2000	15.00%	12.40%	18.50%	19.50%	15.80%	19.70%	12.30%	15.70%	19.90%	17.50%	15.60%
TRANSPORTATION											
Mean travel time to work, workers age 16+ (minutes), 2000	22.3	28.6	29.2	19.8	22.1	21.2	36.7	24.2	24.9	26.3	25.2
Percent of workers who carpool	10	8.3	11.9	12.2	9.8	11.1	13	9.6	12.6	10.4	10.4
Percent of workers who walk to work	3.6	1.7	3.2	3.7	3.5	3.2	2.2	4.1	4	3.5	4.1
Percent of workers who use public transportation	1.7	2.8	0.7	0.9	1.6	1	3.4	1.1	0.4	1	5.2
Percent of workers who work at home	2.9	3.6	1.7	2	2.7	2.1	3.3	2.3	2.6	4.2	3
HOUSING											
Housing units, 2000	150,222	225,498	30,492	86,218	128,910	144,686		106,710	67,806	30,593	5,249,750
Persons per household, 2000	2.55	2.69	2.44	2.38	2.48	2.34		2.53	2.36	2.5	2.48
ECONOMY											
Private nonfarm establishments, 1999	8,079	17,582	1,125	5,393	8,127	7,606	3,180	5,631	3,125	1,423	293,491
Private nonfarm employment, 1999	145,991	240,779	13,645	89,771	161,481	122,554	37,512	77,935	43,609	13,029	4,986,591
Private nonfarm employment, percent change 1990-1999	6.40%	16.10%	0.30%	2.00%	14.00%	3.30%	16.30%	-0.20%	3.80%	11.10%	8.40%

TABLE 2-6. DEMOGRAPHIC AND ECONOMIC DATA BY COUNTY (continued) (US Census Bureau)

	Berks	Bucks	Carbon	Lackawanna	Lehigh	Luzerne	Monroe	Northampton	Schuylkill	Wayne	Pennsylvania
Nonemployer establishments, 1999	17,690	39,189	2,754	9,810	15,338	13,687	8,013	12,281	6,367	3,736	614,594
Manufacturers shipments, 1997 ($1000)	7,729,356	7,592,956	311,894	2,562,696	7,690,056	4,501,055	812,899	2,638,374	2,625,116	182,347	172,193,216
Retail sales, 1997 ($1000)	3,330,720	7,217,380	316,742	1,966,284	3,509,237	2,856,425	1,160,638	1,831,841	1,062,524	396,986	109,948,462
Retail sales per capita, 1997	$9,412	$12,391	$5,387	$9,350	$11,768	$8,998	$9,460	$7,114	$7,028	$8,785	$9,150
Minority-owned firms, percent of total, 1997	3.60%	4.90%	< 100 firms	2.30%	6.10%	2.90%	7.90%	4.10%	2.80%	5.00%	5.90%
Women-owned firms, percent of total, 1997	24.80%	22.60%	26.30%	20.90%	28.70%	23.50%	24.10%	24.00%	20.60%	21.40%	24.20%
Housing units authorized by building permits, 2000	1,809	2,768	207	520	1,344	603	1,630	1,312	352	253	41,076
Federal funds and grants, 2001 ($1000)	1,528,382	2,250,647	304,608	1,400,173	1,406,125	2,018,339	625,530	1,314,787	834,324	263,251	79,310,064
Local government employment-full-time equivalent, 1997	11,661	16,563	1,853	5,851	9,388	8,576	3,705	8,154	3,621	1,392	365,556

FIGURE 2-2. POPULATION GROWTH AND DECLINE IN THE COUNTIES OF THE LEHIGH RIVER WATERSHED (Source: U.S. Census Bureau)



F. The National Register of Historic Places

The National Register of Historic Places is the nation's official list of cultural resources worthy of preservation. Authorized under the National Historic Preservation Act of 1966, the National Register is part of a national program to coordinate and support public and private efforts to identify, evaluate, and protect our historic and archaeological resources. Properties listed in the Register include districts, sites, buildings, structures, and objects that are significant in American history, architecture, archaeology, engineering, and culture. The National Register is administered by the National Park Service, which is part of the U.S. Department of the Interior.

Included among the nearly 73,000 listings that make up the National Register are:

- All historic areas in the National Park System;
- Over 2,300 National Historic Landmarks, which have been designated by the Secretary of the Interior because of their importance to all Americans;
- Properties across the country that have been nominated by governments, organizations, and individuals because they are significant to the nation, to a state, or to a community.

National Register properties are distinguished by having been documented and evaluated according to uniform standards. These criteria recognize the accomplishments of all peoples who have contributed to the history and heritage of the United States and are designed to help state and local governments, federal agencies, and others identify important historic and archeological properties worthy of preservation and of consideration in planning and development decisions.

Listing in the National Register contributes to preserving historic properties in a number of ways:

- Recognition that a property is of significance to the Nation, the State, or the community.
- Consideration in the planning for federal or federally-assisted projects.
- Eligibility for federal tax benefits.
- Qualification for federal assistance for historic preservation, when funds are available.

The Lehigh River watershed is replete with historic landmarks, listed below and shown in Map 2-1.

1. CARBON COUNTY

CARBON COUNTY JAIL

128 Broadway St., Jim Thorpe

This jail was built in 1869 on West Broadway. The Molly Maguires were tried, convicted, and hung at this jail. One of the most famous and unusual events happened in cell #17. Tom Fisher was hanged, but before he died, he placed his hand on the wall and said that his handprint shall never leave to show that he was innocent. Allegedly, to this day his handprint still exists, even after many years of washing, painting, and other techniques to try to remove it.

COUNTY SECTION OF THE LEHIGH CANAL
Weissport and vicinity, along Lehigh River

One of the first sections of the canal to be built, it was used very early to transport the coal from the northern regions to Easton and Philadelphia to be sold in the markets.

CENTRAL RAILROAD OF NEW JERSEY STATION
Susquehanna St., Jim Thorpe

This building was erected in 1888, two years after its sister station in Easton. It served as a train station until 1954, when it turned into a bunking station for the railroad workers. Today it is a tourist attraction and home to a D&L Corridor Landing.

LITTLE GAP COVERED BRIDGE
South of Little Gap on T 376, Towamensing Township

MAUCH CHUNK AND SUMMIT HILL SWITCHBACK RAILROAD
Between Ludlow St. in Summit Hill and F.A.P. 209, Jim Thorpe

This gravity railroad was built in 1827 by Josiah White to bring anthracite coal down from the mines at Summit Hill to the Lehigh Canal at Mauch Chunk. By 1870, the railroad had taken over, and the Switchback was more of an amusement/scenic ride for tourists. Some say that it was one of the first roller coasters.

OLD MAUCH CHUNK HISTORIC DISTRICT
Broadway, Susquehanna, Race, and High Streets, Jim Thorpe

Stone row is one of many famous sites within Jim Thorpe. Stone row is a row of houses that has only a stonewall separating each house. The courthouse, St. Mark's Episcopal Church, the old jail, and many other historic buildings within this area make up this historic district.

ASA PACKER MANSION
Packer Road, Jim Thorpe

Asa Packer made his fortune through building canal boats, then investing into the Lehigh Valley Railroad. Through all his hard work he ended up helping the community by founding Lehigh University. The mansion was built in 1890, had 20 rooms, and was later given to the borough after the death of his daughter, Mary Packer Cummings.

HARRY PACKER MANSION
Packer Road, Jim Thorpe.

This mansion was a wedding gift given to Harry Packer and his wife Mary Augusta Lockhart by Asa Packer. This Victorian style mansion had 18 rooms and now serves as a Bed and Breakfast.

This timeline is a snapshot of the people, events, and forces that helped shape, not only the Lehigh River watershed's environment, but also our nation's industrial heritage.

10,000 B.C. The ancestors of the Lenni Lenape develop stable patterns of living, including farming and government in the region.

1492 Christopher Columbus sets sail from Spain.

1570 The "Five Nations" is established (Onondagas, Cayugas, Senecas, Oneidas, and Mohawks). The French call this confederacy the "Iroquois," while the Lenni Lenape continue to call them the "Mengwe."

1620 The Mayflower lands at Plymouth Rock.

1681 King Charles II of England grants William Penn a New World colony in payment of a debt owned to Penn's father.

1683 William Penn arrives in Philadelphia.

1701 William Penn, with the approbation of the General Assembly, grants the Charter of Pennsylvania.

1720 The Lenape ("Delawares") become subjects of the Iroquois, a condition that will exist until the end of the French and Indian War.

1737 The infamous "Walking Purchase" takes place, beginning the settlement of many of the Lehigh River valley's towns and cities.

1741 Count Zinzendorf, leader of the Moravians, arrives in Bethlehem.[1]

1743 The Moravians in Bethlehem catch over 5,000 American shad in a single day.

1755-1763 Indian uprisings, as well as conflict with the French for control of the New World, interrupt the English settlement of the region.[1]

1755 Indians attack the mission house in Lehighton in the winter killing ten people, capturing one person, and burning all of the buildings to the ground.[3]

1756 Construction of Fort Allen begins in present-day Weissport; the construction is overseen by Benjamin Franklin.[1]

1776 The Declaration of Independence is signed in Philadelphia. The Revolution leaves most of the region untouched, but many great revolutionary military leaders spend time in Allentown, Bethlehem, and Easton.

1777 The Liberty Bell is hidden in the Zion's Reformed Church in Allentown while the British occupy Philadelphia.[1]

1787 Pennsylvania becomes the second state to ratify the Constitution of the United States, on December 12th.

1791 Phillip Ginter discovers anthracite while hunting in the mountains at present-day Summit Hill.[1]

1808 Judge Jesse Fell of Wilkes-Barre experiments with burning the "common stone coal of the valley in a grate, in a common fireplace." [2]

1818 The Lehigh Navigation Company and the Lehigh Coal Company combined forces to improve navigation on the Lehigh. The companies merge two years later to create the Lehigh Coal & Navigation Company.

ST. MARK'S EPISCOPAL CHURCH

Race and Susquehanna Streets, Jim Thorpe

Built in 1848, this is the second oldest church in Jim Thorpe. Richard Upjohn, who was a leader in religious architecture at the time, designed the church. The Packer family gave large contributions to the church, which can be seen on the decorated inside. This is one of the only churches to have a wrought iron elevator.

SUMMIT HILL HIGH SCHOOL

124 West Hazard Street, Summit Hill

The Lehigh Coal and Navigation Company constructed a log structure in the west end of Summit Hill only to teach the three R's-Reading, Writing, and Arithmetic. In 1875, the Lincoln Building was constructed but it was not until 1889 that Summit Hill had its first graduates, Margaret Bynon and Lissie Clark.

2. LEHIGH COUNTY

AMERICUS HOTEL

541 Hamilton Street, Allentown

Built in 1926-27 by Allentown businessman Albert "Bert" Gomery. Named for fifteenth-century Italian explorer Amerigo Vespucci. Stylized eagles give it an all-American touch.

BETHLEHEM ARMORY

301 Prospect Street, Bethlehem

This served as the place where they produced weapons for the soldiers of the Revolutionary War. Today it serves as a base for the National Guard.

BIERY'S PORT HISTORIC DISTRICT

Roughly bounded by Pineapple, Front, Race, and Mulberry Streets, Catasauqua

Frederick Biery purchased a piece of land in 1795 and built some small stone houses. Frederick also had Biery's Ferry and in 1824 built a chain bridge. In 1845, Biery's Port was described as post village, with several dwellings, two taverns, a store, a gristmill, a Presbyterian Church and Crane Iron Works.

BOGERT COVERED BRIDGE

LR 39016, Little Lehigh Park, Allentown

Built in 1841, this is the oldest bridge in Lehigh County and one of the oldest in the nation. Used only for foot traffic now, its single span is 145 feet long.

Bridge in Heidelberg Township
LR 39110 over branch of Jordan Creek, Germansville

Bridge in Lynn Township
LR 39112 over Ontelaunee Creek, Steinsville

Burnside Plantation
Schoenersville Rd., 2 mi. SE of junction with Easton Avenue, Bethlehem

The first single-family Moravian farmhouse and farm, established in 1748 by James and Mary Burnside. Today seven acres are being preserved as a living history museum to interpret farming life between 1748 and 1848, a time of many agricultural advancements.

Catasauqua Residential Historic District
Roughly bounded by Howertown Rd., Railroad Ave., Oak and Bridge Streets, Catasauqua

Once a thriving town due to its success during the coal and iron industry days, Catasauqua was known as the "Million Dollar Town" because it was the first town to sell one million dollars worth of war bonds. A ten room, brick Lincoln school was built at a cost of $30,000 to replace the three schoolhouses on Front, Second, and Bridge Streets.

Centennial Bridge
Station Ave. over Saucon Creek, Center Valley

Coopersburg Historic District
Main St. and Pennsylvania 309, Coopersburg

Coplay Cement Company Kilns
N. 2nd St., Coplay

By 1877, David O. Saylor perfected a method of manufacturing Portland cement, which is both harder and stronger than the previously used hydraulic cement. This is the only historic museum that rewards the hard work of the cement workers in the Lehigh Valley.

Dent Hardware Company Factory Complex
1101 Third St., Whitehall

Dillingersville Union School and Church
East of Zionsville on Zionsville Rd., Zionsville

The first building was built around 1735 but was very small. In 1799 a larger building was built that would accomodate more people for both school and religious events. Eight grades were taught by one teacher in the typical one room building. German was the language taught extensively. Other buildings were to follow the one built in 1799.

1820 Construction of "bear trap" locks begin on the upper Lehigh River.

1822 The Act of February 13, 1822 gives unlimited rights to the Lehigh Coal & Navigation Company to "improve" the Lehigh River between Stoddartsville and Easton, making it the only privately owned river in the country. (It remains in the company's hands for 144 years.)[1]

1827 Railroads enter the region, including the first coal railroad – the Switchback – located between Summit Hill and Jim Thorpe.

1827 Work begins on the Lehigh Navigation, which includes both canals and lock-and-dam devices.

1829 The Lehigh Navigation begins operation.

1829 Artist John J. Audubon visits the upper Lehigh River to explore the variety of birds and other wildlife.[1]

1855 Immigrants from around the world flock to the coal regions to find work in the mines.[4]

1856 The Lehigh Valley Rail Road, owned by Asa Packer, becomes the key link for both freight and passenger service between Pennsylvania and New York.

1859 David Thomas establishes the Thomas Iron Works in Hokendauqua.[1]

1862 A disastrous flood wipes out the Upper Grand Section of the Lehigh Navigation.[1]

1863 Bethlehem Iron Company produces iron for the first time.

1865 Gifford Pinchot (1865-1964), America's first trained forester, is born. Destined to become the governor of Pennsylvania, he is the first to use the term "conservationist."

1866 The restoration of American shad populations is the driving force behind the formation of the current-day Pennsylvania Fish & Boat Commission.[1]

1871 David Saylor begins operation of the first commercially successful cement plant in Coplay.

1886 Hotel Wahnetah opens, and boasts 47 rooms, a dance pavilion, tennis courts, fresh air, and hikes to the scenic Glen Onoko Falls near Jim Thorpe. A fire in 1911 closes the hotel.[1]

1870 Pennsylvania's first statewide mine-safety law covering anthracite mines passes following a fire that suffocates 179 men.

1876 The Philadelphia & Reading Railroad facilitates the prosecution of twenty-four "Molly Maguires," a secret organization of miners promoting labor violence in eastern Pennsylvania. Ten are hung for murder, and the others are sentenced to jail terms of two to seven years in Carbon County.

1897 The New Jersey Zinc & Iron Company becomes the New Jersey Zinc Company.[1]

1897 The first state law authorizing state purchase of woodlands for forest preserves passes.

DIME SAVINGS AND TRUST COMPANY
12 N. 7th St., Allentown

Opened in 1929, only to close in the Great Depression. Today it serves as an office building.

DORNEYVILLE CROSSROAD SETTLEMENT
South of Allentown at jct. of U.S. 222 and Pennsylvania 29

FIREMAN'S DRINKING FOUNTAIN
Main St., Slatington

FOUNTAIN HILL HISTORIC DISTRICT
Roughly bounded by Brighton, Wyandotte, W. Fourth and Seminole Sts., and Delaware Ave., Bethlehem

Bought in 1742 by the Moravians, they kept it until 1848. They sold this land to Rudolphus Kent. He, Charles Hacker, and Samuel Shipley developed the area and named the streets after Indians. The first residences were built between 1858 and 1864.

FRANTZ'S BRIDGE
LR 39060 over Jordan Creek, Weidasville

GAUFF-ROTH HOUSE
427--443 Auburn St., Allentown

GEIGER COVERED BRIDGE
Southeast of Schnecksville on T 681, North Whitehall Township, Orefield

Built in 1858, it has stone parapets and a double wood floor. The structure is 120 feet long, single span.

HAINES MILL
Walnut St. and Main Blvd., Allentown

This water driven gristmill was built before the Revolutionary War. After being gutted by fire in 1908 the interior was rebuilt and the mill remained in service until 1956.

HELFRICH'S SPRINGS GRIST MILL
West of Fullerton, 506 Mickley Rd., Whitehall

This gristmill was built in 1807. Today it serves as the home for the Whitehall Historical Society.

HIGH GERMAN EVANGELICAL REFORMED CHURCH
620 Hamilton St., Allentown

The architect for this church was Lewis Jacoby.

HOTEL STERLING
343-345 Hamilton St., Allentown

The lone survivor of the great days of Allentown, The Hotel Sterling still is operating today on Hamilton Street where it once started. Built in 1889 by Henry A. Troxell, who bought it for $4,000 only to sell it in 1901 for $30,000 to Louis P. and Charles F. Neuweiler.

KEMMERER HOUSE
3 Iroquois St., Emmaus

Built in 1848, this house contains splendid pieces of art, from early Lehigh Valley scenery paintings to oriental rugs and Bohemian glass. This house is presently used as a museum.

LEHIGH CANAL
Walnutport to Allentown Section, Allentown

This part of the canal was used for shipping the coal from the northern parts of the state to Easton and further from there. The canal was a major contributor to the Allentown area, bringing in goods from both the north and south.

LINDEN GROVE PAVILION
Linden and S. Main Sts, Coopersburg

Built by Tilghman S. Cooper in 1900, the pavilion was used as an auction house for cattle during bad weather. The two and one-half story rectangular building, consisting of a wooden shell over a horizontally engineered frame, has no internal support, thereby providing a clear span area for exhibiting cattle.

LOCK RIDGE FURNACE COMPLEX
Franklin and Church Streets, Alburtis

The Thomas Iron Company built two anthracite coal-burning iron furnaces in Alburtis in 1868. Immigrants from Great Britain helped turn Alburtis from a sleepy town into an industrial powerhouse and company town. This town was another contributor to America's Industrial Revolution.

MANASSES GUTH COVERED BRIDGE
West of Greenawalds on T 602, Orefield, South Whitehall Township

Built in 1858, the bridge has characteristic stone parapets and a roadbed made of double planks of wood. Its single span is 140 feet.

ALBERTUS L. MEYERS BRIDGE
Eighth St. over Little Lehigh and Railroad Streets, Allentown

This was the largest concrete-and-steel span in the world when it was built in 1913. It is 2,650 feet long. It was named after Albertus Meyers who was the Allentown Band conductor for 50 years.

1898 Jerome I. Rodale (1898-1971) is born. He is to become a publisher, and the first American advocate for composting and organic agriculture.

1900 The Lehigh Valley becomes the world's leading manufacturer of cement, supplying high-quality Portland cement for the Panama Canal.[5]

1904 Under the leadership of Charles M. Schwab, Bethlehem Iron Company becomes Bethlehem Steel Corporation.[6]

1905 In order to protect public health, the Purity of Waters Act passes. It is the first act to set standards for domestic sewage disposal.

1905 The Mack Brothers Motor Car Company, formed in New York, outgrows its Brooklyn facility and moves its main manufacturing facility to Allentown.[7]

1906 The Lehigh Coal & Navigation Company completes the construction of a mine-drainage tunnel – the Lausanne Tunnel – near Nesquehoning.

1910 Pennsylvania's urban population (4,631,000) is larger than its rural population (3,034,000) for the first time.

1914 The Smith Lever Act provides technical and economic assistance to Lehigh River valley farmers.

1917 The United States becomes involved in the Great War.

1921 The 16-year construction of the Appalachian National Scenic Trail begins with volunteers. Extending from Maine to Georgia, the 2,158-mile trail crosses the Lehigh River at Lehigh Gap.

1921 The Dixie Plant in Easton – where the Dixie Cup is manufactured – is completed employing 78 people.[8]

1927 Pennsylvania Power & Light Company builds the Lehigh Valley's first skyscraper, in Allentown.

1929 The Great Depression begins.

1937 Legislators sign the country's Clean Streams Law, establishing Pennsylvania's basic authority to protect streams from pollution, and from the effects of surface coal mining. Industries start building facilities to treat and dispose of industrial wastes.

1939 World War II begins in Europe.

1941 The United States enters World War II.

1944 Bethlehem Steel reaches peak its production year producing 13 million tons of steel.[6]

1945 Pennsylvania Historical & Museum Commission is established to help protect Pennsylvania's historic resources.

1945 The Surface Mining Conservation and Reclamation Act passes. It is the first comprehensive attempt to prevent pollution from surface coal mining. Today, it remains the basic law regulating this activity.

1947 The transistor is invented at American Telephone & Telegraph's Bell Laboratories in Allentown.[9]

1954 Famous athlete Jim Thorpe is buried in a mausoleum in Mauch Chunk, which is then renamed Jim Thorpe in his honor.[1]

MOUNT AIRY HISTORIC DISTRICT
Roughly Prospect Ave. between Fifteenth and Eighth Aves, Bethlehem

NEUWEILER BREWERY
401 N. Front St., Allentown

OLD LEHIGH COUNTY COURTHOUSE
5th and Hamilton Streets, Allentown

Built between 1814 and 1817, this courthouse was the first to be built in Lehigh County. It still is in use for certain trials today, but mainly acts as a museum for the county's historical culture.

REX COVERED BRIDGE
South of Schnecksville on T 593, Orefield, North Whitehall Township

Built in 1858, this is the longest bridge in Lehigh County stretching 150 feet. It has a stone parapets and a double wood floor.

RODALE ORGANIC GARDENING EXPERIMENTAL FARM
Minesite Rd., Lower Macungie Township

J.I. and Robert Rodale were the pioneers in the Rodale Organic Gardening Experimental Farm. They based their life around finding a way to make human and environmental health work together in farming.

SCHLICHER COVERED BRIDGE
LR 39058, North Whitehall Township, Allentown

Located near the Trexler-Lehigh County Game Preserve, this is the shortest covered bridge in Lehigh County, only stretching 108 feet. It also is the newest, built in 1882.

GEORGE F. SCHLICHER HOTEL
105--107 S. Main St., Alburtis

SHELTER HOUSE
S. 4th St., Emmaus

Built in 1734, this log structure was used as a stopover for travelers on a trail that connected the Great Swamp with Macungie. The building is currently maintained by the Shelter House Society.

GEORGE TAYLOR HOUSE
Front St., Catasauqua

This house was built in 1763, home to George Taylor, a local governmental official, industrialist and signer of the Declaration of Independence. Today it is a historical house museum.

TROUT HALL
414 Walnut St., Allentown

Built in 1770 as a summer residence by James Allen, Allentown's oldest residence, today it is furnished from that period.

TROXELL-STECKEL HOUSE
4229 Reliance St., Whitehall Township

This building dates back to 1755.

VALENTINE-WEAVER HOUSE
146 S. Church St., Macungie

WEHR COVERED BRIDGE
West of Greenawalds on T 597, South Whitehall Township, Orefield

Built in 1841, it is also called Sieger's Bridge. It is 120 feet long, single span, with stone parapets and a double wood floor.

ZOLLINGER-HARNED COMPANY BUILDING
605--613 Hamilton Mall and 14016 N. 6th St., Allentown

This used to serve as the downtown campus for Lehigh County Community College (LCCC). Before and after it served as a campus, it was a department store.

3. LUZERNE COUNTY

BEAR CREEK VILLAGE HISTORIC DISTRICT
Pennsylvania 115 at Bear Creek Dam, Bear Creek Township

The first log cabin was built in 1786 on the Sullivan military road. The first sawmill was built in 1800. This is also the largest township within the boundaries of Luzerne County.

ISRAEL PLATT PARDEE MANSION
235 N. Laurel St. and 28 Aspen St., Hazleton

STODDARTSVILLE HISTORIC DISTRICT
South side of Pennsylvania 115 at Lehigh River, Buck Township

John Stoddart was the founder of Stoddartsville. He started a milling company that brought grain from the Wyoming Valley in Pennsylvania and shipped it down the river to Philadelphia. The Easton-Wilkes Barre Turnpike Company had made its way through the town of Stoddartsville, since Stoddart himself was one of the original investors. After the coal industries had fallen, Stoddartsville, like many other coal towns, lost their financial income.

1955 Hurricane Diane devastates the region.

1955 The Lehigh River Restoration Association is established.

1961 Francis E. Walter Reservoir is constructed to prevent flooding in the Lehigh River valley.

1962 Rachel Carson (1907-1964) helps start the modern environmental movement when she writes The Silent Spring, which warns of the effects of pesticides on the environment.

1966 Pennsylvania State Representative Samuel Frank is instrumental in returning the ownership of the Lehigh River to the Commonwealth after 144 years of ownership by the Lehigh Coal & Navigation Company.[1]

1965 The Open Space Act (Act 515) passes authorizing counties to establish preferential property-tax assessments to preserve farmland and open space.

1968 The Pennsylvania Fish Commission studies the Lehigh and Delaware rivers determining that the American shad could not survive in their polluted waters.

1970 Grassroots organizations and concerned citizens celebrate the first national Earth Day on April 22nd.

1972 The use of the pesticide DDT is outlawed in the United States.

1972 U. S. legislators enact the Federal Water Pollution Control Act Amendments, commonly know as the Clean Water Act.

1972 The Beltsville Reservoir is constructed.

1973 Many grass-roots conservation organizations are formed throughout the county, including Lehigh Valley Conservancy, which eventually becomes Wildlands Conservancy.

1975 The Pool Wildlife Sanctuary is established through a bequest to Lehigh Valley Conservancy (Wildlands Conservancy) from Leonard Parker Pool, founder of Air Products and Chemicals, Inc.

1976 The Pennsylvania Department of Environmental Resources, the Pennsylvania Department of Health, and the Pennsylvania Fish Commission begin fish-tissue studies, and issue fish-consumption advisories to warn anglers of the dangers of eating fish from certain streams and rivers contaminated with pollutants like PCBs.

1980 Lehigh Gorge State Park is created.

1980 Water extractions from the Lehigh River reach 450 million gallons per day.

1981 Treichlers Dam – a stone-and-log crib dam from the canal days – is breached by ice.

1982 The Lehigh River Scenic Rivers Act adds a portion of the Lehigh River to the state Scenic Rivers System.

1983 Improved water-quality conditions enable programs to reintroduce breeding populations of bald eagle, osprey, and river otter in Pennsylvania.

4. Monroe County

Christ Hamilton United Lutheran Church

Bossardsville Rd., Hamilton Township

Pocono Manor Historic District

This historic structure is roughly bounded by Pennsylvania 314, Lake and Cliff Roads, and Summit Ave., Pocono and Tobyhanna Townships, Mount Pocono

5. Northampton County

Central Bethlehem Historic District

Bounded by Main, Nevada, and E. Broad Sts., and the river, Bethlehem

This part of Bethlehem is one of the oldest parts in the Lehigh Valley. The Moravians moved into this area after trying to build a settlement in Savannah, Georgia. They left many of their architectural buildings and the cobble stone roads. Today, this is the site where Musikfest is now held.

Chain Bridge

SW of Glendon on Hugh Moore Pkwy. across the Lehigh River, Easton

Only the remains of the Chain Bridge can be seen today, but it still is an important landmark in American technology. Constructed in 1857 as a wire rope cable suspension bridge, it was to replace an unreliable chain apparatus that shifted the boats from the north shore to the south shore of the Lehigh River. The bridge stretches from Island Park to the south shore of the Lehigh River.

Cold Spring Bridge

Second St. over Spring Creek, Northampton

Easton Historic District

Roughly bounded by Riverside and Bushkill Drs., Ferry and 7th Sts., Easton

Many of the buildings in this district are from the Revolutionary War era. Many well-respected people of that time visited and lived in this area of the Lehigh Valley. The Northampton County Courthouse also sits within this district. It was built in 1860-1861 and overlooks the city at Seventh and Walnut Streets.

Easton House Tavern

167-169 Northampton St., Easton

Benjamin Franklin and other well-known figures visited this 1754 stucco-covered stone building, which served as a social center. George Taylor lived here for many years and owned the property from 1761 until 1779.

EHRHART'S MILL HISTORIC DISTRICT
Mill Rd., Hellertown

ELMWOOD PARK HISTORIC DISTRICT
Roughly bounded by Goepp Circle, Woodruff St., Park Pl., and Carson St., Bethlehem

GEMEINHAUS-LEWIS DAVID DE SCHWEINITZ RESIDENCE
W. Church St., Bethlehem

This five-story log building is Bethlehem's second structure and oldest extant today. Built in 1741 by the Moravians, and the Saal on the second floor is the earliest place of worship in America. This structure is probably the oldest, log building in use in America today.

GRISTMILLER'S HOUSE
459 Old York Rd., Bethlehem

The Moravians were the first to build the Miller house in 1782. They also built three gristmills. The first was built in 1745, which was later torn down. A larger gristmill was built in 1751, which had burnt to the ground sometime later. The last and still-standing gristmill was built in 1869.

WILLIAM JACOB HELLER HOUSE
501 Mixsell St., Easton

KREIDERSVILLE COVERED BRIDGE
North of Northampton on LR 48061, Kreidersville

Built in 1839, it is the only remaining covered bridge in Northampton County.

LEHIGH CANAL: EASTERN SECTION GLENDON AND ABBOTT STREET INDUSTRIAL SITES
Lehigh River from Hopeville to confluence of Lehigh and Delaware Rivers, Easton

Used for shipping the anthracite coal to New York and Philadelphia, this was one of the last canals to use animal power for pulling the boats. The canal was in use until 1942.

LEHIGH VALLEY RAILROAD HEADQUARTERS BUILDING
425 Brighton St., Bethlehem

LEHIGH VALLEY SILK MILLS
Jct. of Seneca and Clewell Sts., Fountain hill borough

The Adelaide Silk Mill was the first of many silk mills in the Lehigh Valley. By 1920, the Lehigh Valley had become the second most important silk producing region in America. There were mills in almost every town in the region.

1988 The Delaware & Lehigh Navigation Canal National Heritage Corridor Commission is established by the federal government.

1988 The Lehigh River Foundation is established.

1990 Bethlehem Steel Corporation discontinues steel production in the Lehigh Valley.[6]

1990 Peregrine falcons return to Pennsylvania nesting on the Rachael Carson State Office Building in Harrisburg.

1990 The protection of 4,000 acres of the headwaters of the Lehigh River is accomplished by a partnership of Wildlands Conservancy, The Nature Conservancy, and the Pennsylvania Game Commission.

1991 May 27th is established in Pennsylvania as Rachel Carson Day.

1991 Concerned fisherman and environmentalists found the Lehigh River Stocking Association, a non-profit organization dedicated to the restoration of the Lehigh River.

1991 Trout stocking begins in the upper Lehigh River.

1994 A passageway for migratory fish is built on the Lehigh River at the Glendon Dam near Easton.

1994 The Pennsylvania Fish & Boat Commission documents that an adult American shad has used the new fish-passage facility on the Lehigh River.

1997 The first Lehigh River Sojourn – a canoe/raft trip down the length of the river – is completed in July. It is lead by Wildlands Conservancy with the help of many partners.

1997 Governor Tom Ridge celebrates the preservation of 100,000 acres of Pennsylvania farmland at a ceremony at the Willard Setzer farm in Lower Nazareth Township, Northampton County.

1998 Over 150 acres of land – and one and one-half miles of Lehigh River shoreline in Salisbury Township, Lehigh County – is acquired from Bethlehem Steel Corporation by Wildlands Conservancy for a partnership of municipalities. Added to an adjacent 250 acres owned by the same partnership, Walking Purchase Park is created.

1998 Water withdrawals in the Lehigh River reach 108 million gallons per day.

1999 The first Lehigh River Watershed Conference is held in Bethlehem sponsored by Wildlands Conservancy and partners.

1998 Wildlands Conservancy's Bike & Boat education/recreation program is established on the Lehigh River between Allentown and Bethlehem.

2000 The Lehigh County Agricultural Lands Preservation Board now holds protective easements on 150 farms in Lehigh County totaling 13,721 acres.

JACOB MIXSELL HOUSE
101 S. 4th St., Easton

MORAVIAN SUN INN
564 Main St., Bethlehem

Built in 1758 by the Moravians for travelers. George Washington, Alexander Hamilton, John Jay, John Hancock, and John Adams all visited and all said, "The best inn I ever saw".

JACOB NICHOLAS HOUSE
458 Ferry St., Easton

This little stone house is one of Easton's few remaining Revolutionary War stone buildings. Jacob Nicholas was a local Durham boat captain.

OLD WATERWORKS
Within Historic Subdistrict near Monocacy Creek, Bethlehem

Built in 1762, this small limestone structure housed the first pumped municipal water system in the American colonies, an event not matched in American technology for the next 35 years.

PACKER MEMORIAL CHAPEL
Packer Avenue, Lehigh University, Bethlehem

Located in Lehigh University, it is the site of the annual Bach Festival. It also is used as one of the University's churches.

PARSONS-TAYLOR HOUSE
4th and Ferry Streets, Easton

Two of Easton's signers of the Declaration of Independence, William Parsons, and George Taylor were both occupants of this stone colonial house that was built in 1757.

PEMBROKE VILLAGE HISTORIC DISTRICT
Roughly bounded by Radclyffe St., Carlisle St., Stefko Blvd., Arcadia St. and Minsi Trail, Bethlehem

SEIPSVILLE HOTEL
2912 Old Nazareth Rd., Easton

Built in 1790, it still is operating as a hotel, although some of the accommodations may have changed. The colonial architecture can still be seen inside the hotel.

HERMAN SIMON HOUSE
41 N. 3rd St., Easton

Herman Simon, a wealthy silk manufacturer of the early 1900s, carved pillars on the exterior of his house which resembled his wife and daughter.

State Theatre
454 Northampton St., Easton

This Beaux-Arts theatre, a former vaudeville palace built in 1926, was designed by Philadelphia architect William H. Lee.

Daniel Steckel House
207 W. Northampton St., Bath

The exact construction date is not known, but estimates are around the early 1800's. The front of the home is made from native limestone and the back is rubble stone.

The Tannery
Within Bethlehem Historic Subdistrict A near Monocacy Creek, Bethlehem

Built in 1761, this was one of the first tanneries in America. The Moravians annually processed over 3,000 animal hides into leather for shoes, harnesses, clothing and machinery parts.

2003 The Lehigh River Water Trail established.

2004 Lehigh River is placed on the Pennsylvania River's Registry.

1 "Life Along the Lehigh" Dr. Buscemi & Wilcox, 2003)

2 Jesse Fell memorandum, Pennsylvania Department of Environmental Protection

3 lehighton.cpals.com/history.htm

4 www.pacoalhistory.com, 2003

5 Lehigh Earth Observatory, 2000

6 Bethlehem Works, 2003

7 Mack Truck History, Page Wise, Inc., 2002

8 Lafayette College Libraries, Easton, Pennsylvania, 2003

9 IEEE History Center, www.ieee.org

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Part III

AQUATIC COMPONENTS

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"If there is magic on this planet, it must be contained in water."
— Loren Eiseley

According to a survey of approximately 4,000 Lehigh Valley residents conducted by the Lehigh Valley Planning Commission in 2000, in order to preserve the environment, priority should be given first to protecting rivers, creeks, streams and lakes.

A. Surface Water

The Lehigh River (Map 1-2) is approximately 103-miles long and drains an area approximately 1,345 square-mile watershed, in which nearly one million people live and work.

The Lehigh River is a tributary to the Delaware River, representing approximately 11% of the Delaware's drainage area. The Lehigh River has Pennsylvania Scenic River status along a 32-mile stretch from the Francis E. Walter Dam to Jim Thorpe. In contrast, the Lehigh River is also listed on the Pennsylvania Department of Environmental Protection's May 1996 "Degraded Watershed List" as "High-Priority" where it flows through Lehigh and Northampton counties.

1. Water Bodies

a. Major Tributaries and Sub-watersheds

TABLE 3-1. MAJOR TRIBUTARY INFORMATION

Main Tributaries	Enter River Miles above Mouth	Drainage Area, Sq. Mi.	Length Miles	Elevation at source, ft.	Elevation at mouth, ft.
Saucon Creek	9.2	58.2	16.5	640	206
Monocacy Creek	11.1	49.6	18	760	212
Little Lehigh Creek	16.2	107	24	830	225
Jordan Creek	Enters Little Lehigh	81	32	740	228
Hokendauqua Creek	22	42.6	15	760	282
Aquashicola Creek	35.7	81.2	22.5	1500	380
Lizard Creek	38.8	53.8	15	750	415
Pohopoco Creek	40.5	111.7	23	1820	435
Mahoning Creek	42.1	37.3	14	1040	480
Mauch Chunk Creek	46.5	8.9	8	1120	512
Nesquehoning Creek	48.4	33.8	13	1540	568
Black Creek	55.4	62.6	14.5	1720	760
Sandy Run	58	21.2	5.7	1340	1200
Mud Run	64.8	35.9	15	1850	970
Bear Creek	77.6	50.2	13	2020	1250
Tobyhanna Creek	83.5	128.3	32	2080	1410

There are 2006 miles of streams in the Lehigh River watershed. Major tributaries in the basin are shown in Map 3-1 and are described in Table 3-1 below. Major sub-watersheds are shown in Map 3-2.

b. Lakes and Reservoirs

As shown in Map 3-3, there are numerous lakes in the watershed, which are more prevalent in the northern portion of the watershed, where glaciation left behind potholes and depressions that are now filled with water. Some of the major lakes in the watershed are Gouldsboro Lake, Tobyhanna Lake, Arrowhead Lake, Lake Harmony, Pocono Lake, and Mauch Chunk Lake.

Since the 1700s numerous dams and impoundments have been constructed by private interests and government agencies on the Lehigh River and its tributaries (see Map 3-3). Upper reach impoundments were originally constructed for recreation or industrial water uses while lower reach dams were constructed mainly to divert water into the Lehigh Canal for navigation (Priority Water Body Survey Report, 1989). The Pennsylvania Department of Environmental Protection lists 139 dams in various states of repair and disrepair in the Lehigh basin. Of particular importance are the Francis E. Walter and Beltzville Reservoirs.

"Water is the most critical resource issue of our lifetime and our children's lifetime. The health of our waters is the principal measure of how we live on the land."

—Luna Leopold

The Francis E. Walter Reservoir is located on the Lehigh River approximately 77 miles above the mouth and immediately south of the Bear Creek-Lehigh River confluence in Luzerne County. It was constructed in 1961 through congressional authorization. It controls a drainage area of 288 square miles and provides 110,000 acre-feet of storage, of which 108,000 acre-feet is reserved for flood control purposes. The remaining 2,000 acre-feet is maintained as a permanent pool for water conservation and public use (Priority Water Body Survey Report, 1989). During the summer months, water is periodically released to the Lehigh River gorge for white water rafting.

The Francis E. Walter Dam in Luzerne County was built in 1961 as a flood-control structure. It provides 110,000 acre-feet of storage capacity. Here it is shown at its "conservation-pool" level.

Beltzville Lake was constructed through Congressional authorization after the 1955 Hurricane Diane floods caused extensive property damage. It is located on Pohopoco Creek about four miles above its confluence with the Lehigh River near Lehighton. Beltzville Lake controls a drainage area of about 96 square miles and provides 94,310 acre-feet of storage, of which 53,087 acre-feet is reserved for flood control purposes (Priority Water Body Survey Report, 1989). The reservoir and most of the surrounding land are now operated by the Commonwealth as a state park.

The Francis E. Walter reservoir is regulated in conjunction with the Beltzville Lake for optimum flood control benefits on the Lehigh River. In the regulation plan for the Lehigh River basin (Beltzville Lake and F. E. Walter Reservoir), the city of Easton receives flood control benefits primarily for Lehigh-oriented flooding problems. As the existing Francis E. Walter Reservoir and Beltzville Lake only control approximately six percent of the drainage area of the mainstream Delaware River between Easton, Pennsylvania and Trenton N.J., flood control benefits in that reach due to regulation of the two projects are negligible. The reservoirs, although regulated as a system primarily for Lehigh River flood control protection, do not make any post event storage evacuation releases that will increase Easton, Pennsylvania and mainstream Delaware River flood stages above what they would have been from Delaware River flooding. Communities along the Lehigh River that receive flood control benefits as a result of Francis E. Walter and Beltzville Reservoirs include Easton, Freemansburg, Bethlehem, Allentown, Catasauqua, Northampton, Treichlers, Walnutport, Palmerton and Bowmanstown.

Releases from the two reservoirs are governed by actual and/or predicted flood stages at critical downstream control points, by predicted inflow volume into the lakes, and by regulation of each of the reservoirs. All of the flood control storage for Beltzville Lake and F.E. Walter Reservoir is utilized to provide optimum flood control benefits. Foremost, F.E. Walter and Beltzville reservoirs provide flood control to downstream communities on the Lehigh River. Additionally, the reservoirs provide important habitat for fish, waterfowl, and other wildlife, and recreational opportunities through fishing, boating and other downstream activities.

Additional information regarding Francis E. Walter Reservoir is located in Appendix A-1.

Other construction on the Lehigh, such as levees, floodwalls, pumping stations, dikes and various channel modifications (deepening, straightening), in conjunction with the reservoirs, constitute the distinctive anthropogenic flow character of the river (Priority Water Body Survey Report, 1989). The Delaware River Basin Commission (DRBC) is the ultimate authority in managing the river's flow regime. DRBC, in coordination with the parties to the 1954 Supreme Court Decree and other affected agencies control river flow to: 1) maintain a maximum sustainable low flow at Trenton, New Jersey, at the head of tidal waters in order to meet water quality and salinity control objectives in the Delaware Estuary; 2) compensate for consumptive uses in the basin and out of basin diversions; and 3) provide acceptable flows below water projections to sustain instream uses, including fish habitat and recreation (Priority Water Body Survey Report, 1989).

c. Wetlands

Wetlands, as defined by the U.S. Fish and Wildlife Service, are "lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water." Wetlands must have at least one or more of the following three attributes: (1) at least periodically, the land supports predominantly hydrophytes (water-adapted plants), (2) the substrate is predominantly undrained, hydric soil, and (3) the substrate is non-soil and is saturated with water or covered by shallow water at some time during the growing season of each year."

Five major wetland classification systems exist: Marine, Estuarine, Lacustrine, Palustrine, and Riverine. Within these major classifications, there are sub-systems, classes, and subclasses to further define the wetland. As shown in Map 3-4, the Lehigh River watershed has over 60 square miles of wetlands that fall into various classifications of Palustrine, Lacustrine, or Riverine wetlands. The Palustrine system includes all non-tidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean-derived salts is below 0.5%. In the Lehigh watershed, Palustrine wetlands are the most abundant wetland system. Nearly 74% of wetlands in the watershed are Palustrine in nature, totaling about 47 square miles. The Lacustrine System includes all wetlands and deepwater habitats that are situated in a topographic depression or a dammed river channel and lack trees, shrubs, persistent emergents, emergent mosses or lichens, with greater than 30 % area coverage. Wetlands of the Lacustrine system are the second most abundant type of wetland in the watershed (11.4 square miles) and account for approximately 18 % of the wetland area in the watershed. The Riverine system includes all wetlands and deepwater habitats contained within a channel. Riverine wetlands are the least abundant wetland system in the watershed, totaling approximately 5 square miles.

One of the most striking features of the glaciated landscape in the northern portion of the watershed is the abundance of wetlands. When the ice retreated it left ice blocks and shallow drainage channels behind. As the ice blocks melted and glacial debris accumulated around

them, deep "kettle hole" lakes formed. Surface water from the glacier was trapped in the shallow depressions and drainage channels that were blocked by debris and marshes and swamps eventually formed behind the blockage.

In many of the kettle holes, bogs formed because there was very little surface and groundwater flow into or out of the lakes. Nutrients and oxygen became scarce in such environments; because of the lack of oxygen, organic matter did not decompose and release nutrients but slowly filled the lake as peat. Therefore the plants growing in the lakes came into less and less contact with water from their watersheds and developed unique adaptations to life in such habitats.

The ancient glacial bogs of this region in Wayne, Monroe, and Lackawanna Counties, constitute the headwaters of the Lehigh River. A floating mat of sphagnum moss is, in some places, thick enough to support small trees.

Within Pennsylvania, the bogs range in size from less than an acre to more than 40 acres. The classic bog has concentric zones of vegetation surrounding a central pond. The first zone is a floating mat overlying the pond and consists of low shrubs, sedges, and Sphagnum sp. (peat moss). The second zone typically contains taller shrubs and peat moss. The final zone is the big forest, or boreal conifer swamp, that is dominated by black spruce and larch with a carpet of mosses. Many of the plant species inhabiting bogs are more typical of peatlands much farther to the north and reach their southernmost limit in these bogs. Most of the plant species that were common during and shortly after the glacial period retreated northward as the climate warmed. However, a few of these "relict" species can still be found in bogs and other wetland habitats.

Swamps, wet meadows, and marshes have formed in shallow depressions and along streams and other water bodies. These wetlands receive water that is generally well aerated and relatively high in nutrients. Relatively little organic matter accumulates in these wetlands, and the organic matter that does accumulate is well decomposed. Because conditions are usually better for plant growth in these wetlands, a greater variety of species is likely to occur than in bogs. Plant species such as red maple, hemlock, ash, black gum, and yellow birch are typical canopy species, while blueberry, viburnums, alder, and swamp azalea are common shrubs in the wooded and shrub wetlands. Reed canary grass, bluejoint grass, manna grass, sedges, rushes, herbs, meadow-sweet, and steeplebush are common in the wet meadows. Cattails, burreeds, arrowhead, and spatterdock are common marsh plants.

Wetlands provide valuable habitat for many fish and wildlife species. Some animals spend their entire lives in wetlands while others use them primarily as feeding areas, nurseries for young, or resting areas. Fish, shellfish, waterfowl and other birds, mammals, reptiles, and amphibians depend on wetlands to maintain healthy population levels. Wetlands improve water quality by filtering nutrients, wastes, and sediments from upland runoff. Wetlands also improve socio-economic value as they provide flood and storm damage protection, erosion control, water supply, groundwater recharge, harvestable natural products, and recreational opportunities.

Inland freshwater wetlands, such as those in the Lehigh watershed, adjacent to rivers and lakes provide valuable nesting and brood habitat for wood ducks, hooded mergansers, and black ducks. These wetlands are also prime habitat for mammals such as beaver, mink, river otter, and muskrat. Eastern painted turtles, bog turtles and snapping turtles are found in the region's freshwater wetlands, as are a host of songbirds.

Wetlands also provide essential habitat for endangered and threatened species. More than one-third of the nation's threatened and endangered plant species and one-half of the animal species are wetland dependent. Many Federally and State-listed threatened species are associated with the wetlands of the northeast.

The hydrologic functions of wetlands are well known but poorly understood. Surface and groundwater recharge and discharge, water quality, floodwater conveyance and storage, and shoreline and erosion protection are some of the public values provided by wetlands. Most wetlands are areas of groundwater discharge with some providing water for public uses. When this function exists, the groundwater moves up to replenish surface water supplies. Groundwater recharge, where the surface water moves down into groundwater aquifers, is also important but less common.

The ability to help maintain water quality or improve degraded water quality is one of the more important functions of wetlands. Wetlands can remove, transform and retain nutrients, process chemical and organic wastes and pollutants, and reduce sediment loads. However, excessive chemical or sediment loading will inhibit the ability of wetlands to process these pollutants. For example, the sediment-trapping value of wetlands is lost if excessive sedimentation occurs, and wetlands are transformed into uplands.

Wetlands also have the potential to store large amounts of water which helps to moderate stream flows during both storm events and droughts. Stormwater runoff can accumulate in wetlands, where it is retained until peak stream flows have passed, and it is then released slowly to the stream. This natural wetland function can help to minimize the extent and duration of peak discharge rates. Chemical and biological processes that occur in wetlands also help to transform deleterious substances like pesticides into less harmful forms for the environment. In addition, wetlands help reduce soil runoff and prevent pollution. Even the best erosion and sedimentation practices allow some soil to leave the field with runoff. Plants in wetlands help slow the movement of water, allowing sediment to drop out. Nutrients such as phosphorous, which cling to the soil, are deposited in the wetland where they can be used by the plants.

Wetlands can reduce peak flow of excessive flooding by temporarily storing water and gradually releasing it to reduce shoreline and riverbank erosion. Both functions are very important in the Northeast. The flood controlling capacity of wetlands is especially important in areas with developed floodplains. The storage potential of the wetland and the rate at which it can release stored waters are the primary factors determining a wetland's capacity to control floods. This capacity is determined by several factors and is related to the position of the wetland in the watershed and to its outlet characteristics. The texture of the substrate and structure of the wetland vegetation also influences the capacity for a wetland to reduce flooding.

d. Floodplains

Floodplains are areas of low elevation lying adjacent to stream channels that correspond to the highest elevation of a known recorded one hundred year flooding occurrence. The floodplain is formed by floodwaters that spill over the riverbank and rework and deposit sediment. This activity results in a complex of terraces, hollows, wetlands, and other land features. Floodplains are a vital part of the river ecosystem and act as flood buffers, water filters, and centers of biological life in the river ecosystem.

Since these areas are frequently subjected to flooding, they should be left in a natural state whenever possible. Disturbance of floodplain areas by construction, clearing of vegetation, filling of wetlands, etc. will result in excessive flooding and negative water quality impacts to the stream, as well as increased potential for property damage. Because it is the natural tendency for streams to migrate and change form over time, any development that takes place within a floodplain may be faced with eroding stream banks, loss of property, and encroachment of the stream to the development within the ensuing years following construction. Improper management of streamside property will also heighten the rate at which erosion and, therefore, loss of property, will occur. For developments that have already been established within floodplains, establishing and maintaining a vegetated buffer will greatly reduce erosion rates as well as the impacts that the establishment has on the stream.

The floodplains in the watershed as defined by the Environmental Resources Institute, 1998, are shown in Map 3-4. There currently exist many instances of development within the 100-year floodplain in the Lehigh River watershed. Throughout most of the watershed, floodplain development takes the form of scattered residences and encroachments associated with road crossings. In the densely urban areas, the natural floodplain has, in many instances, been completely modified by development activities resulting in higher flood damage potential and flood carrying capacity.

Current development within the urbanized areas of the watershed is taking place with rules and laws that largely did not exist for the older, developed sections of the urban areas. Commonly known as Act 166, the Pennsylvania Floodplain Management Act was signed into law in 1978. It was enacted because of a growing concern over the continually increasing loss of life and damage to property caused by flooding. Its primary purpose is to encourage the proper management of floodplain areas within the Commonwealth. The Act requires every local municipality identified as having an area or areas, which are subject to flooding, to participate in the National Flood Insurance Program (NFIP). These municipalities also are required to enact floodplain management regulations, which, at least, comply with the minimum requirements of that program, and the regulations adopted by the Pennsylvania Department of Community and Economic Development (DCED).

All of the applicable watershed municipalities have enacted ordinances consistent with Act 166. With enforcement of those ordinances, any future floodplain development will be limited to that which would not significantly alter the carrying capacity of the floodplain or be subject to a high damage potential. A result of this has been that developments taking place adjacent to streams have had the floodplain areas dedicated for recreation and open space uses or have been otherwise been kept free of development.

2. SURFACE WATER BODY CLASSIFICATIONS

a. Chapter 93

Chapter 93 of the Pennsylvania Code, sets forth water quality standards for the waters of the Commonwealth, including wetlands. These standards are based upon water uses, which are to be protected, and are considered by the Department of Environmental Protection (DEP) in its regulation of discharges. Classifications for protected uses fall into the categories of aquatic life, water supply, recreation, and special protection. Table 3-2 lists the classification category, symbol and protected use and Table 3-3 lists the classifications of the streams in the Lehigh River watershed. Map 3-5 also shows the Chapter 93 classifications of the streams in the watershed.

TABLE 3-2. PROTECTED WATER USES UNDER CHAPTER 93 WATER QUALITY STANDARDS

Symbol	*Protected Use*
AQUATIC LIFE	
CWF	***Cold Water Fisheries***--Maintenance and/or propagation of fish species including the family Salmonidae and additional flora and fauna that are indigenous to a coldwater habitat.
WWF	***Warm Water Fisheries*** --Maintenance and propagation of fish species and additional flora and fauna ***that are indigenous to a warm water habitat.***
MF	***Migratory Fisheries*** --Passage, maintenance, and propagation of anadromous and anadromous fishes and other fishes that ascend to flowing waters to complete their life cycle.
TSF	***Trout Stocking***--Maintenance of stocked trout from February 15 to July 31 and maintenance and propagation of fish species and additional flora and fauna that are indigenous to a warm water habitat.
WATER SUPPLY	
PWS	***Potable Water Supply***--Used by the public as defined by the Federal Safe Drinking Water Act or by other water users that require a permit from DEP under The Pennsylvania Safe Drinking Water Act, after conventional treatment, for drinking, culinary, and other domestic purposes, such as inclusion in foods.
IWS	***Industrial Water Supply***--Used by industry for inclusion into nonfood products, processing, and cooling.
LWS	***Livestock Water Supply***--Use by livestock and poultry for drinking and cleansing.
AWS	***Wildlife Water Supply***--Use for waterfowl habitat and for drinking and cleansing by wildlife.
IRS	***Irrigation***--Used to supplement precipitation for growing crops
RECREATION	
B	***Boating***--Use of the water for power boating, sail boating, canoeing ,and rowing for recreational purposes when surface water flow or impoundment conditions allow.
F	***Fishing***--Use of the water for the legal taking of fish.
WC	***Water Contact Sports***--Use of the water for swimming and related activities.
E	***Esthetic***s--Use of the water as an esthetic setting to recreational pursuits.
SPECIAL PROTECTION	
HQ	***High Quality Waters***--A stream or watershed that has excellent quality waters and environmental or other features that require special water quality protection.
EV	***Exceptional Value Waters***--A stream or watershed which constitutes an outstanding national, state, regional of local resource, such as 1) waters of national, state or county parks or forests, 2) waters which are used as a source of unfiltered potable water supply, 3) waters of wildlife refuges or state game lands, 4 or waters which have been characterized by the Fish Commission as "Wilderness Trout Streams," 5) and other waters of substantial recreational or ecological significance.

TABLE 3-3. CHAPTER 93 CLASSIFICATIONS IN THE LEHIGH RIVER WATERSHED. (from 025 Pa. Code § 93.9d. Drainage List D)

Stream	*Zone*	*County*	*Uses Protected*
Lehigh River	Basin, Source to Tobyhanna Creek	Luzerne-Monroe-Carbon	HQ-CWF
Tobyhanna Creek	Main Stem	Monroe-Carbon	HQ-CWF
Unnamed Tributaries to Tobyhanna Creek	Basins	Monroe-Carbon	HQ-CWF
Jim Smith Run	Basin	Monroe	HQ-CWF
Pole Bridge Run	Basin	Monroe	HQ-CWF
Singer Run	Basin	Monroe	HQ-CWF
East Branch Dresser Run	Basin	Monroe	HQ-CWF
Pollys Run	Basin	Monroe	HQ-CWF
Hummler Run	Basin	Monroe	HQ-CWF
Cross Keys Run	Basin	Monroe	EV
Frame Cabin Run	Basin	Monroe	EV
Kistler Run	Basin	Monroe	HQ-CWF
Wagner Run	Basin	Monroe	HQ-CWF
Upper Tunkhannock Creek	Basin	Monroe	HQ-CWF
Wolfs Spring Run	Basin	Monroe	HQ-CWF
Deep Run	Basin	Monroe	HQ-CWF
Davey Run	Basin	Monroe	HQ-CWF
Red Run	Basin	Monroe	HQ-CWF
Tunkhannock Creek	Basin	Monroe-Carbon	HQ-CWF
Shingle Mill Run	Basin	Carbon	HQ-CWF
Twomile Run	Basin	Monroe	HQ-CWF
Stony Run	Basin	Monroe	HQ-CWF
Lehigh River	Basin, Tobyhanna Creek to Buck Mountain Creek	Carbon	HQ-CWF
Buck Mountain Creek	Main Stem	Carbon	HQ-CWF
Unnamed Tributaries to Buck Mountain Creek	Basin	Carbon	HQ-CWF
Indian Run	Basin	Carbon	HQ-CWF
Shafer Run	Basin	Carbon	EV
Lehigh River	Main Stem, Buck Mountain Creek to Pa. 903 Bridge (at Jim Thorpe)	Carbon	HQ-CWF
Unnamed Tributaries to Lehigh River	Basins, Buck Mountain Creek to PA 903 Bridge	Carbon	HQ-CWF
Drakes Creek	Basin	Carbon	HQ-CWF
Stony Creek	Basin	Carbon	EV
Penn Springs	Basin	Carbon	HQ-CWF
Black Creek	Basin, Source to Beaver Creek	Carbon	HQ-CWF

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TABLE 3-3. CHAPTER 93 CLASSIFICATIONS IN THE LEHIGH RIVER WATERSHED. (continued)

Stream	Zone	County	Uses Protected
Beaver Creek	Basin	Carbon	CWF
Black Creek	Main Stem, Beaver Creek to Mouth	Carbon	CWF
Unnamed Tributaries to Black Creek	Basins, Beaver Creek to Mouth	Carbon	HQ-CWF
Quakake Creek	Basin, Source to Wetzel Creek	Carbon	HQ-CWF
Wetzel Creek	Basin	Carbon	CWF
Quakake Creek	Basin, Wetzel Creek to Mouth	Carbon	CWF
Maple Hollow	Basin	Carbon	HQ-CWF
Bear Creek	Basin	Carbon	HQ-CWF
Nesquehoning Creek	Basin, Source to Lake Greenwood	Schuylkill- Carbon	HQ-CWF
Nesquehoning Creek	Main Stem, Lake Greenwood to Tibbetts Pond Dam	Carbon	HQ-WWF
Unnamed Tributaries to Nesquehoning Creek	Basins, Lake Greenwood to Tibbetts Pond Dam	Schuylkill- Carbon	HQ-CWF
Swartz Run	Basin	Schuylkill	HQ-CWF
Grassy Meadow Run	Basin	Carbon	HQ-CWF
Bear Creek	Basin	Carbon	HQ-CWF
Nesquehoning Creek	Main Stem, Tibbetts Pond Dam to Mouth	Carbon	CWF
Unnamed Tributaries to Nesquehoning Creek	Basins, Tibbetts Pond Dam to Mouth	Carbon	HQ-CWF
Dennison Run	Basin	Carbon	HQ-CWF
Broad Run	Basin	Carbon	HQ-CWF
Deep Run	Basin	Carbon	EV
First Hollow Run	Basin	Carbon	EV
Jeans Run	Basin	Carbon	HQ-CWF
Robertson Run	Basin	Carbon	HQ-CWF
Lehigh River	Main Stem, PA 903 Bridge to Allentown Dam	Lehigh	TSF
Unnamed Tributaries to Lehigh River	Basins, PA 903 Bridge to Allentown Dam	Carbon-Lehigh	CWF
Silkmill Run	Basin	Carbon	CWF
Mauch Chunk Creek	Main Stem	Carbon	CWF
Unnamed Tributaries to Mauch Chunk Creek	Basins	Carbon	CWF
White Bear Creek	Basin, Source to PA 902 Bridge	Carbon	EV
White Bear Creek	Basin, PA 902 Bridge to Mouth	Carbon	CWF
Beaverdam Run	Basin	Carbon	CWF
Long Run	Basin	Carbon	CWF
Mahoning Creek	Basin	Carbon	CWF
Pohopoco Creek	Basin, Source to SR 3016 Bridge at Merwinsburg	Monroe	CWF

TABLE 3-3. CHAPTER 93 CLASSIFICATIONS IN THE LEHIGH RIVER WATERSHED. (continued)

Stream	Zone	County	Uses Protected
Pohopoco Creek	Main Stem, SR 3016 Bridge to SR 0209 Bridge at Kresgeville	Monroe	HQ-CWF
Unnamed Tributaries to Pohopoco Creek	Basins, SR 3016 Bridge to SR 0209 Bridge at Kresgeville	Monroe	CWF
Sugar Hollow Creek	Basin	Monroe	CWF
Weir Creek	Basin	Monroe	CWF
Middle Creek	Basin, Source to T-444 Bridge	Monroe	CWF
Middle Creek	Basin, T-444 Bridge to Mouth	Monroe	HQ-CWF
Pohopoco Creek	Basin, Middle Creek to Wild Creek	Carbon	CWF
Wild Creek	Basin	Carbon	EV
Pohopoco Creek	Basin, Wild Creek to Mouth	Carbon	CWF
Fireline Creek	Basin	Carbon	CWF
Lizard Creek	Basin, Source to T-922 Bridge	Schuylkill	CWF
Lizard Creek	Basin, T-922 Bridge to Mouth	Carbon	TSF
Aquashicola Creek	Basin, Source to Buckwha Creek	Carbon	HQ-CWF, MF
Buckwha Creek	Basin	Carbon	CWF, MF
Aquashicola Creek	Main Stem, Buckwha Creek to Mouth	Carbon	TSF, MF
Unnamed Tributaries to Aquashicola Creek	Basins, Buckwha Creek to Mouth	Carbon	CWF
Mill Creek	Basin	Carbon	CWF
Trout Creek	Basin	Lehigh	CWF
Bertsch Creek	Basin	Northampton	CWF
Rockdale Creek	Basin	Lehigh	CWF
Fells Creek	Basin	Lehigh	CWF
Spring Creek	Basin	Lehigh	CWF
Hokendauqua Creek	Basin	Northampton	CWF
Dry Run	Basin	Northampton	CWF
Coplay Creek	Basin	Lehigh	CWF
Catasauqua Creek	Basin	Lehigh	CWF
Lehigh River	Main Stem, Allentown Dam to Mouth	Northampton	WWF
Unnamed Tributaries to Lehigh River	Basins, Allentown Dam to Mouth	Lehigh- Northampton	CWF
Little Lehigh Creek	Basin, Source to Jordan Creek	Lehigh	HQ-CWF
Jordan Creek	Main Stem	Lehigh	TSF, MF
Unnamed Tributaries to Jordan Creek	Basins	Lehigh	HQ-CWF, MF
Switzer Creek	Basin	Lehigh	HQ-CWF, MF
Lyon Creek	Basin	Lehigh	HQ-CWF, MF
Mill Creek	Basin	Lehigh	CWF, MF

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TABLE 3-3. CHAPTER 93 CLASSIFICATIONS IN THE LEHIGH RIVER WATERSHED. (continued)

Stream	Zone	County	Uses Protected
Haasen Creek	Basin	Lehigh	HQ-CWF, MF
Little Lehigh Creek	Basin, Jordan Creek to Mouth	Lehigh	HQ-CWF
Monocacy Creek	Basin	Northampton	HQ-CWF
Saucon Creek	Basin, Source to Black River	Northampton	CWF
Black River	Basin	Northampton	CWF
Saucon Creek	Main Stem, Black River to SR 412 Bridge	Northampton	HQ-CWF
Unnamed Tributaries to Saucon Creek	Basins, Black Creek to SR 412 Bridge	Northampton	CWF
Saucon Creek	Basin, SR 412 Bridge to Mouth	Northampton	CWF
Nancy Run	Basin, Source to SR 3007 Bridge	Northampton	CWF, MF
Nancy Run	Basin, SR 3007 Bridge to Mouth	Northampton	HQ-CWF, MF
Bull Run	Basin	Northampton	CWF

b. 303(d) List

The DEP has an ongoing program to assess the quality of waters in Pennsylvania. Streams and other bodies of water that do not meet water quality standards are identified as impaired. Water quality standards are uses that waters can support and goals established to protect those uses. Uses include aquatic life, recreation, and drinking water as described in the Chapter 93 discussion above; the goals are water quality criteria that are either numerical or narrative statements that express the levels of substances that must be achieved to support the uses. A report on all impaired waters in the Commonwealth is required under section 305(b) of the federal Clean Water Act.

Section 303(d) of the Act requires states to further evaluate any impaired waters to determine which waters would still not support the uses even after the appropriate required water pollution control Best Management Practices (BMPs) have been applied. For example, a water body impacted by a point source discharge that is not complying with its effluent limit would not be listed on the 303(d) list. The DEP would correct the water impairment by taking a compliance action against the discharger. Water bodies that still do not meet water quality standards after this additional evaluation, however, must be included on the 303(d) list of impaired waters. The 303(d) list includes the reason for impairment, which may be one or more point sources (like industrial or sewage discharges), or nonpoint sources (like abandoned mine drainage or agricultural runoff).

States or the U.S. Environmental Protection Agency (EPA) must determine the conditions that would bring the water up to the quality that meets water quality standards. As a follow-up to listing, the state or EPA must develop a Total Maximum Daily Load (TMDL) for each water body on the list. A TMDL identifies allowable pollutant loads to a water body from both point and nonpoint sources that will prevent a violation of water quality standards. A TMDL also includes a margin of safety to ensure protection of the water.

In separate, more detailed studies, DEP also assesses waters to determine if water quality is better than necessary to protect the uses. Waters that meet the higher level are recommended for re-designation. High Quality Waters are given a more stringent level of protection that provides that the water quality must not be changed by a discharge unless the Department agrees that

the social or economic benefits justify lowering the water quality. Exceptional Value Waters is the highest level of protection given to outstanding waters, and water quality may not be degraded by any discharge. Citizens may participate in the special protection process by submitting petitions to the Environmental Quality Board to consider re-designation of high quality waters.

Table 3-4 and Map 3-6 show the 303 (d) water bodies in the Lehigh River watershed.

c. Total Maximum Daily Loads (TMDLs)

A TMDL, or Total Maximum Daily Load, is a calculation of the maximum amount of a pollutant that a water body can receive and still meet water quality standards, and an allocation of that amount to the pollutant's sources.

The TMDL is designed so that the water body will meet the water quality standards when it is put into place. Although there is no statutory deadline for implementing a TMDL for a water body, the state uses traditional and new approaches to correct the problems as soon as possible. Pennsylvania has committed to developing TMDLs for all impaired

TABLE 3-4 303(d) LIST WATER BODIES OF THE LEHIGH RIVER WATERSHED (source: http://www.dep.state.pa.us/dep/deputate/watermgt/Wqp/WQStandards/303d-Report.htm#2002_List)

Segment ID	Waterbody	Parameters of Concern	Potential Impairment Sources
671	Sandy Run	metals, inorganics	AMD
980529-1330-TTS	Sandy Run	metals, pH	AMD
980514-1530-TTS	Pond Creek	pH, metals	AMD
540	Lehigh River	metals	AMD
633	Nesquehoning Creek	pH	AMD
638	Nesquehoning Creek	metals	AMD
20010530-1449-TTS	Black Creek	Metals, pH	AMD
20010927-1030-TTS	Hazle Creek	metals, pH	AMD
20010530-1547-TTS	Buck Mountain Creek	metals, pH	AMD
20010706-1238-TTS	Wetzel Creek	Metals, pH	AMD
971030-0810-EPK	Saucon Creek	siltation	agriculture, other
971031-1500-TTS	East Branch Saucon Creek	unknown	industrial point source, urban ruoff, storm sewers
971031-1515-TTS	East Branch Saucon Creek	habitat alterations, siltation	habitat modification
971030-0815-TTS	Monocacy Creek	habitat alterations, siltation	agriculture , surface mining, urban runoff, storm sewers
970722-0830-TTS	Little Lehigh Creek	siltation	agriculture, construction
970811-1300-EPK	Jordan Creek	habitat alterations, siltation	habitat modification , urban runoff, storm sewers
6230	Lyon Creek	unknown	natural sources
970721-1300-EPK	Switzer Creek	siltation	agriculture
970618-1400-TTS	Swabia Creek	siltation	agriculture
970919-1530-TTS	Swabia Creek	siltation	agriculture
970820-0800-TTS	Schaefer Run	habitat alterations, siltation	agriculture
970613-1430-TTS	Toad Creek	organic enrichment, low siltation, unknown	agriculture municipal, point source
970721-1025-SRW	Coplay Creek	siltation	agriculture, urban runoff, storm sewers
20010501-0930-SRW	Aquashicola Creek	metals	industrial point source
20020111-1211-FIT	Tobyhanna Creek		source unknown

water bodies. TMDLs are used as the basis for setting National Point Source Discharge Elimination Survey (NPDES) permit effluent limitations to correct point source problems and to identify where best management practices will improve and protect water quality affected by nonpoint sources. If a TMDL has already been established for a water body or impairment can be corrected through an immediate compliance action, that water body is not listed.

Pennsylvania uses a watershed approach to determine TMDLs. This requires selection of watershed size and begins a comprehensive assessment of water quality in the watershed. After water quality impairments are identified, a planning process occurs to develop strategies that can successfully address and correct water pollution in the watershed. Pennsylvania is using this process together with federal Clean Water Act requirements for establishing TMDLs to restore polluted streams so that they meet water quality standards. Water quality standards are the combination of water uses, such as water supply, recreation, and aquatic life, to be protected and the water quality criteria necessary to protect them.

TMDLs can be considered a watershed budget for pollutants, representing the total amount of pollutants that can be assimilated by a stream without causing water quality standards to be exceeded. The pollutant allocations resulting from the TMDL process represent the amount of pollutants that can be discharged into a waterway from each source. The TMDL does not specify how dischargers must attain particular load reduction. The TMDL calculation must include a margin of safety to ensure that the water body can be used for the purposes the state has designated and must also account for seasonable variation in water quality.

In an April 1997 Memorandum of Understanding, the EPA and the DEP agreed to a 12-year schedule to develop TMDLs for impaired streams listed on the 1996 CWA Section 303 (d) list. Over the years the DEP has met those TMDL goals. The DEP is also developing methodologies, processes, and computer models to establish TMDLs on a broader scale. In addition, several contracted TMDL initiatives have been undertaken in various parts of the state. TMDL determinations have not yet been completed for the Lehigh River watershed and are not currently in progress. Pond Creek, Sandy Run, Buck Mountain Creek, Hazle Creek, Black Creek, Nesquehoning Creek, Saucon Creek, and the Lehigh River are scheduled for TMDLs in 2007-2009 (DEP, 2003).

3. Surface Water Quality

The DEP antidegradation regulations protect the existing uses of all surface waters and the existing quality of HQ and EV waters. Existing uses are protected when DEP makes a final decision on any permit or approval for an activity that may affect a protected use. For a new, additional, or increased point source discharge to an HQ or EV water, the person proposing the discharge is required to utilize a nondischarge alternative that is cost-effective and environmentally sound when compared with the cost of the proposed discharge. If a non-discharge alternative is not cost effective and environmentally sound, the person must use the best available combination of treatment, pollution prevention, and wastewater re-use technologies and assume that any discharge is nondegrading, unless (in the case of HQ water), DEP finds, after satisfaction of intergovenermental coordination and public participation requirements, that allowing lower water quality is necessary to accommodate important economic or social development in the area in which the waters are located. In addition, DEP will assure that cost-effective and reasonable best management practices for nonpoint source control in HQ and EV waters are achieved.

a. Explanation of Water Quality Parameters

The chemical character, dissolved solids concentration, and the hardness of the surface water in the watershed changes in varying degrees in different parts of the watershed. The water carried in streams is often considered to consist of a base flow fraction made up of groundwater that infiltrates into the channel and a direct runoff fraction that enters the drainage system during and soon after precipitation. The direct runoff presumably has had no residence time in the groundwater reservoir and only short contact with soil or vegetation. Reactions in the soil zone, however, are commonly extensive enough that the direct runoff has a considerably higher dissolved solids concentration than the original precipitation. Base flow typically has an even greater dissolved solids concentration. The solute concentration of river water thus tends to be inversely related to flow rate.

It is usually not feasible to evaluate the composition of base flow exactly, or for most medium sized and large rivers, to separate the chemical effects of base flow completely from those of direct runoff. The quantity of base flow changes with time and the relative importance of different contributing sources changes. The result is a complex fluctuation of solute concentration.

In addition to mixing groundwater and runoff, the natural factors that influence stream composition include reactions of water with mineral solids in the streambed and in suspension, reactions among solutes, losses of water by evaporation and by transpiration from plants growing in and near the stream, and effects of organic matter and water-dwelling biota. Superimposed on all of these factors are the influences of humans—stream pollution and waste disposal by all kinds of activities within the river basin, and flow diversions and augmentation.

Chemical equilibrium probably controls a few properties of water in flowing streams. For example, the ion-exchange reactions of solutes with suspended sediment probably are rapid enough that they usually are at equilibrium. Certain oxidations also normally reach equilibrium quickly. The equilibrium approach, however, is not adequate for studies of most biologically mediated processes such as the use and production of carbon dioxide and oxygen. A river, by nature, is a dynamic system, and kinetic principles would seem much better suited to stream chemistry that the steady-state equilibrium approaches.

TEMPERATURE

Temperature is a key determinant of what species can survive in a particular environment. Although temperature preferences vary widely among species, they do have one commonality. All species are negatively impacted by rapid fluctuations in temperature.

Discharges of coolant and wastewaters from industrial or utility plants, impoundments that slow the movement of water, runoff from heated surfaces such as pavement and roofs, and lack of vegetative stream cover to provide shading are among the top sources of thermal pollution.

The target standards for water temperature are based on the requirements for trout populations. Growth is impaired in an adult brook trout at temperatures above 66°F or about 19°C. Death of brook trout will occur at temperatures above 75°F or about 24°C. DEP Water Quality Standards dictate a summer temperature no greater than 66°F (for July and August only) for a high quality, cold-water fishery (HQ-CWF). There should also be no fluctuation greater than 2°F in a one-hour period.

DISSOLVED OXYGEN

Dissolved oxygen (DO) is absorbed from the atmosphere and its concentration is related to the temperature and density of the water and to the concentrations of other solutes. Cold water can hold more oxygen than warm water. Therefore, low values can sometimes be attributed to shallow, poorly shaded water, which can cause warming and decrease the amount of oxygen the water can hold. Plant life also influences dissolved oxygen content. Plant life may cause a diurnal fluctuation in DO levels. During the day, while plants are undergoing photosynthesis, they emit oxygen to the stream. However, the DO level will drop at night while the plants are not producing oxygen, but fish and other aquatic life are still consuming it. The result is a drop in DO at night, reaching a minimum just before dawn, then rising to a peak by late afternoon.

Most forms of aquatic life require oxygen for survival, and DO evaluation is used widely in the evaluation of biochemistry of rivers. The extent to which a supply of oxygen can be maintained in a polluted stream or lake depends in part on the hydraulic properties that influence rates at which atmospheric oxygen can be supplied in the water column; the stream can assimilate more organic or other oxidizable material without significant degradation when the rate is rapid than when it is slow.

In areas of dense algae growth, DO levels are likely to drop significantly at night or increase excessively during the day. Low readings may also be indicative of pollutants, such as inadequately treated sewage introduced to the water supply that consumes the available oxygen so that it is not available to aquatic life. Bacteria are capable of consuming large quantities of oxygen during the decomposition of organic material. High DO levels may occur where turbulent conditions increase the natural aeration of the stream.

For unimpaired production, trout require a dissolved oxygen (DO) level of at least 7 mg/L, which is the minimum water quality standard set by the DEP for a high quality, cold-water fishery (HQCWF).

pH

The pH of pure water at 25°C is 7.00. Most groundwater found in the United States has pH values ranging from about 6.0 to 8.5. pH is based on a scale from 0 to 14. Zero is the most acidic value, and 14 is the most alkaline value. A change of one pH unit represents a 10-fold change in acidity or alkalinity. River water in areas not influenced by pollution generally has a pH in the range of 6.5 to 8.5; however, areas in the watershed such as Tunkhannock Creek, which is a major tributary to Tobyhanna Creek, has a natural pH level of 5.5, with some runs as low as 4.5. These low pH waters are normal for bog drainages with low alkalinity and are not an indication of pollution. Bedrock type and other natural conditions may affect pH readings. pH is controlled by equilibrium involving carbon dioxide species and solid calcium carbonate, and streams underlain by limestone, for example, may reach a pH as high as 9. The pH of water can also be affected by oxidation of dissolved ferrous iron so that when high iron concentrations are present pH decreases as ferrous iron oxidizes and precipitates as ferric hydroxide, as in many Abandoned Mine Drainage (AMD) impacted waters.

It should be noted that the pH of streams can also be naturally affected by carbonic acid and other organic matter that are products of decaying plant matter in swamps, such as the Appalachian Plateau province in the northern portion of the watershed.

Sources of abnormal readings include abandoned mine drainage, industrial effluent, acid deposition, sewage lagoons, and livestock containment areas. Sources of alkaline condi-

tions include concrete plants, water treatment plants, and raw sewage. pH levels between 6.5 and 8.2 are optimal for most aquatic organisms. The DEP Water Quality Standard for pH is between 6 and 9.

SPECIFIC CONDUCTIVITY

The specific conductance of a stream measures the quantity of ions in the water, or the ability of the water to conduct an electrical current. Conductivity is typically measured in micromhos. The presence of charged ionic species in solution makes the solution conductive. As ion concentrations increase, conductance of the solution increases. Geologic formations have significant impact on the specific conductance of a stream. Streams flowing through carbonate bedrocks often yield high conductivity. Specific conductance values typically have a direct relationship to total dissolved solids (TDS), which is the concentration of dissolved materials, such as salts, found in the water.

The specific conductance of the purest distilled water is near 1.0 mmho/cm. The conductance of surface and groundwater has a wide range and in some areas may be as low as 50 mmho/cm where precipitation is low in solutes and rocks are resistant to attack. In other areas, conductance of 50,000 mmho/cm or more may be reached; this is the approximate conductance of seawater.

A specific conductance value falling outside the normal range for a site may be caused by almost any pollutant. Point-source discharges as well as stormwater runoff may be contributors to excessive readings. These testing parameters serve as a check to make sure pollutants are not being overlooked that are not part of the regular sampling routine.

ALKALINITY

Alkalinity measures the ability of a stream to resist changes in pH. The alkalinity of a solution may be defined as the capacity for solutes it contains to react with and neutralize acid. This property is often referred to as the buffering capacity of a stream. Buffering capacity is important because it allows a stream to assimilate acidic pollution or contamination. The principal sources of carbon dioxide species that produce alkalinity in surface or groundwater is the CO2 gas fraction of the atmosphere, or the atmospheric gases present between the soils or in the unsaturated zone lying between the surface of the land and the water table. In some natural systems there may be sources of carbon dioxide other than dissolution of atmospheric or soil-zone CO2. Possible major local sources include biologically mediated sulfate reduction and metamorphism of carbonate-limestone rocks.

Alkalinity values in excess of what bedrock types indicate as normal may be a result of sewage, livestock wastes, and/or the production of concrete. Very low readings may be due to heavy rains or other acidic contamination. Abrupt changes in alkalinity may signify pollution. Alkalinity levels between 100 and 200 mg/L provide ideal buffering within a stream. Endurable pH levels may be maintained at this level of alkalinity, and aquatic life may be protected from acidic shock. This occurs when there is a sudden decrease in pH to which aquatic life cannot rapidly adapt for survival.

SULFATE

Sulfur is an essential element in the life processes of plants and animals and is widely distributed in sedimentary and igneous rocks in the form of metallic sulfides. When sulfide minerals undergo weathering in contact with aerated water, the sulfur is oxidized to yield sulfate ions that go into solution in the water. Hydrogen ions are produced in considerable

quantities in this oxidation process. Pyrite crystals occur in many forms of sedimentary rocks, such as coal, and constitute a source of both ferrous iron and sulfate in groundwater. Oxidation of pyrite or other metal sulfides is primarily responsible for mine drainage acidity. The combustion of fuel and ore-smelting processes are major anthropocentric causes of sulfate found in natural waters. Sulfides may also be present in soils that are oxidized through natural processes or organic waste treatment.

High sulfate readings are often associated with the oxidation of minerals such as pyrite, as in the production of abandoned mine drainage. High sulfate as well as chloride concentrations may be found in residual runoff from irrigated areas due to water that was lost through evapotranspiration.

The drinking water standard for sulfate is 250 mg/L. Beyond this point, sulfate levels may cause illness in humans.

IRON

Iron is present in organic wastes and in plant debris in soils, and the activities in the biosphere may have a strong influence on the occurrence of iron in water. Iron in rock minerals is usually in the ferrous (Fe2+) oxidation state, but ferric iron (Fe3+) may also be present. When these minerals are attacked by water, the iron that may be released is generally re-precipitated nearby as a sedimentary species. Freshly re-precipitated material is commonly designated ferric hydroxide, Fe(OH)3. Ferric iron can occur in acid solutions as (Fe3+), FeOH2+, and Fe (OH)2-. The predominant form and concentration depend on the pH. Microorganisms are commonly involved in processes of oxidation and reduction of iron.

Although iron is the second most abundant metallic element on the earth, concentrations in water are generally small. Iron is an essential element in the metabolism of animals and plants.

Water in a flowing surface stream that is fully aerated should not contain more than a few micrograms per liter of uncomplexed dissolved iron at equilibrium in a pH range of about 6.5 to 8.5. Lower pH and higher iron concentration can occur in abandoned mine drainage water. A recommended upper limit for iron in public water supplies is 0.3 mg/L.

MANGANESE

Many igneous and metamorphic minerals contain manganese as a minor constituent, and small amounts are commonly found in dolomite and limestone, substituting for calcium. Manganese is an essential element for both plant and animal life, is an undesirable impurity in water supplies, and tends to deposit black oxide stains.

Manganese is often present to the extent of more than 1 mg/L in streams that have received acid drainage from coalmines. Manganese usually persists in the water for greater distances downstream from the pollution source than the iron contained in the drainage inflows.

The recommended maximum concentration level for manganese in public water supplies is 0.05 mg/L.

ALUMINUM

Aluminum is the third most abundant element in the Earth's outer crust, but it rarely occurs in solution in natural water in concentrations greater than a few tenths or hundreds of a milligram per liter. The exceptions are mostly waters of a very low pH. Because aluminum is so abundant and so widely distributed, most natural waters have many opportunities to dissolve it. In low pH environments, aluminum may be precipitated as an aluminum

hydroxy-sulfate. The dissolved aluminum in waters having low pH has a deleterious effect on fish and some other forms of aquatic life.

Water having a pH below 4.0, such as water draining from abandoned mines, may contain several hundred or even several thousand milligrams of aluminum per liter. Elevated aluminum concentrations have also been observed in runoff and lake waters in areas affected by low pH precipitation.

ZINC

Zinc is essential in plant and animal metabolism, but water is not a significant source of dietary zinc. It has about the same abundance in crustal rocks as copper or nickel and is thus fairly common. Zinc only has one significant oxidation state, Zn2+, and is substantially more soluble in most types of natural water than are the other two metals. Zinc can be considered an undesirable contaminant for some species of aquatic life.

Zinc is widely used in metallurgy, principally as a constituent of brass and bronze, or for galvanizing, in which it is deposited as a coating to inhibit corrosion of steel. Zinc is also used extensively as a white pigment (zinc oxide) in paint and rubber. These applications tend to disperse the element widely into the environment, and the availability for solution in water has been greatly enhanced by modern industrial civilization.

The maximum concentration limit for zinc is 5 mg/L because above this limit it can be detected by taste. No health effects are considered likely for humans, but zinc is an undesirable contaminant for some species of aquatic life at much lower concentrations. Concentrations in river water range from 5 to 45 mg/L. Streams affected by acid mine drainage commonly contain 100mg/L or more.

LEAD

Certain uses of lead by humans have dispersed the element widely through the environment. In the 1920s, addition of tetraethyl lead was found to promote more efficient combustion of gasoline used in automobile engines. The lead content of fuel is emitted as an aerosol in exhaust gases, and the quantities so dispersed increased greatly as the number of automobiles in use grew. Regulation of exhaust emissions of automobiles in the United States substantially decreased this source of lead aerosols during the 1970s and 1980s. Large amounts of lead are also released in the smelting of ores and burning of coal.

Lead pipe once was commonly used to convey drinking water and is still present in many old buildings. Water that has a pH below neutral or is poorly buffered may dissolve considerable amounts of lead from pipes.

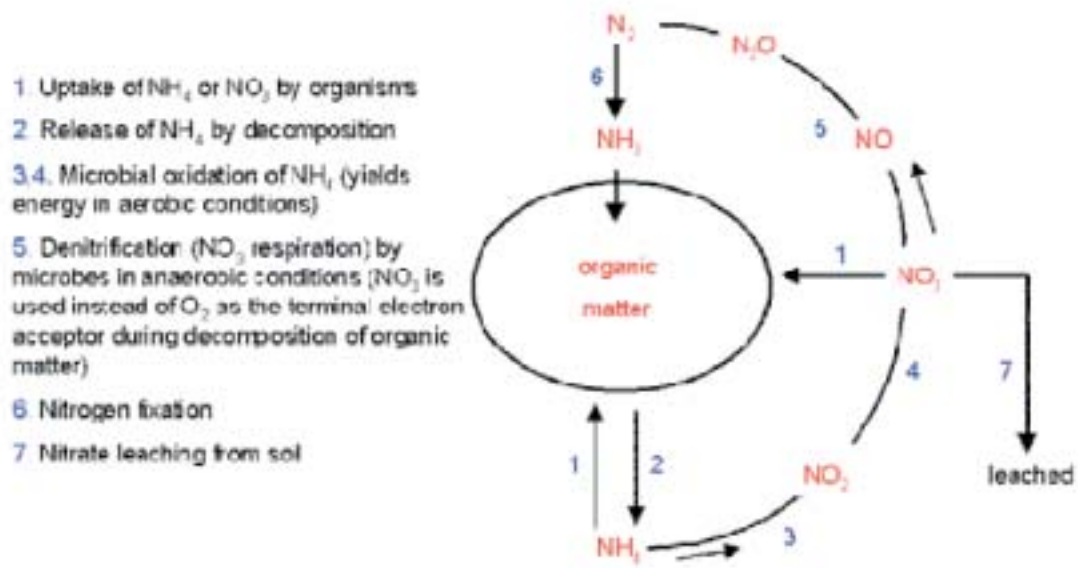
The mandatory upper limit for lead in drinking water in the United States is 5.0 mg/L. Concentrations of lead in rain and snow range from 100 mg/L or more in areas subject to substantial air pollution down to 1.0 mg/L or less in more remote areas. Atmospheric deposition of particulate lead is probably a factor of major importance in the circulation of the element, especially in areas of heavy automobile traffic. Washing of this material into streams during runoff events is a potential source of dissolved lead in river water.

NITROGEN

Most of the Earth's atmosphere is nitrogen gas. Chemical and biological processes that transfer nitrogen to and from the lithosphere, atmosphere, hydrosphere, and biosphere represent the nitrogen cycle (see Figure 3-1). A large amount of scientific investigation of the nitrogen cycle has been done.

Processes by which N2 gas is changed in oxidation state and converted to chemical compounds containing nitrogen are referred to in general as "nitrogen fixation." Biological fixation is accomplished by blue-green algae and certain related organisms that have the capacity of photosynthesis and by certain species of bacteria that use other organic material as energy sources. Man's influence on the nitrogen cycle includes production and use of synthetic fertilizers such as ammonia and other nitrogen compounds. Nitrogen in reduced or organic forms is converted by soil bacteria into nitrite or nitrate in the process of nitrification.

FIGURE 3-1 THE NITROGEN CYCLE
(source: http://helios.bto.ed.ac.uk/bto/microbes/nitrogen.htm)



Nitrogen oxides are present in the atmosphere, in part, from combustion of fossil fuels such as coal and petroleum. Gasoline and diesel engines and most other combustion devices also emit nitrogen oxides. Nitrogen oxides in the atmosphere undergo various chemical alterations that produce H+ and finally leave the nitrogen as nitrate. These processes can lower the pH of precipitation in the same way sulfur dioxides do. Ammonia nitrogen is present in rainfall also.

Nitrogen occurs in water as nitrite or nitrate anions (NO2- and NO3-), in cationic form as ammonium (NH4+), and at intermediate oxidation states as part of organic solutes. The nitrite and organic species are unstable in aerated water and are generally considered indicators of pollution through disposal of sewage or organic waste. The presence of nitrate or ammonium might be indicative of such pollution also, but generally the pollution would have occurred at a site or time substantially removed from the sampling point.

Nitrogen concentrations are determined and reported in different ways in published analyses. Most laboratories studying organic pollution report ammonia, amino and organic nitrogen, and nitrite either separately or as a combined figure and in terms of equivalent concentration of elemental nitrogen. Other laboratories that have been more interested in the inorganic contents of water have determined and reported only nitrate, usually in terms of concentration of the nitrate ion, NO3-. The result of this selectivity has been that the total nitrogen content of many natural waters is not determined.

Unpolluted waters will normally have a nitrate level less than 1 mg/L. The DEP water quality

standard for nitrate is 10 mg/L. Concentrations of nitrate that exceed this level are present in many rural water supply wells. Most investigators have attributed this nitrate to drainage from nearby barnyards or septic tanks. Farm animals produce considerable amounts of nitrogenous organic waste that tends to concentrate in places where large numbers of animals are confined.

The amount of nitrogen fertilizers used on U.S. agricultural fields has increased greatly in recent decades, and this has prompted considerable concern as to possible resulting increases in nitrate in rivers and groundwater. Water from many small and medium-sized rivers in agricultural areas had nitrate concentrations exceeding 10mg/L NO3- at times.

PHOSPHOROUS

Phosphorous is a rather common element in igneous rock, but concentrations present in solution in natural water are normally no more than a few tenths of a milligram per liter. It can occur at oxidation states ranging from P3- to P5+, but the fully oxidized (phosphate) form is the only one of significance in most natural-water systems.

The use of phosphate fertilizers has a potential for increasing the phosphorous content of drainage. Soil erosion, however, may add considerable amounts of suspended phosphate to streams. Phosphorous is a component of sewage, as the element is essential in metabolism, and it is always present in animal metabolic waste. During the 1950s and 1960s, the increased use of sodium phosphate as a "builder" to increase the cleaning power of household detergents tended to increase the output of phosphate by sewage disposal plants. During the decade of the 1960s, the public became increasingly aware of the role of phosphorous as a nutrient for aquatic biota and the implication of phosphorous as a major cause of eutrophication problems in lakes. Various actions were taken to limit the use of phosphate in detergents.

Reduced forms of phosphorous are present in certain synthetic organic chemicals, including some that are used in insecticides. Organic phosphate species synthesized by plants and animals constitute a significant portion of the dissolved and particulate phosphorous in many natural waters.

Phosphorous, along with nitrogen, is an essential nutrient for plant growth. Aquatic vegetation of the free-floating type depends on dissolved nitrogen and phosphorous compounds for its nutrient supply. Dense, rapidly multiplying algal growths or blooms sometimes occur in water bodies that periodically receive increased concentrations of nitrogen or phosphorous. Phosphorous availability is generally believed to be a critical factor in eutrophication of water bodies, as the nutrient in shortest supply will tend to be the control on production rates.

The orthophosphate ion (PO43-) is the final dissociation product of phosphoric acid, H3PO4. Ortho-phosphate is just one form of phosphorous found in natural waters. This is the laboratory tested form of phosphate because it is the form of phosphate used in fertilizer and applied to agricultural fields and residential lawns. Possible sources of elevated phosphate levels are fertilizer runoff, human and animal waste from failing septic systems, sewage treatment plants, and livestock confinement areas, mass quantities of decomposing organic matter, industrial effluent, and detergent wastewater. Detergent wastewaters are responsible for approximately half of the phosphates polluting natural waters.

It is estimated that naturally occurring dissolved inorganic phosphate in river water should average about 10 mg/L as P and total dissolved phosphorous about 25 mg/L. River water with phosphate levels below 0.03 mg/L are generally considered unpolluted. Levels between 0.03 and 0.1 mg/L are sufficient to stimulate plant growth. The critical level for

avoiding accelerated eutrophication is 0.1 mg/L. Levels above 0.1 mg/L are considered problem areas. There has not been a standard set for safe drinking water because humans can tolerate extremely high levels before it has an effect on the digestive system.

DISSOLVED CARBON:

Measurements of total dissolved carbon give an approximation of the total concentration of organic material in a body of water. The average for river waters is approximately 5.75 mg/L.

CALCIUM:

Calcium is a component of many rock minerals and is the most abundant of the alkaline metals on earth. It is essential for both plants and animals. Limestone contains calcium and has a natural buffering capacity for acidic waters.

MAGNESIUM:

An alkaline-earth metal, magnesium is essential to plant and animal nutrition. Like calcium, it occurs in most limestones and therefore is associated with the buffering capacity of a body of water.

SODIUM:

Sodium belongs to the alkali-metal group of the periodic table. The use of salt for deicing highways contributes to the sodium levels of many natural bodies of water. Levels range from 1 mg/L in rainwater to 100,000 mg/L in some brine.

POTASSIUM:

Animals and plants both require potassium that is found in sediments and silicate rocks. Soil leaching by runoff greatly increases levels of potassium in natural waters. Levels are highest in waters having high dissolved-solids concentrations.

CHLORIDE:

Chloride is readily soluble in water. This element is present in low concentrations in all natural waters. Salt used on highways and the leaching of soils by rainwater are major influences on the concentrations in bodies of water.

FLUORIDE:

Generally, levels of fluoride are less than 1.0 mg/L in natural waters. This element is used in the structure of bones and teeth and is often added to human drinking water to improve dental health.

SILICA:

Silica (SiO2) is the second most abundant element in the earth's crust. The weathering of rock minerals produces the levels of silica in water. Concentrations in surface waters average between 1 and 30 mg/L. Levels in groundwater of 100 mg/L are common.

BORON:

Small amounts of boron are essential to plant growth. The toxic concentrations for some plants are as low as 1 mg/L. Concentrations of a few tenths of a milligram are common in both ground and surface waters. Detergents are a source of boron in the environment.

b. Factors that Affect Surface Water Quality

1. ABANDONED MINE DRAINAGE

a. Abandoned Mine Drainage Formation

Abandoned Mine Drainage (AMD) is surface water that emanates from an area disturbed by mining activities. The quantity and chemical composition of mine drainage is the result of the interplay of a variety of geological, climatological, and biological factors. Chemical changes may include the additions of acids, metals, sulfates and other dissolved solids. Physical changes include the addition of silt and sediment, as well as alteration of temperature. Problematic mine drainage forms when water and air contact certain sulfur bearing minerals in rocks associated with mining. Pyrite and other iron-sulfide minerals react with water and oxygen to form acid, which then dissolves other minerals in the rocks associated with coal. Mine Drainage is typically characterized by low pH (less than 6.0) and elevated levels of sulfate, acidity and other metalsæsuch as iron, magnesium, zinc, manganese and aluminum. These constituents often cause stream bottoms to become coated, most noticeably by iron, which results in visible reddish-orange stains termed "yellow-boy" (Zielinski).

The geology of coal field areas can have significant impacts on AMD production and discharge for all types of mining. Coal deposits formed as decaying organic matter accumulated in ancient swamps that were subsequently buried under layers of sediments. This depositional environment and other post-depositional factors cause the differences between coal ranks (anthracite, bituminous and lignite) and the tendency for some rocks to produce AMD when mined.

Abandoned Mine Drainage can be a product of both surface and underground coal mining operations and the waste piles associated with coal cleaning plants. In surface mining, the solid rocks overlying the coal, or overburden, are removed, and in the process broken into large and small rock fragments, which are replaced in the mining pit after coal removal. This exposes the acid-forming minerals in some rocks to water and air, resulting in a high probability of AMD formations if such minerals are present in sufficient quantity. In underground mining, large reservoirs of AMD may form in the cavern-like passageways below the earth's surface. Groundwater movement through the mineral-bearing rocks, creates more AMD, constantly replenishing these reservoirs. The water from these mine pools seeps through the hillsides or gushes from abandoned mine entries, entering the streams, and depositing the metal-rich precipitates on everything in the downstream path. Coal cleaning refuse piles often contain excessive amounts of pyretic materials, and water flowing through the piles will become acidic.

Mine drainage discharges can be as small as a tiny trickle, or they may be huge torrents of thousands of gallons per minute. If the receiving stream does not contain sufficient alkalinity to neutralize any added acid, its water quality may be adversely impacted, and the stream's uses will be limited. Even if the stream has sufficient alkalinity to improve the pH, iron and/or aluminum precipitation may occur.

b. Acid Mine Drainage and Aquatic Life

The first visual observation of the effects of acid mine drainage pollution was probably the red-yellow precipitates of iron hydroxide (Fe(OH3)) and the eradication of fish and other aquatic life from the water systems (Zielinski).

Acidification of aquatic ecosystems is a problem that has received renewed attention with the current focus on the environment. Acid mine drainage involves the element of sulfur and its

conversion to sulfuric acid. Acid mine drainage has destroyed countless aquatic ecosystems in coal mining areas, frequently resulting in impaired water quality and loss of virtually all desirable forms of life (Zielinski).

A qualitative biological examination of a stream contaminated by acid mine drainage may reveal that cattails (Typha sp.), mosses and other vascular plants are not found. Dense flowing mats of green algae (Ulothrix) are common along with Euglena and may color stream beds dark green. Other species of green algae and diatoms are frequently found. In severely contaminated streams, no life will be found. Further from the point source of pollution, midges, alderflies, crane flies and caddis flies may be found. Fish are absent from streams with a pH of 4.5 or lower (Zielinski).

Most aquatic organisms have a well-defined range for pH. Death of organisms is believed to be due to a combination of respiratory and osmoregulatory failure. Sub-lethal elevations in acidity may adversely affect growth rate and reproduction of fish. Mayflies and other insects will be absent at such low pH levels, and the creek is likely to be devoid of fish and frogs as well. Furthermore, the majority of eggs lain at this site, if any species are present to produce them, will be incapable of hatching.

At low pH levels, metals such as aluminum and lead are released in forms that are toxic to aquatic life. Toxics in water tend to attach to suspended particles, drop to the bottom, and then re-suspend during storms. Toxics lower reproductive success and stress the health of aquatic animals. When toxics accumulate in the tissues of fish and shellfish, they pose a threat to human health. Toxics may also seep into the water table and contaminate vast amounts of groundwater. These toxic heavy metals are soluble in acidic waters. Raising the pH of the system would reduce metal concentrations in the aqueous form, which is the most readily available to aquatic life (Zielinski).

Conversion of the iron to ferric hydroxide (Fe(OH)3) produces a bottom coating in the stream known as "yellow-boy." This physical pollutant may decrease oxygen availability to the biota during its formation, cover gills and body surfaces, smother eggs and blanket bottom habitat. In addition, iron particles in suspensions can reduce photosynthesis by covering the surfaces of plants, further inhibiting the penetration of light (Zielinski).

2. General Urban/Suburban Non-Point Source Pollution

As rural and forest lands are urbanized, trees and open fields are replaced by parking lots and roofs. Where undeveloped land absorbs and infiltrates rain and snow, impervious surfaces such as roads and parking lots cause rain to turn into runoff. Urbanization typically results in changes to the physical, chemical, and biological characteristics of a watershed. Vegetative cover is stripped from the land and cut-and-fill activities that enhance the development potential of the land occur. For example, natural depressions that temporarily pond water are graded to uniform slopes, increasing the volume of runoff during a storm event. As population density increases, there is a corresponding increase in pollutant loadings generated from human activities. These pollutants typically enter surface waters via runoff without undergoing treatment.

As watersheds are converted from natural and agricultural areas to urban developments, changes in land use and hydrology can trigger a corresponding flow of adjustments that occur downstream. Because of more efficient delivery systems that are part of the urban development infrastructure (i.e. curbs, gutters, and storm sewer systems), an increased volume of stormwater runoff reaches receiving streams more quickly and with greater velocity. This increased runoff can cause severe degradation, including stream channel erosion, sedimentation, flooding, physical destruction of biota and loss of stream and riparian habitat.

INCREASED RUNOFF

The porous and varied terrain of natural landscapes like forests, wetlands, and grasslands trap rainwater and snowmelt and allow for slow infiltration into the ground. Runoff tends to reach receiving waters gradually. In contrast, non-porous urban landscapes like roads, bridges, parking lots, and buildings do not let runoff slowly percolate into the ground. Water remains above the surface, accumulates, and runs off in large amounts.

Cities install storm sewer systems that quickly channel this runoff from roads and other impervious surfaces. Runoff gathers speed once it enters the storm sewer system. When it leaves the system and enters into a stream, large volumes of quickly flowing runoff erode streambanks, damage streamside vegetation, and widen streamside channels. In turn, this will result in lower water depths during non-storm periods, higher than normal water levels during wet weather periods, increased sediment loads, and higher water temperatures. Native fish and other aquatic life cannot survive in urban streams severely impacted by urban runoff.

INCREASED POLLUTANT LOADS

Urbanization also increases the variety and amount of pollutants transported to receiving waters: sediment from development and new construction, oil, grease, and toxic chemicals from automobiles; nutrients and pesticides from turf management and gardening; viruses and bacteria from failing septic systems; and road salts and heavy metals. These are examples of pollutants generated in urban areas. Sediments and solids constitute the largest volume of pollutant loads to receiving waters in urban areas.

When runoff enters storm drains, it carries many of these pollutants with it. Increased pollutant loads can harm fish and wildlife populations, kill native vegetation, foul drinking water supplies, and make recreational areas unsafe.

3. NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) PERMITS

Information on water discharge permits is contained in the Permit Compliance System (PCS), a national computerized management information system. This system automates the entry, update, and retrieval of National Pollutant Discharge Elimination System (NPDES) data and tracks permit issuance, permit limits and monitoring data, and other data pertaining to facilities regulated under NPDES. PCS records water discharge permit data on more than 75,000 facilities nationwide.

The NPDES permit program regulates direct discharges from municipal and industrial wastewater treatment facilities that discharge into the navigable waters of the United States. Wastewater treatment facilities and other industrial discharges (also called "point sources") are issued NPDES permits regulating their discharge.

The Federal Clean Water Act and the Pennsylvania Clean Streams law require wastewater dischargers to have a permit establishing pollution limits and specifying monitoring and reporting requirements. The federal Clean Water Act requires states to issue NPDES permits to any person or municipality wanting to discharge wastewater into the states' waters. NPDES permits regulate household and industrial wastes that are collected in sewers and treated at municipal wastewater treatment plants. Permits also regulate industrial point sources and concentrated animal feeding operations that discharge directly into receiving waters.

Permits regulate discharges with the goals of protecting public health and aquatic life and assuring that every facility treats wastewater. To achieve these ends, permits include the following terms and conditions: site-specific (or effluent) limits; standard and site-specific manage-

ment; and compliance monitoring and reporting requirements. When and if regulated facilities fail to comply with the provisions of their permits, they may be subject to enforcement actions. DEP and EPA use a variety of techniques to monitor permittees' compliance status, including on-site inspections and review of data submitted by permittees. The NPDES permit is generally valid for a period of five years.

The types of regulated pollutants are listed below:

Conventional Pollutants are contained in the sanitary wastes of households, businesses, and industries. These pollutants include human wastes, ground-up food from sink disposals and laundry and bath waters. Conventional pollutants include:

- *Fecal Coliform*-These bacteria are found in the digestive tracts of humans and animals; their presence in water indicates the potential presence of pathogenic organisms.
- *Oil and Grease*-These organic substances may include hydrocarbons, fats, oils, waxes, and high-molecular fatty acids. Oil and grease may produce sludge solids that are difficult to process.

Toxic Pollutants are particularly harmful to animal or plant life. They are primarily grouped into organics (including pesticides, solvents, polychlorinated biphenyls (PBCs) and metals (including lead, silver, mercury, copper, chromium, zinc, nickel and cadmium).

Non-conventional Pollutants are any additional substances that are not conventional or toxic that may require regulation. These include nutrients such as nitrogen and phosphorous.

There are approximately 140 NPDES point source discharges in the Lehigh River watershed. The locations of the discharges are shown on Map 3-7 and detailed information pertaining to all of the NPDES permits in the watershed are listed in Appendix A-2.

4. STORMWATER

Stormwater management involves the control of water that runs off the surface of the land from rain or melting ice or snow. The volume, or amount, of runoff and its rate of runoff substantially increase as land development occurs. Construction of impervious surfaces, such as roofs and parking lots, and the installation of stormwater pipes which efficiently collect and discharge runoff prevent the infiltration of rainfall into the soil. Management of stormwater is necessary to compensate for the possible impacts of development such as frequent flooding, erosion and sedimentation problems, concentration of flow on adjacent properties, damages to roads, bridges and other infrastructure, as well as non-point source pollution washed off from impervious surfaces.

Flash flooding may be a hazard exacerbated by development. Flash flooding may result from extended periods of heavy rain, such as those associated with tropical storms, or they may result from the spring melt of winter snow and ice accumulations. This is especially a problem in urban areas where the natural floodplains have been so heavily developed and altered that precipitation can not be absorbed by the land, which has been covered by impervious surfaces. Thus, precipitation is quickly carried to the river and its tributaries. The tributaries, when unable to hold the additional stormwater runoff, overflow not onto natural floodplains, but instead onto residential streets, neighborhoods, and commercial properties. Taking steps to minimize stormwater runoff and increase groundwater recharge in urban areas will greatly reduce the impacts and costs associated with flooding.

Pennsylvania cities, boroughs, townships, and counties have been authorized by the Pennsylvania Municipalities Planning Code, Act 247 to prepare comprehensive plans for community development ordinances and subdivision and land development ordinances and regulations that may include provisions for drainage and stormwater management. However, governments are not required to adopt these plans containing development controls. Further, there is no obligation for local governments having stormwater management regulations to consider the effects of runoff beyond their boundaries. Often, municipalities within a watershed may require different levels of control that result in increased flooding problems.

The Pennsylvania legislature enacted the Stormwater Management Act (No. 167) in 1978 to authorize a program of comprehensive watershed stormwater management, which retains local implementation, and enforcement of stormwater ordinances similar to local responsibility of administration of subdivision and land development regulations. Under the Act, the Department of Environmental Protection provides grant money to counties to develop stormwater management plans for designated watersheds. This planning effort results in the incorporation of sound engineering standards and criteria into local codes and ordinances to manage runoff from new development in a coordinated, watershed-wide approach.

Act 167 provides the framework for improved management of the storm runoff impacts associated with the development of land. The purposes of the Act are to encourage the sound planning and management of storm runoff, to coordinate the stormwater management efforts within each watershed, and to encourage the local administration and management of a coordinated stormwater program. The difference between on-site runoff control philosophy and the Act 167 watershed-level philosophy is the consideration of downstream impacts. Whereas the objective of typical on-site design would only be to control post-development peak runoff rates to predevelopment levels from the site itself, a watershed-level design would be geared towards maintaining existing peak flow rates in the entire drainage system.

Act 167 establishes a process for decision-making using a three-step process of runoff control that involves documentation of the existing state of storm runoff in the watershed; preparation of a plan to control storm runoff from new development; and the development of priorities for implementation. Act 167 also specifies that a plan must be updated every five years.

Under Act 167, counties are required to develop stormwater plans for each of the watersheds within their boundaries. The DEP develops grant agreements with counties to pay for 75 % of the cost to prepare the plans. Upon completion of a plan by a county and approval by the department, municipalities located in the watershed adopt ordinances consistent with the plan. Developers are then required to follow the local drainage regulations that incorporate the standards of the watershed plan when preparing their land development plan. Although not all watersheds have been studied, developers in non-studied areas are still required to follow any local drainage regulations adopted under the Municipalities Planning Code. The sub-watersheds of the Lehigh with approved stormwater management plans are shown in Map 3-8 and listed in Table 3-5.

TABLE 3-5. WATERSHEDS WITH APPROVED STORMWATER MANAGEMENT PLANS

Watershed	*Year Completed/ Updated*
Little Lehigh Creek	1999
Monocacy Creek	1989
Nancy Run	1989
Saucon Creek	1991
Jordan Creek	1992
Coplay Creek	1995
Trout/Bertsch Creeks	1995
Lizard/Mahoning/ Nesquehoning/ Mauch Chunk Creeks	1995
Catasauqua Creek	1997
Tobyhanna Creek	1997
Hokendauqua Creek	1998

The NPDES Storm Water Program is a comprehensive two-phased national program for addressing the non-agricultural sources of storm water discharges which adversely affect the quality of our waters. The program uses the NPDES permitting mechanism to require the implementation of controls designed to prevent harmful pollutants from being washed by stormwater runoff into local water bodies.

The NPDES stormwater regulations cover 1) operators of small municipal separate storm Sewer Systems (MS4s) in urbanized areas (as delineated by the Bureau of Census), 2) industrial facilities in any of the 11 categories that discharge to an MS4 or to waters of the United States , unless there is a condition of "no exposure", and 3) operators of construction activity that disturbs 1 or more acres of lands and construction sites less that 1 acre if the construction is part of a larger plan of development.

5. Agricultural Non-point Source Pollution

Under some circumstances, agricultural land can become a source for excessive nutrients – nitrogen and phosphorus –entering surface and groundwater. Along with nutrients, agricultural land can also be a source for bacteria from livestock, as well as soil-dwelling coliform bacteria. Coliform bacteria can thrive in the soil in wet conditions with high levels of nutrients. The nutrients move into waterways by trickling underground or in surface runoff during storms. As a result, waters have become over-fertilized, or eutrophic. When too much nitrogen and phosphorous enter the creek, they fuel the explosive growth of floating plant life, or algae, so extensively that they cloud the water and block out light needed by underwater plant life. When the algae die, they sink to the bottom where their decomposition consumes oxygen. Common sources of agricultural pollution include:

Sediment: row-crop land, streambanks devoid of well-established riparian areas, or where livestock have access, gullies, or other areas with high erosion rates.

Nitrogen: heavily fertilized cropland, animal confinement areas, or improperly designed animal waste storage systems, fields on which manure is applied.

Phosphorous: heavily fertilized cropland, animal confinement areas, or improperly designed animal waste storage systems, fields on which manure is applied. (Municipal sewage treatment plants are also potential sources.)

Bacteria: both from animal and crop sources

6. Toxic Release Inventory

The Toxic Release Inventory (TRI) database, maintained by the U.S. Environmental Protection Agency (EPA), is a valuable source of information regarding toxic chemicals that are being used, manufactured, treated, transported, or released into the environment. It also provides a detailed view of environmental releases and source reduction on an industry sector basis. These industries include printing, publishing, rubber and miscellaneous plastic products and textile mill products.

The TRI database is accessible to the public because of an important piece of environmental legislation passed in 1986 known as the Emergency Planning and Community Right-To-Know Act (EPCRA). The primary purpose of the EPCRA is to inform communities and citizens of chemical hazards in their areas. The goal is to reduce the risk for communities by helping them to prepare and respond to chemical spills and similar emergencies. In order to accomplish this goal, businesses are required to report the locations and quantities of chemicals stored on-site to state and local government.

The EPCRA mandates that a TRI be made public, which provides citizens with accurate information about potentially hazardous chemicals and enables communities to hold companies accountable. Manufacturers are required to report releases of more than 600 designated toxic chemicals to the environment, and these reports are submitted to the EPA and the state government. TRI facilities are also required to report on releases of toxic chemicals into the air, water, and land. In addition, they need to report on off-site transfers, such as a transfer of wastes for treatment or disposal at a separate facility. Facilities are also required to report on pollution prevention activities and chemical recycling. Manufacturing facilities are defined and described in Standard Industrial Classification (SIC) codes, which includes chemicals, petroleum refining, primary metals, fabricated metals, paper, plastics, and transportation equipment.

The TRI database includes information on:

- What chemicals were released into the local environment during the preceding year.
- How much of each chemical went into the air, water, and land in a particular year.
- How much of the chemicals were transported away from the reporting facility for disposal, treatment, recycling, or energy recovery.
- How chemical wastes were treated at the reporting facility.
- The efficiency of waste treatment.
- Pollution prevention and chemical recycling activities.

It is important to understand that reported releases are annual estimates and that the amounts reported could have been released evenly over the course of the year or, possibly, in a single event. Therefore, the TRI database is a starting point for viewing the effects of industrial chemical use and should be used in combination with information from other sources in order to determine levels of exposure or risk.

FIGURE 3-2. NUMBER OF TRI FACILITIES IN THE LEHIGH WATERSHED.

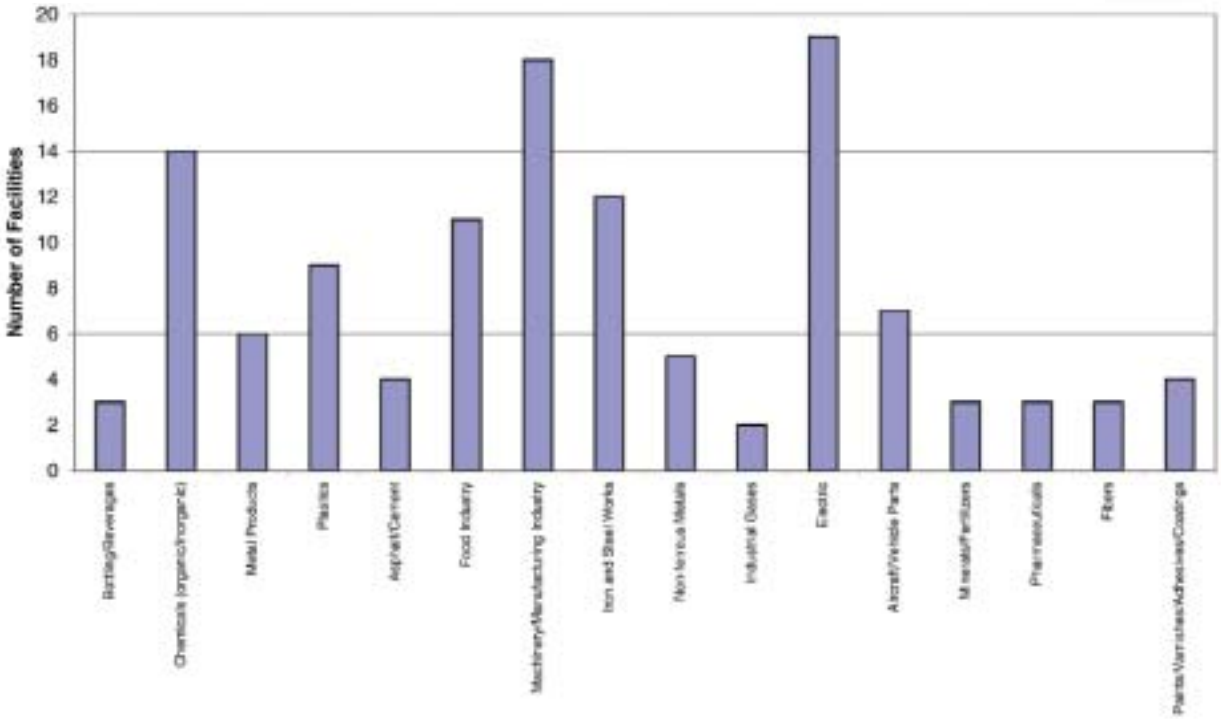


Figure 3-2 shows the TRI Facilities located in the Lehigh River watershed (see Map 3-9 and Appendix A-3) grouped into categories according to a general description of each company's products, by-products, and production. Facilities/corporations that are connected to electric products as well as the machinery/manufacturing industry were the most abundant in this area. The categories concerning the production of chemicals, iron/steel, and the food industry were also rather large. The remaining categories contained significantly smaller numbers, with the smallest category being industrial gases.

TABLE 3-6. PUBLIC SEWAGE TREATMENT PLANTS IN THE WATERSHED.

Name	*County*	*Receiving Stream*
Allentown City	Lehigh	Lehigh River/Little Lehigh Creek/Other
Allied Utility Services INC	Lehigh	Coplay Creek
Arrowhead Sewer Company	Lackawanna	Lehigh River
Bath Boro Auth	Northampton	Monocacy Creek
Beaver Meadows Mun Auth	Carbon	Beaver Creek
Bethlehem Authority- Waste Water	Lehigh	Lehigh River
Bethlehem City	Northampton	Indian Creek
Bowmanstown Boro	Carbon	Lehigh River
Catasauqua Boro	Lehigh	Lehigh River
Central Carbon Municipal Auth	Carbon	Lehigh River
Coolbaugh Twp	Monroe	Tobyhanna Creek
Foster Twp	Luzerne	Lehigh River
Freeland Boro Mun Auth	Luzerne	Wet Weather Channel to Pond Creek
Jim Thorpe Boro	Carbon	Mauch Chunk Creek
Jim Thorpe Boro	Carbon	Lehigh River
Lehigh County Auth-Heidelberg	Lehigh	Mill Creek
Lehigh Twp Mun Auth	Northampton	Indian Creek
Lehigh Twp Mun Auth	Northampton	Bertsch Creek
Lehighton Boro	Carbon	Mahoning Creek
Lehighton Water Auth	Carbon	Long Run
Montrose Mun Auth	Susquehanna	Pettis Creek
Nesquehoning Boro Council	Carbon	Nesquehoning Creek
Northampton Boro	Northampton	Hokendauqua Creek
Northampton Boro Mun Auth	Lehigh	Spring Creek
Palmerton Boro	Carbon	Aquashicola Creek
Slatington Boro Auth	Lehigh	Lehigh River
Tobyhanna Twp	Monroe	Tobyhanna Creek
Topton Boro	Berks	Toad Creek
Upper Saucon Twp Mun Auth	Lehigh	Saucon Creek
Weatherly Boro	Carbon	Black Creek
White Haven Mun Auth	Luzerne	Lehigh River

7. WASTEWATER

Domestic sewage and wastewater are treated and disposed of by various methods, ranging from large municipally owned sewage treatment plants to community or individual on-lot septic systems. Malfunctioning sewage disposal systems, regardless of type, pose a serious threat to public health and the environment. They can pollute public and private drinking water sources, often by discharging directly into the groundwater, and they can expose humans and animals to various bacteria, viruses, and parasites. Repairs to these systems often can lead to financial hardships for affected municipalities or homeowners.

In 1966, the Pennsylvania Sewage Facilities Act (Act 537) was enacted to correct existing sewage disposal problems and prevent future problems. To meet this objective, the law requires proper planning of all types of sewage systems, permitting of individual and community on-lot systems, and uniform standards for on-lot systems.

The municipal wastewater treatment plants (WWTP) discharging to the Lehigh River, in downstream order, are White Haven, Western Poconos, Jim Thorpe, Lehighton, Slatington, Northampton, Catasauqua, Allentown, and Bethlehem (see Table 3-6). Numerous other municipal dischargers are located on tributary streams several miles from their confluences with the Lehigh River. Private or non-municipal treatment plants serving developments, mobile home parks, industries, schools, etc. far outnumber the municipal treatment plants in the basin. The majority of these private facilities are less than 0.05 milllion gallons per day (mgd) in capacity and are located on tributary streams in outlying areas. Any water quality impact resulting from these small discharges is expected to be localized (Priority Water Body Survey Report, 1988); however, cumulative numbers of non-municipal WWTPs in a watershed have the potential to significantly impair surface water quality not only on local streams that receive discharges, but also on the Lehigh River, which ultimately receives the discharges.

In many instances, as people move from rural to urban or urbanizing areas, construction of city sewage systems and wastewater treatment facilities has not kept pace with growth. As a result, the individual septic-tank disposal system, long used in rural areas not connected to sewer systems, continues to be an important method of sewage disposal in outlying areas. Improperly functioning septic systems are a source of stream and groundwater contamination.

A septic system tank is designed to separate solids from liquid, biochemically digest and store organic matter through a period of detention, and allow the clarified liquid to discharge into the drain field (absorption field), a system of piping through which the treated sewage may seep into the surrounding soil. As the wastewater moves through the soil, the natural processes of oxidation and filtering further treat it. By the time the water reaches the freshwater supply, it should be safe for other uses. Sewage absorption may fail for several reasons. The most common causes are failure to pump out the septic tank when it is full of solids and poor soil drainage, which allows the effluent to rise to the surface in wet weather. When a septic tank absorption field does fail, serious pollution of groundwater and surface water may result.

4. Surface Water Quality Studies

Accurately evaluating the present health of the Lehigh River greatly depends upon understanding the historical condition of the river. Studies completed over several decades provide a comparison for determining if the water quality and habitat conditions are improving or deteriorating. Several studies that have been completed in the watershed are described in Appendix A-4. These studies include:

- Baseline Historic Data: Lehigh River Biological Investigation, DRBC, Pa. Fish Commission, and Pa. Dept. of Health, 1965-1966
- A Biological and Chemical Survey of the Lower Lehigh River, Summer 1981, Lehigh University, March 1982
- "Priority Water Body Survey Report, Lehigh River and Tributaries, and Little Lehigh Creek and Tributaries" DER, Bureau of Water Quality Management, April 1988
- Effects of Heavy Metal Contamination on Aquatic Fauna near the Palmerton, Pennsylvania Smelters. Pennsylvania Cooperative Fish and Wildlife Research Unit, School of Forest Resources, Pennsylvania State University, August 1989
- An Evaluation of Recreational White-Water Releases from Francis E. Walter Dam, Lehigh River, Luzerne, and Carbon Counties, Pennsylvania. Prepared for Whitewater Challengers, Inc by

Ichthyological Associates, Inc., August 1990Lehigh River Fishkill, Pennsylvania Department of Environmental Protection, April, and May 1995

- "Upper Lehigh River 'Exceptional Value' Feasibility Report, Wildlands Conservancy, 1995
- Parkland School District and Lehigh University Hydrolab Probe Data Collection
- Water Quality Review: 1995-2000 Pennsylvania DEP and USGS-NAWQA Data
- Pennsylvania DEP Benthic Macro-invertebrate and Habitat Analysis, 1995-2000
- F.E. Walter White Water Releases, Effects on Macroinvertebrates, Pa. Fish and Boat Commission, December 2000
- Lehigh River 2001 Water Quality Monitoring, DRBC and PADEP
- Lehigh River Benthic Macroinvertebrate Sampling, Pa. Fish and Boat Commission, US Army Corp of Engineers, 2002

This section summarizes a recent AMD and overall water quality surface water quality study completed in the watershed.

a. Lehigh River, Mine Drainage Assessment and Abatement Plan, Wildlands Conservancy, 2000.

Historically, coal was mined with little thought of environmental consequences and without formal regulation. When all available coal was extracted from a mine site, operators would move to another and leave the original mine abandoned, failing to return the earth to its previous condition. Over 15 billion tons of coal were removed from Pennsylvania's ground, and 250,000 acres of mine land were left abandoned (Pennsylvania DEP Status Report #5000-BK-DEP2274).

Today the Lehigh River is still impacted by the remains of the mining industry. Studies conducted on the Lehigh River by the Pennsylvania Fish Commission in 1965, Lehigh University in 1981, and the Pennsylvania Department of Environmental Protection in 1987-88 concluded that AMD is a major problem facing the Lehigh River. As noted in the "Summary and Recommendations" of the Priority Water Body Survey Report, (prepared by Glen Johnson and Rodney Kime and conducted September-October 1987 and July-September 1988), the main stem of the Lehigh River, from White Haven in Luzerne County to Lehighton in Carbon County, is negatively impacted by abandoned mine drainage from tributaries draining abandoned coal fields. This conclusion has been confirmed by studies conducted by Wildlands Conservancy in partnership with Parkland High School's "Lehigh River Watch." The drainage from these mining tunnels and the runoff from abandoned strip mines and spoil piles lower alkalinity levels, decreasing the Lehigh River's natural buffering capacity, and introduce high concentrations of sediment, iron, sulfate, aluminum, zinc, and acidity. This study concludes that low alkalinity levels and high heavy-metal concentrations combine to produce daily and seasonal changes in the river that are approaching critical levels.

Mine drainage continues to be a major impact on water quality. Although significant improvement in water quality has been made in the last 30 years regarding AMD, the Lehigh River still suffers from low alkalinity, high heavy-metal concentrations and fluctuating pH. Several abandoned mine reclamation projects have been completed in the watershed, and numerous attempts were made in the past to minimize the impacts of mine drainage tunnels entering the river, however none of these facilities are currently in operation.

1. TRIBUTARIES CONTAINING MINE DRAINAGE (TAKEN FROM LEHIGH RIVER MINE DRAINAGE ASSESSMENT AND ABATEMENT PLAN TO MITIGATE THE MINE DRAINAGE IMPACTS TO THE LEHIGH RIVER WATERSHED)

As shown in Map 1-6 there are four tributaries that contribute abandoned mine drainage (AMD) to the Lehigh River. Table 3-7 contains the average AMD parameter concentrations and loads in these four tributaries and summarizes the total AMD-related impact each tributary has on the Lehigh River. Two separate percent loads were calculated: the "measured" value was determined using the difference in AMD parameters upstream and downstream in the Lehigh River as the total Lehigh River AMD load; and the "calculated" value was determined using the sum of the four AMD tributary loads as the total AMD load in the river.

The first tributary, Sandy Run, is the northernmost AMD tributary and is impacted by mine drainage from three discharges: Owl Hole, Sandy Run, and Pond Creek. The Sandy Run tributary is a major contributor of aluminum and acidity, due primarily to the Owl Hole discharge, and the tributary accounts for approximately 18% of the total mine drainage entering into the Lehigh River. The second AMD-contributing tributary from the north, Buck Mountain Creek, is impacted by mine drainage from two AMD discharges: Buck Mountain #1 and Buck Mountain #2. Like Sandy Run, Buck Mountain Creek is characterized by low alkalinity and high concentrations of aluminum. The creek accounts for approximately 12% of the acidity and 10% of the aluminum entering the Lehigh River. Black Creek is the third tributary contributing mine drainage to the Lehigh River and it has four main tributaries: Hazle Creek, Beaver Creek, Wetzel Creek, and Quakake Creek. Black Creek is impacted by AMD from the Quakake Tunnel (which enters Wetzel Creek) and the Hazle Brook overflow (which enters Hazle Creek). Black Creek has the largest discharge of the four AMD tributaries in the study area and contributes approximately 23% of the total AMD into the Lehigh River. The final and southern-most AMD contributing tributary is Nesquehoning Creek, which is impacted from only one tunnel, the Lausanne Tunnel. The combination of the Nesquehoning Creek and the Lausanne Tunnel is responsible for more than 53% of the total AMD contribution to the Lehigh River.

TABLE 3-7 PERCENT AMD PARAMETER LOADS FROM TRIBUTARIES TO THE LEHIGH RIVER

Parameter	Load lbs/day	% Load measured	% Load calculated
Sandy Run			
Acidity	4526	344%	48%
Aluminum	660	51%	39%
Manganese	162	34%	23%
Sulfate	8594	12%	13%
Total Iron	42	7%	7%
TOTAL AMD	13984	19%	18%
Buck Mountain			
Acidity	1108	30%	12%
Aluminum	168	13%	10%
Manganese	57	12%	8%
Sulfate	2882	4%	4%
Total Iron	12	2%	2%
TOTAL AMD	4227	6%	6%
Black Creek			
Acidity	3723	283%	40%
Aluminum	589	45%	34%
Manganese	188	39%	26%
Sulfate	13121	19%	20%
Total Iron	46	8%	7%
TOTAL AMD	17666	24%	23%
Nesquehoning Creek			
Acidity	0	---	---
Aluminum	293	22%	3%
Manganese	307	24%	18%
Sulfate	39523	56%	62%
Total Iron	538	94%	84%
TOTAL AMD	40661	55%	53%

(a) Sandy Run

Sandy Run drains an area of approximately 22.6 square miles in Luzerne County. Sandy Run is a third order tributary of the Lehigh River. The source of Sandy Run is located less than 0.5 miles south of the township of Sandy Run and the surrounding strip mines. It completes its eight-mile journey approximately two miles south of the tannery entrance to the river. Sandy Run is impacted by mine drainage from three AMD discharges: the Owl Hole, which drains the Big Black Creek Coal basin; Sandy Run, which drains the Cross Creek Coal basin; and Pond Creek, which drains the Upper Lehigh Coal basin. Sandy Run is listed on the 1998 303(d) List of impacted streams in Pennsylvania.

The creek has an average discharge of 40.7 cfs (18,224 gpm) and is acidic (pH 4.4). Large amounts of iron and aluminum oxide can be seen precipitated out where Sandy Run meets the Lehigh River. With a mean flow of 40.7 cfs, Sandy Run is the major contributor of aluminum and acidity, due in large part to the Owl Hole discharge. Sandy Run ranks second in AMD contribution to the Lehigh and accounts for between 18 and 19% of the total mine drainage from tributaries. The Sandy Run tributary is the largest contributor of AMD aluminum and acidity to the Lehigh River.

(b) Buck Mountain Creek

Buck Mountain Creek, locally termed Indian Run, drains an area of approximately 8.88 square miles in Carbon County. Buck Mountain Creek is a second order tributary of the Lehigh River. The source of the creek is located just south of the town of Buck Mountain in Lausanne Township, Carbon County, and it completes a five-mile journey, entering the Lehigh River in the Lehigh Gorge State Park at the Rockville access point. Buck Mountain Creek is impacted by mine drainage from two AMD discharges: Buck Mountain #1 and Buck Mountain #2, both of which drain the Buck Mountain Coal basin. Buck Mountain #1 and #2 discharges both enter near the headwaters of the creek near the town of Buck Mountain. Pennsylvania DEP classifies the creek as a HQ-CWF, and it is listed on the 1998 303(d) list of impaired streams in Pennsylvania.

Relatively high concentrations of aluminum and low concentrations of alkalinity were measured in the creek. The creek has a comparatively low mean flow of 18.57 cfs (8,316 gpm), which minimizes the loads of Buck Mountain Creek to the Lehigh River. Buck Mountain Creek contributes the least amount of mine drainage with 6% of the total AMD coming into the Lehigh from tributaries. The creek fails to meet DEP water quality standards for aluminum, alkalinity, and pH.

(c) Black Creek

Black Creek drains an area of approximately 60.4 square miles in Luzerne and Carbon Counties and is a tributary of the Lehigh River. The source of Black Creek is located several miles west of Weatherly, and it completes a more than ten-mile journey, entering the Lehigh River in the Lehigh Gorge State Park at Penn Haven Junction. The creek has four main tributaries: Hazle Creek, Beaver Creek, Wetzel Creek, and Quakake Creek. The creek is impacted by mine drainage from two AMD discharges. The Quakake Tunnel, which drains the Jeansville Coal basin, enters Wetzel Creek. The Hazle Brook overflow enters Hazle Creek near the old beryllium plant. Pennsylvania DEP classifies the creek as a HQ-CWF from its source to Beaver Creek and a CWF from Beaver Creek to its confluence with the Lehigh River. The creek is listed on the 1998 303(d) list of impaired streams in Pennsylvania.

The Black Creek has the largest discharge of the four AMD-affected streams in the study with a mean discharge of 71.64 cfs (32,078 gpm). It accounts for between 23 and 24% of the mine drainage factors entering the Lehigh. The creek is the second highest contributor of AMD acidi-

ty, aluminum, iron, and sulfate. Aluminum, pH, and alkalinity fail to meet Pennsylvania Chapter 93 water quality standards at this site.

(d) Nesquehoning Creek

Nesquehoning Creek drains an area of approximately 33.9 square miles in Carbon and Schuylkill Counties. The creek is a third order tributary of the Lehigh River. The source of Nesquehoning Creek is located along the eastern boarder of Schuylkill and Carbon Counties and it completes its 13-mile journey, entering the Lehigh River in the Lehigh Gorge State Park, about two miles north of the town of Jim Thorpe. The creek is impacted by mine drainage from one AMD discharge and some unidentified non-point sources of AMD. Drainage from the Lausanne Tunnel, from portions of the Southern Coal basin, enters the Nesquehoning Creek approximately 200 yards above the confluence of the Nesquehoning Creek and the Lehigh River two miles north of Jim Thorpe. The creek has three separate classifications from Pennsylvania DEP. From its source to Lake Greenwood, it is a HQ-CWF, while from Lake Greenwood to the Tibbetts Pond Dam it is a High Quality-Warm Water Fishery (HQ-WWF). From the Tibbetts Pond Dam to the confluence of the Lehigh River, it is listed as a CWF. The creek is listed on the 1998 303(d) list of impaired streams in Pennsylvania.

With a mean flow of 67.5 cfs, Nesquehoning Creek is responsible for between 53 and 55% of the total AMD in the Lehigh. Approximately one-half of this contribution is attributed to the Lausanne Tunnel, and the other half comes from unidentified non-point source AMD. The tunnel contributes more than 84% of the total alkalinity from AMD tributaries into the Lehigh River. Nesquehoning Creek is the largest contributor of AMD alkalinity, sulfate, iron, and manganese. Its mean pH of 6.4 is the highest of all the AMD sources and the only one to meet water quality standards. It fails to meet water quality standards for aluminum and iron, and yellow boy (aluminum and iron oxides) is thick in its discharge to the Lehigh River.

TABLE 3-8. MINE DRAINAGE TUNNELS AND OUTFLOWS DRAINING TO THE LEHIGH RIVER (Adapted from Wood, 1996)

Tunnel/ Overflow	Coal Basin	Latitude	Longitude	Receiving Stream	Average Flow (cfs)
Quakake Tunnel	Jeansville	40°55′09″	75°54′07″	Wetzel Creek	16.86
Hazle Brook	Hazleton	40°58′08″	75°53′52″	Hazle Creek	1.492
Buck Mt. #1	Buck Mountain	40°58′53″	75°48′49″	Buck Mountain Creek	0.1289
Buck Mt. #2	Buck Mountain	40°58′51″	75°49′27″	Buck Mountain Creek	2.765
Owl Hole	Big Black Creek	40°00′02″	75°49′11″	Sandy Run	6.136
Sandy Run	Cross Creek	41°00′58″	75°50′55″	Sandy Run	1.997
Pond Creek	Upper Lehigh	41°02′29″	75°50′44″	Sandy Run	1.39
Lausanne Tunnel	Southern	40°51′30″	75°45′15"	Nesquehoning	10.17

2. LOCATION AND EXTENT OF MINING IMPACTS

The Lehigh River watershed is impacted by mining activities from the Eastern and Southern Coal fields. Six AMD tunnels and two overflows drain numerous pits, culm (coal refuse) banks, stripping areas and underground workings. The tributaries of Sandy Run, Buck Mountain, Black Creek and Nesquehoning Creek are affected by discharges and surrounding runoff from the following AMD sources: Pond Creek, Sandy Run, Owl Hole, Buck Mountain #1, Buck Mountain #2, Hazle Brook Discharge, Quakake Drainage Tunnel and the Lausanne Tunnel. Additional information on these discharges is located in Table 3-8.

(a) Mine Drainage Tunnels

The early mining companies used several techniques to minimize the amount of water entering the mines. Side hill ditches were dug on the flanks of the ridges surrounding the mine basin in order to collect and divert surface water runoff around the coal outcrops where it could easily enter the mine. Wooden or steel flumes were built to carry the creeks that crossed the mine basin, thus minimizing streambed leakage into the mine. Some creeks were purposely seeded with silt in an attempt to make the streambed impervious. These techniques only served to minimize the amount of surface water entering the mine. Direct precipitation and groundwater infiltration from adjacent areas necessitated the use of stream-driven pumps to bring the mine water to the surface (LaRegina).

Engineering marvels of their time, these drainage tunnels were built under the Eastern-Middle Coal Field to drain intruding surface water from the mines. Some as long as seven miles in length, these tunnels pour hundreds of pounds of heavy metal into the Lehigh River every day.

As time passed, miners followed the coal deeper into the ground and strip mining, first introduced in the 1870s, saw greater use. The increased depth of the mines coupled with increased infiltration due to strip mining resulted in the need for greater pumping capabilities. Sudden influxes of water from storm events, snow melts or subsidence near a creek channel often required shutting down the mine until the water could be pumped out. Pump maintenance was a concern due to the corrosive nature of mine drainage. These factors contributed to an increase in operating costs (LaRegina).

The solution to this problem was the mine drainage tunnel. These tunnels are not to be confused with mine workings, which were driven into coal as part of the mining process. Mine drainage tunnels are rock tunnels generally driven cross-strike for conveying mine drainage to a surface stream outside of the coal measures. In some instances, if the geometry of the basin was favorable, the tunnels tapped the lowest point in the mine and provided gravity drainage that allowed the mine to be dewatered without pumping. Other tunnels, coupled with pumping systems, operated as drainage levels. A drainage level is a horizontal tunnel that intersects the surfaces and serves as a conduit for a pump discharge. These tunnels reduced the head against which a pump had to work to reach the surface (LaRegina).

To understand why mine drainage tunnels were commonly used in the Eastern Middle field, two of the field's characteristics should be examined. First, most of the coal basins are perched above or nearly above the elevation of the surface drainage networks in the surrounding non-coal valleys. Thus, it was feasible in many cases to drive a tunnel with sufficient gradient to drain most, if not all, of each individual mine by gravity. In the three other anthracite fields, the coal measures extended well below the elevation of the local surface drainage networks. Secondly, the discontinuous nature of the basins in the Eastern Middle field has, in effect, hydrologically isolated each basin. Thus, individual tunnels were constructed to dewater the individual basins (LaRegina)

(b) Sandy Run Discharge

The Sandy Run Tunnel is located approximately 0.4 miles southeast of the town of Sandy Run in Foster Township, Luzerne County. The tunnel drains to the Sandy Run tributary. The Sandy Run Drainage Tunnel was constructed to dewater portions of the Cross Creek Coal basin and was driven a total of 1,900 feet for the M.S. Kemmerer Company (LaRegina).

The discharge has a relatively low average pH of 3.7. In 1998, the average flow of Sandy Run was 771 gpm, making it the fifth largest discharge in volume to the Lehigh River. Sandy Run Tunnel is one of the three mine discharges that enter Sandy Run. Its discharge represents between 13 and 17% of the total AMD discharge into the Sandy Run tributary and 2.4% of the total AMD load to the Lehigh River. Factors failing to meet Pennsylvania Water Quality standards at this location are pH, aluminum, manganese, alkalinity, and iron. The Sandy Run discharge contributes approximately 5% of the iron and 4.5% of the manganese associated with mine drainage that enters the Lehigh River.

Precipitated iron, or "yellow boy," from water emanating from the Sandy Run mine drainage tunnel in Carbon County, stains the creek's bottom.

(c) Pond Creek

Pond Creek is a mine overflow of the Upper Lehigh Coal basin and is located 3.5 miles west of White Haven in Foster Township, Luzerne County. The overflow itself enters out into a small wetland area and then enters Pond Creek, a tributary of Sandy Run. Pond Creek is the least impacting mine discharge. The pH of the discharge is 4.7, and a minimal amount of alkalinity is present. In 1998, the average flow of Pond Creek was 350 gpm. Aluminum, alkalinity, and pH fail to meet Pennsylvania DEP water quality standards at the outfall. The discharge represents between 1.2 and 1.6% of the mine drainage entering the Sandy Run tributary and 0.23% of the AMD entering the Lehigh River.

Very few living things can survive in this water laden with heavy metals from abandoned mines.

Pond Creek seems to be influenced by mixing with surface runoff. The clues are the presence of alkalinity, reduced acidity, and a higher mean pH. Pond Creek contributes 92% of the AMD alkalinity to Sandy Run. Sandy Run Creek's discharge to the Lehigh contains an average 217 lbs/day of alkalinity. Pond Creek only contributes an average of 35 lbs/day of that total. Therefore, significant loading of alkalinity is occurring from non-point or point sources other

than AMD. Pond Creek's overall contributions to Sandy Run are relatively low compared to the other mine discharges draining to Sandy Run.

(d) Owl Hole

The Owl Hole Tunnel is located two miles east of the town of Eckley in Foster Township, Luzerne County and is the third discharge to the Sandy Run tributary. The Owl Hole Tunnel is technically a drift rather than a rock tunnel (LaRegina). It was driven in the Buck Mountain seam in the Eckley North basin and served as a portal for the removal of coal. The tunnel is now collapsed and serves as a groundwater overflow point (LaRegina).

A potent stew being discharged from the Owl Hole tunnel near Eckley Village, Luzerne County, contains the highest average level of aluminum concentration of all such discharges entering the Lehigh River.

Owl Hole is an acidic discharge and has the highest average aluminum concentration (21 mg/L) of all the discharges entering the Lehigh River. The discharge also has a low average pH (3.7) and a high average total dissolved solids (412 mg/L). The iron in the discharge is low with an average concentration of 0.89 mg/L. The largest discharge by far to Sandy Run Creek is the Owl Hole. Its mean flow of 2,340 gpm and very low pH of 3.7 allow it to contribute between 64 and 82% of the AMD load in the Sandy Run tributary and 12% of the total AMD discharged to the Lehigh River. Only the Quakake discharge to Black Creek contributes slightly more acidity to the Lehigh River. Aluminum, manganese, alkalinity, and pH fail to meet water quality standards at this site. The key mine drainage parameter within the discharge is aluminum with a total load of approximately 578 lbs/day.

(e) Buck Mountain #1 Tunnel

The Buck Mountain #1 drainage tunnel was the first drainage tunnel constructed in the Eastern Middle field and was completed in 1847 (LaRegina). The tunnel is located approximately 0.2 miles north of the town of Buck Mountain in Lausanne Township, Carbon County and was constructed to dewater portions of the Buck Mountain Coal basin into Buck Mountain Creek. In order to provide drainage for the mine as well as to improve coal-handling abilities, the #1 tunnel was driven from the southern flank of Buck Mountain 1,570 feet northward to intercept the #1 basin at its lowest point, 1,489 ft mean sea level (MSL), thus providing gravity drainage (LaRegina).

The tunnel has the lowest flow (58 gpm) of any of the mine discharges entering the Lehigh River watershed. The discharge contains relatively low average iron, acidity, and aluminum concentrations, as compared to the other discharges entering the Lehigh River watershed.

Buck Mountain #1 Tunnel is one of two mine discharges that enter Buck Mountain Creek. The discharge represents 2% of the mine drainage entering Buck Mountain Creek and approximately 0.1% of the AMD load to the Lehigh River. The low mean flow of 58 gpm makes the Buck Mountain #1 Tunnel a minor contributor to the loadings in Buck Mountain Creek. Factors not meeting water quality standards are aluminum, manganese, alkalinity, and pH.

(f) Buck Mountain #2 Tunnel

The Buck Mountain #2 Tunnel was constructed in 1895 to dewater Buck Mountain #2 basin. The tunnel is located about 0.2 miles north of the town of Buck Mountain in Lausanne Township, Carbon County. The Coxe Brothers and Company drove the Buck Mountain #2 Drainage Tunnel 1,650 feet northward to intercept the eastern end of the #2 basin. The tunnel was at an elevation of 1,426 feet MSL and was positioned 140 feet above and 1,400 feet east of the deepest point of the #2 basin (LaRegina). Water was actually pumped to the #2 tunnel, which served as a drainage level and reduced the pumping head nearly 200 feet (LaRegina).

The discharge from the Buck Mountain #2 tunnel contains aluminum and manganese, and represents seven percent of the AMD load to the Lehigh River.

The tunnel is just east of Buck Mountain #1 Tunnel. A restoration project was completed on the Buck Mountain #2 Tunnel in an attempt to improve water quality in the Lehigh River. A lime slurry tower was constructed immediately below the discharge and can still be seen today. The Commonwealth of Pennsylvania still has a lease on a portion of the property immediately around the discharge, which should prove beneficial in future restoration work.

The tunnel drains to Buck Mountain Creek, a tributary of the Lehigh River and drains portions of the Buck Mountain Coal basin. In 1998, the average flow of Buck Mountain #2 was 1,367 gpm. The discharge has a relatively high average aluminum concentration of 17 mg/L. The tunnel also has the second highest average acidity concentration of 133 mg/L and completely lacks alkalinity.

Buck Mountain #2 Tunnel is the second discharge entering Buck Mountain Creek. The discharge represents 98% of the mine drainage entering Buck Mountain Creek and 7% of the AMD load to the Lehigh River. Aluminum, manganese, alkalinity, and pH fail to meet water quality standards.

(g) Hazle Brook

The Hazle Brook overflow drains the eastern most portion of the Hazleton basin and is located one mile south of the Borough of Jeddo in Hazle Township, Luzerne County. The overflow itself enters out into a small ponded area just east of the railroad tracks north of Ashmore Yards and then enters Hazle Creek, a tributary of Black Creek.

The discharge contains relatively low acidity and aluminum concentrations as compared to the other discharges entering the Lehigh River watershed.

The Hazle Brook overflow, located near the borough of Jeddo, Luzerne County, fails to meet water-quality standards for aluminum, manganese, alkalinity, and pH.

Hazle Brook is the second mine discharge that enters Black Creek. Hazle Brook, with a mean flow of 668 gpm, contributes between 7 and 8% of the AMD discharged into Black Creek and 1% of the total AMD load to the Lehigh River. It fails to meet water quality standards for aluminum, alkalinity, iron, and pH.

(h) Quakake Drainage Tunnel

The Quakake Drainage Tunnel, started in 1899 and completed in 1902, was driven a total of 5,487 feet to drain the #3 and #4 slopes of the Jeansville basin (LaRegina). The tunnel is located in Packer Township, Carbon County approximately one mile southeast of the town of Beaver Meadows. The tunnel drains the Beaver Meadows, Coleraine and portions of the Spring Mountain deep mine workings (Quakake Tunnel Demonstration Project SL 135-10). All complexes, however, were interconnected by miners in an effort to increase gravity drainage from the mines. At present, surface water enters the mines by infiltration through fractured strata and abandoned strip pits. Natural drainage patterns of surface flow have been greatly disturbed by strip mining, which has created additional interconnections at higher elevations in the mine complexes (Quakake Tunnel Demonstration Project SL 135-10).

Completed in 1902, the Quakake drainage tunnel discharges nearly 5,600 gallon per minute into Wetzel Creek in Packer Township, Carbon County.

The tunnel drains to Wetzel Creek, a tributary of Black Creek. The tunnel discharge has the highest flow of any of the mine discharges entering the Lehigh River watershed with a mean of 5,565 gpm. The discharge contains relatively low average iron concentration of 0.67 mg/L, minimal alkalinity (1.7 mg/L), and average acidity and aluminum compared to the other discharges entering the Lehigh River. The discharge fails to meet water quality standards for aluminum, manganese, alkalinity, and pH.

(i) Lausanne Tunnel

Construction by Lehigh Coal & Navigation Company on the Lausanne Tunnel began in July 1905. It is 24,000 feet in length and was estimated to cost $700,000 at the time of construction. The purpose of the tunnel, which discharges into the Nesquehoning Creek approximately 200 yards before its confluence with the Lehigh River, was to dewater portions of the Southern Coal field in order to facilitate mining. The tunnel is located two miles north of the town of Jim Thorpe, Carbon County.

The Lausanne mine drainage tunnel is 24,000 feet in length, discharges into the Nesquehoning Creek near Jim Thorpe, and, unlike other discharges into the Lehigh River, is relatively high in alkalinity.

The Lausanne discharge has a relatively high alkalinity (81 mg/L) and is the only alkaline discharge entering the Lehigh drainage basin. The Lausanne Tunnel, with an average flow of 4,618 gpm, is the largest mine discharge impact to the quality of the Lehigh River due, in part, to its close proximity to the river and to its high sulfate load. The discharge has an average pH of 6.3 and has the highest sulfate concentration of all the mine discharges entering the Lehigh River watershed.

Lausanne Tunnel is the only mine discharge that enters Nesquehoning Creek. However, based on the information collected, other point or non-point AMD sources are believed to be entering Nesquehoning Creek above the Lausanne Tunnel discharge. Further study is necessary to identify the locations of additional AMD sources impacting Nesquehoning Creek and the Lehigh River. The Lausanne discharge represents approximately 46% of the AMD entering the Nesquehoning Creek and between 24 and 25% of the mine drainage load entering the Lehigh River. Because the Lausanne Tunnel is the only identified source of AMD entering the Nesquehoning Creek, a "calculated" (determined by summing the discharges) load would be 100%. Because the "measured" percent contribution of Lausanne to the Nesquehoning is 46%, we can conclude that 54% of the AMD parameters identified in the tributary are coming from the above-mentioned unidentified source or sources. This 54% equals 21,928 lbs/day, which is nearly 30% of the AMD entering the Lehigh River. Total dissolved solids, aluminum, manganese, sulfate, iron, and hardness all fail to meet DEP water quality standards at the Lausanne Tunnel.

The Lausanne Tunnel dewaters portions of the Southern Coal field, but much of the pyretic-bearing material that was once in these areas has been mined and removed. The Nesquehoning Valley was used extensively to process coal extracted from portions of the Southern Coal field. The Nesquehoning Valley is not underlain by coal but is being impacted by the culm and coal waste generated in this process that has been relocated from the Southern Coal field into the Nesquehoning Creek watershed. Upstream from the Lausanne Tunnel are numerous large culm banks, which are likely the contributor of, or at least a significant portion of, the remaining 54% of the AMD load to the Nesquehoning Creek.

(j) Summary of Discharge Loads

Table 3-9 summarizes the loads and the percent contribution of AMD parameters from each discharge to their receiving stream. The Lausanne Tunnel has the highest total AMD load of the eight discharges. Owl Hole and the Quakake Tunnel are the next two most impacting discharges. Quakake has the second largest total AMD load, but Owl Hole has a very high aluminum concentration.

b. Water Quality in the Delaware River Basin, Pennsylvania, New Jersey, New York, and Delaware, 1998-2001 , USGS

Since 1991, the U. S. Geologic Survey (USGS) has conducted the National Water Quality Assessment (NAWQA) Program. Scientists in the NAWQA program work with partners in government, research, and public interest groups to assess the spatial extent of water quality conditions, how water quality changes with time, and how human activities and natural factors affect water quality. The Delaware River basin is one of 51 water-quality assessments initiated since 1991 and was intensively investigated between 1997 and 2001. The study design was based on analyses of the geology, physiography, population, and land use.

Ten fixed surface water sample sites were monitored from 1998 to 2001, two of which, the Jordan Creek near Schnecksville and the main stem at Glendon, are in the Lehigh River water-

TABLE 3-9. LOADS AND PERCENT CONTRIBUTION OF AMD FROM EACH DISCHARGE.

	SANDY RUN TRIBUTARY			BUCK MOUNTAIN		BLACK CREEK		NESQUEHONING
Load, lbs/day	**Sandy Run**	**Pond Creek**	**Owl Hole**	**Buck #1**	**Buck #2**	**Quakake**	**Hazle Brook**	**Lausanne**
TDS	2979.57	407.23	12336.86	137.05	6617.24	18019.42	1117.69	27765.52
Acidity	694.97	40.70	4083.41	37.64	2187.92	3571.24	224.50	0.00
Aluminum	67.81	1.55	578.22	4.31	277.69	406.88	13.70	78.69
Manganese	32.49	2.11	97.98	0.88	65.81	106.63	3.57	140.77
Sulfate	1020.30	127.34	4177.01	42.96	2476.45	6182.89	551.45	18267.05
Alkalinity	2.98	34.68	0.00	0.22	0.00	113.77	52.60	4484.05
Total Iron	32.80	1.18	26.07	0.34	16.34	44.64	45.70	246.06
pH	3.7	4.7	3.7	3.8	3.6	4.0	4.3	6.3
Flow (gpm)	771.45	349.98	2340.21	57.53	1366.70	5564.60	668.15	4618.35
Calculated % AMD to Tributary*	16.83%	1.57%	81.60%	1.69%	98.31%	92.48%	7.52%	100.00%
Measured % AMD to Tributary**	13.22%	1.24%	64.09%	2.04%	118.85%	58.37%	4.75%	46.07%
Calculated % AMD to Lehigh River*	2.41%	0.23%	11.71%	0.11%	6.56%	13.47%	1.10%	24.47%
Measured %AMD to Lehigh River**	2.48%	0.23%	12.05%	0.12%	6.75%	13.86%	1.13%	25.18%

Note: Because of loading and unloading factors, accurate percent AMD contribution is difficult to determine. For ranking purposes, the total AMD load of each tributary was calculated using both a "measured" load and a "calculated" load:

* % Discharge AMD load was calculated using the sum of a tributary's AMD discharges.

** % Discharge AMD load was calculated using the load measured at the tributary mouth.

shed. Synoptic surveys were conducted at more than 80 sites throughout the Delaware basin to describe spatial distributions of contaminants and examine relations among land use, water quality, and biological communities. Bed-sediment and fish-tissue samples were collected throughout the basin to document the distribution of metals, organochlorine pesticides, industrial compounds, and semi-volatile organic compounds. Water quality studies were also conducted on domestic wells in three aquifer systems: the clastic rocks of the Piedmont province, the clastic rocks of the Valley and Ridge province and the unconsolidated glaciofluvial valley sediments in the Appalachian and Valley and Ridge provinces.

1. MAJOR FINDINGS

Stream water quality and the health of aquatic life in rivers of the Delaware basin are greatly affected by human activities related to agricultural and urban development. Many nutrients, pesticides, and VOCs (Volatile Organic Compounds) were detected in stream samples, but con-

centrations were low and met most federal and state drinking water quality guidelines. Current guidelines, however, do not address the occurrence of many of these chemicals or the mixtures of compounds that commonly were detected in streams. Organic and trace element contaminants were detected in streambed-sediment and fish-tissue samples from many streams and rivers throughout the Delaware basin. Concentrations of these compounds typically were higher in samples from urban watersheds than those from streams in other land use settings, and commonly failed to meet guidelines for protection of aquatic life and fish-eating wildlife.

Two of the most heavily applied pesticides in agricultural areas of the Delaware basin, atrazine and metolachlor, were detected in more streams (over 70 %) and wells (almost 30 %) than any other pesticide. Also commonly detected in streams were four pesticides: prometon, diazinon, carbaryl, and chlorpyrifos that are associated with non-agricultural land uses. Surface water concentrations of atrazine, metolachlor, and pendamethalin increased with the percentage of the drainage basin occupied by agricultural land. Surface water concentrations of four other frequently detected pesticides (prometon, diazinon, carbaryl, and chlorpyrifos) were found to increase with the percentage of the drainage basin occupied by urban land. In general a greater number of pesticides were detected at urban than at agricultural sites.

2. PESTICIDES

Comparisons of individual pesticide concentrations in surface water and groundwater to drinking water criteria indicate that pesticides are not a public health risk. No drinking water criteria were exceeded in homeowner wells sampled. The health effects of many of these compounds is unknown because drinking water criteria exist for only 19 of the 35 pesticides and pesticide degradation products detected,. In addition, none of these standards takes into account the possible synergistic effects of the pesticide mixtures that are often present in water samples. For instance, cumulative concentrations of all pesticides and degradation products in more than 14 % of domestic wells sampled exceeded 1 mg/L, and five or more compounds were detected in more than 18 % of wells. Although surface water treatment plants can reduce the concentrations of some of these contaminants, the combined effects of prolonged exposure to multiple co-occurring compounds on human health are unknown.

Diazinon was the pesticide that most often exceeded aquatic biota criteria. As with drinking water standards, benchmarks are not available for all pesticides and their degradation products. Because of the possible synergistic effects of mixtures of pesticides are not considered, some of the hazards of pesticides to aquatic life may be unknown.

3. ORGANOCHLORINE COMPOUNDS

Organochlorine compounds were widely detected in streambed sediment and fish tissue throughout the Delaware River basin, even though the manufacture and use of these compounds were prohibited more than 20 years before the study. The most commonly detected organochlorine compounds were DDTs, PCBs, chlordanes, and dieldrin. This result indicates that these compounds persist in the physical environment at concentrations less than laboratory detection limits, and are biomagnified (increased in concentration at higher levels in the food chain) to detectable concentrations by fish and other organisms.

DDT, the most frequently detected organochlorine compound, occurred in fish tissue and/or bed sediments from more than 80 % of wadable streams in forested, agricultural and urban watersheds and in the main stems of the Lehigh, Schuylkill, and Delaware Rivers.

Concentrations of DDT in fish tissue and bed sediment, like its detection frequencies, were highest in urban watersheds and lowest in forested watersheds.

PCBs were widely detected in fish tissue throughout the study area. They were detected in fish from wadable streams in all land-use settings and from the Lehigh, Schuylkill, and Delaware Rivers. Detections in bed sediment, however, were limited to streams in urban settings and large rivers downstream from major population centers.

4. Wildlife Protection

Concentrations of dieldrin, PCBs and DDT exceeded wildlife protective guidelines (Newell et. al. 1987) at many sites, especially at a high percentage of urban sites. Harmful concentrations of organochlorine compounds were more likely to occur in fish and bed sediment from urban streams and from large rivers downstream from urban or industrial areas than in streams and rivers in agricultural or forested watersheds. Thus, fish in streams in urbanized watersheds are most likely to contain multiple organochlorine compounds at concentrations of concern. Concentrations of PCBs in fish from the Lehigh, Schuylkill, and Delaware Rivers exceeded wildlife protective levels. Streambed sediments in many urban settings may be harmful to aquatic life. Many urban sites had concentrations of multiple co-occurring organochlorines that exceeded sediment criteria.

An analysis of historical data from reaches of the Delaware and the Schuylkill indicate that the fish-tissue-PCB concentrations have declined in the past 20 to 30 years. However, limited data indicates that less improvement has occurred in the Lehigh River (Riva-Murray et. al. 2003). PCB concentrations in game fish fillets collected in 1998 from the Lower Delaware, Lehigh, and Schuylkill Rivers still exceeded the lowest fish consumption advisory criterion for humans.

5. Semi-Volatile Organic Compounds

One or more semi-volatile organic compounds (SVOCs) were detected in 95 % of the streams sampled. SVOCs analyzed in the study include three broad groups: PAHs (polycyclic aromatic hydrocarbons), phthalates, and phenols. Compounds in all three of these groups were detected at 46 % of sample sites. Some of these compounds are probable human carcinogens, are endocrine disrupters, and are toxic to aquatic organisms.

6. Trace Elements

Trace elements that are contaminants of concern, such as arsenic, cadmium, chromium, copper, lead, nickel, and zinc were detected in bed sediment at all sites sampled. Although many of these trace elements occur naturally in the environment, their presence in high concentrations at some sites indicates that aquatic biota may be at risk from sediments contaminated by multiple trace metals in many streams throughout the basin. Chromium, lead, nickel, and zinc were the metals whose concentrations most frequently exceeded the threshold at which adverse biological effects commonly occur.

Concentrations of every trace metal contaminant (except arsenic) generally were higher in streams in urban watersheds than in streams in other land-use settings (Romanok et. al. 2003). Many of the forested sites at which levels of cadmium and zinc were elevated are in the headwaters of the Lehigh and Schuylkill rivers, where coal was mined extensively. Moreover, the Lehigh River received atmospheric discharges from the New Jersey Zinc Company's zinc smelt-

ing operation at Palmerton. Concentrations of cadmium and zinc were highest at two stream sites on the Lehigh River.

7. MERCURY

Elevated mercury concentrations were found in fish collected throughout the Delaware River basin. Concentrations exceeded the human health criterion (0.3 mg/g, U.S. Environmental Protection Agency, 2001) at 22 % of the sample sites, and exceeded the criterion for protecting fish-eating wildlife (0.1 mg/g, U.S. Fish and Wildlife Service, Eisler 1987) at 87 % of the sample sites. These criteria were exceeded at sites in both urban and forested land use settings, and the wildlife criteria was exceeded at some agricultural sites.

8. VOLATILE ORGANIC COMPOUNDS

One or more volatile organic compounds (VOCs) were detected in 92 % of stream samples and 59 % of well samples. Water samples were analyzed for 85 different VOCs. Forty-two VOCs were detected at all streams sampled and 26 VOCs were detected in 45 of the 76 wells sampled. The most frequently detected classes of VOC compounds were chlorinated solvents and disinfection by-products (compounds produced when water is disinfected). Many compounds that are components of gasoline, compounds such as benzene, toluene, ethylbenzene, and xylene, were detected frequently in surface water, but were not detected in groundwater, most likely because they are readily biodegradable in the subsurface at low concentrations. The only gasoline-related compounds found in groundwater were gasoline oxygenates such as Methyl tert butyl ether (MTBE) that are not readily biodegradable.

Although VOCs were detected frequently, concentrations generally were low. Concentrations in surface water and groundwater met drinking water criteria; however, these criteria exist for only 23 of 42 VOCs detected in surface water, and 21 of 26 VOCs detected in groundwater. Concentrations of VOCs in surface water met benchmarks for aquatic biota, but these benchmarks exist for only 19 of 42 VOCs detected in the study area.

Analysis of surface water samples also indicated that the number of VOC compounds detected and the frequency of detection were highest in the group of urban sites, intermediate in the group of agricultural sites and lowest at the forested sites. In general, the same classes of compounds (solvents, gasoline, and disinfection by-products) were detected at both agricultural and urban sites, but the frequency of detection and number of compounds detected was lower at agricultural sites than at urban sites. This pattern of higher VOC detection in both surface and groundwater in urban regions reflects a greater intensity of use or production of solvents, gasoline products, and sewage in urban areas than in other areas.

9. ARSENIC

Arsenic was detected in more than 70 % of the domestic wells sampled in the Piedmont clastic rocks, but was detected in only 20 and 6 % of the wells in the Valley and Ridge and glaciofluvial aquifers, respectively. The median concentration for arsenic was 2.8 mg/L in the Piedmont region and below 1.0 mg/L in the Valley and Ridge and glaciofluvial regions. Arsenic concentrations in samples from two wells in the Piedmont exceeded the 10 mg/L drinking water standard.

B. Groundwater

As rain and snow fall to the earth, some of the water soaks into the ground and moves downward. It first passes through a zone where the open spaces in rocks and soil are filled with a mixture of air and water and then passes to the water table, below which all of the pore spaces between soil and rocks are filled with water. This saturated zone below the water table is called groundwater. Groundwater does not stay in one place, but flows from upland, recharge areas to groundwater discharge areas such as marshes, lakes, streams, rivers, and springs. Except for a short time during and after precipitation events, all the water in a stream is provided by groundwater seeping through streambanks and streambeds—technically known as a stream's base flow. How fast groundwater moves depends on the type of rock or soil through which it travels. It may travel several feet per day or only a few inches per year. Groundwater usually moves in parallel paths or layers, and there is generally little mixing of water in these layers. Most water seeping into the soil moves only a few miles to the point where it is discharged; in most instances, it stays within the same watershed.

When the well is dry, we will know the worth of water.
—Benjamin Franklin

Groundwater in Pennsylvania is a vast resource, estimated at more than twice the amount of water that flows annually in the state's streams. Excluding electric power plants, which rely almost exclusively on surface water, groundwater accounts for about 12 % of all water use in the state. Daily groundwater use in the Commonwealth amounts to more than three-quarters of a billion gallons. In addition, almost half of the groundwater used is for drinking water supplies, which demand high quality, uncontaminated water. Groundwater is vital and furnishes almost four and a half million Pennsylvanians (about 37 % of the population) with the water they use every day. It also helps meet the water needs of industrial, mining, and agricultural operations statewide (Pennsylvania Association of Conservation Districts, 1995).

1. AQUIFERS

Geologic formations that can readily store and transmit useable amounts of water are called aquifers. Aquifers can be as large as several states or as small as a few acres. They can be found a few feet or hundreds of feet below the surface, and their thickness can likewise run from a few feet to hundreds of feet deep. In Pennsylvania, most aquifers are consolidated aquifers, where limestone, sandstone, granite, and other rock holds the water in interconnected fractures, small cracks, pore spaces, spaces between rock layers, or channel openings. The amount of water held and yielded by consolidated aquifers depends on the size of the rock openings and cracks. Limestone aquifers yield the most water; sandstone aquifers moderate amounts; and granite aquifers yield the least. The aquifers of the Lehigh River watershed, as defined by the USGS) are listed in Table 3-10.

TABLE 3-10. AQUIFERS OF THE LEHIGH RIVER WATERSHED (Source: USGS Principal Aquifers of the 48 Contiguous United States, 1998)

Aquifer	*Mi2*	*Rock Type*
Valley and Ridge aquifer	749	Shale, slate, sandstone, conglomerate, and some carbonates
Valley and Ridge carbonate-rock aquifer	224	Carbonates
Early Mesozoic basin aquifer	6	Sandstone

Open spaces (woodlands, vacant lands, parks, etc.) found throughout the watershed are valuable for more than just their recreational, aesthetic, and habitat benefits. These areas also provide the necessary area for precipitation to infil-

trate to the groundwater table. By preserving open spaces, we will be protecting our groundwater resources. Since a river or creek is actually the surface water expression of the groundwater table, by preserving groundwater recharge areas, the flow of the stream will be sustained, especially during the dry summer months when some of the tributaries occasionally run dry. Not only are large open spaces such as the State Game Lands and State Parks critical recharge areas, smaller spaces such as city and municipal parks are important too. City parklands are particularly important because pervious surfaces are so scarce in an urban environment, making it extremely difficult to prevent or mitigate flooding and to protect and maintain adequate quality groundwater supplies.

2. GROUNDWATER QUALITY

Silica, iron, calcium, magnesium, sodium, potassium, carbonate, sulfate, chloride, nitrate, and hardness can all be naturally occurring constituents in groundwater. In general terms, groundwater obtained from the unconsolidated glacial drift in the northern portion of the watershed contains very small amounts of dissolved mineral constituent. The amount of dissolved mineral matter in waters from different rock formations varies widely, sometimes even within the same rock formation. However, certain formations generally show some similarities. Groundwater from the pre-Cambrian formations (gneiss and schist) are generally low in dissolved mineral content. Waters from formations composed of light-colored conglomerate or sandstone and red and green shales (such as the Pottsville, Pocono, Mauch Chunk, and Catskill formations) generally contain less dissolved mineral matter than water from formations composed of dark-colored shales, slates, or sandstones (such as the Hamilton and Marcellus formations) (Lohman, 1957). Waters containing the largest amounts of dissolved mineral matter come from carbonates (Lohman, 1957). Water pumped from coal mines contains an abundance of iron from the oxidation of pyrite in the coal, and is generally not acceptable as a groundwater source.

In general, the groundwater in the watershed is of good quality and does not contain enough mineral matter to be unsatisfactory for drinking. However, some water is moderately hard and some may contain high levels of dissolved iron and other minerals such as copper. Aside from the natural dissolved mineral matter in the groundwater, the quality of water in the watershed can be affected by any of the pollutants described in the section below. In addition, excavations that expose rocks to air and groundwater allow more minerals to react with air and to dissolve in the groundwater (Fleeger, 1999). If limestone or dolomite formations are disturbed in this way, higher pH (alkaline) water may result. If iron and sulfur minerals are present in the disturbed areas, acid drainage, which is characterized by low pH and high levels of metals and sulfates, may develop.

a. Factors Affecting Groundwater Quality

Protecting groundwater is of particular public concern because so many people derive their domestic water supplies from groundwater. The residency time for groundwater in aquifers can be measured in hundreds to thousands of years; therefore, once aquifers are damaged by pollutants, it may be difficult or impossible to reclaim them for continued use. Aquifers are also important because a significant portion of stream flow is supplied by groundwater (base flow) that emerges as springs or other seepages along the stream channel (Pennsylvania Association of Conservation Districts,1995). Therefore, maintaining high-quality groundwater is important in maintaining good quality stream flow. The most significant sources of groundwater contamination in Pennsylvania are described in Table 3-11.

TABLE 3-11. POTENTIAL SOURCES OF GROUNDWATER POLLUTION.

Municipal and Industrial Waste Disposal Sites
Biggest problems are abandoned sites, older unlined pits, and illegal dumping.

On-lot Sewage Systems
Poor design, installation and maintenance can leach nitrates, bacteria, viruses, detergents, and household chemicals into groundwater.

Agriculture
Most common problem is high levels of nitrate from over application of manure and fertilizer; most productive farmland in the watershed is located over areas with carbonate aquifers that allow for rapid infiltration and contamination.

Underground and Above Ground Storage Tanks
DEP estimates a potential 30,000 leaking tanks statewide; pollutants include hydrocarbons, especially gasoline (including MTBE), solvents, and other organic compounds from industrial sites, farms, gas stations, dry cleaners, and machine shops.

Garden Activities
Over application of fertilizers and pesticides by homeowners, golf courses, farms, etc can degrade water quality.

De-icing Operations
Can result in salt contamination when road salt is spread on roads or stored in piles without adequate protection against runoff.

Coal Mining
Mine drainage releases iron, manganese and sulfates to groundwater and surface water; deep mining of coal can fracture rock layers and, in turn, cause water to drain into a deeper aquifer.

Urbanization
Paved land cannot absorb precipitation and, as a result, much of the rainwater and snowmelt goes directly into streams rather than recharging local groundwater. Over pumping of aquifers to satisfy a growing concentrated population can also draw down aquifers.

Wells
Poorly constructed wells or deteriorating casings and grouting can be a direct pathway to groundwater; many abandoned wells have not been properly plugged or sealed.

Several natural processes can lessen the impact of pollutants as they are transported to groundwater: the trapping of suspended solids, biological decay, oxidation, and dilution. However, once in the groundwater, a contaminant forms a plume that can flow along the same path as the groundwater. Wells in the path of the plume will draw contaminated water and may be lost as water sources for years or decades. Cleaning up a contaminated aquifer is possible, but is typically slow and expensive. Prevention therefore remains the best approach to a clean groundwater supply. At the local level, prevention requires specific groundwater protection measures that are predominantly up to local governments. Information about the state's well had protection program is located in Part VII.

b. Previous Groundwater Quality Studies

The preliminary groundwater quality findings of the draft USGS NAWQA study conducted in the Delaware River basin are reported in this section (the final report will be issued in December 2003). Additional information on groundwater is available from a variety of USGS reports and the following websites:

- http://www.dcnr.state.pa.us/topogeo/groundwater/groundwater.htm
- http://waterdata.usgs.gov/pa/nwis/gw
- http://www.dep.state.pa.us/dep/deputate/watermgt/wc/subjects/groundwaterprotection/links.htm#data
- http://pa.water.usgs.gov/pa_pubs.html

Since 1991, the USGS has conducted the NAWQA Program. Scientists in the NAWQA program work with partners in government, research, and public interest groups to assess the spatial extent of water quality conditions, how water quality changes with time, and how human activities and natural factors affect water quality. The Delaware River basin is one of 51 water-quality assessments initiated since 1991 and was intensively investigated between 1997 and 2001. The study design was based on analyses of the geology, physiography, population, and land use.

Groundwater quality studies were conducted on domestic (household) wells. Wells constructed in the Valley and Ridge aquifer were the focus in the Lehigh River watershed. Wells in the Valley and Ridge aquifer were sampled once for dissolved oxygen, pH, alkalinity, specific conductance, temperature, turbidity, major ions, nutrients, organic carbon, 21 trace elements, 53 pesticides, 85 volatile organic compounds (VOCs), and radionuclides to provide a broad overview of water quality. Sampling results indicate that groundwater quality has been affected by human activities and geologic characteristics.

Pesticides were detected in the Lehigh River watershed; however, comparisons of individual pesticide concentrations in groundwater to drinking water criteria indicate that pesticides are not a public health risk. No drinking water criteria were exceeded in the homeowner wells sampled. It should be noted that drinking water criteria exist for only 19 of the 35 pesticides and pesticide degradation products detected, therefore, the health effects of many of these compounds is unknown.

VOCs were detected in wells in the Lehigh River watershed, the concentrations were low and met drinking water standards. In general, the frequency of VOC detections in wells was greater in the more urbanized areas.

Nutrients (nitrogen and phosphorous) are essential for plant growth, but in elevated concentrations they can degrade water quality. Most nitrogen detected in groundwater in the Lehigh River watershed was in the form of nitrate, because it is more soluble, not easily degraded, and unlikely to sorb to sediments. The drinking water standard was exceeded in two wells in the Valley and Ridge Aquifer in the Delaware River Basin. Nitrate concentrations in the Valley and Ridge aquifer were generally higher in the Great Valley where agricultural development is much more extensive than elsewhere.

Naturally occurring radon concentrations were greater than the proposed drinking water standard (300 pCi/L (picocuries per liter) in more than 96 % of the domestic wells sampled in the Delaware River basin. Concentrations ranged from 60 to 6,200 pCi/L; median concentrations were highest in the Piedmont region (1,820 pCi/L), followed by the Valley and Ridge (1,400 pCi/L), and the glaciofluvial aquifers (1,011 pCi/L). Some of the highest concentrations were measured in the Valley and Ridge, where concentrations in 33 % of the wells exceeded 3,000 pCi/L, and those in 13 % of the wells exceeded 4,000 pCi/L. Other forms of radioactive materials in water have also been identified as health risks. Some of these elements, such as radium-224, radium-226 and radium-228, as well as alpha- and beta- particle emitters, were analyzed for and detected in wells in the rocks of the Piedmont and Valley and Ridge regions. Many of these constituents are short-lived (decaying in a matter of days), but are a concern because particles emitted in the decay process can cause genetic damage and cancers. Gross alpha-particle emitters were detected in 72 and 8 % of the wells sampled in the Piedmont and Valley and Ridge provinces respectively, and exceeded the 15 pCi/L standard in 10 and 3 % of the wells in each region respectively. Gross beta particle emitters were detected in 41 and 30 % of the wells sampled in the Piedmont and Valley and Ridge respectively, but did not exceed the 15 pCi/L standard. The 5-pCi/L standard for radium-226 plus radium-228 was exceeded in 3 % of the wells in the Piedmont and none of the Valley and Ridge regions.

The NAWQA study concluded that the major influences on groundwater in the Delaware River basin are agricultural and urban development, use of pesticides and VOCs, characteristics of soils and aquifer materials, and naturally occurring radon.

C. Water Budget, Water Use, and Act 220

1. Water Budget for the Watershed

A water budget is a quantitative balance between the gains and losses of water in an area. To complete a water budget, one must numerically balance the water entering the watershed basin to the water leaving the basin through various phases of the hydrologic cycle, plus or minus any change in storage. An equation for determining a hydrologic budget is shown below.

$$P=Q+ET+U+\Delta SMS+\Delta GWS+D$$

where, ***P*** is Precipitation

Q is streamflow

ET is Evapotranspiration or water re-entering the atmosphere either directly through evaporation or indirectly through plant uptake

U is groundwater underflow

Δ***SMS*** is the change in Soil Moisture Storage during the time period

Δ***GWS*** is the change in Groundwater Storage during the time period

D is Diversions of water in or out of the watershed by man.

The USGS has stream gauging stations that collect time-series data that describe stream levels, streamflow (discharge), reservoir and lake levels, surface-water quality, and rainfall. Once a complete day of readings are received from a site, daily summary data are generated and stored in a database. Recent provisional daily data are updated on the web once a day when the computation is completed. These can be found at http://waterdata.usgs.gov/pa/nwis/sw/. Annually, the USGS finalizes and publishes the daily data in a series of water-data reports. Daily streamflow data and peak data are updated annually following publication of the reports. The USGS stream gauges in the Lehigh River watershed are shown on Map 3-10.

The stream gauge information collected at the Glendon station was used to perform a water budget for the Lehigh River watershed. Due to the limited amount of accessible groundwater flow data available, sophisticated water budget analyses were not possible within the scope of this report. A simplified annual water budget was conducted for the watershed using the equation $P = Q + ET$ such that:

1. ***Q*** is the annual volume of streamflow as measured at the USGS Glendon gauge in Easton from 1967-2002,
2. ***P*** is the annual precipitation measured at the ABE airport near Bethlehem, and
3. ***ET*** is the difference between P and Q.

For the determining ET, the variables U, SMS, and GWS were considered negligible compared to P and Q. These assumptions are generally considered reasonable when conducting an annual water budget over the hydrologic water year (October 1 – September 30). However, for unusually wet or dry years, changes in storage may be significant, which would affect the ET estimate. In addition, D was assumed to be zero for the calculation. Finally, it should be noted that Q is affected by the reservoir regulation at the Francis E. Walter Dam, which has been in place since 1961. A plot of the results of the calculation are shown in Figure 3-3. In addition, a plot of the runoff ratio (Q/P) for each year is shown in Figure 3-4. It can be seen that streamflow accounts for approximately 50-75% of the precipitation volume entering the watershed.

FIGURE 3-3 WATER BUDGET COMPONENTS FOR LEHIGH RIVER BASIN WY1967-WY2002

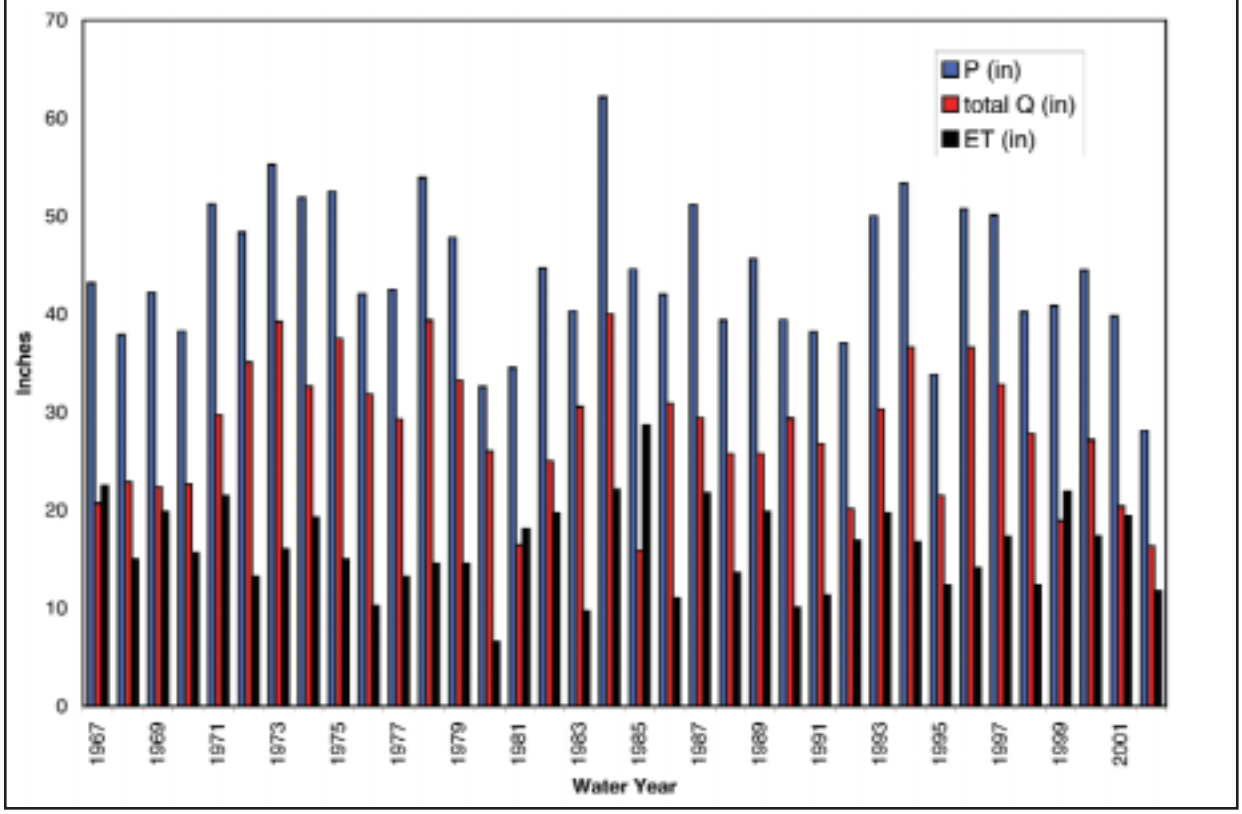
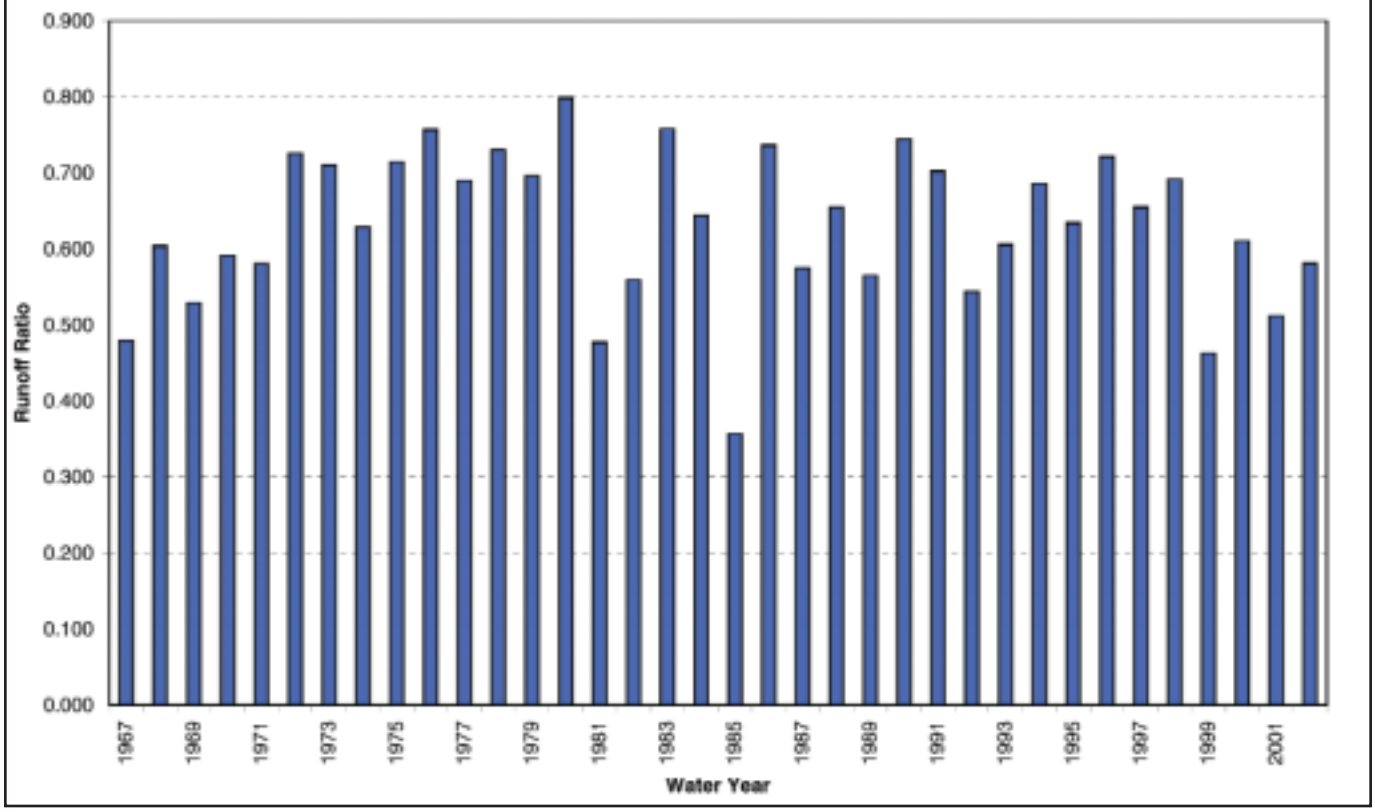


FIGURE 3-4 RUNOFF RATIO (Q/P) FOR LEHIGH RIVER AT GLENDON, WY1967-WY2002

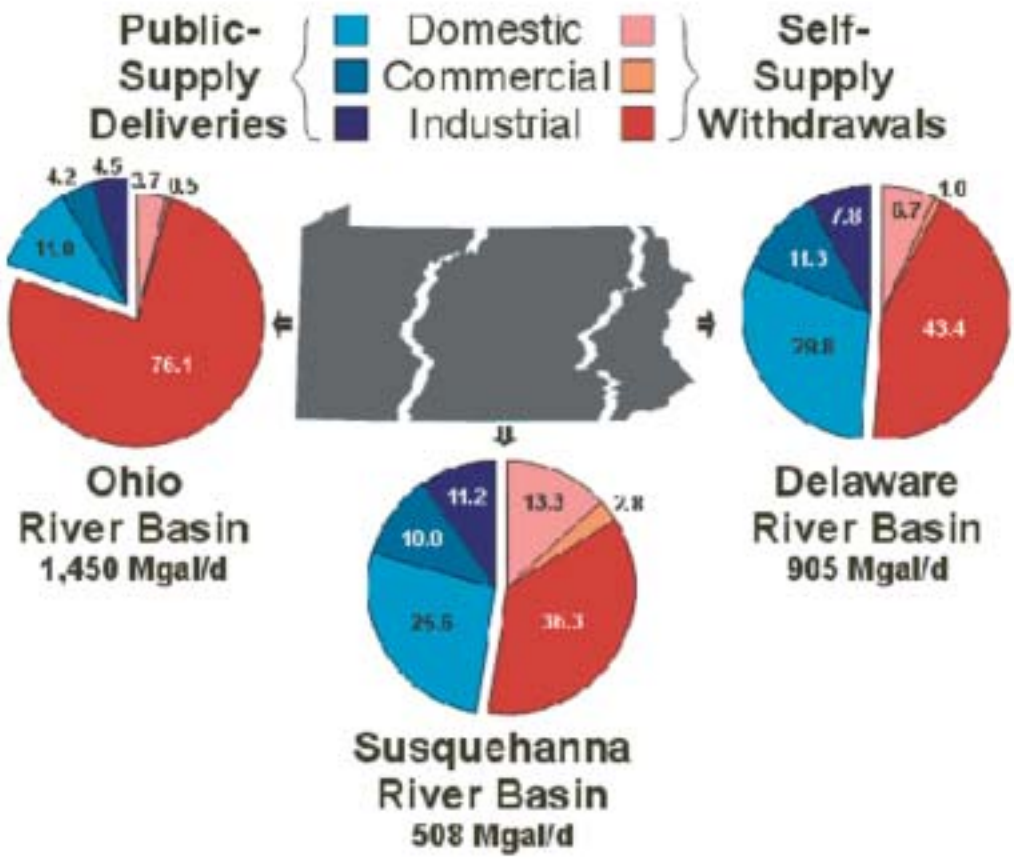


2. WATER USE

Water users obtain water from groundwater and surface water sources. The monitoring of water withdrawals in Pennsylvania is shared between the state (PADEP) and two river-basin commissions formed as federal-state compacts, the Delaware River Basin Commission (DRBC) and the Susquehanna River Basin Commission (SRBC). The PADEP regulates surface water withdrawals for public supply and provides overall supervision of all public suppliers in Pennsylvania. The DRBC has authority in the Lehigh River watershed to register all groundwater withdrawals greater than 10,000 gpd and review all surface water withdrawals greater than 100,000 gpd.

Figure 3-5 shows the average amount of surface water and groundwater used in Pennsylvania by both self-supplied water withdrawals (those who withdraw water for their own use) and public water withdrawals (those who withdraw water for use by other water users) in Pennsylvania's three major river basins (Ohio, Susquehanna, and Delaware river basins). The amounts shown in the Figure include deliveries and withdrawals in adjacent river basins to the extent the basins are within the borders of the Commonwealth. The pie charts indicate percentages of water use within each area. The Figure indicates that about 905 mgd are withdrawn from the Delaware River Basin, of which the Lehigh River Basin is a part. The primary water users in the Delaware River Basin are domestic public water supplies and self-supplied industrial water users.

FIGURE 3-5. PUBLIC-SUPPLY DELIVERIES AND SELF-SUPPLIED WITHDRAWALS IN PENNSYLVANIA'S THREE MAJOR RIVER BASINS. THE AMOUNTS INCLUDE DELIVERIES AND WITHDRAWALS IN ADJACENT RIVER BASINS TO THE EXTENT THE BASINS ARE WITHIN THE BORDERS OF THE COMMONWEALTH. PIE CHARTS INDICATE PERCENTAGES OF WATER USE WITHIN EACH AREA. ((USGS Fact Sheet 174-99, February 2000, Estimated Water Withdrawals and Use in Pennsylvania, 1995.)



Water resources have been a major factor in developing the Lehigh River basin. Nationally, Pennsylvania ranks second for total number of wells, second for total number of households wells, and third for total number of public water supply wells (Fleeger, 1999). The USGS estimated

surface and groundwater use in the Lehigh River watershed in 1990 as shown in Table 3-12. The table shows that public and industrial water supplies are the two major surface and groundwater uses in the Lehigh River watershed.

TABLE 3-12. AVERAGE WATER USE IN THE LEHIGH RIVER WATERSHED, (USGS, 1990)

	Withdrawals (million gallons/day)	
	Surface Water	***Groundwater***
Public Supply	38.7	45.2
Commercial	0.2	0.7
Domestic	0	6.8
Industrial	163.7	19.7
Mining	0.1	4
Livestock	0.1	0.5
Irrigation	0.5	0.1
Totals	203.3	77

TABLE 3-13. WATER-USE CHARACTERISTICS OF THE DELAWARE RIVER BASIN VS. THE LEHIGH RIVER BASIN IN 1996, (DRBC, 2003).

	Delaware River Basin	***Lehigh River Basin***
Area (sq.m):	13,539	1,345
Population (m) (est):	7.75	0.59
Total Withdrawals (MGD):	7,715	156
Consumptive Use (MGD):	318	21
Consumptive %:	4.1	13.5

The DRBC compared water-use characteristics of the Delaware River Basin and the Lehigh River basin, as shown in Table 3-13. The percentage of consumptive use in the Lehigh River Basin is more than three times the percent of consumptive use in the entire Delaware River Basin.

The estimated monthly surface withdrawals from the Lehigh River are shown in Figure 3-6. Figure 3-6 shows again that the major overall water withdrawals in the watershed are for industrial and public water supply uses. The three major consumptive water uses in the watershed are for industrial, public water supply, and agricultural purposes.

FIGURE 3-6. LEHIGH WATERSHED WATER USE IN 1996, (DRBC, 2003)

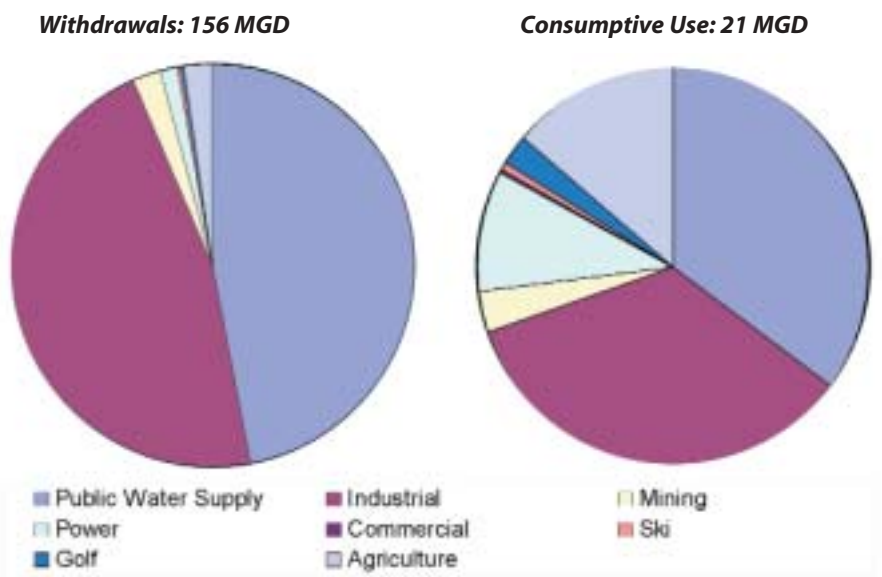


FIGURE 3-7. GROUNDWATER AND SURFACE WATER USE IN 1996, LEHIGH RIVER BASIN, (DRBC, 2003).

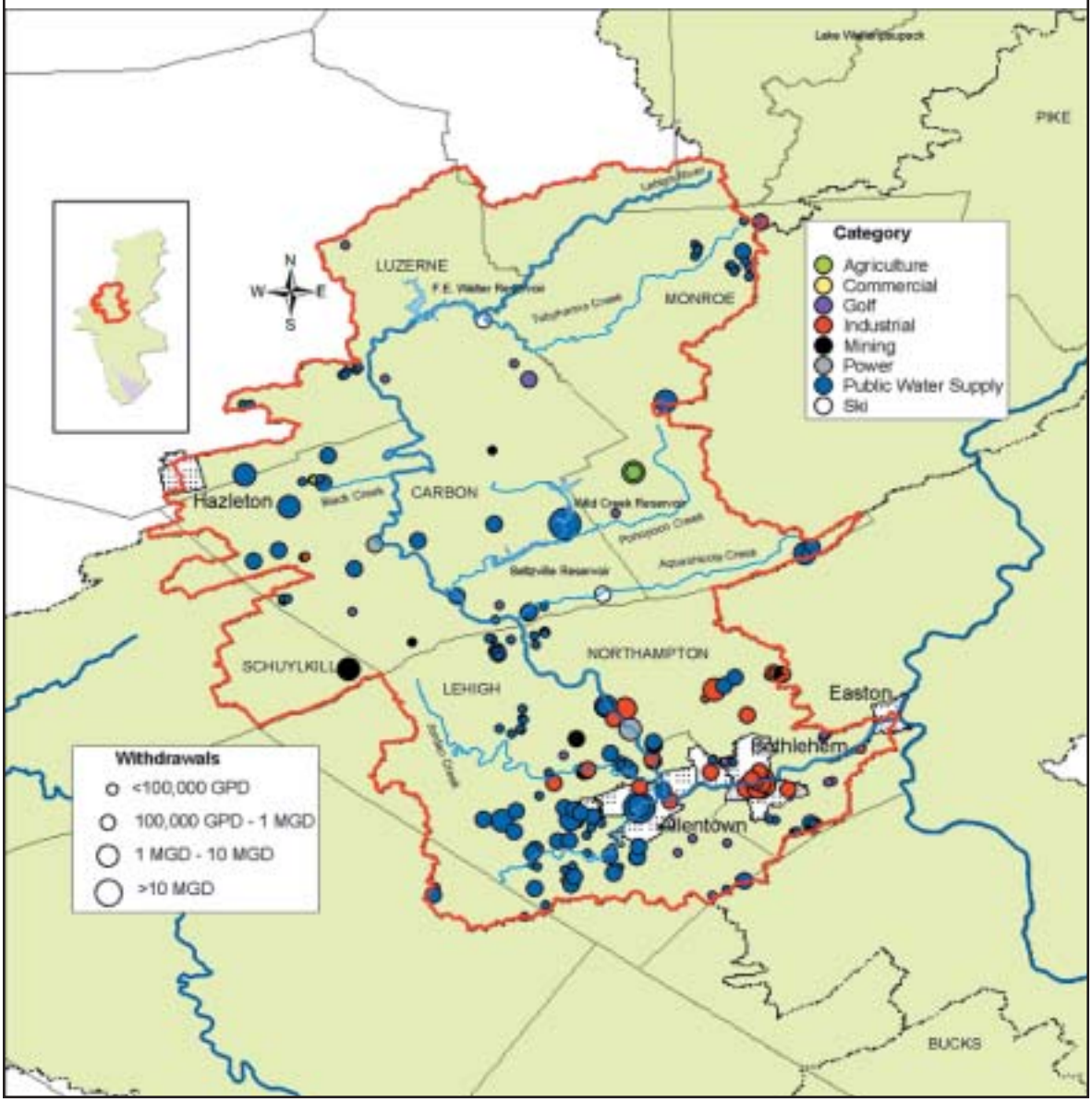


Figure 3-7 is a map of the Lehigh River watershed showing the combined surface and groundwater withdrawals in the river basin in 1996. The map shows that most water withdrawal occurs in the southern portion of the watershed.

Figure 3-8 is a bar graph comparing the surface and groundwater uses in the Lehigh River Basin from 1990 – 1996. Figure 3-9 shows monthly groundwater withdrawals in the Lehigh River from 1987-1996, and Figure 3-10 shows monthly surface water withdrawals from the basin during 1987-1996 and 2002. Groundwater use has generally remained the same from 1990-1996; however surface water use has changed. A large portion of the reductions observed in surface water use are attributable to Bethlehem Steel's water-use history. Water use at Bethlehem Steel decreased significantly between 1995 to 1999, and in 1999, Bethlehem Steel stopped reporting surface water withdrawals to DRBC.

FIGURE 3-8. LEHIGH WATERSHED AVERAGE DAILY WATER WITHDRAWALS, 1990-1996, (DRBC, 2003)

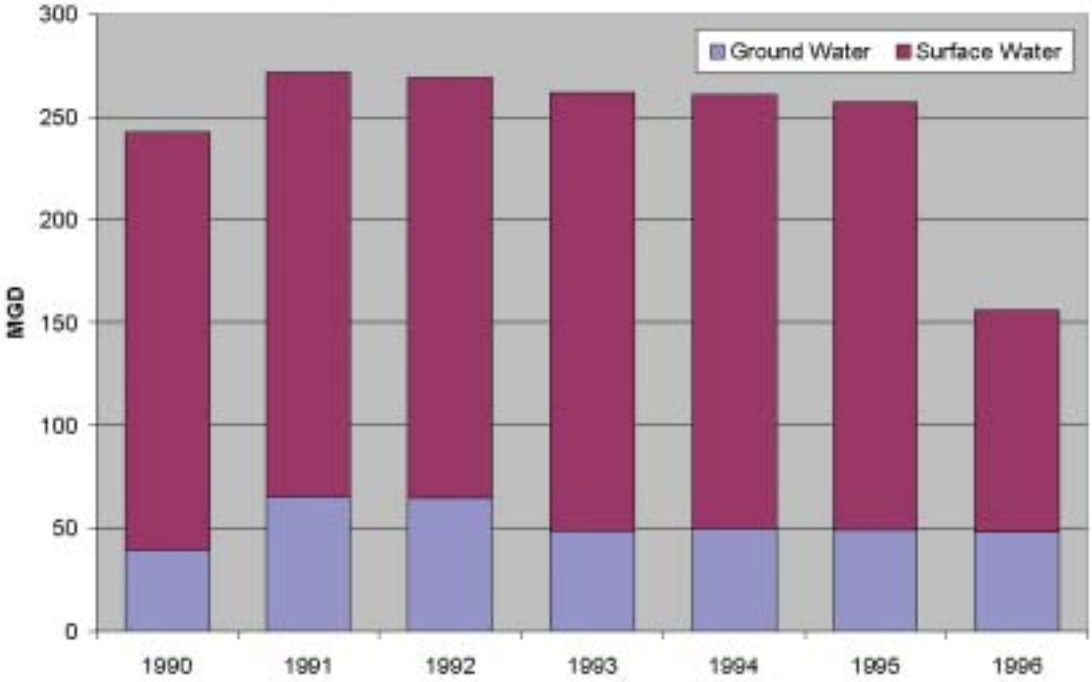


FIGURE 3-9. MONTHLY GROUNDWATER WITHDRAWALS IN THE LEHIGH RIVER WATERSHED, 1987-1996, (DRBC, 2003)

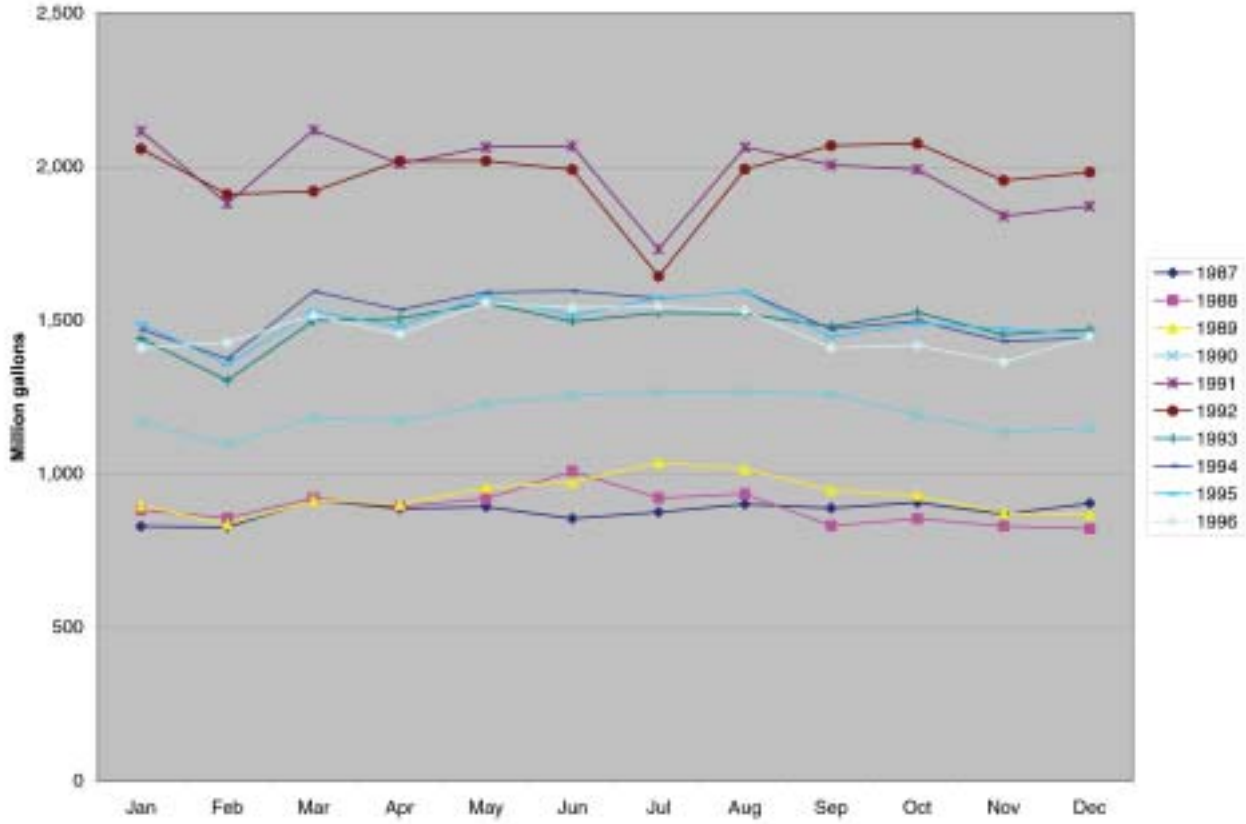


FIGURE 3-10. MONTHLY SURFACE WITHDRAWALS IN THE LEHIGH RIVER WATERSHED, 1987-1996 AND 2002, (DRBC, 2003)

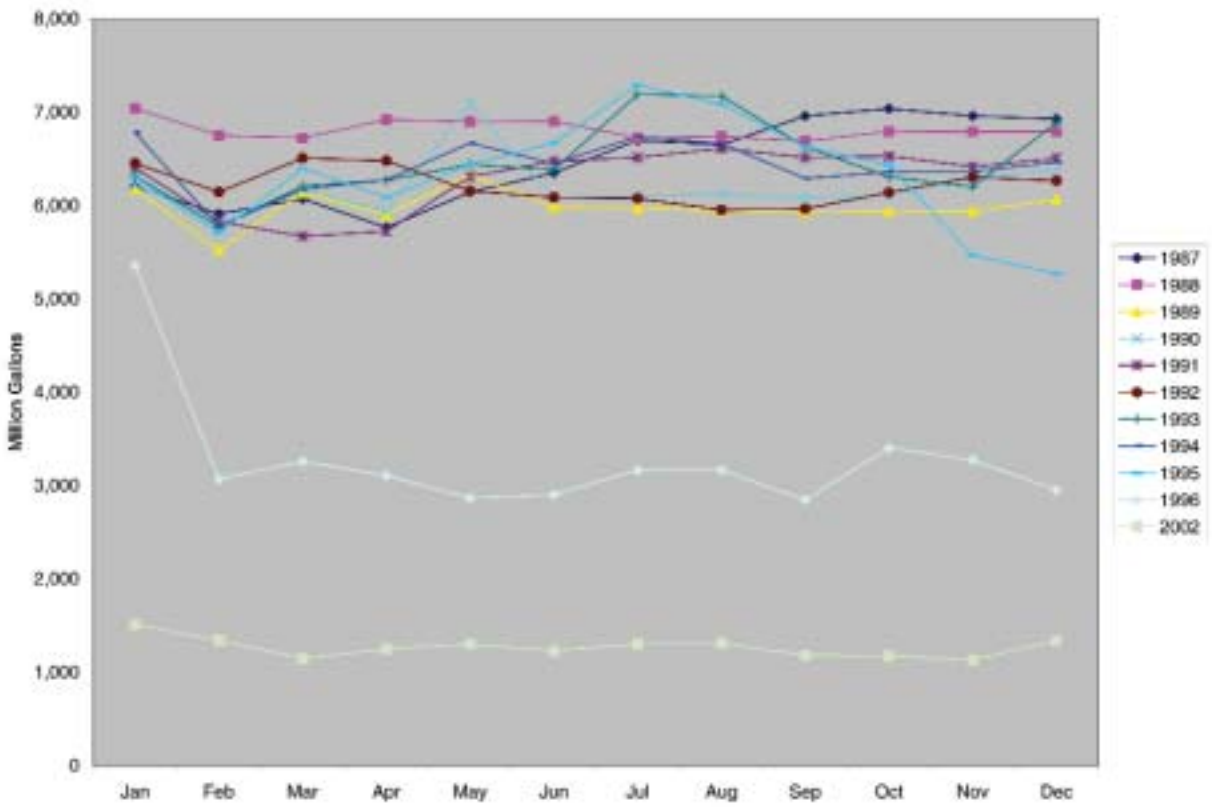


Table 3-14 lists the major surface water users in the watershed in 2002 (this table does not include groundwater users, since that data was not available). A total of about 15,250 million gallons of surface water were used in 2002. The two major surface water users in the watershed in 2002 were the Allentown Authority and the Bethlehem Authority.

3. ACT 220

In 2002, the Pennsylvania General Assembly enacted the Water Resources Planning Act (Act 220), which is designed to help the state better assess and plan for current and future water uses and needs. The Act requires the DEP to update Pennsylvania's State Water Plan over the next five years to determine how much water we have, how much we use, and how much will be available in the future.

The State Water Plan has not been updated in more than 25 years. As a result, we do not know which areas presently have critical water needs until wells or local water supplies dry up. Since 1990, residential water use has increased from 5 gallons to 62 gallons per person per day (DEP, 2003). Total water use in Pennsylvania has climbed to 10 billion gallons per day, and there are increasing conflicts over the same sources of water (DEP, 2003).

Act 220 requires any commercial, industrial, and agricultural, or individual activity that withdraws or uses 10,000 or more gallons per day, averaged over any 30-year period, to register and periodically report their water use to DEP. Those activities that use less than 10,000 gallons per day may choose to register voluntarily to help DEP get a more complete picture of water use.

TABLE 3-14. 2002 SURFACE WATER USE IN THE LEHIGH RIVER BASIN, (ALL VALUES IN MILLION GALLONS) (DRBC, 2003)

Use	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Use
POWER													
NORTHAMPTON GENERATING COMPANY L.P. *Annual Use Only*													509.4
PANTHER CREEK ENERGY FACILITY *Annual Use Only*													121.5
GOLF COURSE													
BLUE RIDGE COUNTRY CLUB	0.0	0.0	0.0	0.1	0.1	0.5	4.0	1.6	0.9	0.4	0.0	0.0	7.6
CENTER VALLEY CLUB, STABLER CO.	0.0	0.0	0.0	0.1	0.7	2.7	3.4	3.4	3.1	0.4	0.1	0.0	14.0
INDIAN MOUNTAIN GOLF COURSE	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.3	0.2	0.0	0.0	0.0	0.7
LOCUST VALLEY GOLF CLUB	0.0	0.0	0.0	0.0	0.5	0.8	3.4	3.3	1.6	0.1	0.0	0.0	9.7
MAHONING VALLEY COUNTRY CLUB	0.0	0.0	0.0	0.1	0.2	1.4	5.6	5.1	1.7	0.0	0.0	0.0	14.2
MAHONING VALLEY COUNTRY CLUB	0.0	0.0	0.0	0.0	0.0	1.3	4.4	4.1	1.8	0.0	0.0	0.0	11.6
MOUNTAIN LAUREL RESORT & GOLF CLUB *Estimated. No data supplied for 2002. Averaged annual total of 3.2 MG over five years 1997-2001*													3.2
POCONO FARMS COUNTRY CLUB	0.0	0.0	0.0	0.0	0.4	1.8	3.0	2.8	1.9	0.0	0.0	0.0	9.9
SAUCON VALLEY COUNTRY CLUB	0.0	0.0	0.0	0.0	2.1	3.5	9.4	10.3	6.9	1.8	0.2	0.0	34.2
SOUTHMOORE GOLF COURSE	0.0	0.0	0.0	0.6	1.3	3.0	4.3	5.0	3.2	2.7	0.6	0.0	20.7
TUMBLEBROOK GOLF COURSE	0.0	0.0	0.0	0.0	0.0	0.1	0.8	0.7	0.6	0.0	0.0	0.0	2.2
WEDGEWOOD GOLF COURSE INC	0.0	0.0	0.0	0.0	0.5	0.7	3.9	2.9	1.6	0.3	0.0	0.0	9.9

continued on next page

TABLE 3-14. 2002 SURFACE WATER USE IN THE LEHIGH RIVER BASIN, (continued)

Use	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Use
INDUSTRIAL													
BETHLEHEM STEEL CORP													
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ELEMENTIS PIGMENTS, INC (FORMERLY HARCROS PIGMENTS) *Annual Use Only*													53.2
HAB INDUSTRIES INC *Annual Use Only*													50.1
LAFARGE CORP, WHITEHALL CEMENT MFG CO *Annual Use Only*													395.2
PUBLIC WATER SUPPLY													
ALLENTOWN AUTHORITY													
	360.6	302.8	206.2	195.5	171.8	201.8	234.3	242.0	197.2	177.1	132.0	135.4	2,556.6
ALLENTOWN CITY *Annual Use Only*													11.2
BETHLEHEM AUTHORITY													
	11.0	0.0	0.0	112.7	137.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	261.0
BETHLEHEM AUTHORITY													
	462.1	409.4	451.0	454.4	477.1	483.0	532.5	531.9	472.2	478.8	464.5	494.3	5,711.2
HAZLETON CITY AUTH, BUCK MTN *Annual Use Only*													22.8
HAZLETON CITY AUTH, DRECK CREEK *Annual Use Only*													890.1
HAZLETON CITY AUTH, HUDSONDALE *Annual Use Only*													404.6
HAZLETON CITY AUTH, LEHIGH RIVER *Annual Use Only*													163.9
HAZLETON CITY AUTH, QUAKAKE *Annual Use Only*													0.0
HERCULES CEMENT CO *Annual Use Only*													0.0
JIM THORPE BORO WD													
	12.3	11.0	11.1	9.6	10.1	9.7	10.6	10.2	10.5	11.7	10.6	11.3	128.7
LEHIGHTON WATER AUTHORITY													
	15.4	15.4	13.6	13.8	14.7	16.0	15.2	16.1	17.0	14.7	15.1	14.4	181.4
LEHIGHTON WATER AUTHORITY													
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NESQUEHONING BORO AUTHORITY													
	0.0	0.0	0.0	0.0	20.7	36.5	0.0	1.1	1.2	21.6	32.8	30.0	143.8

TABLE 3-14. 2002 SURFACE WATER USE IN THE LEHIGH RIVER BASIN, (continued)

Use	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Use
PUBLIC WATER SUPPLY (continued)													
NORTHAMPTON BORO MA *Annual Use Only*													1,346.2
Pa. AMERICAN-BLUE MT *Annual Use Only*													644.0
PALMER WATER CO													
	0.0	0.0	0.1	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
PALMER WATER CO													
	22.7	19.7	19.9	20.4	23.3	25.4	26.1	23.7	22.7	25.1	22.2	22.0	273.1
SKI													
BEAR CREEK (FORMERLY DOE MTN) *Nov. and Dec. estimated; monthly average based on five month total.*													
	6.0	3.0	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.4	4.4	20.8
BIG BOULDER													
	67.4	62.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	85.4	215.0
BLUE MOUNTAIN													
	60.0	60.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	15.0	137.0
JACK FROST													
	51.3	18.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.6	83.3	159.9
												Totals	**15,239.1**

Act 220 created a statewide water resources committee to oversee the creation and approval of the updated State Water Plan. The act also creates six regional water resource committees, made up of representatives of business, agriculture, local government, and environmental interest, which will oversee the creation of water resources plans on the local level. These six committees will compile and review water-use data, take public comment, identify where existing and potential water-use conflicts and water quality issues may occur, and create recommendations for the State Water Plan. The regional committees will make recommendations to the statewide water resources committee, which will establish the approach and policies to guide the planning process. The statewide committee will also have a formal review and approval role of the updated State Water Plan. The statewide committee will be comprised of six members drawn from the regional committees and twelve members appointed by the governor. The statewide committee will include the heads of various state agencies and river basin commissions having jurisdiction in Pennsylvania. Additional information can be obtained from www.state.pa.us, keyword:"DEP Water Management."

The Regional Committee for the Lehigh River watershed, which is included in the Delaware River Basin, is as follows:

DELAWARE REGIONAL COMMITTEE

(from http://www.dep.state.pa.us/dep/deputate/watermgt/wc/act220/default.htm)

- Carol Collier-(compact admin)
- John J. Coscia-(planning director)
- Leonard E. Crooke-(production agriculture)
- Jeffrey Featherstone, Ph.D.-(professional)
- Julie Lyn Gallisdorfer-(local government)
- Lisa Hamilton-(industrial)
- The Honorable Kate Harper-(professional)
- Helen B. Haun-(local government)
- David A. Hodge-(horticulture)
- John Hoekstra-(environmental)
- Darryl A. Jenkins, P.E.-(industrial)
- Leonard Johnson-(industrial)
- Gary M. B. Kribbs, P.G.-(geologist professional)
- Michael Meloy-(professional)
- Howard Neukrug-(wastewater)
- Wayne "Ted" Reed-(water supply)
- Barbara L. Smith, Esquire-(local government)
- Michael M. Stokes-(planning director)
- Maya K. Van Rossum-(environmental)
- Robert Wendelgass-(environmental)
- Desiree Henning-Dudley- DEP-(DEP Representative)

D. State of the Delaware River and Bay

The Delaware River watershed encompasses 13,539 square miles in New York, Pennsylvania, New Jersey, and Delaware. About 50.3% of the watershed is located in Pennsylvania, 23.3% in New Jersey, 18.5% in New York, and 7.9% in Delaware. The watershed contains 42 counties and 838 municipalities. The river is fed by 216 tributary streams, the largest being the Lehigh and the Schuylkill rivers.

The Delaware River Watershed drains only 0.4% of the nation's land but nearly 10% of the nation's population, about 22 million, rely on the river system for water. Some of the 22 million live outside the watershed. A major source of water for New York City comes from the upper reaches of the Delaware watershed in the Catskill Mountains of New York.

In 1990, the watershed population was 7.3 million people with concentration in the metropolitan Philadelphia area. Since 1980 the fastest growing areas have been the Pocono counties of Pike, Monroe, and Wayne, and the southeastern Pennsylvania counties of Chester and Bucks. The Delaware River is within a day's journey for 40% of the nation's population.

The Delaware rises on the western slopes of the Catskill Mountains in eastern New York. At that point, the river consists of two branches: the West Branch and the East Branch. The West Branch is the chief branch; it flows southwest as far as Deposit, New York, and then turns southeast. From a point near Hale Eddy, New York, to Hancock, New York, it forms the boundary between Pennsylvania and New York. The East Branch parallels the course of the West Branch above Deposit. The two branches meet at Hancock. From this point, the Delaware, flowing southeast, continues as the New York-Pennsylvania boundary as far as Port Jervis, New York. There it becomes the boundary between Pennsylvania and New Jersey, following a generally southern course to its outlet in Delaware Bay. The lower Delaware forms the boundary between New Jersey and Delaware for a few miles.

Important tributaries of the Delaware include the Neversink, Calicoon, and Mongaup rivers in New York; Lehigh, Schuylkill, and Lackawaxen rivers in Pennsylvania; and the Maurice and Musconetcong rivers in New Jersey. The West Branch flows for 90 miles and the East Branch flows for 75 miles. It is 280 miles from the junction of the two branches to Delaware Bay.

The Delaware is a source of hydroelectric power and an important waterway. It is navigable by large, oceangoing vessels as far inland as Philadelphia and by smaller vessels to Trenton, New Jersey. A canal once connected Trenton to New Brunswick, New Jersey on the Raritan River. The canal has been filled in at numerous points, such as Manville and New Brunswick. The Chesapeake and Delaware Canal connects the Delaware River below Wilmington, Delaware, with Chesapeake Bay. The canal is navigable by oceangoing vessels. Through the Delaware River Basin Commission, created in 1961, the federal government and the four basin states—New York, Pennsylvania, New Jersey, and Delaware—jointly manage basin assets and problems.

Sections of the Delaware River are particularly scenic. Three reaches of the Delaware have been included in the National Wild and Scenic Rivers System. One section extends 73 miles from the confluence of the river's East and West branches at Hancock, New York. downstream to Milrift, Pennsylvania; the second is a 40-mile stretch from just south of Port Jervis, New York downstream to the Delaware Water Gap near Stroudsburg, Pa. Combined, these two river corridors take in 124,929 acres. The Lower Delaware Wild and Scenic Rivers Act, signed into law on November 1, 2000, adds about 65 miles of the Delaware and selected tributaries to the national system, linking the Delaware Water Gap and Washington Crossing, Pennsylvania, just upstream of Trenton, New Jersey Three-quarters of the non-tidal Delaware River is now included in the National Wild and Scenic Rivers System. The Maurice River in New Jersey (a Delaware Bay tributary) and the White Clay Creek in Pennsylvania and Delaware (which flows into the Christina River, a tributary to the Delaware) also have been included in the national system.

The Delaware Bay is an arm of the Atlantic Ocean, bounded on the northeast by New Jersey and on the southwest by Delaware. From its mouth, a channel about 12 miles wide between Cape May, New Jersey, and Cape Henlopen, Delaware, it extends generally northwest to the mouth of the estuary of the Delaware River. Its length is 50 miles and its width ranges from about 4 miles at the point of its confluence with the Delaware River estuary to 30 miles at its central portion. The depth of the bay varies from 30 to 60 feet. In addition to the Delaware River, it receives the waters of numerous streams and creeks of New Jersey and Delaware. The bay has few natural harbors, but Delaware Breakwater, at Cape Henlopen, provides Lewes, Delaware, with an excellent protected anchorage. Delaware Bay is the natural route followed by shipping to and from Wilmington, Delaware, Philadelphia, Pennsylvania, Camden, New Jersey, and Baltimore, Maryland. Baltimore and other points on Chesapeake Bay are reached by the

Chesapeake and Delaware Canal, a sea level, inland waterway navigable by deep-draft vessels. The waters of Delaware Bay yield large annual catches of oysters, clams, crabs, and lobsters.

An average annual rainfall of 44 inches falls on the Delaware River basin, and roughly half of the rainfall eventually becomes part of the stream flow. The water in the Delaware River is under considerable demand for use by surrounding populations because of the watershed's proximity to major industrial and population centers. Water withdrawals within the watershed are primarily used for power generation, public and industrial use, golf course irrigation, livestock watering, and snowmaking.

The Delaware River is cleaner than it has been in the past one hundred years (Lower Delaware National Wild and Scenic River Study Report 1999). Its waters support year-round fish populations, offering excellent trout, bass, walleye, striped bass, shad, and herring fisheries, which is in sharp contrast with its state even just forty years ago. The first impacts on the Delaware River occurred in the seventeenth century as settlers arrived and began to colonize the area. The primary impacts at this time were from wetland drainage, farming, intensive fishing, and land clearing. Pollution from raw sewage and industrial wastewater also became a significant impact as more people settled along the river. As early as the American Revolution, the water was so polluted, especially from sewage wastes that thousands of people who drank from the river became ill and died from waterborne diseases.

By the beginning of the twentieth century, many fish populations had already collapsed as a result of the significant pollution, habitat destruction, and over-fishing. Pollution from 1910-1930 remained significant over much of the Delaware River. Major causes of pollution at this time were coal mine runoff, inadequate sewage treatment, and industrial wastes. In 1936, the Interstate Commission on the Delaware River Basin was established by the four Delaware River basin states: New York, New Jersey, Pennsylvania, and Delaware. The commission was established in order to implement pollution control measures throughout the watershed. They succeeded in increasing the amount of wastewater treatment plants within the watershed that resulted in significantly improved water quality. Pollution to the Delaware River increased again during World War II due to industrial activity that supported the war effort. Pollution in the Delaware River reached its maximum after World War II, and its degradation was among the worst in the country (Lower Delaware National Wild and Scenic River Study Report 1999). Within the Delaware Estuary during 1946, the pollution was so significant that there was a 20-mile stretch of river, which contained no dissolved oxygen, thereby preventing all migratory fish passage. A breakthrough in water resources management occurred in 1961 when President Kennedy and the governors of Delaware, New Jersey, Pennsylvania, and New York for the first time signed concurrent compact legislation into law creating a regional body with the force of law to oversee a unified approach to managing a river system without regard to political boundaries. The DRBC began programs aimed at reducing pollution resulting from industrial discharge among other point sources of pollution, as well as creating more water treatment facilities and requiring more thorough treatment of wastes already entering the facilities. Because of these measures, water quality increased dramatically in the Delaware River.

The most significant impairments to the Delaware River today are, in descending order: flow alterations; siltation; heavy metals, excess nutrients, and pH; excessive algal growth; non priority organics; organic enrichment/low DO; other habitat alterations; water/flow variability; and pathogens (Delaware River Source Water Assessments 2001). Examples of continuing impairment to the Delaware River include the reach from Trenton to the Philadelphia/Bucks County border as well as other reaches in the Delaware Estuary, where fish advisories due to toxic sub-

stances found in fish tissues still occur periodically. The two tributaries that contribute the most water to the river between Trenton and Philadelphia, the Rancocas Creek in New Jersey and the Neshaminy Creek in Pennsylvania, have fair to poor water quality (Lower Delaware National Wild and Scenic River Study Report 1999). The major impacts on these tributaries are from residential, agricultural, and roadway runoff.

Dissolved oxygen in the Delaware Estuary has greatly increased from the 1940s and 1960s when, during periods of time in the summer months, there was no dissolved oxygen, and fish were unable to migrate through the water (Delaware Estuary Environmental Indicators 2001). In 1998, the dissolved oxygen levels remained around 6 mg/L throughout the estuary, which is high enough to sustain fish populations and allow migration (Delaware Estuary Environmental Indicators 2001). In 1992 and 1993, the water quality in the reach from the Delaware Water Gap to Trenton was generally good with the main impairment being occasionally high pH levels (Delaware Estuary Environmental Indicators 2001). Water quality in the reach from Trenton to the Philadelphia/Buck County border has also been improving, and in 1991, the reach obtained the swimmable goal of the Clean Water Act. A multi-year, interstate, toxic management program to address the problem of toxic substances in the water is also nearing completion. Although many pollution problems remain in the Delaware River, substantial increases in water quality have already been seen in the past forty years, and future increases in water quality are possible with more effort aimed at reducing the many non-point sources of pollution that are currently impairing the river.

E. Review of Lehigh River Aquatic Components

In general, the Lehigh River, its tributaries, and the groundwater reservoirs make up a complex hydrologic system that, if managed properly, should provide sufficient water for present and future needs. The quality of the water resources in the watershed is generally good with a few exceptions. In addition, the Lehigh River is cleaner today then it has been in the last 150 years.

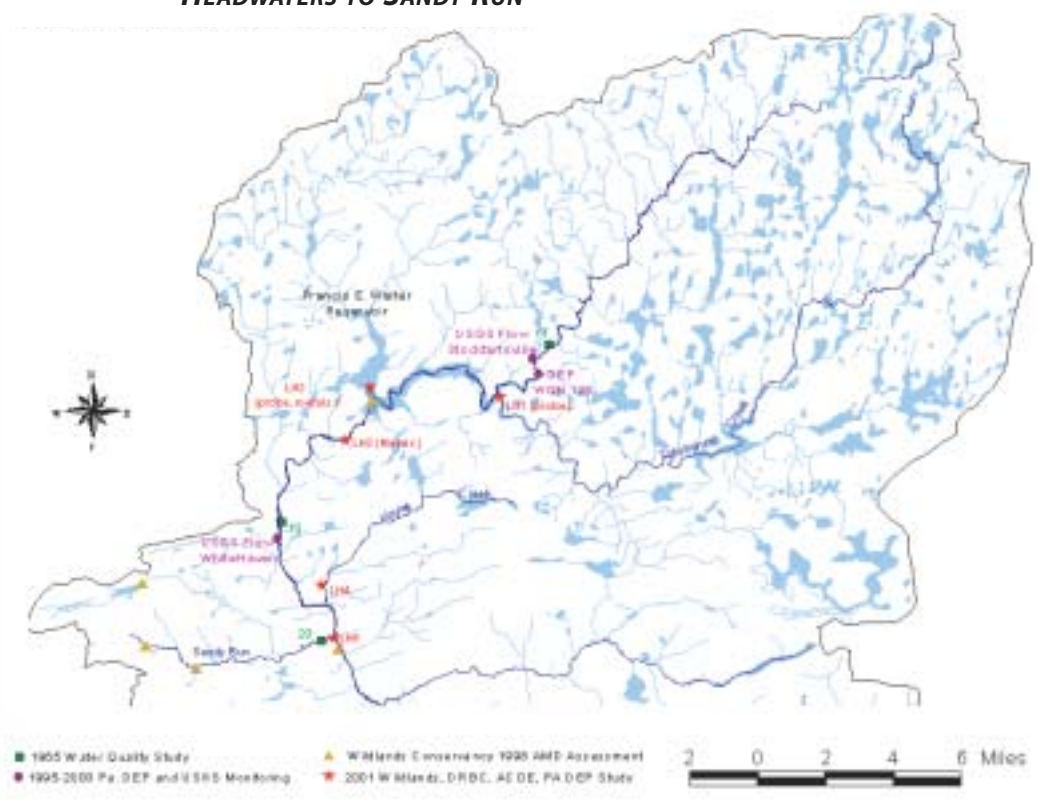
For summary purposes the Lehigh River watershed has been divided into three regions: from the headwaters to the river's confluence with Sandy Run; from Sandy Run to the Pohopoco Creek confluence at Lehighton; and from Lehighton to the Lehigh-Delaware River confluence in Easton.

This section of the Lehigh River is high in the watershed and adjacent to Pennsylvania Game Land #127. It is located in the Appalachian Plateau physiographic province.

1. Headwaters to Sandy Run

The first region, shown in Figure 3-11, represents the Lehigh River prior to any Abandoned Mine Drainage impacts. The major tributaries in downstream order are Tobyhanna Creek, Hayes Creek, and Sandy Run, which is the first of four AMD tributaries to enter the Lehigh. Francis E. Walter Reservoir is also in this region. This area is located in the Appalachian Plateau

FIGURE 3-11 WATER QUALITY MONITORING LOCATIONS: HEADWATERS TO SANDY RUN



Physiographic Province and is geologically characterized by the shale and sandstones of the Catskill, Pocono, and Mauch Chunk Formations.

TEMPERATURE

The Lehigh River and its tributaries in this section are currently classified as High Quality-Cold Water Fisheries (HQ-CWF). According to the 2001 water quality sampling, station LH1 (above F.E.W. at the Tobyhanna confluence), LH2 (just below F.E.W.), and LH3 (approximately 2.5 miles downstream of F.E.W.) did not comply with Pennsylvania DEP temperature requirements for a HQ-CWF.

The Pennsylvania Fish and Boat Commission collected water quality data in this region of the watershed (river mile 95.4) in July 1977 and June 2000 that indicated that water temperature during this period remained at 21.0° C, exceeding HQ-CWF standards.

In 1965, sampling at Stoddartsville and White Haven in August and September averaged 20.5°C, slightly exceeding HQ-CWF standards.

DISSOLVED OXYGEN

Dissolved Oxygen (DO) levels in this region are also of concern. Levels below the recommended 7.0 mg/L were recorded in 25% of the 2001 measurements at station LH1. Low DO levels (below 5.0 mg/L) occurred mostly in June and July. At station LH2, DO levels were rarely below 7.0 mg/L, indicating that Francis E. Walter is not adversely impacting dissolved oxygen levels in the river. Concentrations at this location were consistently above 8.0 mg/L and increased to above 10.0 mg/L by October.

Samples from DEP's Water Quality Network (WQN) station 126 indicate dissolved oxygen levels averaged 9.82 from 1995–2000 and were between 7.0 mg/L in July 1996 and 13.2 in December 1997. Measured DO levels never dropped below the 7.0 mg/L Pennsylvania DEP HQ-CWF standard at WQN 126 between 1995 and 2000. Throughout 2000-2001, dissolved oxygen levels averaged 10.89 mg/L at this site.

According to the 1965 sampling, dissolved oxygen at Stoddartsville was 9.3 mg/L and 8.7 mg/L at White Haven.

Temperature and dissolved oxygen are the parameters of concern in this region of the watershed and are likely attributable to the numerous dammed ponds and lakes that characterize the headwaters region.

pH

In 2001, pH levels in this region remained within the 6 to 9 range recommended by Pennsylvania DEP, with only 26 out of 3,000 records slightly below 6.0.

Between 2000 and 2001 pH at WQN 126 averaged 6.54 and between 1995 and 1997 averaged 6.22. Analysis by the Pennsylvania Fish and Boat Commission concluded that pH at river mile 95.4 did not change (pH=6.8) between 1977 and 2000. In 1965, sampling pH at White Haven ranged from 6.4 to 7.1.

NUTRIENTS

Nutrient concentrations in the region were normal in 2001. Ammonia levels averaged between 0.1 and 0.2 mg/L, nitrite concentrations were generally less than 0.02 mg/L and ammonia levels rarely violated Pennsylvania DEP criteria for the given temperature and pH of the sample. Phosphorous levels averaged less than 0.1 mg/L.

According to Pennsylvania DEP data from WQN 126, ammonia averaged 0.023 mg/L, nitrite was generally below detection limits, nitrate values averaged 0.16 mg/L, and phosphorous averaged 0.019 between 1995 and 2000.

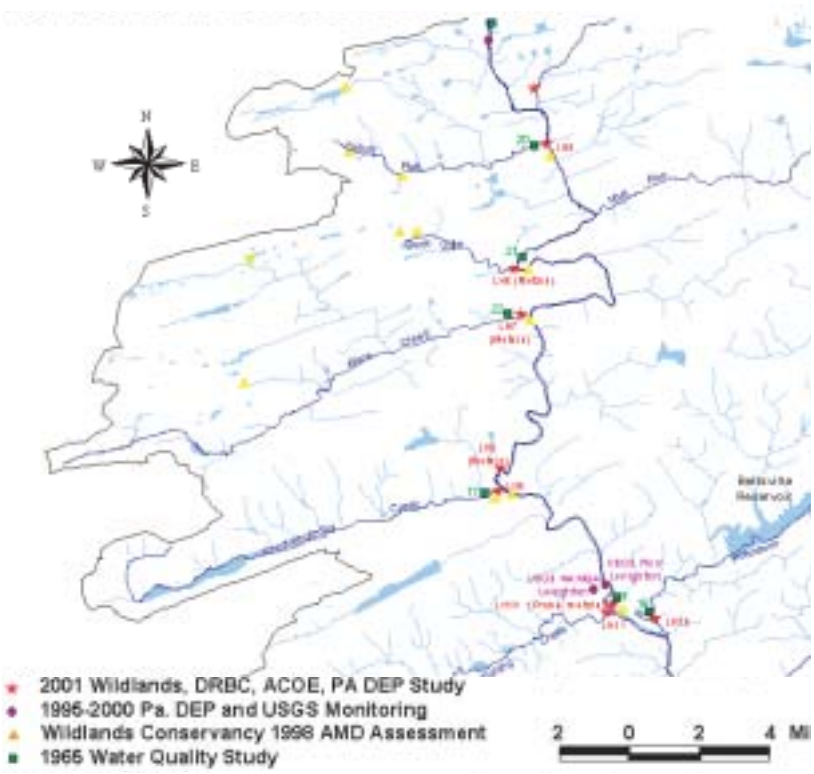
METALS

In 2001 metals analysis (aluminum, cadmium, iron, manganese, and zinc) revealed aluminum concentrations at LH2 and LH3 above the Delaware River Basin Commission's (DRBC) chronic criteria of 0.087 mg/L. Aluminum concentrations ranged between 0.11 mg/L at LH3 in May to 0.16 mg/L at LH2 in June. All other metal parameters in this region were within acceptable limits.

Sampling conducted by Pennsylvania DEP Bureau of Mine Reclamation during Wildlands Conservancy's AMD study showed aluminum concentrations at F.E.W. averaged 0.14 mg/L. Manganese averaged 0.07 mg/L, total iron averaged 0.27 mg/L, and sulfate averaged 16.55 mg/L at the dam during this 1998 study.

Pennsylvania DEP data from 1995-2000 showed aluminum concentrations at WQN 126 averaged 0.096 mg/L (above DRBC's chronic criteria). Other metal averages were: 0.017 mg/L Fe, 0.049 mg/L Mn, 0.010 mg/L Zn, 0.001 mg/L Pb, and 6.91 mg/L SO4.

FIGURE 3-12 WATER QUALITY MONITORING LOCATIONS: SANDY RUN TO POHOPOCO CREEK



2. SANDY RUN TO POHOPOCO CREEK

The second water quality region, shown in Figure 3-12, is the middle portion of the watershed and includes the four tributaries delivering abandoned mine drainage to the Lehigh River. These tributaries all enter the main stem from the west and in downstream order are Sandy Run, Buck Mountain, Black Creek, and Nesquehoning Creek. The non-AMD tributaries in this region include Mud Run, Pohopoco Creek, and Mahoning Creek. Beltzville Reservoir is located on Pohopoco Creek.

These streams drain portions of the Eastern Middle and Southern coal fields. Surfaces in this region have been extensively disturbed by surface mining and are presently scarred with open abandoned pits, spoil piles, and refuse banks. These abandoned deep and surface mining operations have destroyed the natural surface-water and groundwater systems within the mining area. The open pits and fractured strata allow all surface water not controlled at the surface to infiltrate into the deep mine workings. The quality of this water has been greatly affected through contact with acid-producing minerals present in the coal and associated rock exposed to infiltration water.

TEMPERATURE

The reach from station LH5 downstream through station LH10 is classified as a High Quality-Cold Water Fishery and station LH11 to LH12 is classified as a Cold Water Fishery (CWF). In 2001 temperatures above HQ-CWF critical use criteria were measured at LH8 (Glen Onoko) and LH10 (Lehighton), and LH7 (Black Creek) was occasionally over the CWF minimum in June and July. Water temperatures at tributary stations LH6 (Buck Mountain) and LH9 (Nesquehoning Creek) were below the CWF criteria for most of the study.

The USGS gauge station at Lehighton measured an average water temperature of 17.05°C with a maximum of 18.6°C. In August and September of 1965, water temperature at Lehighton averaged 22.7°C.

DISSOLVED OXYGEN

Dissolved oxygen in this region in 2001 was monitored at LH10 (Lehighton) and was never below the 7.0 mg/L HQ-CWF requirement. The average dissolved oxygen at the USGS Lehighton gauge was 10.4 mg/L between 1995 and 2000.

In August and September of 1965, dissolved oxygen averaged 8.8 mg/L at Lehighton.

pH

Measured pH values were generally within the required range at LH10. Approximately 11 out of 3,300 pH values logged were below 6.0 in 2001. In Wildlands Conservancy's 1998 AMD study pH averaged 4.4 in Sandy Run, 4.8 in Buck Mountain Creek, 4.8 in Black Creek and 6.4 in Nesquehoning Creek. The average pH at Lehighton during the AMD study was 6.6.

Beginning with the confluence of Sandy Run, four AMD tributaries enter the Lehigh River. In 1965, the pH of each was as follows: Sandy Run, 3.7; Buck Mountain, 3.8; Black Creek, 4.6; and Nesquehoning Creek 4.5. There was an immediate lowering of pH in the river at each point of confluence followed by a gradual recovery. The average pH at Lehighton in 1965 was 4.7.

The significant improvement in pH in this region from 4.7 at Lehighton in 1965 to 6.6 in 1998 is largely due to the natural attenuation of mine drainage and to the shift from an acidic to alkaline discharge from the Lausanne Tunnel. Nesquehoning Creek now contributes approximately 7,854 lbs/day of alkalinity to the Lehigh River.

NUTRIENTS

Station LH10 is located in the main stem of the river near the Lehighton water plant intake and ammonia nitrogen, nitrite, and nitrate concentrations were consistently higher at this site than any other in the study during 2001. Ammonia at this site averaged 5.5 mg/L, nitrate concentrations averaged 1.5 mg/L, and nitrite concentrations averaged 0.11 mg/L. Phosphorous levels and five-day Biological Oxygen Demand (BOD) were also elevated at LH11 (0.38 mg/L and 5.0 mg/L, respectively).

Nitrite concentrations averaged 0.01 mg/L, and nitrate concentrations averaged below 0.2 mg/L at Lehighton in 1999, according to USGS NAWQA monitoring. Orthophosphate and phosphorous concentrations remained below detection limits at Lehighton in 1999.

METALS

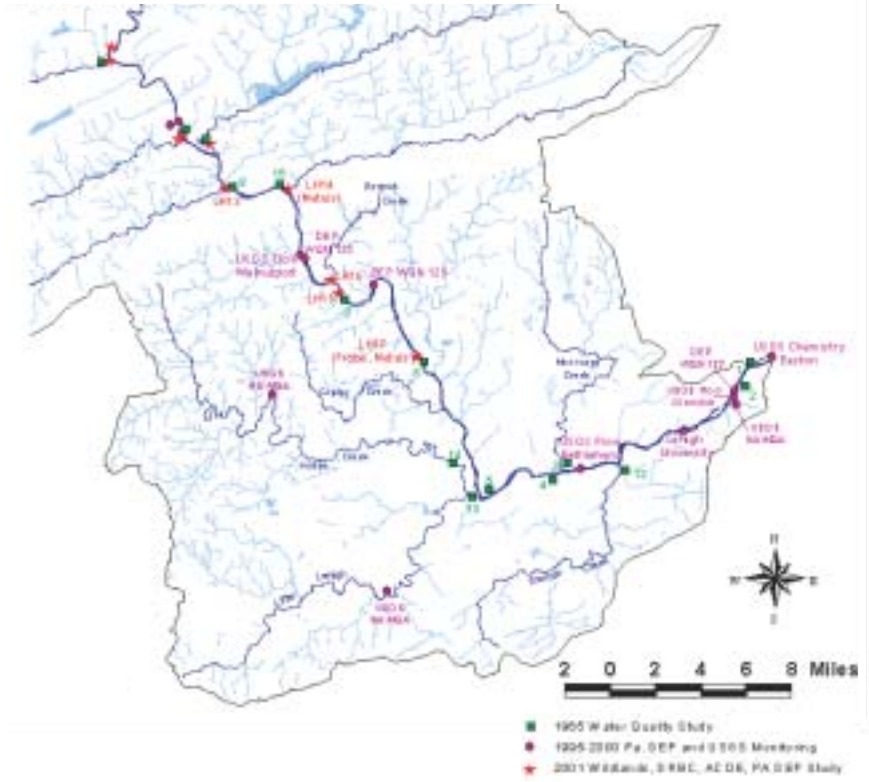
Throughout all of May and June and portions of August and September 2001, aluminum concentrations exceeded DRBC criteria in this region (stations LH6, LH7, LH 8 and LH10). Iron concentrations were below Pennsylvania DEP CWF criteria and, as with aluminum, were higher in May and June when concentrations averaged 0.3 mg/L relative to August and September when they averaged 0.05 mg/L. One sample collected at LH6 (Buck Mountain) resulted in a manganese concentration over Pennsylvania DEP criteria of 1.0 mg/L. Total zinc concentrations exceeded criteria of 0.10 mg/L on three occasions in this region, twice at Buck Mountain and once at Black Creek.

In 1998, Wildlands Conservancy conducted a detailed study of the chemistry in the four AMD tributaries. Sandy Run is the largest contributor of aluminum to the river with an average concentration of 3.21 mg/L. Sandy Run has an average iron concentration of 0.21 mg/L, 41.77 mg/L of sulfate, 0.79 mg/L of manganese and contributes a total AMD load of 13,984 lbs/day to the Lehigh River.

Buck Mountain contributes the smallest AMD load (4,227 lbs/day) to the Lehigh. Average metal concentrations at Buck Mountain include 1.74 mg/L of aluminum, 0.59 mg/L of manganese, 41.77 mg/L of sulfate, and 1.98 mg/L of iron.

Black Creek loads approximately 17,666 lbs/day of AMD to the Lehigh River, accounting for nearly 24% of the mine drainage in the river. Black Creek is the second highest contributor of AMD acidity, aluminum, iron, and sulfate. Metal concentrations in Black Creek in 1998 were 1.53 mg/L of aluminum, 0.49 mg/L of manganese, 34.10 mg/L of sulfate and 0.12 mg/L iron.

FIGURE 3-13 WATER QUALITY MONITORING LOCATIONS: LEHIGHTON TO EASTON



Nesquehoning Creek is the largest contributor of AMD alkalinity, sulfate, iron, and manganese with a total AMD load of 40,661 lbs/day. AMD concentrations in the Nesquehoning Creek include 0.89 mg/L of aluminum, 0.93 mg/L of manganese, 119.67 mg/L of sulfate, and 1.63 mg/L of iron.

3. POHOPOCO CREEK TO EASTON

The final water quality region, shown in Figure 3-13, begins at the confluence of Pohopoco Creek and ends at the Lehigh-Delaware River confluence in Easton. Tributaries in this region include Lizard, Aquashicola, Bertsch, Coplay, Little Lehigh, Monocacy, and Saucon creeks. This portion of the watershed is mostly in the Valley and Ridge and New England Physiographic Provinces and is underlain by shale, slate, sandstone and limestone and other carbonate rocks. The groundwater that seeps into streams from carbonate rocks is alkaline and capable of buffering some of the acidic mine drainage entering the Lehigh above Lehighton. The southern-most portion of the watershed is underlain by the Allentown Formation, which significantly affects water quality due to its high concentrations of limestone.

This lower portion of the watershed is characterized by a mixture of agricultural land uses and is more highly urbanized than the upper and middle reaches as the river flows through Allentown and Bethlehem before entering the Delaware in Easton.

Water quality parameters of concern in the lower watershed include thermal impacts, sedimentation, excess nutrient loading, and polluted stormwater contributions.

TEMPERATURE

Monitoring stations in this region are classified as either Trout Stocked Fisheries (TSF) or Cold Water Fisheries (CWF). Data collected in 2001 show that, with only a few exceptions in the summer months, most of the tributaries and main stem stations met Pennsylvania DEP temperature standards. Temperatures above the critical use requirements for Bertsch Creek (LH16) were observed for most of the sampling period.

In August and September of 1965, the mean temperature was approximately 76-77°F from Walnutport to the upstream area of Bethlehem. Sharp rises in temperature were recorded at the Freemansburg Bridge. The mean temperature at this point was 85°F with a maximum reading of 92°F one day in August. The temperature decreased downstream to mean values

of 83°F at the 25th St. Bridge in Easton and 80°F at the Third St. Bridge in Easton.

DISSOLVED OXYGEN

In 2001, dissolved oxygen was measured at Northampton (LH17). Dissolved oxygen concentrations were consistently measured above 6.0 mg/L with only two out of 2,298 measurements dropping slightly below 5.0 mg/L. Pennsylvania DEP classifies this station as a Trout Stocked Fishery and requires a daily average DO of 6.0 mg/L and minimum levels of 5.0 mg/L.

In August and September of 1965, an initial dissolved oxygen deficit of 22 % from saturation was found immediately below the City of Bethlehem. Dissolved oxygen levels were then fairly constant for about seven miles. The second deficit, which was a very steep drop of 33 % from saturation, occurred in the two-mile stretch at the mouth of the river. The total DO deficit from Bethlehem to the mouth was 54 % from saturation where DO values averaged 3.6 mg/L.

pH

All 2001 pH measurements at Northampton were within the 6 to 9 range required by Pennsylvania DEP.

In August and September of 1965, the influence of streams from the limestone and dolomite areas of the basin raised the alkalinity from about 20 mg/L to over 70 mg/L in the Allentown to Easton area.

NUTRIENTS

In 2001, nutrient concentrations at Northampton were within acceptable limits with average ammonia concentrations between 0.12 and 0.20 mg/L, average nitrate concentrations between 0.4 and 0.7 mg/L, average nitrite concentrations between 0.01 and 0.03 mg/L, and average phosphorous concentrations between 0.10 and 0.06 mg/L.

During the PA DEP and USGS NAWQA study conducted from 1995-2000, Nitrate levels at Glendon were between 0.02 and 0.22 mg/L and appeared to be decreasing over the study time; the average value is 0.118 mg/L. The average level of phosphorous obtained from the NAWQA at Glendon was 0.26 mg/L.

METALS

In 2001 sampling for metals occurred at the Aquashicola Creek confluence and at Northampton. Aluminum concentrations exceed DRBC's chronic criteria at both stations throughout May and June. In August zinc concentrations at station LH14 (Aquashicola Creek) reached 0.771 mg/L, and in June when dissolved metals were measured, station LH14's zinc concentration was 0.629 mg/L. DRBC's chronic criterion for zinc is 0.082 mg/L.

"Anything else you're interested in is not going to happen if you can't breathe the air and drink the water. Don't sit this one out. Do something. You are by accident of fate alive at an absolutely critical moment in the history of our planet."

—Carl Sagan

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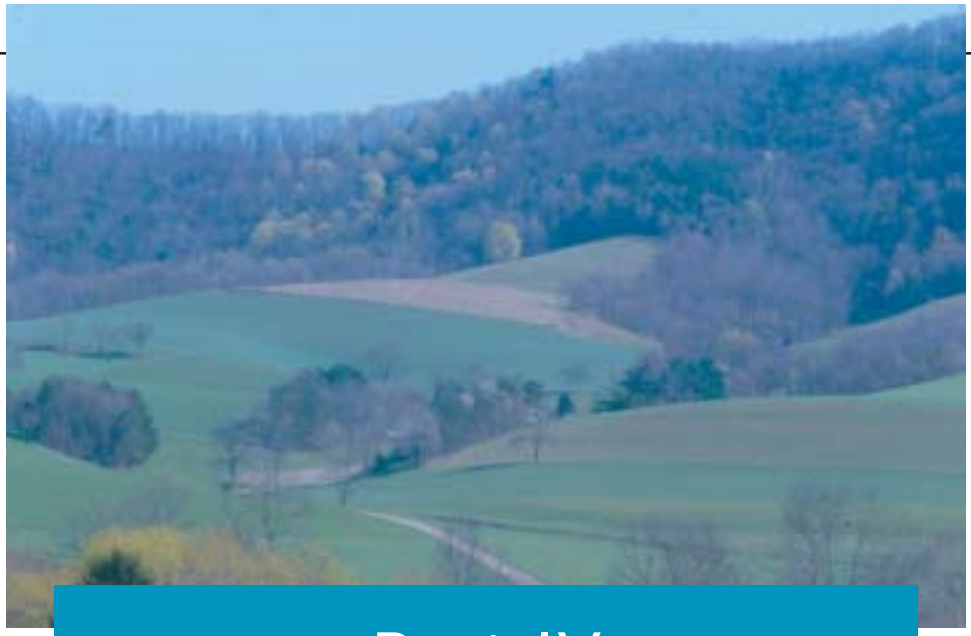

Part IV

LAND COMPONENTS

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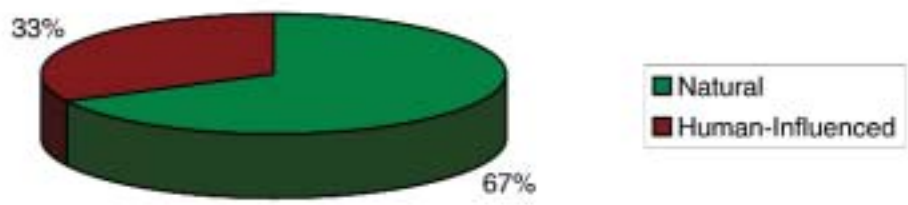
A. Land-use Types and Their Significance

"Protect your mountains and you will protect your rivers."
—Chinese proverb

HUMAN-INFLUENCED LAND

Land is an important component of the watershed. Within the watershed, the land cover consists of 67.5% (905.7 square miles) natural conditions and 32.5% (437.4 square miles) human-influenced land cover, as shown in Figure 4-1. Natural conditions are defined as forests, shrub lands, meadows, grasslands, and vegetated riparian zones. Human-influenced land cover, including agriculture, urban, suburban, and mining uses, may cause environmental problems. These problems can range from soil erosion, pollution, and aquatic and terrestrial habitat loss to enhanced peak stormwater flows containing high levels of nutrients, sediment, and other contaminants.

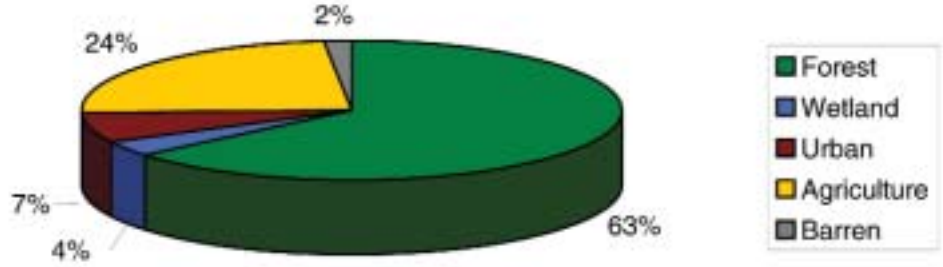
FIGURE 4-1. AREA OF NATURAL AND HUMAN-INFLUENCED LAND IN THE LEHIGH RIVER WATERSHED.
Source: Canaan Valley Institute, www.canaanvi.org
Data Source: National Land-cover data (circa mid-1990s)
Data processed for inclusion in the Geographic Profiler by Canaan Valley Institute.



*(The human-influenced land represents the percentages of area with agriculture, urban, mining, and transitional and grassland land-uses. *An Ecological Assessment of the Unites States Mid-Atlantic Region: A Landscape Atlas.)*

The five main land-use types in the watershed are forest (64.9%), agriculture (23.9%), and urban (7.1%), with the remaining land cover consisting of wetlands (3.5%) and barren lands (1.5%) (Figure 4-2). In terms of square miles of land-cover types, Figure 4-3 shows that forest dominates the watershed with 858.3 square miles, followed by agriculture with 321.4 square miles, urban with 95.5 square miles, wetland with 47.3 square miles, and barren land with 20.5 square miles.

FIGURE 4-2. LAND-COVER TYPES IN THE LEHIGH RIVER WATERSHED (PERCENT).
Source: Canaan Valley Institute, www.canaanvi.org
Data Source: National Land-cover Data (circa mid-1990s)
Data processed for inclusion in the Geographic Profiler by Canaan Valley Institute



Land cover classes were combined to create five major land cover types. Row crops and hay/pasture were combined to form the agriculture data set. Forestlands were combined, as were developed lands to form the forest and urban data sets.)

In the Lehigh River watershed, forested and open space dominates the headwater stream areas; agricultural, rural and some abandoned mine land-uses characterize the center of the watershed; and developed land-uses dominate the downstream urban areas of Allentown, Bethlehem, and Easton (Map 4-1).

When combined, the land-uses of forest and agriculture occupy 88.8% of the watershed. These land-use types are beneficial by providing habitat for wildlife, land for food production, and groundwater recharge due to their pervious land cover.

Population growth and decline has an effect on land-use. The changes in population growth in the watershed are shown in Figure 2-2. Lehigh County is the most populated county in the watershed, with Northampton County the second most populated county. This is largely due to the urban areas of Allentown (pop. 106,632), Bethlehem (71,329) and Easton (pop. 26,263). Allentown ranks third in population across the Commonwealth, behind Philadelphia (pop. 1,517,550) and Pittsburgh (pop. 334,563) respectively (United States Census Bureau, 2000).

FIGURE 4-3. LAND-COVER TYPES IN THE LEHIGH RIVER WATERSHED (ACREAGE).
Source: Canaan Valley Institute, www.canaanvi.org
Data Source: National Land cover Data (circa mid-1990s)
Data processed for inclusion in the Geographic Profiler by Canaan Valley Institute

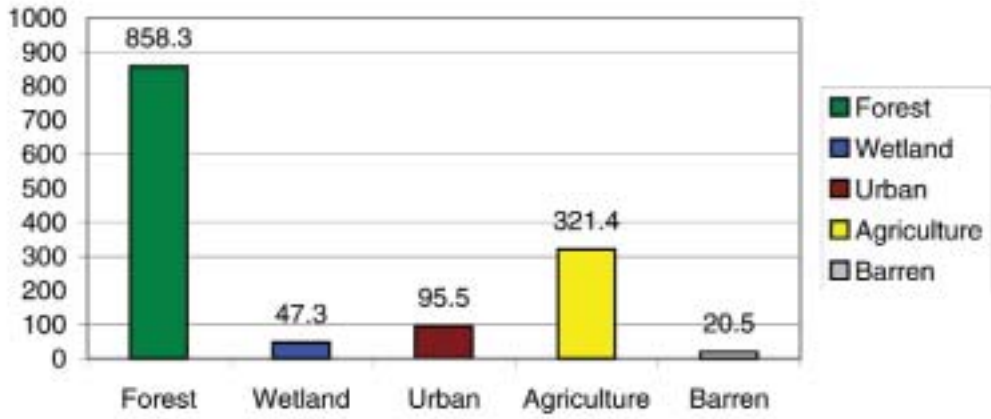
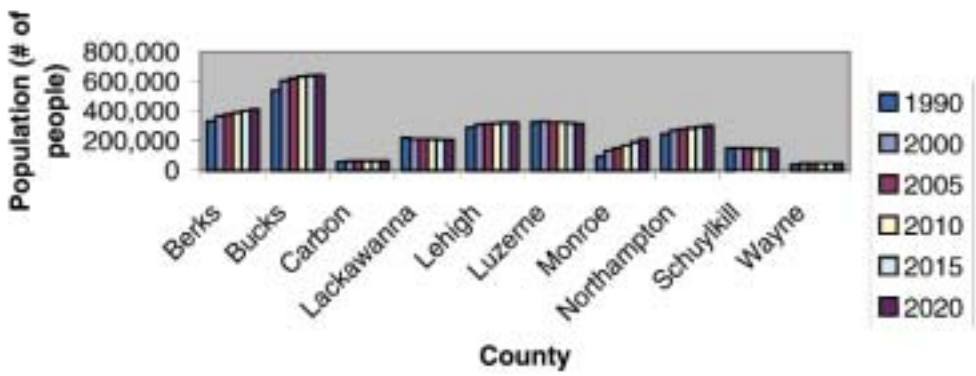


FIGURE 4-4. POPULATION PROJECTIONS FOR THE COUNTIES IN THE LEHIGH RIVER WATERSHED.
Source: U.S. Census 2000



According to the United States government, all of the counties in the watershed, except Luzerne and Lackawanna, will be experiencing growth through the year 2020 (Figure 4-4). The Counties of Berks, Bucks, Monroe, and Northampton are predicted to have the largest population increases.

1. FOREST LANDS

a. Historical Perspective

Forest vegetation has long been the predominant land-use type in the watershed. Early European settlers cleared small areas of forest for construction of towns and agricultural purposes. During the industrial revolution, the coal, iron, leather tanning, transportation and timber industries clear-cut vast areas of forest for canal boats, and later railroad lines, charcoal for heating, and lumber for housing construction material. Forests were cleared with little or no

The value of trees and forested land can be determined in several ways. One method, however, may overvalue one function at the expense of another.

regard for environmental conservation, soil erosion prevention, or forest regeneration.

In 1829, John James Audubon visited what was then called the Great Pine Forest, generally in the area from Glen Summit to Slatington, and including the Lehigh Gorge. He stayed for six weeks to watch and paint birds. The industrial revolution was just beginning in the area, and the Lehigh Coal and Navigation Company owned thousands of acres of virgin white pine and hemlock forest. During the visit, Audubon wrote that …. "Trees one after another were, and are yet, constantly heard falling, during the days; and in calm nights, the greedy sawmills told the sad tale that in a century the noble forests around should exist no more. Many mills were erected, many dams raised, in defiance of the impetuous Lehigh. One-full-third of the trees have already been culled, turned into boards, and floated as far as Philadelphia."

To illustrate the extensive use of forest resources in the past, by 1841, 38 sawmills stood on the Lehigh River between Jim Thorpe and White Haven. Most of the tributaries of the Lehigh River were dammed to provide power for the mills and to create ponds to hold the logs before they were sent down the Lehigh when water levels were high.

b. Current Status

Forest lands continue to be the predominant land-use type in the watershed, covering 64.9% (858.3 square miles) (Map 4-1) of the watershed. From a watershed perspective, the high percentage of forested land has a beneficial effect on stream and environmental conditions in the watershed, compared to the potentially harmful effects of increased stormwater flows, pollution, and erosion from the agricultural and urban uses. Forest community types vary throughout the watershed depending on underlying soils and geology, climatic differences and human influences. Mixed deciduous forest communities are common, with smaller patches of coniferous species. North of the Blue Mountain are large areas of relatively contiguous forest, and south of the Mountain forests are more fragmented and exist mainly on the hilltops and ridges. Timber harvesting occurs throughout the watershed.

The health and sustainability of the forestlands in the watershed are threatened due to unsustainable forestry practices, extensive white-tailed deer browsing, and forest pests. In many areas, the deer population is too high for the forest. With high deer populations, saplings are eaten and do not have a chance to form an understory and eventually grow into mature trees. In addition, with the absence of a healthy understory tree growth, hay-scented fern becomes the dominant ground-cover species and thus shades out other plant species.

Several forest pests are prevalent in forestland throughout the watershed. Hemlock stands are increasingly becoming infested with the hemlock adelgid, an Asian insect that sucks plant juices from the needles, resulting in reduced tree vigor and eventual tree death. American

beech and sycamores are experiencing pathogen infections, which reduce tree vigor, the weakened trees are unable to withstand any additional stress and/or disease, and eventually die. Many alien, i.e., non-native plant species, such as Norway maple (*Acer platanoides*), tree-of-heaven (*Ailanthus altissima*), multi-flora rose (*Rosa rugosa*), and barberry (*Berberis spp.*) are becoming problems in some forestlands.

2. AGRICULTURAL LANDS

a. Historical Perspective

In the past, self-reliance was commonplace, and the majority of the population was involved in the production of their own food supply. Towns were surrounded by farms, and farm families supplied foodstuffs to the townspeople. People ate seasonally available, locally grown foods, and home-processed canned and dried foods. Agriculture was a major industry for large areas south of the Blue Mountain and smaller valley areas just north of the Blue Mountain.

Proper management of agricultural lands is critical to proper stewardship of the watershed.

The Lehigh Valley (Lehigh and Northampton Counties) led the Commonwealth in the production of potatoes (*Solanum tuberosum*) for many years due to the ideal growing conditions in the Valley – warm sunny days, cool nights and acidic soil.

b. Current Status

Agricultural uses occupy 23.9% (321.4 square miles) (Map 4-1) of the watershed. While the northern tier of the watershed, north of the Blue Mountain, is predominantly forested, smaller areas of agricultural lands are in valleys immediately north of the mountain. In general, agricultural land-use patterns reflect the underlying soils. The valley soils interspersed between the forested hills and ridges below the Blue Mountain are deeper and better suited for agricultural production than are most of the soils in the northern region. Below the Blue Mountain, the soils in the northern townships of Northampton and Lehigh Counties are shale soils, which are more sensitive to drought conditions and require frequent rain events during the growing season to yield worthwhile harvests. Soils are more productive and provide good yields, even in drought years, in the more southern townships below the Blue Mountain. The area around Fogelsville was once the largest contiguous acreage of non-irrigated prime farmland soils in Pennsylvania. This area has mostly been converted to highways, warehouses, and commercial and residential development.

Agriculture continues to be an important industry throughout large areas of the watershed, despite the increasing conversion of farmland to residential and commercial uses. Fewer people are directly involved with farming as an occupation than ever before. The majority of farmers have off-farm employment to supplement their farm income. Most farmers farm their own land plus additional acres that they rent from someone who no longer farms or from other absentee landowners. In many cases, farm income is also supplemented by government subsidies, which help moderate the negative effects of market-price fluctuations and keep the prices that consumers pay for food artificially low.

TABLE 4-1. PRINCIPAL CROPS HARVESTED IN YEAR 2000 FOR THE TEN COUNTIES IN THE LEHIGH RIVER WATERSHED.

County	Field & Forage Crops-Acres Harvested	Value	Vegetable Crops- Acres Harvested	Value	Fruit Value
Berks	174,800	$44,907,000	952	$1,547,000	$3,027,000
Bucks	63,900	$13,964,000	2059	$3,315,000	$544,000
Carbon	9,700	$1,914,000	416	$881,000	$37,000
Lackawanna	14,900	$3,310,000	1386	$3,419,000	$3,000
Lehigh	78,700	$17,046,000	1150	$2,242,000	$2,033,000
Luzerne	24,000	$5,597,000	3117	$8,336,000	$304,000
Monroe	10,400	$2,218,000	404	$614,000	$71,000
Northampton	74,600	$18,331,000	718	$1,218,000	$471,000
Schuylkill	54,900	$12,731,000	1990	$4,439,000	$1,008,000
Wayne	46,500	$9,553,000	99	$128,000	$92,000

TABLE 4-2. PRINCIPAL LIVESTOCK HARVESTED IN YEAR 2000 FOR THE TEN COUNTIES IN THE LEHIGH RIVER WATERSHED.
Source: Pennsylvania Agricultural Statistics – 2000-2001. Pennsylvania Agricultural Statistic Service, Pennsylvania Department of Agriculture, Harrisburg, Pennsylvania.

County	Hogs & Pigs # Head	Hogs & Pigs Value	Cattle & Calves # Head	Cattle & Calves Value	Sheep & Lambs # Head	Sheep & Lambs Value
Berks	62,000	$4,340,000	61,100	$56,212,000	1,900	$237,500
Bucks	500	$35,000	8,200	$7,544,000	1,500	$187,500
Carbon	500	$35,000	1,500	$1,380,000	450	$56,250
Lackawanna	n/a	n/a	5,300	$4,876,000	250	$31,250
Lehigh	5,000	$35,000	4,400	$4,048,000	650	$81,250
Luzerne	n/a	n/a	5,300	$4,876,000	600	$5,000
Monroe*	n/a	n/a	n/a	n/a	n/a	n/a
Northampton	1,300	$91,000	8,400	$7,728,000	300	$37,500
Schuylkill	13,400	$938,000	13,000	$11,960,000	150	$18,750
Wayne	n/a	n/a	22,500	$20,700,000	550	$68,750

** Separate Monroe County data was not available but is grouped in the Statistics Report under "other counties."*

Production agriculture has changed drastically over recent years due to a variety of factors. The number of people involved with farming has decreased but the number of acres that each individual actually farms has increased. Combinations of low commodity prices, competition for a world market, and high land prices have made modern-day farming an expensive and risky business.

Some farms are still "vertically integrated," as were farms of the past, meaning that they feed the crops they raise to cattle, hogs, or poultry, and then sell these animal products either privately or, more typically, at livestock auctions. Many farm operations are converting to strictly crop farming or livestock production, but not both.

The principle crops grown in the watershed are corn, soybeans, and wheat, with lesser acreage of barley, oats, rye, timothy hay, clover hay, and alfalfa hay, all of which are grown for animal feed. Most of the harvest of these crops is utilized in animal feeding operations on the east coast of the United States. The principle livestock raised in the watershed include cattle, hogs, sheep, poultry, horses, and fish.

Tables 4-1 and 4-2 summarize the crops, livestock grown, and revenue generated for the ten counties in the watershed. The major agricultural counties are Berks, Lehigh, and Northampton.

More acres of field/forage crops are grown in southern regions of the watershed, while more vegetables are grown north of the Blue Mountain. Fewer acres of fruit orchards are grown

within the watershed, with the counties of Berks, Lehigh, and Schuylkill having the most acres of land devoted to fruit production. Lehigh and Berks Counties rank in the top 10 in Pennsylvania in apple production. Peaches, which are quite sensitive to frost, are grown in counties below the Blue Mountain, with Berks, Lehigh, and Northampton Counties ranking in the top 10 in Pennsylvania for peach production. In the Lehigh Valley in the past fifteen years, several farms have been converted into vineyards and retail wineries.

During the mid-1900s, the Lehigh Valley was number one in Pennsylvania for potato production. Today, only a few farms still grow potatoes. Lehigh County ranks sixth in potato production in Pennsylvania and the downward shift is substantial. Pennsylvania holds first place nationwide in the potato chip and pretzel industries. Soybean production has increased in Pennsylvania over the past 25 years, and this holds true for the watershed below the Blue Mountain. Few farmers grow soybeans above the mountain, due to the generally cooler growing conditions.

Dairy farms were once prevalent throughout agricultural areas of the watershed, but more recently, their numbers are on the decline. In the past, most dairy farms bottled their own milk at the farm or at a nearby farm. Today, most farms sell their raw milk to a milk co-op and central bottling and milk products facility. More recently, farms in the "Green Industry" (i.e.: nursery, greenhouse, and landscape operations) are increasing in numbers. Pennsylvania ranks third in nursery and greenhouse sales nationwide.

Throughout the watershed, agriculture is showing signs of diversification and entrepreneurial development. Specialty vegetables and flowers, organically raised fruits, vegetables and meats, and small-scale vegetable operations, which concentrate on direct marketing to consumers, can be found. The number of horse farms in the region is on the increase. Several farms in the watershed are supplementing their cash flow by incorporating "agro-tourism" features into their operations. These include bed and breakfast facilities, hayrides, pumpkin patches, corn mazes, and pick-your-own operations (Halma and Oplinger, 2001).

Loss of farmland to other land-uses is a major concern for the agricultural community in the watershed. Pressures are great to sell farmland to developers and land speculators who can offer large sums of money to farmers who are struggling to make a living in farming. The farming population is aging, and fewer people are seeking to make a career of farming due to a variety of reasons including the business risks involved. Commodity prices are low; land and equipment are expensive, thus making it very difficult for a young person to get started in farming.

In recent years, Pennsylvania legislators worked with the Pennsylvania Department of Agriculture and the counties to develop a very effective method for farmland preservation. In the county/state purchase of development rights program, farm owners are paid for their development rights and the farm remains as available farmland. All ten counties in the Lehigh River watershed have these programs. As of May 2003, 2,166 farms, totaling 255,252 acres, have been preserved statewide. Pennsylvania now ranks number one nationwide for acres of farmland preserved. Within the Lehigh River watershed, 108 farms totaling 10,654.217 acres have been preserved through the farmland preservation program (Map 4-2). This reflects 4% of the preserved farmland acres statewide.

This state/county funded program protects farmland from conversion to other uses into perpetuity. These farms will be available for agricultural use for future generations. Another benefit of these preserved farms is that they are generally more affordable for new farmers to purchase and become established in a farming business.

3. URBAN LANDS

a. Historical Perspective

The location and development of Native American and early European settlements, towns and, eventually, urban areas were greatly influenced by the physical resources of the watershed. To access these resources, Native Americans strategically laid out footpaths throughout the watershed. European settlers built homes and towns along these existing paths. Many modern highways in the watershed also follow the routes of these original pathways.

A view of the borough of Emmaus, Lehigh County, and South Mountain. This ridge is within the New England physiographic province, and is also known as the Reading Prong.

Immigrants were drawn to the watershed because of jobs in timber harvesting, coal and iron ore mining, tanning of animal hides, slate mining, and later to the canal and railroad transportation industries, zinc, cement, and steel manufacturing. These workers built homes in the rapidly growing towns. Towns grew larger as the farms in the countryside grew more prosperous, producing surpluses of grain, dairy products, and cattle. Towns became trading centers where the farmers went to sell their goods and purchase what they could not grow themselves. The towns also provided centers for cultural, religious, and educational enrichment.

b. Current Status

Overall, urban uses cover 7.1% (95.5 square miles) (Map 4-1) of the watershed. While at first glance this seems like a relatively small percentage, compared to other land-uses in the watershed, many areas have been experiencing rapid urban and suburban development in recent years.

Map 4-3 illustrates the individual parcel boundaries of the counties in the watershed (where available in Geographic Information System). In urban and surrounding suburban areas, the parcels are smaller, to the extent that the parcel boundaries appear as a solid mass.

The common term used to describe this rapid urban and suburban development is 'sprawl.' Whether referred to as 'urban sprawl' or 'suburban sprawl,' sprawl has been spreading, transforming open space, farmland, and natural areas into residential, commercial, and industrial developments, with infrastructure to support the development. Additionally, studies have shown that sprawl contributes to pollution, failing water and wastewater systems, urban decline, higher poverty rates in the cities, higher taxes, and crime. Sprawl has been characteristic of American life in the half century since the end of World War II, and the Lehigh River watershed has been especially subject to sprawl and the precipitous loss of open space during the past two decades.

The collective efforts to combat sprawl are labeled the "Smart Growth and Livable Communities Movement," or Smart Growth for short. Smart Growth endeavors to reconcile growth in subur-

ban and rural areas with restoration of brownfields, urban renewal and in-fill housing, and preservation of important natural, scenic, historic, and agricultural lands (Duany et al, 2000).

One of the principal ways to slow conversion of agricultural and silvicultural lands to development or sprawl is to speed the process of urban renewal. When cities and larger towns address the issue of urban renewal, thus once again becoming desirable places in which to live and work, pressure on rural lands decreases. Concentration of population also means it becomes easier to provide human services and infrastructure such as clean water, treatment of waste, control of pollution, etc.

Urban renewal is being stimulated and/or encouraged by many methods, and many incentives to encourage people to remain in, or to move into, cities and towns. Such incentives include: designation of certain tax preference districts such as Main Street Programs, Market Town Initiatives and Keystone Opportunity Zones, the designation of historic districts, the enhanced support for existing economic development bodies to obtain grant monies and to obtain tax reduction or forgiveness, the provision of proper social and human services, efficient public transportation, cheap clean public water, prompt removal of waste and sewage, and adequate lighting.

America's Main Street Program

In the 1970s and 1980s, as malls, superstores, and strip malls increased, traditional downtowns, the "heart" of a community, began to decline. Typically, blighted downtown storefronts began to empty, crime and vandalism rose, and property values declined, not only in the downtown district but in the surrounding residential neighborhoods as well. In response to these patterns, the National Main Street Center, founded in 1980, has been working with communities across the nation to revitalize their historic or traditional commercial areas. The Pennsylvania Downtown Center works locally with commonwealth communities. Based in historic preservation and developed to save historic commercial architecture and the fabric of American communities' built environment, The Main Street Approach™ has become a powerful economic development tool as well. It encompasses the four points of revitalization: organization, promotion, design, and economic re-structuring.

The comprehensive, community-based revitalization approach analyzes all aspects of the downtown or central business district, producing both tangible and intangible benefits. Improving economic management, strengthening public participation, and making the downtown a fun place to visit are as critical to Main Street's future as recruiting new businesses, rehabilitating buildings, and expanding parking. Building on the downtown's inherent assets – rich architecture, personal service, traditional values and, most of all, a sense of place – the Main Street approach has rekindled entrepreneurship, downtown cooperation, and civic concern. It has earned national recognition as a practical strategy appropriately scaled to a community's local resources and conditions. Because it is a locally driven program, all initiative stems from local issues and concerns.

The Borough of Emmaus is an example of a municipality within the Lehigh River watershed that boasts a Main Street program. (Main Street National Trust for Historic Preservation).

The Borough of Emmaus, Lehigh County

The Emmaus Main Street Program, officially incorporated in 1995, is a non-profit program dedicated to supporting and revitalizing Emmaus' historic downtown. The Borough of Emmaus initially matched funding provided by the state Department of Community and Economic Development. The Emmaus Main Street Program employs one employee, an exec-

utive director, or Main Street Manager. A volunteer board of directors oversees the management of the organization, and dedicated volunteer committees carry out much of the work of the organization. Business people and residents alike are involved in the organization, board, and committees.

THE CORRIDOR MARKET TOWNS INITIATIVE

The Corridor Market Towns Initiative is a cooperative pilot project of the Delaware & Lehigh National and State Heritage Corridor Commission (D&L) and the Pennsylvania Downtown Center. Both organizations are committed to improving and sustaining the historic, cultural, and economic viability of its communities. This Initiative marks the first regional revitalization effort supported by the Commonwealth. It receives partial funding from the Pennsylvania Department of Community & Economic Development's (DCED) New Communities Program and Pennsylvania Department of Conservation & Natural Resources (DCNR). By blending conservation and economic development strategies, the Market Towns Initiative is improving the economy of the Corridor's small towns through place-based heritage development strategies.

Traditionally, market towns were towns that served the area by distributing goods for sale and consumption. Before and today, market towns share strategic trade areas due to historic, geographic and cultural alliances.

In January 2000, the D&L hired a full-time Heritage Development Specialist to develop and facilitate strategies to help revitalize local economies while enhancing heritage and cultural resources, and in January 2002, hired a full-time Market Towns Manager who works with partner communities. Methods employed include:

- ***The 4-point Main Street Approach™***
  Revitalization Organization, Promotion, Design, Economic Re-structuring
- ***Municipal Planning for Conservation***
  Streetscape Improvements, Zoning, Gateways, Protective Ordinances
- ***Heritage Tourism Product Development***
  Museum & Tour Development, Marketing & Promotion, Authentic Interpretation, Visitor Amenities
- ***Traditional Economic Development Tools***
  Financial Incentives, Business Advocacy, Grantsmanship, Site Promotion

The initial focus of the Corridor Market Towns Initiative began in six small towns in Luzerne, Carbon, and Lehigh Counties: White Haven, Lansford, Jim Thorpe, Lehighton, Palmerton, and Slatington. Services are now available to Weatherly, Coaldale, Summit Hill, Nesquehoning, Weissport, and Walnutport and are extending into Schuylkill and Northampton Counties. In addition, there are active heritage development efforts in two Bucks County communities.

The Market Towns Manager and the Heritage Development Specialist assist local groups to design and develop revitalization strategies. They work to address self-identified needs while strengthening heritage tourism and economic development opportunities that support the local economy. The end result is trail development, improved visitor amenities, enhanced museums and tours, as well as innovative new uses for old buildings that encourage local business development.

Many of the Corridor Market Towns are in the Lehigh River watershed, including White Haven, Nesquehoning, Jim Thorpe, Lehighton, Palmerton, Slatington, Weissport, and Walnutport (Map 4-4).

Jim Thorpe, Carbon County, is widely considered a crown jewel of Pennsylvania's historic resources. A popular canal and railroad transfer and tourist destination in the 1800s, Jim Thorpe continues to offer a respite for visitors seeking outdoor adventure, National Historic Landmarks, specialty shopping, and cultural diversity. One of the nation's first "Main Street" revitalization efforts, today Jim Thorpe is focusing on strategies to preserve the best of its natural and historic amenities through sound conservation and preservation measures. Heritage tourism and economic development co-exist in order to improve its economy as well as residential quality of life. Other Market Towns efforts in Jim Thorpe include the completion of a Visitor/Marketing Survey, a Community Visioning Project under the direction of the National Park Service, and publication of a new heritage attractions brochure.

Slatington, Lehigh County, is located along the Lehigh River, just across from its sister town, Walnutport. As its name suggests, Slatington was once a world supplier of slate for blackboards, sidewalks, curbing and roofs. Visitors today find a variety of architectural styles that highlight the use of this durable building material. The towers, turrets and spires that embellish its homes are the basis for the development of a National Historic District. The site of the former high school was redesigned to create a focal community park that celebrates local history. In addition, gateway improvements and the construction of a Slate Heritage Trail to link the main D&L Trail system through the heart of town are well on their way to reality. This cooperative effort is possible through the close relationship of borough government, Northern Lehigh Future Focus and the Market Towns office.

Palmerton, Carbon County, benefits from the benevolent founding fathers of N.J. Zinc Company (later known as Horsehead Industries). It has a longtime reputation for a self-sustaining, vibrant downtown business district. Free parking, wide boulevards, cultural opportunities and a strong traditional downtown are among its attributes. An attractive downtown park and bandstand are central to many annual special events. A tour of historic sites developed for its Centennial celebration will become the basis of a new walking tour publication. Plans on tap include a renewed image campaign, streetscape and gateway improvements, as well as measures to assure sympathetic treatment of its older building stock. The current challenges of rectifying the environmental issues created by past industries are ongoing and have a negative impact on the local economy.

Lehighton, Carbon County, has become a popular residential community with easy access to the PA Turnpike and the Lehigh Valley (Lehigh and Northampton Counties). A steady decline in the traditional downtown core has been caused by increased strip development nearby and the construction of a bypass. However, with a resurgence of interest in its historic resources and downtown assets, the borough and business interests are tackling a long-term cycle of disinvestment. Key efforts include the re-use of the former Lehighton High School, re-education of local consumers, the establishment of a local historical society, creation of remote parking facilities, as well as extensive building improvements.

White Haven, Luzerne County, is the smallest Market Town. Located at the northern end of Lehigh Gorge State Park, it is best known for its access to whitewater rafting on the Lehigh River and the 25-mile bike path leading to Jim Thorpe. A new trailhead for the 17-mile Anthracite Scenic Rail-Trail is in the design phase. Named for Josiah White, a founder of the Lehigh Coal & Navigation Company, White Haven was once a rugged outpost of the lumber industry. The ingenious 'high lift' locks of the Upper Grand section of the Lehigh Canal tamed the river in the mid-1800s. Today, local residents are working together to link these two important trail segments through interpretation, bicycle and pedestrian improvements along Main Street.

TABLE 4-3: ACRES OF KEYSTONE OPPORTUNITY ZONES FOR THE COUNTIES IN THE LEHIGH RIVER WATERSHED. Source: Pennsylvania Department of Community and Economic Development.

COUNTY	MUNICIPALITIES WITH KOZs
Carbon	Banks Twp. Lehighton Borough Nesquehoning Borough Summit Hill Borough
Lehigh	City of Allentown North Whitehall Twp.
Luzerne	Butler Twp. Hazleton City Hazle Twp.
Northampton	Allen Twp Bath Borough City of Easton Walnutport Borough

COUNTY	ACRES
Lehigh, Northampton, Monroe	1,086 acres
Schuylkill, Carbon	3,395 acres
Lackawanna, Luzerne, Wayne	6,017 acres

(Note: This data reflects the entire area of the counties, not just the portions of the counties that are within the watershed.)

TABLE 4-4. LEHIGH VALLEY OCCUPATION TRENDS. Source: Lehigh Valley Planning Commission and U.S. Census 2000.

Occupation	2000	2020 (est.)
Administrative Support/Clerical	46,040	61,518
Agriculture/Forestry/Fishing	2,480	5,298
Executive/Administrative	19,170	35,256
Marketing/Sales	29,820	36,680
Operators/Fabricators/Labelers	38,390	46,493
Production Product Craft/Repair	27,920	33,939
Professional/Paraprofessional	58,860	58,005
Service	41,290	56,541

Conversion of the historic Lehigh Valley RR Engine House into a community library is also a focal point (Delaware and Lehigh National Heritage Corridor).

KEYSTONE OPPORTUNITY ZONES

The Keystone Opportunity Zones (KOZs) program eliminates state and local taxes within specific underdeveloped or underutilized areas of Pennsylvania to help communities experience economic growth and investment and foster employment. Projects within KOZs receive priority consideration for state assistance under state community and economic development programs as well as community building initiatives. Projects in KOZs that are approved for Pennsylvania Industrial Development Authority (PIDA), or Small Business Financing, receive the lowest interest rate extended to borrowers. Since 1999, over 10,000 new jobs have been created statewide as a direct result of Keystone Opportunity Zones. Table 4-3 lists the number of acres of Keystone Opportunity Zones for the counties in the Lehigh River watershed.

Figure 4-5 and Figure 4-6 reflect the KOZ areas in two watershed communities – the City of Allentown and the Borough of Slatington (Lehigh Valley Land Recycling Initiative, 2004).

c. Industry

The history of the Lehigh River watershed is rich with the development and establishment of a wide variety of industries. The Tables 2-1 and 2-2 respectively list the current major employers in the Lehigh River watershed and the current major manufacturers in the Lehigh River watershed.

Of the entire employment in the Lehigh Valley (approximately 305,375 persons), the highest percentage of employed persons is found in the service, manufacturing, and retail trade categories. Mining and agriculture/forestry/fishing make up a small percentage of employment. Table 4-4 summarizes employment according to occupation in the Lehigh Valley (Lehigh and Northampton Counties); the number of people employed accordingly and projected employment trends.

d. Transportation

A strong transportation infrastructure is integral to the economy of the Lehigh River watershed area. An extensive railroad system and an international airport exist in the watershed, along with a well-developed network of highways and roads (Map 4-5).

AIR TRANSPORTATION IN THE LEHIGH RIVER WATERSHED

The Lehigh Valley International Airport (LVIA) is the principal airport for all the municipalities in the Lehigh River watershed. It is located immediately to the northeast of Allentown in Hanover Township, Lehigh County. Outside of the Philadelphia and Pittsburgh airports, LVIA offers more flights to more destinations than any other airport in the state. In addition to passenger service, it sees a substantial amount of airfreight traffic and is the principal area airport for general aviation. As an international airport, it offers United States Customs Services to flights originating outside the country. Military training flights also utilize this airport. The authority that operates this airport is also responsible for operating Queen City Airport, a general aviation facility for relatively light aircraft located in the southern end of Allentown.

FIGURE 4-5. KOZS IN THE CITY OF ALLENTOWN.

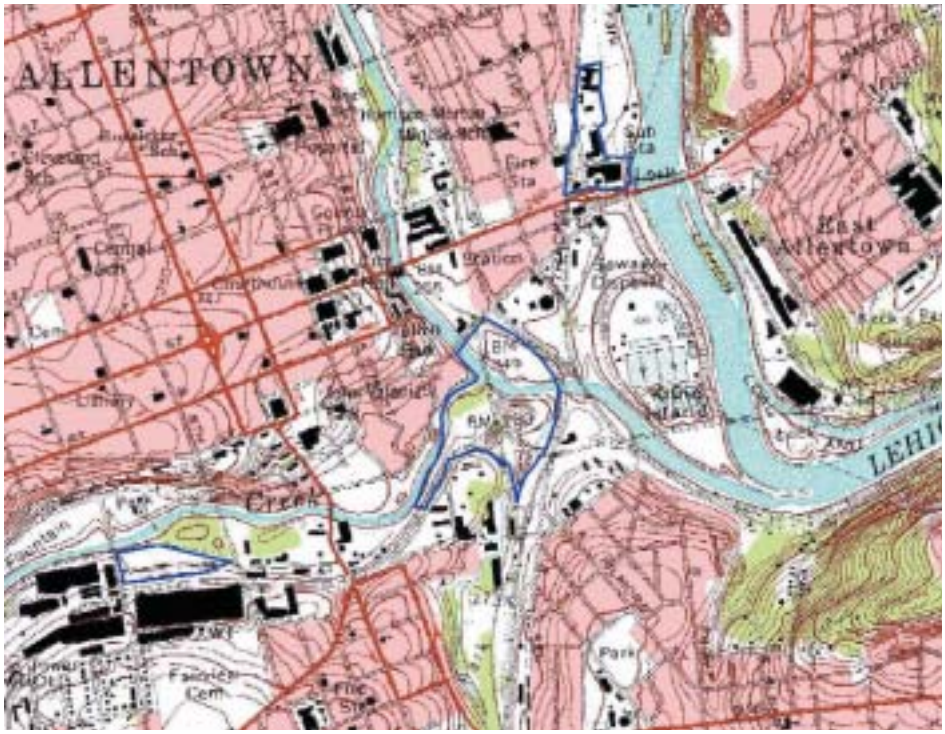


FIGURE 4-6. KOZS IN THE BOROUGH OF SLATINGTON

In addition to LVIA, there are numerous other private airports in the watershed. Some have improved runways and offer fuel, repair, and hanger facilities; others are basically grass airstrips

for one or several private aircraft. A number offer charter services and commercial air taxi services, and some are equipped for night landings.

RAIL SERVICE IN THE LEHIGH RIVER WATERSHED

Rail service is only a ghost of what it once was. There are no passenger services offered in any of the towns in the watershed. The only two Class -1 railroads servicing the area are the Norfolk and Southern, and the Canadian Pacific. Freight services continue to move freight by rail in and out of the area, mostly through the use of piggy-back containers. The recent establishment by the Norfolk and Southern Railroad of a 200-acre major intermodal facility on former Bethlehem Steel land has created a first-class terminal for rail/truck/rail. These are used for the movement of domestic and international freight. A number of movements are of coal for area power generation facilities. Plans have often been discussed by planners, investors, businesses and travelers alike for light-rail passenger service to Philadelphia and New York from Bethlehem, but no firm commitment has yet to be made by public or private investors.

ROADWAYS OF AMERICA

Roadways have improved as well as greatly expanded since the early roadways in created by the first European settlers. As of 2002:

- Over 1.5% of the land in the United States is covered by public roads – an area the size of South and North Carolina.
- Road impacts spread beyond the actual roadway. Roads affect 15-20% of the United States landmass.
- Every state has the equivalent of over 100,000 football fields of land devoted to roads.
- 3.9 million miles of public roads crisscross the United States.
- 200 million vehicles utilize these roads.
- More than 200 motorists are killed each year in animal-vehicle collisions.
- More than a million vertebrates are killed on roadways every day in the United States. (American Wildlands, 2002)

ROADWAYS OF THE LEHIGH RIVER WATERSHED

The Lehigh River watershed possesses a wide variety of land-uses and this variation directly affects the transportation system within the watershed. Rural areas are dominated by automobile traffic on smaller roadways servicing residences, farms, and small businesses. Suburban areas demand larger roads with similar service to residences and businesses, but with a greater access to major roadways for long distance travel. Urban areas tend to need similar access to residences and businesses, but with greater intra-city public transportation outlets.

The main reasons the majority of the roads are smaller in the northern portion of the watershed are that there is a lower density of people and rural land-uses like agriculture, open space, and mining lands dominate. The major roads in the north are Interstate 380, which runs north-south and Interstate 80, which runs east-west. The Northeast Extension of the Pennsylvania Turnpike, Interstate 476, connects the northern and southern portions of the watershed.

The southern part of the watershed is more suburban surrounding Allentown, Bethlehem and Easton, and urban within the cities. The suburban and urban nature of the southern portion of

the watershed creates two relationships with the transportation routes. Because of this urban area, more major roads were constructed through the area, and these major roads have made the area more attractive to residents. This has brought increased development to the area. Increased development has placed increased pressure on the large highways, Route 22 and Interstate 78, both of which are major east-west roadways through these urban centers (Map 4-5). Major improvements on roads have recently taken place or are taking place within the watershed in response to this increased pressure.

Streams and roads have been shown to have an important relationship at the landscape level. Roads constructed near watercourses pose potential risks to water quality and may alter stream hydrology. Map 4-5 demonstrates the location of roads in relation to streams.

As shown in Figure 4-7, in the watershed, 21% of the roads are within 300 feet of streams. Non-point source pollution, in the form of runoff from roads near streams containing vehicle-related chemicals and pollutants such as sediments and nutrients, oils and greases, salts, etc., enters and pollutes adjacent watercourses. Runoff from roads can also increase peak stream flows.

Additionally, streams that are crossed by roads are affected by non-point source pollution from the roads and increased water volume. Generally, the primary and secondary roads pose greater non-point source pollution threats due to the larger amount of impervious cover and increased vehicular volume. As Figure 4-7 shows, of the types of roads crossing streams in the Lehigh River watershed, only 4% are primary roads, 9% are secondary roads, and the majority (87%) are local and rural roads.

Figure 4-8 categorizes the 1,758 instances where a road crosses a stream in the Lehigh River watershed according to the type or class of road crossing the stream body. Primary crossings include major and minor highways; secondary crossings include smaller routes and connecting roads; and local/rural crossings include neighborhood streets as well as rural routes.

According to the U.S. 2000 census, 92.5% of employees drive to work, and the average workplace commute of watershed residents takes 25.5 minutes. Of the 92.5% that drive, 11% carpool to work. Of the remaining 7.5% commuters, 1.5% use public transportation, 3.3% walk to work, and 2.7% work from their homes.

FIGURE 4-7. % STREAMS NEAR ROADS.
Source: Canaan Valley Institute, www.canaanvi.org

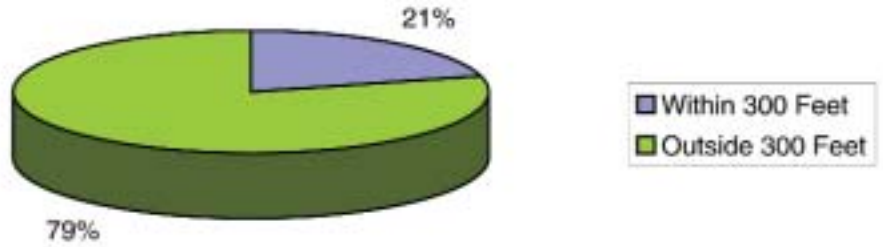
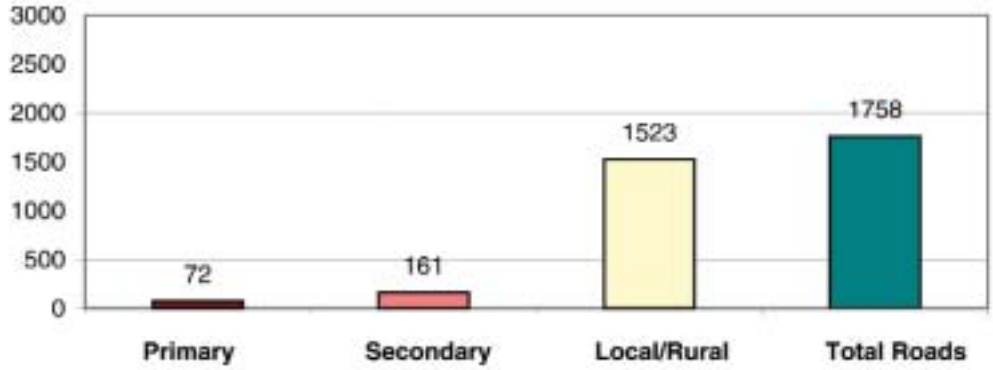


FIGURE 4-8. RATIOS OF ROADS AND STREAMS.
Source: Canaan Valley Institute, www.canaanvi.org

ROADWAYS AND LAND-USE

The Pennsylvania Department of Transportation (Penn DOT) has developed a process for coordinating transportation and land-use planning and implementation in the case of major transportation projects. Major transportation projects

FIGURE 4-9. RATIOS OF ROADS AND STREAM CROSSINGS.
Data Source: National Hydrography Data, U.S. Census TIGER Roads, Canaan Valley Institute
Data processed for inclusion in the Geographic Profiler by Canaan Valley Institute.



span a development period of four to six years or more, and during this period, an analysis may be conducted to determine existing gaps in local and county land-use, zoning, comprehensive, open space and/or transportation plans for those communities impacted by the transportation project. Funding or technical assistance may then be available to update plans to provide for anticipated impacts of the project. Utilizing this practice allows a municipality to update its comprehensive plan and/or ordinances prior to the actual impacts associated with a transportation project. This allows a municipality to plan for transportation in areas where the community will benefit from it, and limit access to those areas designated as open space.

Transportation projects span several years, may not coincide with the local land-use and/or municipal planning process, and typically extend beyond municipal boundaries. To adequately plan for the anticipated impacts of a transportation project, a regional cooperative effort by affected local municipalities and counties has proven to be the most successful. Local municipalities and Penn DOT can work together to form a partnership that fosters communication and involvement by the municipalities throughout the planning process. This partnership also allows Penn DOT to take community plans and/or visions into account when considering project alternatives.

Examples of planning for transportation in the Lehigh River watershed include Lackawanna, Lehigh, Northampton, and Monroe Counties.

THE LACKAWANNA-LUZERNE TRANSPORTATION STUDY

The Long Range Transportation Plan, Lackawanna-Luzerne Transportation Study Area, 2002 Plan prepared for Lackawanna County Regional Planning Commission and the Luzerne County Planning Commission presents the long-range transportation plan for the bi-county region. The plan documents the current transportation planning status and proposed new projects. Geographic Information System (GIS) mapping was utilized to describe current modes of transportation, including trails, and identify future initiatives. (Lackawanna County Regional Planning Commission, 2003).

THE LEHIGH VALLEY TRANSPORTATION STUDY

The Metropolitan Planning Organization (MPO) for Lehigh and Northampton Counties conducted the Lehigh Valley Transportation Study (LVTS). The Study, created in 1964, reflected a legal agreement between the Cities of Allentown, Bethlehem, and Easton; the Counties of Lehigh and Northampton; and the Department of Highways of the Commonwealth of Pennsylvania (now the Pennsylvania Department of Transportation – Penn DOT).

The purpose of the study was to document the current status of transportation projects in the Lehigh Valley and to recommend solutions to solve long-term transportation problems. Goals and objectives for the study were derived in part from the Comprehensive Plan for Lehigh and Northampton Counties and identify improvements to be implemented. The Study also focused on investment in future transportation infrastructure that will be implemented by Penn DOT, Lehigh and Northampton Transportation Authority (LANTA), and local governments over the next twenty years. The study recognizes the interconnection between transportation and land-use issues. (Lehigh Valley Planning Commission).

The Lehigh Valley Planning Commission (LVPC) works with local governments in Lehigh and Northampton Counties on land-use planning issues. Implementation of land-use policies is the responsibility of local government under Pennsylvania law, and the Lehigh Valley Transportation Study (LVTS) has no authority over local land-use planning or zoning. The study does not address issues concerning police enforcement of traffic laws or security issues, but focuses on workable solutions to problems of transportation safety, maintenance, congestion and mobility.

The Monroe County Comprehensive Plan

The Monroe County 2020 Comprehensive Plan addresses transportation in Monroe County. The principal transportation corridors are along Routes 209 and Business 209, 611, 940, and 447. The Comprehensive Plan calls for concentration of new growth as extensions and infill of existing centers, and along connecting roadways and at sites serviced by both rail and highway. The transportation challenge for the county and Penn DOT together is to create a countywide systems plan for transportation (including transit, rail, and new bicycle and pedestrian opportunities) that supports the centers and corridors concept.

Monroe 2020s goals for roadscape improvement state:

- Create a fine visual impression of the county for visitors and residents and enhance the county's appearance (county-wide).
- Change the image of the Poconos, emphasizing diversity of attractions and sophistication (East Stroudsburg).
- Create signage compatible with community character (Pocono Mountains).
- Accelerate efforts to establish billboard standards and erect prototype signs that convey a more appropriate visual image (Stroudsburg) (Monroe County Planning Commission).

Road Impacts on Wildlife and the Environment

The construction and continued existence of roadways have a negative impact on wildlife and the environment.

Initially, the construction of roadways causes the death of any sessile or slow-moving organisms, trees and any other vegetation in the path of the road, plus any organisms living in that vegetation. After they are built, roads bring humans, houses, and development, leading to a loss of wildlife habitat. Roads also facilitate increased human access to formerly remote areas and increase the likelihood and efficiency with which natural resources can be extracted.

In general, animals try to avoid roads and surrounding lands. The presence of a road may cause wildlife to shift home ranges and alter their movement pattern, reproductive behavior, escape response, and physiological state. When roads act as barriers to movement, they fragment habitat by barring gene flow where individuals cannot or will not cross to breed.

However, animals cannot always avoid the roads, and road kill is the primary way that humans kill wildlife in the United States. Additionally, radiant heat is absorbed by the dark pavement and released at night, creating a "heat island" around roads, which, in turn can attract heat-seeking species such as birds and snakes to roads, increasing their mortality by vehicle collision.

Environmentally, a road transforms the physical conditions on and adjacent to it, creating harmful effects with consequences that extend beyond the road itself. The soil becomes compacted and remains so long after a road is in use and soil porosity is reduced, allowing for less absorption of water. Passing cars stir up dust from the road, and the dust settles on nearby plants, blocking photosynthesis. Amphibians, such as frogs and salamanders, are also affected by traffic dust.

Most road surfaces are impermeable and so act as channels to redirect water flow, often rerouting sediments, and non-point pollution into streams. Non-point source pollution from roads is a result of maintenance and use of roads. At least five different general classes of chemicals are added to the environment from impervious roads. They include heavy metals (gasoline additives), salt (from de-icing), organic molecules (dioxins, hydrocarbons), ozone (produced by vehicles), and nitrogen (Trombulak and Frissell, 2000).

Dirt and Gravel Road Pollution Prevention Program

Pennsylvania has over 17,000 miles of unpaved roads serving rural residents, agricultural users, forest product companies, and tourism. These roads can become sources of non-point source pollution to neighboring streams and waterways if not properly maintained. Non-point source pollution is responsible for the majority of the degradation of Pennsylvania's waterways.

In 1999-2000 a statewide committee spearheaded a statewide inventory and assessment of all 17,000 + miles of Pennsylvania's dirt and gravel road network. This huge work effort, conducted by the county conservation districts, identified more than 9,600 specific pollution sites affecting more than 3,000 miles of roadway. All of these sites are mapped, rated on a 12-step, 100-point scale, and recorded on a GIS database.

These efforts gave rise to Pennsylvania's Dirt and Gravel Road Pollution Prevention Program. Signed into law April 1997 by Governor Tom Ridge as Section 9106 of the Pa. Vehicle Code, the program is based on the principle that informed local control is the most effective way to stop pollution. It offers local municipalities a locally controlled program supported by $5 million annually in non-lapsing funding. Funding is annually apportioned by the Pennsylvania State Conservation Commission. This special funding and technical support helps municipalities repair, manage, and maintain their dirt and gravel roads. Funding allocations for the program are based on the identified pollutions worksites. The program is administered through county conservation districts and local Quality Assurance Boards. The four-member local Quality Assurance Board is represented by the conservation district, Pennsylvania Fish and Boat Commission (Pa.F&BC), and the USDA Natural Resources Conservation Service.

To date, 500 projects have been completed. To be eligible, municipalities must send representatives to a special training program, and their projects must employ "environmentally sound" maintenance practices and products to correct pollution problems related to the roadway. In the first three years of the program, top priority has been given to identifying pollution trouble spots within watersheds protected as exceptional value and high quality (Center for Dirt and Gravel Road Studies, 1999-2000).

FIGURE 4-10. PERCENTAGE OF IMPERVIOUS COVER IN THE LEHIGH RIVER WATERSHED. SOURCE: CANAAN VALLEY INSTITUTE, www.canaanvi.org

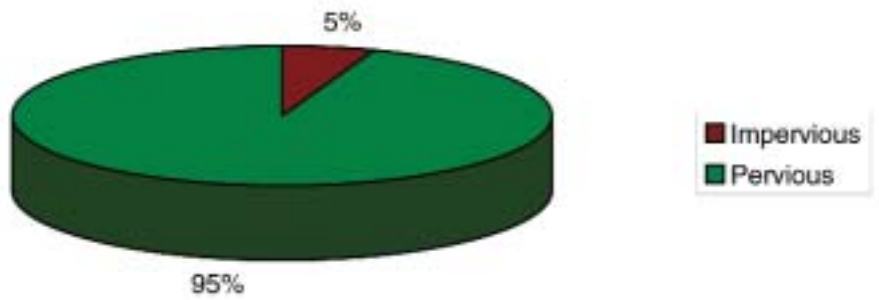
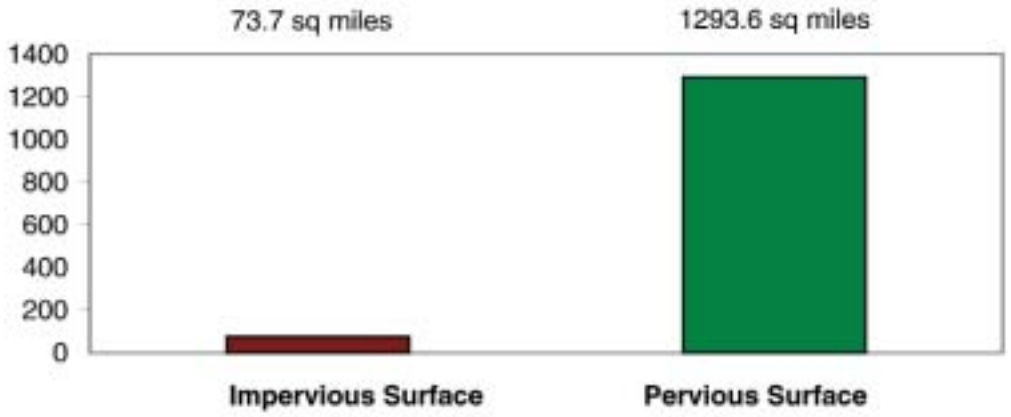


FIGURE 4-11. AREA OF IMPERVIOUS AND PERVIOUS COVER IN THE LEHIGH RIVER WATERSHED.
Source: Canaan Valley Institute, www.canaanvi.org
Data Source: National Land-cover Data (circa mid-1990s)
Data processed for inclusion in the Geographic Profiler by Canaan Valley Institute (Impervious surfaces include roads, rooftops, parking lots, and compacted soils)



IMPERVIOUS COVER

The pervious and porous terrain of natural landscapes like forests, wetlands, and grasslands trap rainwater and snowmelt and allow it to slowly filter into the ground and reach receiving waters gradually. In contrast, impervious and non-porous urban landscapes like roads, bridges, parking lots, and buildings do not let runoff slowly percolate into the ground. Water remains above the surface, accumulates, and runs off in large amounts.

Cities install storm sewer systems that quickly channel this runoff from roads and other impervious surfaces. Runoff gathers speed once it enters the storm sewer system. When it leaves the system and enters into a stream, large volumes of quickly flowing runoff erode streambanks, damage streamside vegetation, and widen streamside channels. In turn, this will result in lower water depths during non-storm periods, higher-than-normal water levels during wet weather periods, increased sediment loads, and higher water temperatures.

Stormwater temperatures are undesirably increased due to water running off warm, dark-colored

Land development that involves impervious surfaces, as seen here near Allentown, Lehigh County, can dramatically affect the quality and quantity of water in our streams and rivers.

pavement and rooftop surfaces, and this increases the temperature of streams, adversely affecting aquatic life. These may include sediment from development and new construction; oil, grease and toxic chemicals from automobiles; nutrients and pesticides from turf management and gardening; viruses and bacteria from failing septic systems; and road salts and heavy metals. Sediments and solids constitute the largest volume of pollutant loads to receiving waters in urban areas. When runoff enters storm drains, it carries many of these pollutants with it. Increased pollutant loads can harm fish and wildlife populations, kill native vegetation, foul drinking water supplies, and make recreational areas unsafe.

FIGURE 4-12. PERCENTAGE OF IMPERVIOUS COVER IN THE SCHUYLKILL RIVER WATERSHED.
Source: Canaan Valley Institute, www.canaanvi.org

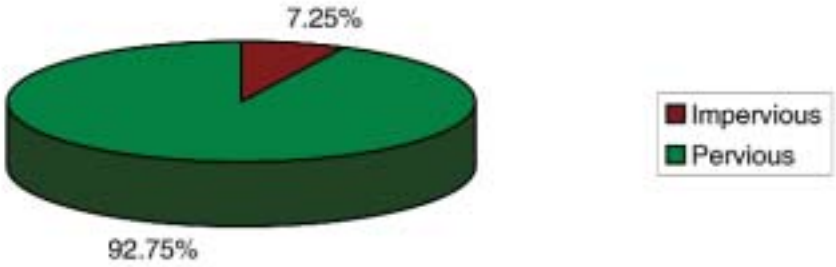


FIGURE 4-13. AREA OF IMPERVIOUS AND PERVIOUS COVER IN THE SCHUYLKILL RIVER WATERSHED.
Source: Canaan Valley Institute, www.canaanvi.org

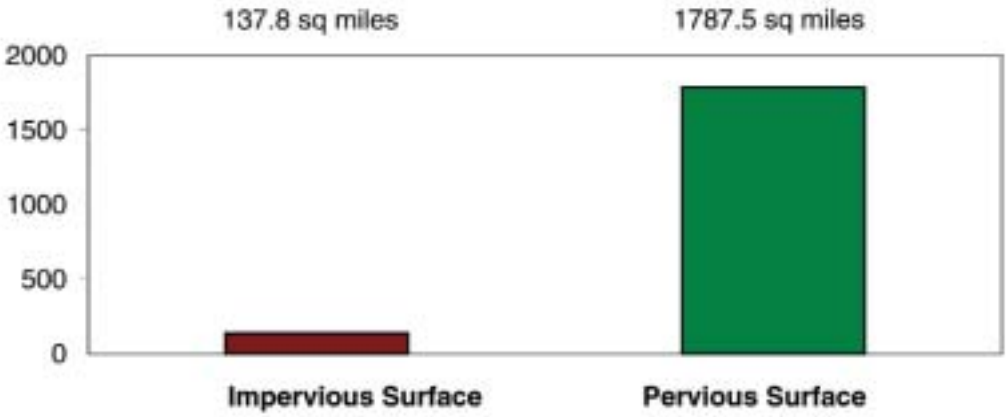


FIGURE 4-14. PERCENTAGE OF IMPERVIOUS COVER IN CARBON COUNTY.
Source: Canaan Valley Institute, www.canaanvi.org

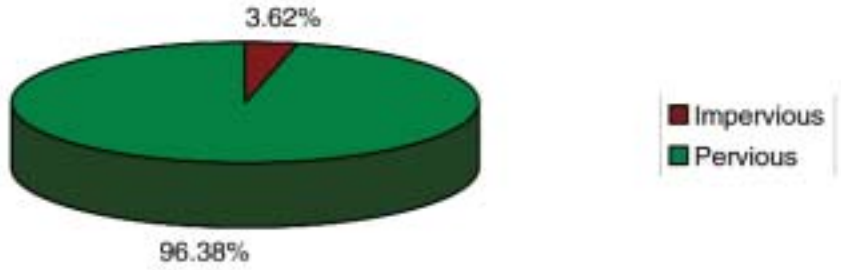
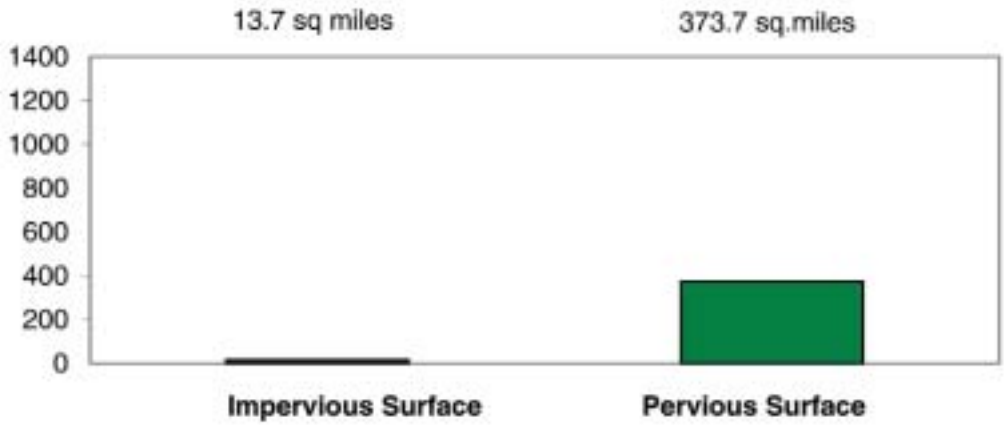


FIGURE 4-15. AREA OF IMPERVIOUS AND PERVIOUS COVER IN CARBON COUNTY.
Source: Canaan Valley Institute, www.canaanvi.org
Data Source: National Land cover Data (circa mid-1990s)
Data processed for inclusion in the Geographic Profiler by Canaan Valley Institute



Urbanization also has a harmful effect on stream biota. Studies have shown that when the impervious land cover in a watershed exceeds 25%, only hardy, pollution-tolerant reptiles and amphibians can thrive, while more pollution-sensitive species are eliminated. When the impervious land cover in a watershed exceeds 15% and the stream health is rated on the Index of Biotic Integrity (based on combined fish and macro-invertebrate levels), the health of the stream is never rated good. Even low levels of impervious land cover affect streams. When upstream impervious land cover is above 2%, pollution-sensitive brook trout are absent. In the Lehigh River watershed, the streams most affected are in the Allentown-Bethlehem-Easton portions of the Little Lehigh, Jordan, Monocacy, and Saucon Creek basins.

Currently, the impervious land cover in the Lehigh River watershed is only 5% (73.7 square miles), well below the 15% danger mark. (Figure 4-10 and Figure 4-11) However, it does exceed the 2% brook trout indicator mark.

Comparing the impervious and pervious land cover ratios of the Lehigh River watershed with the neighboring Schuylkill River watershed shows that the Lehigh River watershed impervious ratios are lower (Figures 4-12 and 4-13). This is due to the greater amount of open space in the Lehigh River watershed

FIGURE 4-16. PERCENTAGE OF IMPERVIOUS COVER IN MONROE COUNTY.
Source: Canaan Valley Institute, www.canaanvi.org

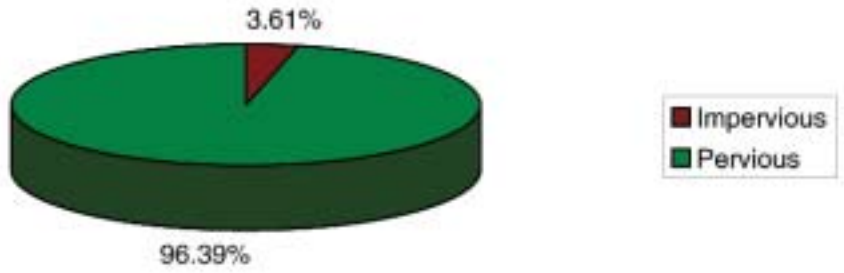
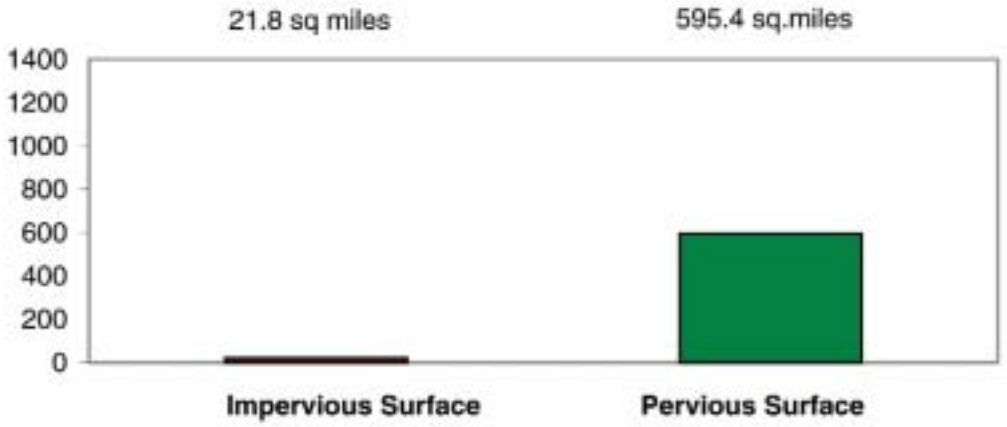


FIGURE 4-17. AREA OF IMPERVIOUS AND PERVIOUS COVER IN MONROE COUNTY.
Source: Canaan Valley Institute, www.canaanvi.org
Data Source: National Land-cover Data (circa mid-1990s)
Data processed for inclusion in the Geographic Profiler by Canaan Valley Institute



IMPERVIOUS COVER IN THE NORTHERN AND SOUTHERN REGIONS OF THE WATERSHED

A clearer picture of the location of impervious cover in the watershed emerges by comparing the percentages and areas of impervious and pervious cover in the northern region of the watershed with the southern region of the watershed.

The northern region of the watershed consists of Carbon, Lackawanna, Luzerne, Monroe, Schuylkill, and Wayne Counties, with Carbon and Monroe Counties encompassing the largest area. The southern region consists of Berks, Bucks, Lehigh, and Northampton Counties, with Lehigh and Northampton dominating the region. As the following charts indicate, when comparing the impervious and pervious cover in Carbon and Monroe Counties (Figures 4-14, 4-15, 4-16, and 4- 17) with the same covers in Lehigh and Northampton Counties (Figures 4-18, 4-19, 4-20, and 4- 21), the two northern Counties contain less impervious cover than the southern region. This is consistent with the history and current status of the development of commerce and industry in these two regions.

FIGURE 4-18. PERCENTAGE OF IMPERVIOUS COVER IN LEHIGH COUNTY.
Source: Canaan Valley Institute, www.canaanvi.org

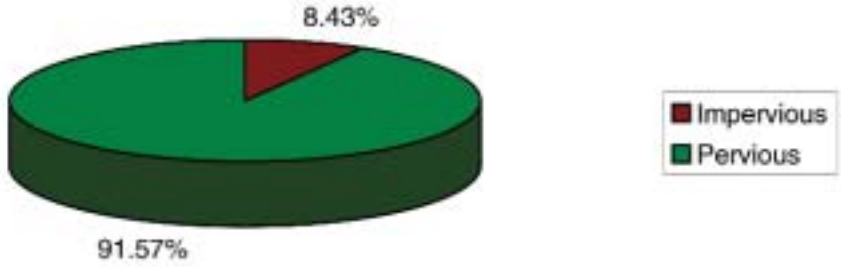
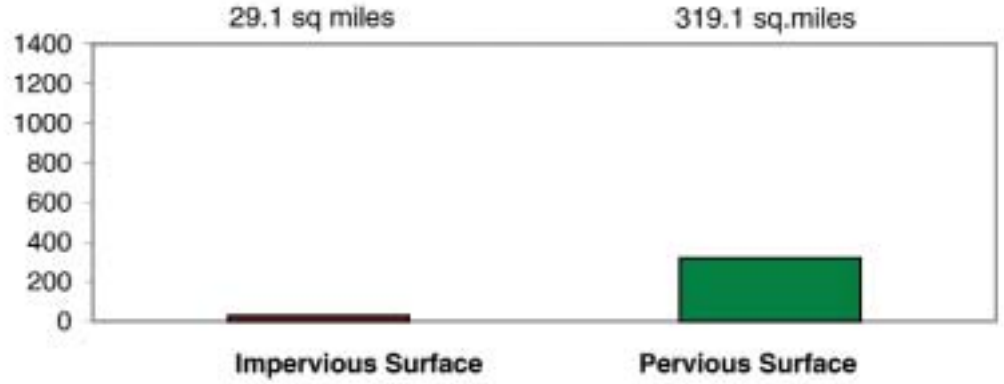


FIGURE 4-19. AREA OF IMPERVIOUS AND PERVIOUS COVER IN LEHIGH COUNTY.
Source: Canaan Valley Institute, www.canaanvi.org
Data Source: National Land-cover Data (circa mid-1990s)
Data processed for inclusion in the Geographic Profiler by Canaan Valley Institute



4. WETLANDS

The English language is filled with many descriptive terms for wetlands, such as swamp, marsh, and bog. Often these terms are highly localized. In some areas, bog can refer to any peat-accumulating wetland while in other places it might refer to a specific type of moss-lichen wetland. In order to circumvent the problems associated with these common and regional terms, more consistent terminology was developed by the United States Fish and Wildlife Service (USFWS). (See Section III – Aquatic Components for a complete description of the wetland systems in the Lehigh River watershed.)

a. Historical Perspective

As builders, farmers, and engineers moved across North America, wetlands were seen as obstacles. When the United States was settled, there were 215 million acres of wetlands, but as of the mid-1970s there were only 99 million of those acres left. Millions of acres were tiled and drained to make land available for roads, railroads and agriculture. Between 1956 and 1979, Pennsylvania experienced a net loss of 28,000 wetland acres (USFWS, 1990). Today, around 95 million acres of wetlands remain. In some states fully 95% of all wetlands have been drained. In Iowa, 1,196,392 acres of "swamplands" were granted to the state for "reclamation," and today less than 70,000 acres remain. (Johannesen and Gorganus, 1991). Wetlands once covered 25%

FIGURE 4-20. PERCENTAGE OF IMPERVIOUS COVER IN NORTHAMPTON COUNTY.
Source: Canaan Valley Institute, www.canaanvi.org

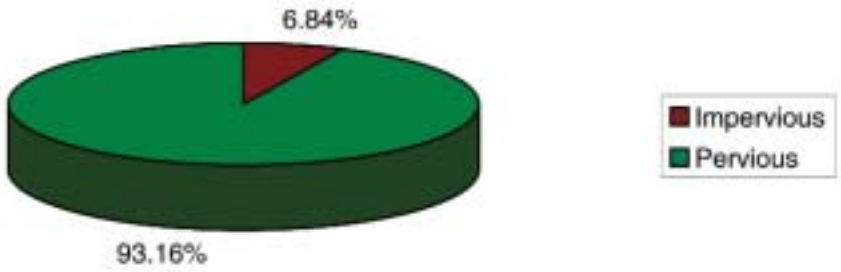
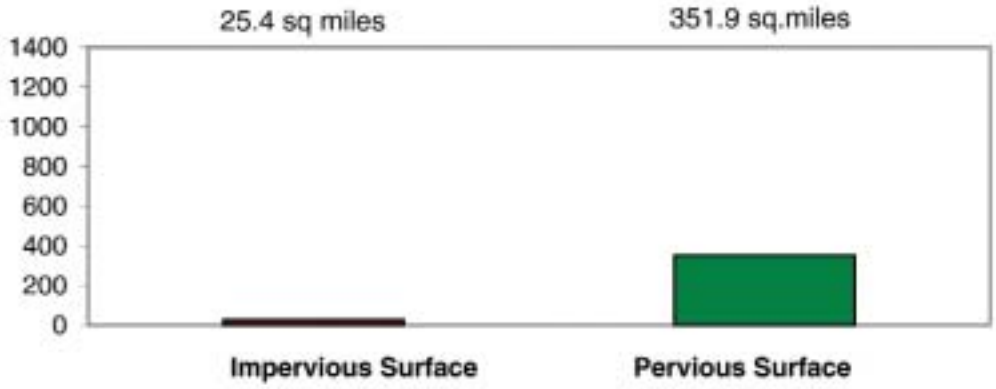


FIGURE 4-21. AREA OF IMPERVIOUS AND PERVIOUS COVER IN NORTHAMPTON COUNTY.
Source: Canaan Valley Institute, www.canaanvi.org
Data Source: National Land-cover Data (circa mid-1990s)
Data processed for inclusion in the Geographic Profiler by Canaan Valley Institute



of Indiana's land surface, an area amounting to about 5.6 million acres. As of 1981, Indiana had about 784,000 acres of wetlands, only 14% of its original wetlands. (Weller, 1981).

b. Current Status

The Lehigh River watershed has 64 square miles of various wetlands that fall into the three major classifications of palustrine (smaller than 20 acres, dominated by trees and shrubs), lacustrine (larger than 20 acres, lacking trees and shrubs), or riverine (channels of open water) wetland systems. The largest concentration of wetlands occurs in Monroe County (Map 3-4).

Agriculture has been a contributing factor to inland freshwater wetland loss in Pennsylvania, along with coal mining and oil and gas development. Historically, wetlands have been converted principally for agricultural use, but, in more urban areas, current wetland losses are more often from commercial, residential, and highway development. Most alterations that are due to development, such as filling and dredging, occur near urban and suburban areas. Other less-developed areas under pressure are those with strong growth in the recreation and vacation home market. The wetlands in the Poconos are threatened by vacation home, road, and driveway construction. (USFWS, 1990).

There have been efforts to recognize the ecological and wildlife benefits of wetlands and to protect them. Specifically, section 404 of the Clean Water Act prohibits unauthorized place-

ment of dredged or fill material into waters of the United States, including most wetlands. The United States Army Corps of Engineers (USACE) administers this program with Environmental Protection Agency (EPA) oversight. Within Pennsylvania, The Pennsylvania Department of Environmental Protection (DEP) has jurisdiction for the protection of wetlands and stream encroachments under Chapter 105 of the Dam Safety and Encroachment Act of 1978.

This photograph of a frog and its surroundings depicts a largely unseen, but nonetheless vitally important, link between man's health and the health of the environment in which he lives.

It is extremely difficult to ascribe monetary value to natural systems such as wetlands. More often than not estimates of land value are more a reflection of the assessor's values than any intrinsic quality of the land. For example, a collection of estimates on the value of an acre of prime Pennsylvania wetland would display distinct inconsistency.

The lowest estimates would probably come from early European settlers or 19th century economists. Those assessors would have been inclined to assess land in terms of the potential value it could provide to the purchaser. Since the land would probably be unfit for either agriculture or development, its appraised value would probably be extremely low.

Conversely, an estimate published by the National Wildlife Federation in the mid-70s gave an estimate of between $50,000 and $80,000 per acre. These types of estimates evaluated the often hidden services these wetlands provided to the larger community instead of the benefits received by the purchaser. Some of these services included flood prevention, erosion and sedimentation control, purification of groundwater and surface water as well as the production of commercially and recreationally important species of fish and waterfowl. (National Wildlife Federation).

5. BARREN LANDS

For this report, barren lands are defined as non-vegetated land, cleared for mining or timbering. This does not include naturally occurring barrens habitats.

a. Historical Perspective

Barren lands were created as vast areas of forest were cleared for transportation routes, construction purposes, and coal mining activities throughout the industrial era. Initially, there was little concern for the detrimental effects that these large land-clearing activities were having on the environment, and few if any efforts were undertaken to remedy the problems that these activities were causing in the watershed.

b. Current Status

Currently, barren lands encompass only 1.5% of the watershed (Map 4-1). In general, eastern upland forest ecosystems are resilient, and over time they recover from human- induced or natural disturbances. Such disturbances affect soil moisture, nutrients, and temperature conditions and alter lighting conditions, greatly modifying environmental conditions for natural ecosys-

Sometimes it is impossible to identify the entity which created these problems. Even when it is found, often there are no funds available for remediation.

tems, but can also be agents of regeneration. Plant and animal communities respond to disturbances, causing the progression from early succession to climax communities to occur. Forest regeneration has become especially challenging in recent years due to the high feeding pressure from the large white-tailed deer population.

Overall, logging practices have changed since the earlier days of indiscriminate logging and road building. There is awareness that our forest resources must be managed sensibly and that best management practices and forest stewardship plans are necessary for these resources to be sustained and renewable and for the watershed environment to be protected.

Over the years, there has been an increase in regulations to reduce the disruptive effects of mining activities. In 1977, Congress introduced the federal Surface Mining Control and Reclamation Act (SMCRA). As a result, coal-producing states were required to update their mining regulations if they wished to retain primary responsibility (primacy) for regulating their surface mining industry. SMCRA mandated that all active coal operators must return the lands they mine back to their original contour and post bonds to guarantee the work is completed within a specific amount of time after active mining ceases. Should an operator fail to undertake reclamation, the state would then use the financial guarantee to pay a contractor to reclaim the property. In addition, the act established the Abandoned Mine Reclamation Fund

TABLE 4-5. LIST OF ACTIVE MINING PERMITS IN THE LEHIGH RIVER DRAINAGE AREA
Source: Pennsylvania Department of Environmental Protection, 2004

Site Name	*County*	*Municipality*	*Company Name*	*Permit Number*
Rossi Excavating Banks Mine	Carbon	Banks Twp.	Rossi Excavating Co.	13940201
Pagnotti Ent. Spring Mnt. Mine	Carbon	Banks Twp.	Pagnotti Enterprises Inc.	13743002
Rossi Excavating Centown Mine	Carbon	Banks Twp.	Rossi Excavating Co.	13980201
Rossi Excavating Greenfeild Mine	Carbon	Banks Twp.	Rossi Excavating Co.	13990201
Panther Creek Partners	Carbon	Nesquehoning	Panther Creek Partners	13890201
JEZ Nesquehoning Mine	Carbon	Nesquehoning	JEZ Inc.	13800202
JEZ Nesquehoning 2 Mine	Carbon	Nesquehoning	JEZ Inc.	13800203
Jeddo Highland Coal 2 N mine	Luzerne	Foster	Jeddo Highland Coal Co.	40663031
Jeddo Highland Coal Lehigh 6 Mine	Luzerne	Foster	Jeddo Highland Coal Co.	40663033
Jeddo Highland Coal Lehigh 6 Mine	Luzerne	Foster	Jeddo Highland Coal Co.	168M007
Pagnotti Ent. Highland 2 S Mine	Luzerne	Foster	Pagnotti Enterprises Inc.	40663030
Pagnotti Ent. Highland 5 Mine	Luzerne	Foster	Pagnotti Enterprises Inc.	40663029
No. 1 Contracting Corp.	Luzerne	Foster	No. 1 Contracting Corp.	40980101
Coal Contr. 1991 Stockton Mine	Luzerne	Hazel	Coal Contr. 1991 Inc.	40663024

TABLE 4-6. LIST OF NON-COAL MINING PERMITS IN THE LEHIGH RIVER DRAINAGE AREA
Source: Pennsylvania Department of Environmental Protection, 2004

LOWER LEHIGH RIVER WATERSHED QUARRIES

Company Name	*Site Name*	*Permit No.*	*Site Status*
Lafarge North Amer Inc	Lafarge Cementon Quarry	7875SM2	Active
Waylite Div Intl Mill Svc Inc	Waylite Bethlehem Slag Bank Iv Quarry	48990301	Active
Penn Big Bed Slate Co Inc	Penn Big Slate Manhattan Quarry	7873SM1	Active
Haines & Kibblehouse Inc	Haines & Kibblehouse Abe Allentown Quarry	39870302	Active
Lafarge North Amer Inc	Lafarge Egypt Quarry	39970301	Active
Essroc Cement Corp	Essroc Cement Imperial Quarry	7475SM4	Active
Keystone Cement Co	Keystone Quarry	7475SM3	Active
Coplay Aggregates Inc	Coplay Plt 2 Quarry	39920301	Active
Bpb Mfg Inc	Bpb Amer Fullerton Waste Slag Quarry	7874SM1	Active
Lafarge North Amer Inc	Lafarge Northampton Quarry	48750401	Active
Eastern Ind Inc	Eastern Ind Ormrod Quarry	7874SM2	Active
Eastern Ind Inc	Eastern Ind Lehigh E Quarry	39920302	Active
Essroc Cement Corp	Essroc Cement Egypt Quarry	7876SM1	Active
Waylite Div Intl Mill Svc Inc	Ims Waylite Bethlehem Slag Area Ii Quarry	48990302	Active
Chrin Bros Inc	Chrin Bros Quarry	48980301	Active
Coplay Aggregates Inc	Coplay Aggregates Plt 1 Quarry	39880302	Active
Waylite Div Intl Mill Svc Inc	Ims Waylite Bethlehem Slag Quarry	48880301	Active
Lehigh Stone Co	Eastern Ind Lehigh Quarry	7875SM4	Active
Collis Used Auto Parts	Collis Quarry	SM 512-1	Active
Eastern Ind Inc	Eastern Ind Whitehall Limestone Quarry	7874SM3	Active
Eastern Ind Inc	Eastern Ind Lehigh Quarry	39880301	Active
Blue Ridge Auto Ctr	Blue Ridge Quarry	48890801	Active
Eastern Ind Inc	Eastern Ind Friedensville Quarry	39870301	Active
Collis Used Auto Parts	Collis Quarry	48000801	Active

MIDDLE LEHIGH RIVER WATERSHED QUARRIES

Company Name	*Site Name*	*Permit No.*	*Site Status*
Alliance Sand Co	Alliance Sand Palmerton Quarry	13000301	Active
Harley Henning	Henning Quarry	SM430-1	Abandoned
Lehigh Asphalt Pav Const Co	Lehigh Asphalt Paving & Const E Penn Quarry	7374SM2	Active
Royal Oak Homes Inc	Royal Oak Homes Quarry	45960802	Active
Lehigh Asphalt Pav Const Co	Lehigh Asphalt Paving & Const Plt 2 Quarry	PA0593206	Active
Lehigh Asphalt Pav Const Co	Lehigh Asphalt Paving & Const Plt 2 Quarry	PA0593206	Active
Connie Merwine	Connie Merwine Quarry	45880806	Active
Eastern Ind Inc	Eastern Ind Little Gap Quarry	13760301	Active
Alliance Sand Co	Alliance Sand Palmerton Quarry	7373SM2	Active
Lehigh Asphalt Pav Const Co	Lehigh Asphalt Paving & Const Andreas 2 Quarry	54970301	Active
Clark H George	Clarks Quarry	45970801	Inactive
Kuehner Excav	Kuehner Quarry	45940802	Active

continued on next page

TABLE 4-6. LIST OF NON-COAL MINING PERMITS IN THE LEHIGH RIVER DRAINAGE AREA (continued)

MIDDLE LEHIGH RIVER WATERSHED QUARRIES *(continued)*

Company Name	*Site Name*	*Permit No.*	*Site Status*
Haines & Kibblehouse Inc	Haines & Hibblehouse Chestnut Ridge Quarry	45900301	Active
Shiffer Bit Svc Co	Shiffer Bituminous Svc Quarry	52770301	Active
Haines & Kibblehouse Inc	Haines & Kibblehouse Jamico S Quarry	13930301	Active
Douglas D Eckhart	Eckhart Quarry	13850801	Active
Francis Merwine	Francis Merwine Quarry	45852308	Active
Douglas D Eckhart	Eckhart Quarry	13032801	Active
Michael Bocko Jr Excav	Bocko Smith Quarry	45860806	Active
Jane Helm	Jane Helm Pit 1 Quarry	45850811	Active
Haines & Kibblehouse Inc	Haines & Kibblehouse Jamico S Quarry	7373SM1	Active
Lehigh Asphalt Pav Const Co	Lehigh Asphalt Paving & Const E Penn Quarry	13990301	Active
Bruce N George	George Sterling Quarry	45930802	Active
Lehigh Asphalt Pav Const Co	Lehigh Asphalt Paving & Const Andreas W Quarry	54910301	Active
Olin Miller	Miller Quarry	58980845	Active
Lehigh Asphalt Pav Const Co	Lehigh Asphalt Paving & Const Plt 2 Quarry	7373SM3	Active
Haines & Kibblehouse Inc	Haines & Kibblehouse Altemose Quarry	6575SM4	Active
Lehigh Cement Co	Lehigh Portland Cement Barlieb Quarry	6575SM5	Active
Haines & Kibblehouse Inc	Haines & Kibblehouse Jamico N Quarry	5878SM3	Active
Warren Merwine Jr	Merwine Quarry	45852307	Active
Carefree Lawns	Carefree Lawns Penn Forest Quarry	13920801	Active

UPPER LEHIGH RIVER WATERSHED QUARRIES

Company Name	*Site Name*	*Permit No.*	*Site Status*
W Jack Kalins Inc	Kalins Quarry	45992801	Active
Carl L Kresge & Sons Inc	Meadow Run Quarry	40960806	Inactive
Selig Const Co Inc	Selig Pocono Quarry	45880301	Active
Spencer H Diehl	Diehl Quarry	13860801	Active
Pocono Transcrete Inc	Pocono Transcrete White Haven Quarry	40870302	Active
Donald Brennan	Brennan Quarry	45910804	Active
Kenneth F Detweiler	Detweiler Quarry	13852301	Active
Michael Safin	Safin Quarry	45880803	Active
John E Heller	Heller Quarry	45880807	Inactive
Haines & Kibblehouse Inc	Haines & Kibblehouse Locust Ridge Quarry	45950302	Active
Jonathan Point Inc	Point Quarry	13870803	Active
Smith Partnership	Smith Quarry	13870801	Active
Bfb Const Co	Bfb Quarry	45870809	Active
Mt Airy Lodge Inc	Mt Airy Lodge Long Pond Quarry	45910803	Inactive
Floyd C Hoffman	Hoffman Quarry	40900806	Active
Hanson Aggregates Pa Inc	Hanson Aggregates Pa White Haven Quarry	40000301	Active
Tony Szymanosky	Szymanosky Quarry	35900801	Active
W. Jack Kalins, Inc.	Kalins Dennison Topsoil Quarry	40032802	Active

by imposing a fee on active mine operators based on the tonnage of coal removed. The trust fund, administered by the Office of Surface Mining and Enforcement (OSM), is used to reclaim mine lands abandoned prior to 1977. An amendment to SMCRA also allows states to put aside grant money specifically for treating mine drainage.

Since the early 1980s, under the Reclamation-In-Lieu of Civil Penalties Program, Pennsylvania's Department of Environmental Protection (DEP) has routinely allowed operators to perform reclamation instead of paying civil penalties assessed for active permit violations. The reclamation performed is always more valuable than the actual assessed civil penalty and the activity cannot address the operation's legal responsibility. DEP's District Mining offices have used this program to facilitate many types of abandoned mine reclamation, including abandoned surface mine reclamation, deep mine sealing and reclamation, mine drainage remediation projects, and control of surface subsidence due to abandoned deep mine operations.

Many coal, slate, sand, stone, and other mining operations are active in the Lehigh River watershed. Table 4-5 outlines the active coal mining operations and Map 4-6 and Table 4-6 show the active non-coal mining operations.

B. Publicly Owned and Protected Lands

Publicly owned lands include federal and state parks, wilderness areas, and wildlife refuges. Data from the U.S. Department of Agriculture's (USDA) report, Major Uses of Land in the United States, shows that nationally, Pennsylvania ranks 17th in the number of publicly owned acres. The USDA estimated that the number of acres of public land in the United States tripled between 1959 and 1997. During this period, USDA reports that Pennsylvania gained about 530,000 acres of publicly owned parkland.

In 2000, one in seven acres of land in Pennsylvania was publicly owned by Pennsylvania State Game Commission, the Pennsylvania Fish and Boat Commission, the Bureaus of Forestry and State Parks, the U.S. Park Service, and the U.S. Forest Service. Collectively, they owned 4.2 million acres at the time.

The largest owner of public land in Pennsylvania is the state Bureau of Forestry, a bureau within the Department of Conservation and Natural Resources (DCNR), which manages more than 1.9 million acres throughout the Commonwealth. The next largest landholder is the Pennsylvania Game Commission with nearly 1.4 million acres. These two agencies combined own nearly 80 percent of the public land in Pennsylvania. (Center for Rural Pennsylvania).

1. Federal Lands

There are two federally-owned lands, totaling 6565.05 acres, in three of the counties in the watershed. The federally-owned lands include the Francis E. Walter Reservoir in Carbon, Luzerne and Monroe Counties and the Beltzville State Park in Carbon and Monroe Counties. Although Beltzville State Park is federally-owned, it is state operated and maintained. (See description of Beltzville State Park below.) (Map 4-7) Both are located north of the Blue Mountain. Table 4-7 lists these lands, their location, and acreage.

The Francis E. Walter Reservoir, originally known as Bear Creek Reservoir, is located near the convergence of Bear Creek and the Lehigh River in Luzerne and Carbon Counties in northeastern Pennsylvania. It is a man-made impoundment created by the U.S. Army Corps of Engineers

(USACE) in 1961 by damming the Lehigh River at the confluence with Bear Creek. It is an 1,800-acre project, having a small 90-acre reservoir but no Corps-operated recreation facilities. The F. E. Walter Reservoir provides water supply and recreation, as well as being an integral part of the Lehigh River flood control plan.

Available recreational activities include picnicking, hiking, boating, and fishing. There is a boat launch area (no ramp), although there is a 10 hp limit. Swimming is not permitted. Hunting, in season, is allowed on adjacent Pa. State Game Lands. Whitewater rafting is also available downstream during the regularly scheduled release dates. These release dates are listed on the Army Corps of Engineers web site.

2. COMMONWEALTH PARKS AND GAME LANDS

There are portions of two state forests and five state parks, owned by The Commonwealth of Pennsylvania, totaling 56,088 acres, in four of the counties in the watershed. There are 14 Pa. State Game Lands, totaling 109,327.64 acres (Map 4-7) . The majority of these lands are located north of the Blue Mountain. These parks, their location, and acreage are listed in Table 4-7.

STATE FORESTS

The two state forests include Weiser State Forest and Lackawanna State Forest. Portions of both of these state forests are in the Lehigh River watershed.

The Weiser State Forest consists of eight tracts of State Forest Land located in northern Dauphin, Schuylkill, Carbon, and Berks Counties. Rugged and secluded wooded areas within the Weiser State Forest can be reached by the 65 miles of roads which have been constructed for wildfire suppression and administrative use. The Weiser State Forest contains the headwaters of mountain streams, and several of these streams provide the sole source of drinking water for the communities of Port Clinton, Lykens, and Williamstown.

The Lackawanna State Forest is located in Lackawanna and Luzerne Counties. The name Lackawanna is the English spelling of an Indian word which means "a place where the river forks." The Lackawanna State Forest is noted for its diverse recreational opportunities. It contains a total of 8,115 acres of State Forest land in two separate tracts, the Thornhurst Tract and the West Nanticoke Tract.

The Thornhurst Tract is a 6,711-acre woodland that offers extensive outdoor recreational opportunities such as picnicking, hiking, backpacking, hunting, snowmobiling, cross-country skiing, fishing and nature walks. Two mountain streams contribute to the uniqueness of this site.

STATE PARKS

The five state parks in the watershed include Beltzville, Gouldsboro, Hickory Run, Lehigh Gorge, and Tobyhanna.

Beltzville State Park

In Carbon County, the 2,972-acre Beltzville State Park is developed around the U.S. Army Corps of Engineers flood control project, Beltzville Dam. The resulting Beltzville Lake is 949 acres with a shoreline of 19.8 miles. The park is along the Pohopoco Creek with recreation areas around the lake. Recreational facilities are a result of a cooperative effort of the U.S. Army Corps of Engineers, the Department of Conservation and Natural Resources-Bureau of State Parks and the Pennsylvania Game Commission.

TABLE 4-7. LIST OF PUBLICLY-OWNED AND PROTECTED LANDS
Source: Pennsylvania Recreational Guide and Highway map, DCNR 2003 and Pa. Game Comission

Ownership	*County*	*Name*	*Acres*
FEDERAL GOVERNMENT			
	Carbon	Francis E. Walter Reservoir	935.81
	Luzerne	Francis E. Walter Reservoir	1,820.30
	Monroe	Francis E. Walter Reservoir	125.71
		Francis E. Walter Reservoir Total	2,881.82
	Carbon	Beltzville State Park	3,646.30
	Monroe	Beltzville State Park	36.93
		Beltzville State Park Total	3,683.23
		Total Acres	***6,565.05***
COMMONWEALTH OF PA			
State Forests	Dauphin, Schuylkill, Carbon & Berks	Weiser State Forest	19,200.00
	Lackawanna & Luzerne	Lackawanna State Forest	8,400.00
		Total Acres	***27,600.00***
State Parks	see above	Beltzville State Park	
	Monroe/Wayne	Gouldsboro State Park	2,800.00
	Carbon	Hickory Run State Park	15,700.00
	Carbon/Luzerne	Lehigh Gorge State Park	4,548.00
	Monroe/Wayne	Tobyhanna State Park	5,440.00
		Total Acres	***28,488.00***
State Game Lands	Monroe	*State Game Land No. 38	5,488.61
	Carbon	*State Game Land No. 40	6,118.51
	Lackawanna/Luzerne	State Game Land No. 91	16,659.20
	Luzerne	*State Game Land No. 119	7,967.29
	Monroe	*State Game Land No. 127	25,518.95
	Carbon/Monroe	*State Game Land No. 129	3,518.40
	Lackawanna	*State Game Land No. 135	3,430.54
	Carbon	*State Game Land No. 141	17,047.91
	Luzerne	*State Game Land No. 149	1,989.69
	Northampton/Carbon/Monroe	State Game Land No. 168	5,802.85
	Lehigh	*State Game Land No. 205	1,302.80
	Lehigh/Carbon/Schuylkill	State Game Land No. 217	7,122.30
	Schuylkill	State Game Land No. 257	3,448.47
	Lackawanna/Monroe/Wayne	State Game Land No. 312	3,912.12
		Total Acres	***109,327.64***

**All acres contained within the Lehigh River watershed*

Fishing, picnicking, hiking, boating, swimming, water-skiing, hunting, camping, ice fishing, and cross-country skiing, are a few of the recreational activities available at Beltzville State Park. School groups, scouts, civic organizations and the general public can learn about the natural and historical resources of the area at the environmental interpretive center.

The original covered bridge, built across Pohopoco Creek in 1841 by local craftsman Jacob Buck, has been relocated at the suggestion of local residents. It is now between the picnic areas and the beach for public use and enjoyment. This bridge was first used by horse and buggy traffic, later by one-lane car traffic, and is now for pedestrian use only.

Gouldsboro State Park

Gouldsboro State Park, in Monroe and Wayne Counties in northeastern Pennsylvania, contains 2,800 acres of land, including the 250-acre Gouldsboro Lake. The park offers recreational opportunities such as boating, picnicking, hiking, swimming, fishing, ice fishing, hunting, and wildlife watching.

Hickory Run State Park

The 15,700-acre Hickory Run State Park, Carbon County, lies in the western foothills of the Pocono Mountains. This large park has over 40 miles of hiking trails, three state park natural areas and miles of trout streams. The Boulder Field, a striking boulder-strewn area, is a National Natural Landmark.

Recreational opportunities include camping, picnicking, hunting, swimming, fishing, cross-county skiing, hiking, ice skating, snowmobiling, mountain biking and wildlife watching.

Lehigh Gorge and Hickory Run state parks are in the Audubon's Lehigh Reach of the Delaware and Lehigh National Heritage Corridor. The Corridor stretches more than 150 miles from Wilkes-Barre to Bristol, in eastern Pennsylvania, and follows the historic routes of the Lehigh & Susquehanna Railroad, the Lehigh Navigation, and the Delaware Canal. Lehigh Gorge State Park and Hickory Run State Park are also featured in a unique auto tour entitled "Exploring Audubon's Lehigh." The tour focuses on famed naturalist John James Audubon's 1829 visit to the Rockport area of the Lehigh River Valley and looks at the valley's natural and historical landscapes.

Lehigh Gorge State Park

Lehigh Gorge State Park, located in Carbon and Luzerne Counties, contains 4,548 acres of land and about 30 miles of the Lehigh River. The park follows the Lehigh River from the outlet of the U.S. Army Corps of Engineers' Francis E. Walter Dam at the northern end to the town of Jim Thorpe at the southern end of the park. The deep gorge, steep walls, thick vegetation, rock outcroppings, and many waterfalls characterize the entire park. Lehigh Gorge State Park is administered by the Pennsylvania Department of Conservation and Natural Resources, Bureau of State Parks.

Recreational opportunities include hiking, biking, hunting, fishing, cross-country skiing, snowmobiling, and whitewater boating. The Lehigh Gorge Trail, which is 26 miles of abandoned railroad grade, follows the river throughout the park providing opportunities for hiking, bicycling, sight-seeing and photography, and also providing access for hunting and fishing. Parking areas are provided in White Haven, Rockport, and Glen Onoko. Very limited parking is available at Lehigh Tannery but no boat launching is permitted. Whitewater boating is a major attraction of the park. This section of the Lehigh River is Class III whitewater and is popular for rafting, kayaking, and canoeing.

Tobyhanna State Park

Tobyhanna State Park is situated in Monroe and Wayne Counties. The 5,440-acre park includes the 170-acre Tobyhanna Lake. Tobyhanna is derived from an American Indian word meaning "a stream whose banks are fringed with alder." Boating, swimming, snowmobiling, ice skating, ice fishing, fishing, hunting, camping, picnicking, hiking, and wildlife watching are a few of the recreational activities available at the park.

Visitors using more remote and undeveloped areas of Tobyhanna State Park need to be aware that they could encounter old, unexploded artillery shells in the park. The shells originated from the Tobyhanna Army Depot. Shells are found in a severely rusted condition without any recognizable markings or imprints and their overall appearance is that of a pointed cylinder of rusted steel. These items should not be touched, moved or disturbed, and the park office should be notified of the location of any shells to insure proper disposal. (DCNR State Parks).

3. CONSERVATION EASEMENT LANDS AND PRESERVES

Additional lands are protected, through conservation easements and fee acquisition, by non-profit land conservation organizations or landowners in cooperation with conservation organizations (Map 4-7). Wildlands Conservancy and The Nature Conservancy are the principal land conservation organizations actively preserving lands in the watershed. Wildlands Conservancy has protected 5,500 acres through conservation easements, and The Nature Conservancy has protected 3,650 acres through conservation easements and fee acquisition.

A view of the Lehigh River between Lehigh and Northampton Counties. The land on the left side of the photograph is protected by a donated conservation easement. A section of the canal of the old Lehigh Navigation can be seen on the opposite shore.

Wildlands Conservancy developed a methodology for land protection prioritization, which can be utilized to protect additional lands throughout the watershed (Appendix B – 1.).

Conservation easements are open space preservation tools that help protect environmental areas, farmlands, woodlands, meadows, riparian corridors, greenways, and scenic vistas into perpetuity. Additionally, these protected open spaces continually preserve and aid in the health of water quality, be it groundwater, wetlands, or streams. Simply put, a conservation easement is a legal agreement between a landowner and a land trust (a private, non-profit conservation organization) or government agency that permanently limits a property's uses in order to protect its conservation values.

Landowners retain many rights associated with their land. When a landowner sells or donates a conservation easement, the owner permanently forfeits some of those rights. As examples, both a conservation easement designed to protect wildlife habitat and an easement on a farm designed to perpetuate continued farming would prohibit commercial and/or residential development. Future owners of the land will also be bound by the easement terms.

Other protected lands are owned by governmental or non-profit entities. Two governmental examples within the Lehigh River watershed are the Trexler-Lehigh County Game Preserve owned by Lehigh County and the 13,000 acre site owned by the Bethlehem Water Authority. Protected lands or preserves owned by non-profit entities include over 750 acres known as the Lehigh Gap Wildlife Information Center; over 3,200 acres owned by The Nature Conservancy; the 700-acre Robert Rodale Reserve, 72-acre Pool Wildlife Sanctuary, 11-acre Reimert Preserve, 26-acre Burkhart Preserve, and 38-acre Buehler Preserves owned by Wildlands Conservancy; and the 12-acre Kalmbach Memorial Park.

TREXLER-LEHIGH COUNTY GAME PRESERVE

The Trexler-Lehigh County Game Preserve was founded by a local industrialist, the General Harry C. Trexler, in the early 1900s. Located north of Allentown, it encompasses approximately 1,200 acres of maturing second-growth forest, a remarkable reach of the Jordan Creek and its unique riparian areas, steeply sculpted uplands, open hilltop areas providing dramatic vistas, and a 23-acre zoo, home to indigenous and exotic species of animals. (Trexler-Lehigh County Game Preserve, 2003).

LEHIGH GAP

The Lehigh River runs through the Lehigh Gap, and the town of Palmerton is north of the gap. Palmerton is in a valley where Stony Ridge lies north of the town, the Aquashicola Creek runs the length of the valley, and Blue Mountain borders the valley on the south. The Lehigh Gap cuts through Blue Mountain south of Palmerton. Palmerton is known for the Palmerton Zinc Pile industrial complex, which is currently listed on the Environmental Protection Agency's National Priorities, or Superfund List. (US Environmental Protection Agency, 1983).

In 2002, the Lehigh Gap Information Center purchased over 750 acres on the Blue Mountain along the Lehigh River. Much of the degraded land is being restored using native, warm-season grasses. Other parts of the refuge contain undamaged wildlife habitats, including ponds, bottomland wetlands, a 2.5 mile riparian zone, forested slopes, cliffs, and savanna at the higher elevations. The refuge serves as a wildlife refuge, an educational outdoor classroom, a site for wildlife research, and a site for recreational activities. (Lehigh Gap Information Center, 2003).

THE NATURE CONSERVANCY

Adams Swamp, located in Monroe County, is one of the largest, least disturbed boreal conifer swamps in Pennsylvania. The 1200-acre site contains two major wetland communities: a conifer swamp and an acidic shrub swamp. The Nature Conservancy purchased Adams Swamp in 1987 and currently leases it to a nearby residential community.

The Long Pond area contains a 2,000-acre boreal wetland surrounded by a 5,600-acre pitch pine/scrub oak barren, and the barren is the only known remaining barren in the northeastern United States. The large expanse of pitch pine and scrub oak forests interspersed with moorlike heathlands and swamps is the only natural community of its kind in the world. Since 1987 The Nature Conservancy has purchased more than 2,000 acres in the Long Pond area. Monroe County and the City of Bethlehem assisted with some of the acquisitions, and matching funds from the Commonwealth of Pennsylvania helped purchase two of the tracts.

The 2,200-acre Thomas Darling Preserve at Two Mile Run in Monroe County was purchased through a three-way partnership of Tobyhanna Township, The Nature Conservancy (TNC) and the Wildlands Conservancy. Funded in part by matching grants from the Commonwealth of

Pennsylvania's Keystone Recreation, Parks, and Conservation Fund, TNC now manages the entire preserve.

Named for Wilkes-Barre naturalist and long-time TNC supporter Thomas Darling, Jr., the groundwater-fed wetland has one of Pennsylvania's largest untouched peatlands and one of the largest and healthiest native spruce forests in the state. Two Mile Run, a tributary of the Lehigh River, runs through the property.

Lehigh Pond, one of only a few unpolluted glacial lakes left in Pennsylvania, is located on State Game Lands (SGL) No. 312 at the headwaters of the Lehigh River and Tobyhanna Creek. The cold sphagnum bog surrounding the pond supports five rare-to-Pennsylvania plants. The entire 3,912-acre SGL property was purchased by The Nature Conservancy and Wildlands Conservancy for the Pennsylvania Game Commission with assistance from Ducks Unlimited. Partial funding was also provided by the Federal Land and Water Conservation Fund. (The Nature Conservancy, 2003).

Robert Rodale Reserve

The approximately 700-acre Robert Rodale Reserve, located in Lehigh County, was established to protect the beautiful viewshed of the Lehigh Valley, to assure the protection of wildlife habitat, and to provide recreational uses for the surrounding communities. The Reserve is chiefly comprised of the City of Allentown's South Mountain Park (350 acres) and Wildlands Conservancy's South Mountain Preserve (350 acres). Both contain maturing, second-growth forest, are home to rare or threatened plant species, are prime breeding habitat for amphibians, and provide nesting habitat for more than 59 species of birds. Additionally, the properties are significant passive and active recreational areas.

Pool Wildlife Sanctuary

The 72-acre Pool Wildlife Sanctuary was a gift by bequest in 1975 from the late Leonard Parker Pool, founder of Air Products and Chemicals, Inc., to Wildlands Conservancy. Located in Lower Macungie Township, Lehigh County, the Little Lehigh Creek runs adjacent to the sanctuary on three sides of the property. The Sanctuary features a watershed display center, an environmental education center, a pavilion, many nature trails, a bird blind, wildlife habitat, and an arboretum.

Through generous, private donations since 1973, Wildlands Conservancy has acquired the Reimert, Burkhart, and Buehler properties. These three properties are located in Lehigh County and serve as preserves by maintaining open space, providing wildlife habitat, and offering passive recreational opportunities.

Kalmbach Memorial Park

Kalmbach Memorial Park is a distinct community center in the Borough of Macungie, Lehigh County, established by the late industrialist, Frederick Kalmbach Sr., founder of Electric Furnace Man, in Emmaus. His fondness for the Macungie community motivated him to direct that his home and surrounding property be developed as a "public park for the physical, cultural, and educational advancement of the people of the community." Kalmbach Memorial Park provides a variety of programs, workshops and events geared to all ages and interests of the Macungie community. A nature trail and walking path meanders through field and wooded areas of the estate, and youth programs embrace the simple childhood activities of the past and offer creative learning opportunities for the entire family. (Kalmbach Memorial Park. 2003

Greenway corridors are vital linkages for man and beast. They may have a valuable recreational component, but not necessarily.

4. GREENWAYS

Greenways are publicly and/or privately owned corridors of protected open space managed for conservation and recreation purposes. They often follow natural land or water features, and link nature reserves, parks, cultural features, and historic sites with each other and with populated areas. Some greenways include recreational trails, while others are solely for the protection of conservation resources. Trails are pathways used for walking, bicycling, horseback riding, or other forms of recreation or transportation.

Environmentally, greenways and trails support the health of the watershed by: enhancing the quality of life in a community or region; accentuating the scenic beauty of the area; protecting water resources by buffering non-point source pollution; providing opportunities to protect and manage wildlife, forests and ecological systems; providing recreational opportunities for families and individuals of all ages and abilities; providing alternatives to automotive transportation, thus reducing traffic congestion; adding positively to our economic climate, and being beneficial for health and wellness for individuals of all ages.

In 1998, Pennsylvania Governor Ridge's Executive Order 1998-3 called for an action plan for advancing the Pennsylvania's Greenways Partnership Program into the 21st century. This greenway vision is to develop an outstanding network of greenways across the Commonwealth. The existing, proposed, and future greenway systems in the watershed will connect with this vision.

KITTATINNY COALITION

The Kittatinny Coalition began as a loose-knit coalition of groups with interests in protecting the Kittatinny Ridge (also know locally as the Blue Mountain). This ridge, one of the so-called "front" ridges of the Allegheny Mountains, runs from the Delaware River in Monroe and Northampton Counties to the Maryland border in Adams and Franklin Counties. It is pierced by the Lehigh River north of Allentown. The heavily forested ridge is a major bird migration corridor across Pennsylvania, best known for raptor watching sites as Hawk Mountain Sanctuary, Second Mountain, Bake Oven Knob and other local areas. The ridge contains many sites of historic interest and is the source of drinking water for many of the communities that abut it. In addition, it is a major part of the visual landscape of southeastern Pennsylvania, separating the lower predominately agricultural lands in the southeast from the rolling ridges to its northwest. It is the principal scenic feature of east-west travel from the eastern border of Pennsylvania to Harrisburg, Carlisle, and Gettysburg. The Appalachian Trail in Pennsylvania runs primarily on the Kittatinny Ridge. A substantial amount of land on the Kittatinny Ridge is in public ownership, and the existence of the Appalachian Trail creates a greenway for public use.

The Kittatinny Coalition is made up of over forty groups; some professional land trusts from across the region, with a strong percentage of concerned citizens organizations. With support from the Department of Conservation and Natural Resources as well as from private founda-

tions, the Coalition has a full-time executive director. The Coalition is mapping critical areas along the ridge, and has conducted a number of public meetings designed to educate citizens, landowners and municipalities in the need to protect and preserve the ecology and environment of the ridge.

THE HIGHLANDS COALITION

The Highlands Coalition's mission is the protection of an area of high ground stretching across four states. From the Massachusetts/Connecticut border in western Connecticut, south and west across the Hudson River in New York State in the area of West Point, across all of northern New Jersey, and from the Delaware River at Easton, Pa. southwest to the Maryland border in Adams and York Counties. This high ground encompasses the geologic New England Province with some continuing hills running from Reading southwest to the area of Hanover. It is predominately forested and provides habitat and migration corridors for animals and birds. In addition, it contains hundreds of historic sites as well as being the source of drinking water for millions of people, especially in the cities of northern New Jersey. It is within driving distance of less than an hour for people in the New York to Philadelphia corridor and is heavily used by people for recreation and scenic enjoyment.

The groups and organizations forming the membership of the Highlands Coalition began to come together over a decade ago in New Jersey, and then expanded to the other three states. They recently formed a 501(c) (3) non-profit organization specifically called the Highlands Coalition, with its own executive director and other staff. Each state has its own organizational committee. The organization is supported by grants from private foundations and has received substantial support of both staff and money from regional, statewide and multi-state organizations.

BERKS-LEHIGH VALLEY GREENWAY TASK FORCE

The Berks-Lehigh Valley Greenway Task Force was created – and is chaired by – the Pennsylvania Department of Conservation and Natural Resources' Bureau of Recreation and Conservation (DCNR). Its membership includes any conservation organization, municipal entity, institution, or individual interested in greenway and trail development in the Berks County/Lehigh Valley region.

The mission of the task force is to coordinate and facilitate federal, state, county, and municipal planning and implementation of greenways in Berks, Lehigh, and Northampton Counties. It seeks to identify existing and potential projects in the region and to provide guidance in planning and implementation, as needed. It provides information on the availability of funding, technical assistance, and other resources. It reviews projects and concepts that are potential models for advancing greenways and conservation goals in the area. It explores the availability of DCNR's technical and staff resources for current and future planning activities.

C. Impacted Areas

LANDFILLS

A secure landfill is a carefully engineered depression in the ground where wastes are deposited. The goal of a landfill is to avoid any water-related connection between the wastes and the surrounding environment, particularly groundwater. Landfills can leak in one of two ways: out the

sides and bottom or over the top. There are four critical elements in a secure landfill: a bottom liner, a leachate collection system, and a cover. If possible, the landfill location is selected to minimize the possibility of wastes escaping to groundwater beneath the landfill. The three other elements must be engineered.

There are three types of bottom liners: clay, plastic, and composite. Good landfill liners today are made of a tough plastic film called high density polyethylene (HDPE).

A leachate collection system basically captures the water leaching through the landfill. This contaminated water (leachate) seeps to the bottom of a landfill and is collected by a system of pipes, and may be pumped to and treated at a wastewater treatment plant.

A cover or cap is like an umbrella over the landfill to keep water out, thus helping to prevent leachate formation. It generally consists of several sloped layers: a clay or membrane liner (to prevent rain from intruding), overlain by a very permeable layer of sandy or gravelly soil (to promote rain runoff), and overlain by topsoil in which vegetation can root (to stabilize the underlying layers of the cover). (Environmental Research Foundation)

Currently, there are no active landfills in the Lehigh River watershed. (Pa. Department of Environmental Protection)

CERCLA Sites

CERCLA is an acronym for the Comprehensive Environmental Response, Compensation, and Liability Act, which Congress passed into federal law in 1980. These sites are often referred to as Superfund sites. The Superfund Amendments and Reauthorization Act (SARA) is an extension of CERCLA that was passed in 1986. This five-year extension increased funding and put in place standards for remediation. The original act, CERCLA, instated a tax on the chemical and petroleum industries to identify and clean up hazardous sites as well as to evaluate the damages to natural resources. Congress is currently discussing the reauthorization of the act.

Pennsylvania has the second largest number of sites on the National Priority List (NPL) for CERCLA sites. There are thousands of sites within the state clean-up system. A large number of the CERCLA sites are located in the eastern portion of the state, including many in the Lehigh River watershed. The state has a statutory and regulatory system in place to manage the clean-up of these sites. Pennsylvania's Land Recycling and Environmental Remediation Standards Act provides a framework for the clean-up standards within the state. This act outlines standards to transform old industrial sites into areas safe for productive use. Pennsylvania's Industrial Sites Environmental Assessment Act provides grant money for assessments of these sites. Authority was given to the Department of Environmental Protection (DEP) in clean-up of the sites from the Pennsylvania's Hazardous Site Clean-up Act in 1988. Nine sites in the Lehigh River watershed are currently on the NPL and recently, six other sites were removed from that list.

The ***Palmerton Zinc Piles site*** is located in the Borough of Palmerton, Carbon County. As of April 2000, this site was still undergoing evaluation. Heavy metals such as lead, cadmium, and zinc are found in the soils. Creeks in the area also are contaminated from these metals by runoff. High lead levels are present in the blood of children and animals living near site. Approximately 2,000 acres of land are affected and large portions of this area on Blue Mountain are defoliated. Viacom International, Inc. and Horsehead Industries, Inc., the parent company to the Zinc Corporation of America, are the parties potentially responsible for the contamination, or PRPs. Clean-up of the site was proposed in 1987; a proposal was issued for the clean-up of

residences in the Palmerton area in May 1994, and the clean-up is currently being supervised by the U.S. Environmental Protection Agency (EPA). The site is divided into four separate clean-ups, known as operable units. (US EPA, Region 3).

The Blue Mountain hillsides near Palmerton, Carbon County, have not been blue – or green – for some time, as an effect of nearby zinc-smelting operations. An ambitious planting project, begun recently, is bringing back the green.

The ***Tonolli Corporation site*** is located in the Borough of Nesquehoning, Carbon County. The area was the site of a lead-smelting facility and lead-acid battery facility. Arsenic and cadmium were discovered on site in 1985, the same year that the corporation filed for bankruptcy. The nearby Nesquehoning Creek is contaminated with heavy metals. Lead and chromium are also located on the site. Since 1998, the contaminated buildings were cleaned up and demolished, and over 77,000 cubic yards of soil were excavated. Preliminary reports on the final status of the clean-up were completed in December 1999.

The ***Dorney Road Landfill***, also known as the ***Oswald Landfill***, is located in Mertztown. The majority of the site is located in Lehigh County, though a small portion extends into Berks County. EPA clean-up plans were set into motion in 1998, and a cap for the landfill was completed in September of 1999. The site was an open-pit iron mine before it became an industrial landfill in 1952. Contaminants found in the groundwater and soil includes ketones, vinyl chloride, trichloroethane (TCE), benzene, arsenic, lead, chromium, and the pesticide dieldrin.

The clean-up of the ***Heleva Landfill***, located in Ormrod, Lehigh County, is continuing. A landfill cover, gas venting system, and groundwater pump and treatment system have been operating since October 1999. This twenty-six acre site was the location of an open-pit iron ore mine. In 1967, the site became a sanitary landfill, which included the disposal of industrial wastes. The groundwater and soils are contaminated with volatile organic compounds (VOCs).

The ***Hellertown Manufacturing site***, also known as the ***Champion Spark Plug Company***, is located in Hellertown, Northampton County. The EPA is currently overseeing the operation of a water pump and treatment system, expected to be in operation until the year 2016. The site is contaminated with TCE from a plating process used in spark plug manufacturing. VOCs are present in the groundwater, and chromium and cyanide contaminate on-site soils and sludge. An aquifer used to supply water to approximately 15,000 people is within three miles of the site, and Saucon Creek, used for fishing, is located 1,000 feet from the contaminated area.

Clean-up of the ***Novak Sanitary Landfill*** has been completed. This site is located on sixty-five acres in a residential area of South Whitehall Township, Lehigh County. In 1972, the owner of the landfill received government permission to dispose of various organic wastes including some that contained heavy metals. VOCs, TCE, and heavy metals are present at the site and low levels of VOCs were detected off-site in some residential wells. The cap of the landfill and construction of a leachate collecting system are completed.

The ***Rodale Manufacturing Company***, Inc. is located in Emmaus, Lehigh County. Rodale operated the plant from the 1950s to 1975, manufacturing electrical components, and Square D

Company assumed control in 1975, manufacturing wiring devices as well as electrical connectors. Trichloroethylene (TCE) is used in this manufacturing process and is the primary contaminant of this site. The TCE was disposed of on-site in deep injection wells in the aquifer. Approximately 21,000 people obtain drinking water from wells within four miles of the area. Air strippers were installed on the wells, and various actions were taken to contain further contamination of surrounding areas.

The ***Route 940 Drum Dump site*** consisted of two and one-half acres in Tobyhanna, Monroe County. Various VOCs from buried drums are the main source of contamination. In November 2000, the EPA Region III and the Pennsylvania Department of Environmental Protection (Pa. DEP) have determined that all appropriate CERCLA response actions have been implemented and that no further clean-up by responsible parties is appropriate. Moreover, EPA and Pa. DEP have determined that remedial activities conducted at the site to date have been protective of public health, welfare and the environment.

The ***Tobyhanna Army Depot site***, in Monroe County, is being cleaned up by the combined efforts of the Army, EPA, and the state of Pennsylvania. The current function of this 1,293-acre facility is to design, fabricate, repair, and modify a wide range of communications and electronics systems. VOCs were first discovered in an on-site well in 1981. Contaminants also include various heavy metals. Past clean-up efforts include the excavation of contaminated soils. Actions to treat the on-site groundwater are currently being discussed.

The ***Voortman Farm***, located in Upper Saucon Township, Lehigh County, was deleted from the National Priority List in June 1989 after receiving a "No further action, with continued monitoring" status from the EPA. The location of contamination on the farm was a large sinkhole where battery casings were dumped. Elevated levels of heavy metals were detected in the area before the state removed the old battery casings and the contaminated soil.

Reeser's Landfill is located in Upper Macungie Township, Lehigh County. The EPA has installed several monitoring wells on the property. Past uses of this site include mining and a dumpsite for un-permitted municipal and commercial wastes. In the 1980s, lead, zinc, cadmium, mercury, and low levels of polynuclear aromatic hydrocarbons and phenol were detected near the site. Most of the runoff from the site enters Iron Run, a tributary of the Little Lehigh Creek. Approximately 268 wells are located within three miles of the site. It was determined that there are no significant threats posed to human health or the environment, so a "No Action" decision was reached in March 1989. The site was deleted from the National Priority List in May 1990.

The ***Chain Bike Corporation site***, located in Allentown, Lehigh County, was constructed in 1969. The existing facility was occupied by Ross Bicycles, Inc. (formerly named Chain Bike Corporation), and they manufactured bicycles and metal ammunition boxes from 1970 until 1987. The manufacturing processes during this period included metal electroplating, electrostatic spray painting, metal stamping, finishing, assembly and warehousing. Various aboveground and underground storage tanks, an on-site wastewater treatment plant which processed the wastes generated from the electroplating baths, drum storage pads, and a drum storage building for hazardous and non-hazardous materials were part of the facility. The facility has been inactive since 1988, but is currently being cleaned up by its current owner, Conewago Contractors, Inc. for future use as a warehouse. Corrective Action activities at this facility are being conducted under the direction of EPA Region III with assistance from the PADEP. The main contaminants of concern at the facility are metals, such as barium, nickel, lead, and antimony. The contaminated soils have been removed.

On September 30, 2000, clean-up was completed of the mercury contamination that occurred

in Allentown on April 6 of the same year. Several children playing on the nearby playground at ***Central Elementary School*** were exposed to the harmful, hazardous liquid after a repair person threw it out. The clean-up cost $300,000 and took eight weeks to complete. Seventy-eight people were treated, and several homes were evacuated in an effort to remedy the situation. Of those treated, 26 people had moderately elevated levels of mercury. (U.S. EPA, Region 3)

D. Outstanding Natural Features and Habitats

1. Pennsylvania Natural Diversity Inventory

Numerous and various outstanding ecological areas grace the watershed. For over a decade, efforts have been underway by the Pennsylvania Natural Diversity Inventory (PNDI) partnership, individual county planning offices, The Nature Conservancy (TNC) in eastern Pennsylvania, and the Western Pennsylvania Conservancy in the western portion of the Commonwealth to inventory these ecological areas in each county. County inventories are referred to as County Natural Areas Inventories (CNAIs) in eastern Pennsylvania and County Natural Heritage Inventories (CNHIs) in western Pennsylvania. These inventories identify, map and discuss important ecological places within a county, prioritize them based on their attributes, and provide recommendations regarding their management and protection. These areas possess animal or plant species and habitats of concern. County inventories inform county residents about their living heritage and provide a tool to use in planning the future of their communities. Inventories have been completed for 32 of the 67 counties in Pennsylvania, and the remaining county inventories are scheduled for completion over the next five years.

2. County Natural Area Inventories

Funding for the county inventories has been provided by state grants from Pennsylvania Department of Conservation and Natural Resources (Pa. DCNR) and a mix of private and public funds obtained by local conservation organizations.

The inventories are completed by scientists who collect, analyze, and summarize ecological information gleaned from aerial photography, aerial reconnaissance, on-the-ground field surveys, geologic maps, interviews with knowledgeable people, and a review of historical records. Cooperating offices include The Pennsylvania Natural Diversity Inventory, Pennsylvania Game Commission, Pennsylvania Fish and Boat Commission, and county-level agencies.

County inventories are being used successfully as planning tools across the Commonwealth. Community planners are utilizing the inventories in their comprehensive plans and in reviewing development plans. Conservation organizations are using the inventories to prioritize their land protection efforts. County inventories are providing invaluable information about Pennsylvania's natural resources to landowners, community planners, and regulatory and local government officials.

"If future generations are to remember us with gratitude rather than contempt, we must leave them more than the miracles of technology. We must leave them with a glimpse of the world as it was in the beginning, not just after we got through with it."

—President Lyndon B. Johnson, upon signing the Wilderness Act of 1964

Bake Oven Knob, located in Lehigh and Carbon counties, is an important and widely appreciated natural area. Bird watchers have used the site for many years to observe, each fall and spring, the annual migration of raptors.

Within the boundaries of the Lehigh River watershed, all of the counties, except Carbon County, have completed CNAIs. A preliminary study (which does not include field checking) is available for Carbon County. Carbon County Commissioners recently voted to have the field verification work proceed and the study completed. County Natural Areas sites have been identified within the watershed. Carbon County possesses the greatest number of sites compared to the other counties.

Following are the 108 CNAI sites within the Lehigh River watershed, listed by county. The counties within the watershed containing CNAI sites are Carbon, Lehigh, Luzerne, Monroe, Northampton, and Wayne Counties (Map 4-8).

BERKS COUNTY AREAS – 1 SITE:

LITTLE LEHIGH CREEK WATERSHED-This area contains the headwaters of the Little Lehigh Creek which has been designated by the PA DEP as a High-Quality Cold Water Fishery.

CARBON COUNTY AREAS – 54 SITES:

AQUASHICOLA CREEK-There are currently no threats to this creek. A tentatively undetermined plant species was found on this site in an open area of the creek bottom.

AQUASHICOLA CREEK WETLANDS-This creek's floodplain contains wetlands and wet meadows succeeding from past grazing, beaver activity, and flooding. Two species of state-threatened plants are found in this wetland. Mowing is suggested over spraying for controlling plant growth in the pipeline right-of-way in this wetland.

BAKE OVEN KNOB-See Lehigh County description.

BEAR CREEK LAKE BARREN -This privately owned woodland area is on the edge of a housing development. Both a rare species and endangered species of plant are found on this property, and both are threatened by development and brush dumping.

BEAR MOUNTAIN-This site includes ridge top and summit communities surrounded by forest and sufficient buffers. There is fragmentation due to a fire tower and a road. No rare elements were found in a 1990 visit.

BEARS ROCKS-BLUE MOUNTAIN-This steep, rocky, and wooded slope contains deciduous trees and a ravine with conifers. This ravine may have rare plants and animals. Most of the site is Pennsylvanis State Game Lands, and trails, including the Appalachian, cut through it.

BERRY RUN BARRENS-This area contains a ridge top community that has a medium-high priority for field surveying. Agriculture, houses, and a road fragment the area.

BIG BOULDER LAKE HEADWATERS-This wetland site may contain two different swamp communities with moderate fragmentation, a pipeline, old beaver activity, and nearby resort. There is a low possibility for rare plants.

BLACK CREEK GORGE-This gorge has conifer forest and shale cliff communities. Black Creek is a High Quality Cold Water Fishery, and the surrounding woodlands may contain

rare animal species and may merit natural community designation. The area is most threatened by surrounding urban and agricultural areas.

> *"Wipe out wilderness and the world's a cage."*
> *—David Brower, Executive Director, Sierra Club*

BLACK SHANTY RUN RAVINES – This narrow, steep ravine has what appears to be a mature hemlock stand that has recovered from probable logging. The ravine is sufficiently buffered from suburban development on its east side but lacks buffer on other sides. There is a golf course 0.25 miles north of the ravine.

BROAD MOUNTAIN BARREN – Areas of the Broad Mountain Barren provide habitat for various rare animal species. There are no known immediate threats to this Pennsylvania State Game Land. Pesticide spray programs may cause problems in the future.

BROAD MOUNTAIN WEST-This flat ridge is fragmented by pipelines and fire roads and has been disturbed by past logging and fires. There may be high wildlife diversity, and a field survey is recommended for the ridge.

CALL MOUNTAIN EAST AND WEST-These ridge top communities are both disturbed by roads, past logging and fire. Both sites may have rare plants and animal species. Call Mountain East is surrounded by forest and Call Mountain West has a neighboring power line.

CHRISTMANS WETLAND-There are a few distinct wetland communities, and one swamp is bisected by the Northeast Extension of the Pennsylvania Turnpike. Surrounding land has housing and a highway rest area. There may be rare plant and animal species. The wetland is unique in its area of Carbon County, and it is an important headwater for Stony Creek, which is an Exceptional Value stream.

CIDER RUN SWAMP-This conifer swamp is under the ownership of the Pennsylvania Game Commission, the U.S. Army Corps of Engineers, and private owners. It contains mature conifers, wetland plants, and bird habitat. The area should be protected from logging, filling, drainage, and other alterations.

DILLDOWN CREEK BARRENS-A mesic forest community that may contain rare plant species and may have potential for natural community designation is located here. There is also an acidic shrub swamp. The area is fragmented into three parts. Beaver activity and a man-made dam downstream are disturbances to the swamp.

DRAKES CREEK HEADWATERS-This highly fragmented area contains forested upland, beaver wetlands, and meadow. The meadow may contain rare plants. The area is disturbed by beavers, logging, and suburban development.

FAWN RUN SWAMP-This glacial wetland includes three types of swamps, and all swamps have potential for rare species. A field survey and possible natural community designation are recommended for this natural area.

FOURTH RUN-This site within Hickory Run State Park includes shrub swamp and transitional wetland/woodland ecotone. Beaver activity, logging, and a road are disturbances to the area. There may be rare species, and the stream quality may be relatively high.

GLEN ONOKO-An endangered species of plant is found in this deep gorge owned by the Pennsylvania Game Commission. There are several waterfalls throughout the gorge making it a popular spot for hikers. Erosion from heavy trail use is a serious threat to these slopes and more careful trail maintenance is prescribed for the area. Littering and off-trail hiking are also threats.

HAZLE CREEK BARRENS-There are mixed barrens and swamp communities at this site, and the swamp may serve as an important buffer for Hazle Creek. There may be unique mesic barrens with a reasonable possibility of rare species. A field survey is recommended for the site.

HAZLE CREEK VALLEY CONIFER FOREST-There are conifer forest and swamp communities recovering from past logging. The site is surrounded by forest and beaver swamp, and a field survey is recommended for this site.

HAZLETON BARRENS-These ridge-top barrens are disturbed by past fires, perimeter roads, power lines, reservoir, and a pumping station. The surrounding land contains urban development and coal mining. The area is intact internally.

HELL CREEK RAVINE-This rocky slope community may host rare animals. The area is free of fragmentation, and disturbance is limited to rockslides. The land is surrounded with forest and combines with three other natural areas to make a large complex.

HICKORY RUN BOULDER FIELD-Pennsylvania DCNR, Bureau of State Parks preserves this land as a National Natural Landmark. The structure, form, and physical character of the boulder field are the result of periglacial climatic conditions during the approach of the Wisconsin ice sheet. The approximately 30-acre area is irregular in outline, roughly 400 by 1,800 feet in extent, and at least 12 feet deep. The surface of the field is a bare expanse of unsorted, loosely packed boulders, some of which are up to 20 feet in diameter. It is the largest formation of its kind in the Pocono Mountains.

HUNTER RUN CONIFER STAND-This 40-acre stand contains some older white pines and hemlocks, and has been fragmented by a road and disturbed by selective logging. Air photos were taken of the area; however, the photos have not been examined.

IRISHTOWN RUN-This mix of woodlands and swamps is surrounded by forest and wetland and impacted by beaver activity. The site is highly fragmented with low recovery potential, and there is a slight potential for rare species.

LAKE HARMONY SWAMPS-This site has mature boreal coniferous swamps and other wetlands. There may be rare species. The greatest threat to recovery from logging is fragmentation and minimal buffer.

LAKE MOUNTAIN-This area contains ridge top-dwarf tree forest and scrub oak barrens that would benefit from a field survey. Disturbance includes a power line and pipeline, but the area is only moderately fragmented.

LEHIGH RIVER GORGE-The gorge's conifer-dominated forest and talus cliffs provide viewscapes from the river, and may host rare species. The site hosts vegetative buffers and is surrounded by agricultural land. Field surveying is recommended for the gorge in conjunction with other surveying along the river.

LESLIE RUN- Lehigh River Slope-This northeast-facing slope along the Lehigh River provides an aesthetic view from the river. There may be wintering eagle-roost sites and other rare animal species. A wetland may mitigate possible upstream water quality problems.

MOSEY WOOD POND BOG-This potential oligotrophic kettle-hole bog is surrounded by natural land and a summer camp. There may be rare species, and the bog could be considered for natural community designation. The area has potential as a valuable outdoor classroom for the summer camp.

NIS HOLLOW-The Nis Hollow Hunting Club restricts access to this area. The forested area along the stream edge provides excellent wildlife habitat as well as a buffer

OBERSON RUN-This site includes Oberson Run and Quakake Creek. Threats to the creek include power lines, a trail, and upland logging.

PENN HAVEN OAK BARREN-Bald Mountain is the location of this dwarf-tree forest owned by Blue Ridge Real Estate. Future management of this mountain top community includes prescribed burning.

PINE RUN BARRENS-This area contains a ridge top community disturbed by a trail, clearing and past logging. The area is well buffered from agriculture and housing and is close to Rt. 476. Fire management is recommended, and there may be rare plants and animals warranting high priority for field surveying.

POCONO MOUNTAIN BARREN-Jim Thorpe Water Authority owns this area, which is very similar in composition to the Penn Haven Oak Barren. Periodic burning occurs as evidenced by patches of new and old growth. There are no present threats to this natural area.

POCONO MOUNTAIN LAKE ESTATES SWAMP-This shrub swamp contains a nice diversity of wetland trees, shrubs, and herbaceous plants. There are unique bog plants and wetland associated birds including duck, warbler, and swallow species. Protection from filling, logging, impoundment, drainage, and other alterations is recommended. Pennsylvania Game Commission and private landowners own this swamp, which is located south of the Cider Run Swamp. It is partially protected as State Game Lands.

POHOPOCO MOUNTAIN EAST-This ridge-top community may include a barrens community that could benefit from prescribed burning. The site is surrounded by barrens, forest, and ravine.

POHOPOCO MOUNTAIN WEST-This ridge top forest is naturally fragmented by internal barrens. The area is surrounded by forest and some development within 0.5 miles. A mesic barrens section warrants high priority for field surveying, with possibility for rare wildlife and plant species.

PORTER RUN CLIFF-This privately owned, acidic cliff area has high scenic value over the Lehigh River. It is relatively undisturbed with a maintained forested buffer around the rock face.

QUAKAKE CREEK-This creek is lined with a linear riverine community, and the site also contains a wetland. The creek's watershed is mostly forested with some agriculture and urban development, and the creek contains mine drainage and is devoid of life. The wetland is disturbed by filling and damming and has very little buffer.

REXTOWN QUARRY-A threatened species of plant is found in this privately owned wetland. The greatest threat is the possibility of resuming activities in this abandoned slate quarry.

ROADSIDE SHRUB SWAMP-This swamp contains wetland shrubs and herbs such as blueberry and leatherleaf. Forest and residential areas surround the site.

ROUND HEAD MOUNTAIN-This 65-acre ridge-top barrens community contains no fragmentation and is surrounded by forest. The site may be colder and wetter than other sections of the mountaintop due to geology.

SCRUB MOUNTAIN BARRENS-This site contains two ridge-top communities, (A&B), 0.5 miles apart. A field survey is recommended for site B. The sites are disturbed by logging, dirt roads, and wildlife food plots.

SHINGLE MILL RUN SWAMP-This acidic shrub swamp may contain unique broad-leaf evergreen shrubs, based on aerial photographs, and needs a field survey to determine rare species.

SPRING MOUNTAIN-This site includes four or more wooded and wetland communities disturbed by logging, fire, railroad, and pipeline. One area burned around 1980 may have rare plants and animals. A rocky summit climax community has much diversity and good potential for rare species.

STAGE TRAIL-This site includes a wetland and boulder field disturbed by a pipeline, agriculture encroachment, past cutting, and vacation housing. The boulder field may be of ecological interest.

STONY CREEK-This tributary to the Lehigh River is considered a high-gradient clear water creek community. The area through which it runs is owned by the Pennsylvania Game Commission, Pennsylvania Department of Conservation and Natural Resources (DCNR) Bureau of State Parks, and private landowners. Development and logging are the two most severe threats to the creek. It is listed by the Pennsylvania Department of Environmental Protection as being an Exceptional Value stream.

STONY RIDGE-This ridge contains an acidic rocky summit community with no fragmentation, and the potential for natural community designation. The area lacks a buffer against some suburban development.

UPPER BELTZVILLE SLOPE-This conifer-forested slope faces south to the Beltzville Reservoir and lacks a buffer against the reservoir, housing, and agriculture. The slope offers potential roosting sites for osprey and other water-associated birds. The slope provides scenery and sediment and nutrient buffer for the reservoir.

WILD CREEK-This site includes 55 acres in Penn Forest Township, and no other information is available about this natural area.

WILD CREEK SEEPS-There are several vernal pools scattered throughout the 200 acres, and the pools may contain rare plants and amphibian breeding sites. Threats to the seeps include significant fragmentation, dirt roads, and logging on surrounding land.

LEHIGH COUNTY AREAS – 24 SITES:

BAKE OVEN KNOB-This site is located on State Game Lands and is considered a top priority natural area in Lehigh County. Included on the site is a northern Appalachian acidic rocky summit community. Prominent bedrock outcrops and large sandstone boulders are characteristic of the area. It is recognized as an important research area including for a yearly census of migrating raptors.

BLUE MOUNTAIN PUMPING STATION-This site is located in the same area as the Lehigh Furnace Gap on Pennsylvania State Game Lands. A state-threatened animal species inhabited this area in the past, but there is no indication of this species' current presence.

CRACKERSPORT PONDS-Both a state-rare and a state-threatened species of plant are found on this site. Protection from further disturbance such as forest fragmentation and industrial development is suggested.

EAST TEXAS-LITTLE LEHIGH CREEK-There is a population of a state-threatened plant species along this creek. The creek itself is considered a high-quality cold water fishery area. Disturbances and development are the two main threats.

FRIEDENSVILLE QUARRY-A state-endangered (globally rare) plant inhabits this privately owned site. Due to recommendations from The Nature Conservancy, the landowner has excluded the site from development plans. The greatest threat to plant species is competition from other vegetation.

GAUFF HILL-A population of a state-rare plant species is found along the stream edge on this site. Suggested management of the site includes a forest corridor along the stream. Exotic plant species are the greatest threat to the plant species.

HELFRICH SPRINGS CAVE-This is a privately owned cave composed of limestone and dolomite. Several species of bat inhabit the rear portion of the cave. In 1998, one individual of an animal species of special concern was observed. Current threats to the cave include pollution of groundwater.

INDIAN CREEK FLOODPLAIN-In 1996, evidence of a state-endangered animal species was observed on this site. Surveys to determine the status of this species are highly recommended for the floodplain forest and open marsh areas.

JORDAN CREEK SLOPES-These second-growth forests are located on State Game Lands. They provide good habitat for various species of wildlife along the Jordan Creek. Exotic species are the greatest threat, including a species of multi-flora rose that is very abundant.

JORDAN VALLEY MARSH-A population of a state-endangered plant species inhabits this area. The current threat to this species is natural succession.

THE JUNGLE-This site is considered an area of local significance and is also ranked high in county significance. It receives water input from several springs along with Spring Creek and Iron Run. There are no current species of concern found on this site, though several state-listed species were found there in the past. Further surveys of the area are recommended. The greatest threats to The Jungle include disturbance from mills and agricultural activity.

LAURYS STATION-This privately owned open marsh is excellent habitat for an endangered plant species. Off-road vehicles pose the greatest threat to the plants and the marsh in general.

LEASER LAKE WOODS-This site is partly owned by Lehigh County and the Pennsylvania Fish and Boat Commission. It is listed as a locally significant area due to its high species diversity. Habitats on the property include streams, a lakeshore, forest, and a boulder field.

LEHIGH FURNACE GAP-Signs of a state-threatened animal species were documented on this site in 1991, but no evidence of this species has been observed since that time. There is no management action recommended on this area of State Game Lands.

LEHIGH MOUNTAIN-Wildlands Conservancy protects part of this area and the rest is privately owned. Tulip trees and oaks dominate the canopy of this north-facing slope. It is woodland in an urban setting with future logging and some gypsy moth damage being its only known threats.

LEHIGH MOUNTAIN SEEPS-The City of Allentown, Salisbury Township, and Lehigh County jointly own this circumneutral seeps community. It is listed as one of the top priority natural areas in Lehigh County by Pennsylvania State biologists. There are various habitats located within this site and one plant species of special concern inhabits it. Preservation of biodiversity and recreational use by nearby urban residents are both reasons that this site is a top priority area. Both forest fragmentation and invasion of exotic species are serious threats to the quality of this site.

MACUNGIE WATERSHED-This site is owned by Macungie Borough and includes some circumneutral seeps communities. This type of habitat can potentially be inhabited by several plant species of special concern, though their presence has not been observed. Threats to the watershed include forest fragmentation and disturbance.

MILL ROAD WETLANDS-An animal species of special concern inhabits this area. A series of wetlands along an unnamed river are included in this site, and additional studies are recommended.

REDINGTON CAVE-The Steel City Gun Club owns the cave that is located in the base of a cliff. Part of the site is located on the property of the City of Bethlehem. One individual of a state-rare animal species was observed there in 1998.

REXTOWN PONDS-This upland forest contains several shallow vernal ponds. A state-threatened plant species is located in one of these ponds. Vegetative competition is the greatest threat to this area.

ROBERT RODALE RESERVE-The City of Allentown and Wildlands Conservancy both own this reserve. It is a good quality northern Appalachian circumneutral seeps natural community containing two plant species of special concern. There are multiple vernal pools within the site, which are important for the breeding of amphibians. Forest fragmentation is the greatest threat to this natural area.

ROCKDALE CLIFFS-A highly endangered plant species inhabits these privately owned cliffs. The greatest threat to this plant is from being shaded out by maturing trees.

TREXLER HOLLOW-Part of this site is located on the Trexler-Lehigh County Game Preserve. Two plant species of special concern inhabit rocky outcrops. Roadside herbicide spraying is the greatest current threat to the species.

TROUT RUN WOODS-Part of these locally significant woods is located on State Game Lands. Further survey is recommended for this area consisting of woodlands, streamlets, seeps, and vernal pools. These multiple areas provide excellent habitat for numerous animals and plants.

LUZERNE COUNTY AREAS – 6 SITES:

FRANCIS E. WALTER RESERVOIR-The U.S. Army Corps of Engineers owns this reservoir that is habitat for an endangered animal species.

KENDALL CREEK SWAMPS-These swamps are under the ownership of Blue Ridge Real Estate and other private landowners. The area is considered good wildlife habitat as well as functioning as a filtering area for waters entering the Lehigh River. No rare species were located on the site containing highly disturbed areas.

POND CREEK SWAMP-This swamp is a large wetland area with a closed canopy of white pine, hemlock, and red maple. It provides good habitat for various animals including potentially rare species and has good scenic value as well. Pond Creek Swamp is privately owned.

SNAG POND EAST-This pond is privately owned and considered a glacial bog community. The biggest threat to this area and the threatened plant species within it is hydrologic changes. Runoff from the nearby road and discarded yard waste are also considered possible threats.

WRIGHT CREEK SWAMP-This large swamp is important bird habitat for several species. It is privately owned, and the greatest current threat is degradation. The edges of the habitat are bordered with a railroad, road, and houses. Within the swamp, several ponds were constructed.

WYOMING MOUNTAIN OAK BARREN-The Pennsylvania Game Commission and private landowners jointly manage this three hundred-acre mountain-top habitat. A large variety of plant species are found in this area with no apparent signs of recent disturbance. Pesticide application, natural succession, and developers are threats to the current condition of this area.

MONROE COUNTY AREAS – 28 SITES:

ANGLEWOOD LAKE SWAMP-A state-rare plant is found in a clearing in this area. This clearing should be maintained yearly to help protect the species.

BARNEY'S LAKE SWAMP-This open hardwood-conifer swamp is habitat for a state-rare plant species. There are no current threats to the species or the habitat in general.

BIG MARSH-The Pennsylvania Game Commission owns the eighty-acre acidic shrub swamp that contains one endangered and various rare plant species. Logging is one of the biggest threats to this marsh mainly due to the sediment runoff from clear-cutting.

BIG OFFSET BARREN-A state-endangered plant species is found in this publicly owned area on Blue Mountain. This open forest should be protected from use, especially by hikers of the nearby Appalachian Trail.

BRADYS SWAMP-The eighty-acre acidic shrub swamp is owned by the Pennsylvania Game Commission. Shrubs of both the rare and threatened state statuses are located in this area. There are indications of hunting and past logging. Currently there are no immediate threats to this habitat; however, logging and hydrology changes are concerns for the future.

BUCKWHA CREEK-The main threat to the plant species of special concern found at this site is natural succession and competition. Mowing every other year would help to prevent this from occurring. This area is considered seasonally wet marshland.

CROSS RUN BARRENS -This site, mostly in Monroe County, contains several vernal ponds and may host rare plant and animal species. Logging, dirt roads, and possible fires disturb the area. The area is immediately surrounded by forest with more distant agriculture and reservoir.

EAST BRANCH SHRUB SWAMP-Power line maintenance and beaver activity are the greatest threats to this site. A state-threatened plant was found growing there.

FRITZ RUN SWAMP-Beaver and logging have changed this swamp into a shrub-dominated area. It is good wildlife habitat, and a population of one threatened plant species is found on the land owned by the Pennsylvania Game Commission. The protection status of this area is under Pennsylvania State Game Lands.

GOULDSBORO LAKE TRACKS-The Pennsylvania DCNR, Bureau of State Parks owns this area, and it has no known threats. It is a lakeside shrub swamp with one threatened species found in the area.

HUMMLER RUN-This area provides habitat for an animal species of special concern. A wide variety of fish species are found in the stream that has no current threats.

LEHIGH RIVER- RT. 115 BRIDGE-A state-rare plant species inhabits an open area in the Lehigh River. There are no immediate threats to this site.

LOST LAKES-This is a kettle-hole bog community with three plant species of special concern. The greatest current threat is development of residential communities and draining for this development.

NINES POND-This pond is located south of Tannery Road Swamp and is also owned by Pennsylvania DCNR, Bureau of Forestry. The growth of a rare plant in this area is under further investigation.

OAKES SWAMP-Both a state-rare and a state-threatened species of plant are found on this site. Current threats include flooding from both beaver activity and nearby highway construction.

PIMPLE HILL BARREN-A plant species of special concern inhabits the site. This is an edge habitat between a conifer forest and a heath barren.

POCONO LAKE NORTH-This area of State Game Lands is home to a population of a state-rare plant species. Past excavation has taken place in this wet, acidic shrub thicket. Currently there are no major threats.

POCONO LAKE PRESERVE SITE-A state-rare plant species inhabits the area surrounding Pocono Lake. There are no known threats to this site at the current time.

POWDER SMOKE RIDGE WETLANDS-Species of special concern inhabiting this site include one animal species and two plant species. There are no immediate threats to the species and no current management plans for the wetlands. The site includes four wetlands.

SAND SPRING WOOD-Pennsylvania DCNR, Bureau of Forestry owns this area, as it is located in the Lackawanna State Forest. A rare plant is located in the area that faces two main threats: heavy deer browsing resulting in reduced natural succession of the forest.

SCOTT PROPERTY SITE-This area is a kettle-hole bog community containing an acidic shrub swamp community within it. The site appears to have been logged in the past, but there are no current threats.

SULLIVAN TRAIL/LAKE NAOMI-Both a rare plant species and an endangered plant species inhabit this bog and northern hardwood forest area. There are four main threats to this area including deer browsing, trash dumping, hiking trails, and potential development.

TANNERY ROAD SWAMP-Pennsylvania DCNR, Bureau of Forestry owns this area of shrub swamp, conifer swamp, and mixed broadleaf-conifer swamp. It is located in Lackawanna State Forest, and the only present threat is herbicide runoff from a forest road in the area.

TOBYHANNA WEST SWAMP-This acidic shrub swamp is also owned by the Pennsylvania DCNR, Bureau of State Parks. It is located within Tobyhanna State Park, and it is suggested that it be maintained in its current condition.

TWO MILE RUN SWAMP-This area consists of boreal conifer swamp and shrub swamp communities. This privately owned swamp contains both rare and threatened plant species. The largest threat to Two Mile Run Swamp is the potential pollution and hydrology changes from a nearby housing development. The Nature Conservancy ranks it as a high-priority protection site.

WAGNERS BOG-This bog is owned by the Wagner Forest Park Home Owners Association and is protected as a conservation area. Populations of a state-rare and a state-endangered plant species are found on the site. Deer browsing is the greatest threat to the plant species.

WARNERTOWN WETLANDS-Four species of special concern are found on this site. It is a clearing produced by past logging and the site where several Tobyhanna Creek sources come together. There are no current threats to this area of marshes, bogs, shrub, thickets, and beaver ponds.

WEIR CREEK WOODS-This area of woodland borders a road and is habitat for a state-endangered plant species. There are various threats to these woods including mowing, pesticide spraying, road-widening projects, and road de-icing agents in the winter.

NORTHAMPTON COUNTY AREAS – FOUR SITES:

BERTSCH CREEK-This creek is used for many recreational purposes and is privately owned. Currently there are no immediate threats to the creek and the surrounding valley.

HELLERTOWN FEN-Four plant species of special concern are found in this area of rare wetland type along with a state-endangered and a state-threatened plant species. It is rich in nutrients due to the limestone substrate, and the Nature Conservancy highly suggests is should be protected due to the rarity of this type of wetland in Pennsylvania. Hellertown Fen is privately owned.

ISLAND PARK-This is a county park, also called Hugh Moore Park, owned by Northampton County. A state-endangered plant has been found on the island. The river to the east of the island is very high in fish species diversity. Currently there are no known threats to this area.

LOCKPORT MARSH-This marsh is privately owned and has no current threats. It is suggested that this habitat remain undisturbed to protect an endangered plant that is found there.

WAYNE COUNTY AREAS – FOUR SITES:

ENGLISH SWAMP-These sixty acres of boreal conifer swamp are privately owned. It consists of a spruce/larch forest, dense shrubs, an open peat moss mat, and a small area of open water. Threats to this area include nearby development and the pollution associated with it.

FREYTOWN SWAMP-Pennsylvania Gas & Water owns this boreal conifer swamp. The dominant plants include larch, red spruce, and red maple. Although there are no immediate threats to this area, herbicide use, logging, and development are future concerns.

HARDWOOD RIDGE SWAMP-This is a small acidic shrub swamp inhabited by a state-rare plant species. It is suggested to protect the area from over development and the septic effluent created from these developments. The wetland is located in Tobyhanna State Park.

LEHIGH POND-Lehigh Pond is a glacial bog community owned by the Pennsylvania Game Commission. Four rare plant species and one rare animal are found in this community that is located at the headwaters of the Lehigh River. Runoff from fertilizers, faulty septic systems, and stormwater runoff from nearby streets all pose a threat to this bog community.

Reports exist for all of the CNAIs and are available from the sources listed in the Reference Section located at the end of this section.

What I have learned convinces me that there is one overriding consideration for any open space program. It is, simply, that open space must be sought as a positive benefit. Open space is not the absence of something harmful; it is a public benefit in its own right, now, and should be primarily justified on this basis.

—William Whyte, Securing Open Space for Urban America: Conservation Easements, 1959

LANDS OF BETHLEHEM WATER AUTHORITY

Except for the lands owned by the Bureau of Forestry and the Pennsylvania Game Commission, the largest land holdings in the watershed are those of the Bethlehem Water Authority. These lands, comprising approximately 23,000 non-contiguous acres, stretch across the Pocono plateau in Carbon and Monroe Counties. They were acquired decades ago to protect the water sources for the city of Bethlehem and surrounding communities.

Extensive forest tracts, open meadows and pastures, lakes, streams and a variety of habitats are within the ownership of the authority. The lands include some of the most environmentally sensitive land in Pennsylvania because of the existing plant and animal species. The authority has actively managed these lands to allow considerable public use, including hunting and fishing. While these lands are quasi-publicly owned, there are no permanent protection arrangements in place. In recent years, the authority has openly considered selling some of the land and/or assets derived from the land, such as timbering.

The Nature Conservancy and others have long discussed the permanent protection of these lands with the authority. There are large tracts of permanently preserved land close to or abutting the authority's lands, including land owned by The Nature Conservancy. Some of The Nature Conservancy's land has been obtained from the authority. Other land close to or abutting authority land is owned by Bureau of Forestry, the Bureau of State Parks, the Pennsylvania Game Commission, and several privately owned preserves. Thought has been given to linking these open spaces with other nearby privately- and publicly-owned, protected open spaces to create a vast area of permanently protected open space and habitats in one of the most environmentally critical areas of Pennsylvania. Progress has been very slow due to monetary and political considerations.

E. Development and Municipal Planning

1. LAND-USE FORUMS AND CITIZENS' SURVEY RESULTS

During the summer of 1999, the Governor's Center for Local Government held 53 Land-use Forums across the state to gather comments from Pennsylvanians on the subject of land-use. People voiced their concerns with regard to land-use and made their call for change clear.

Intergovernmental cooperation was identified as the most desirable land-use practice. Preservation of farmland was one of the most frequently expressed concerns, followed by open space preservation. The remaining eight of the top ten concerns were infrastructure concerns, urban revitalization, water concerns, planning, education of local officials, concerns for farming and the family farmer, property taxes, and sprawl.

According to a survey of approximately 4,000 Lehigh Valley residents conducted by the Lehigh Valley Planning Commission (LVPC) in 2000:

- Respondents feel most new residential development should take place in the cities and suburban townships.
- People in the Lehigh Valley are interested in new concepts such as cluster development as well as traditional neighborhood development.
- The feature in new residential development most important to survey respondents is the preservation of open space and environmentally sensitive areas (Figures 4-22 and 4-23).
- About two thirds of persons who answered the survey want new retail development to occur in the cities.
- The three most important planning issues are the preservation of farmland, the preservation of environmentally sensitive areas, and the renewal of the cities (Table 4-8).

When asked "What features in new residential development are important to you?" no other response came close to getting the number of votes

TABLE 4-8. RESPONSES TO THE QUESTION: WHICH OF THE FOLLOWING DO YOU FEEL ARE MOST IN NEED OF SPECIAL PROTECTION TO PRESERVE THE ENVIRONMENT?
Source: Lehigh Valley Planning Commission, 1999

	Ranked		Total
Type	***1st***	***2nd***	***Responses***
Rivers, creeks, streams, and lakes	397	252	649
Air	206	177	383
Prime farmland	176	163	339
Groundwater	100	131	231
Wooded areas	74	116	190
Areas subjected to flooding	24	36	60
Wetlands	21	39	60
Other	17	3	20
Hillsides and mountains	9	65	74

FIGURE 4-22. RESPONSES TO THE QUESTION: WHAT FEATURES IN NEW RESIDENTIAL DEVELOPMENTS ARE IMPORTANT TO YOU?
Source: Lehigh Valley Planning Commission, 1999

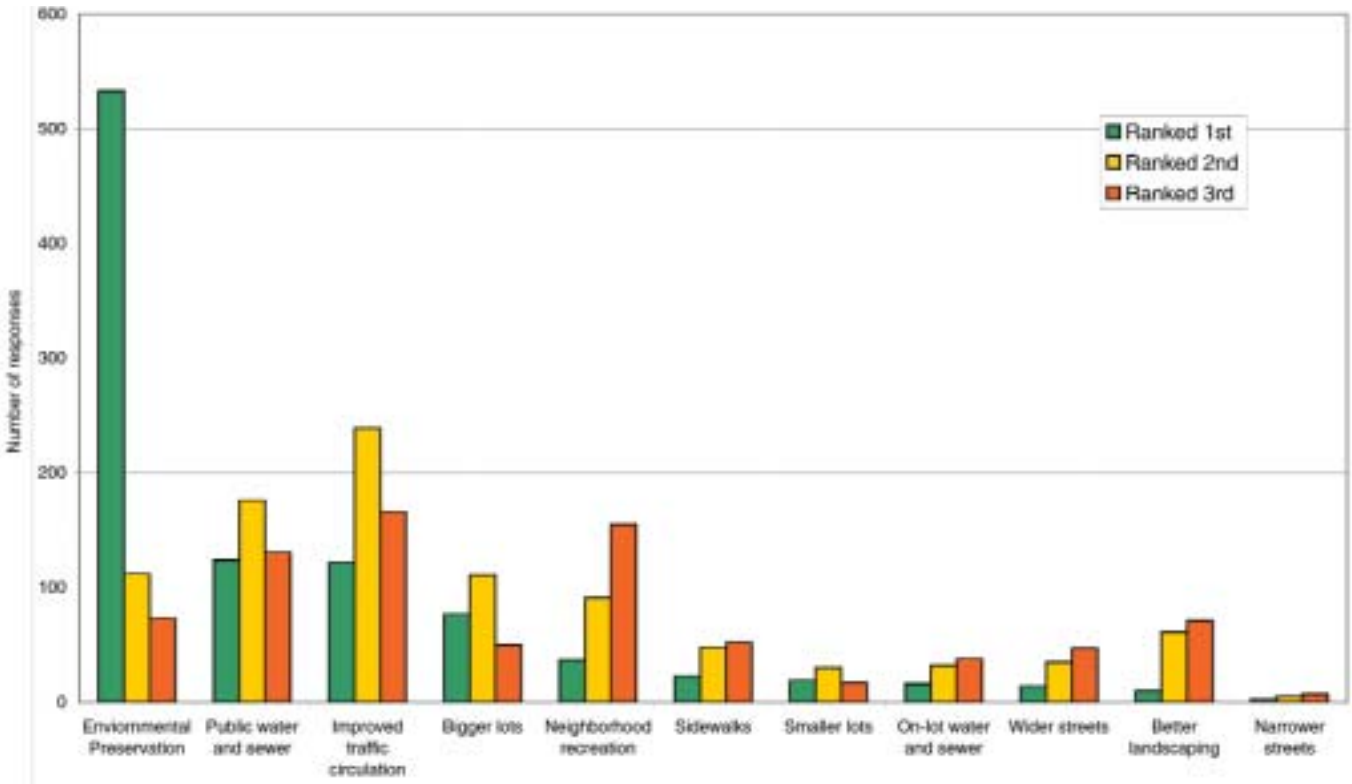
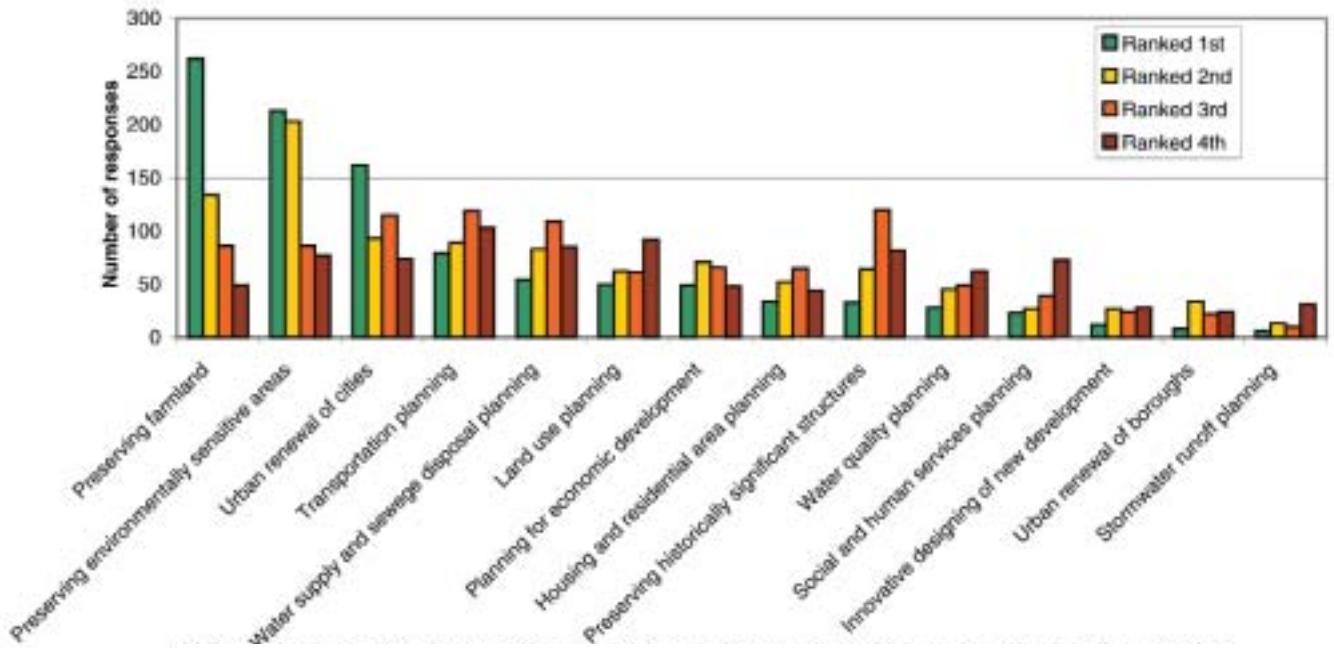


FIGURE 4-23. RESPONSES TO THE QUESTION: WHAT DO YOU THINK ARE THE MOST IMPORTANT PLANNING ISSUES NEEDING TO BE ADDRESSED WITHIN THE NEXT TEN YEARS?
Source: Lehigh Valley Planning Commission, 1999



that was received by the preservation of open space and environmentally sensitive features. Nearly 55% of the first place votes went to this response.

This question demonstrated that 91.4% of the respondents believe it is important to preserve farmland and environmentally sensitive areas in the Lehigh Valley (Figure 4-22). There is also good support for addressing the urban renewal of the Lehigh Valley's cities.

The response to the question clearly indicated that the majority of the respondents believe it is important to address environmental issues within the next ten years (Figure 4-23).

2. DEVELOPMENT

The northern region of the watershed, north of the Blue Mountain (Kittatinny Ridge), includes Carbon, Monroe, Schuylkill, Luzerne, Lackawanna, and Wayne Counties. The southern region, below the Blue Mountain, predominately represented by Lehigh and Northampton Counties, also includes small portions of Berks and Bucks Counties. Throughout the Lehigh River watershed, most of the land is still in agriculture and forest, with relatively low-density housing. In the Lehigh Valley, south of the Blue Mountain, there is increasing industrial and commercial development, along with markedly increased residential housing density, because of the cities of Allentown, Bethlehem, and Easton and their suburbs. The residential and commercial development in the Lehigh River watershed has progressed differently in the northern and southern regions.

a. Development in the Northern Region of Watershed

The area of the watershed north of the Blue Mountain (Kittatinny Ridge) has experienced much less residential development over the years in terms of total housing units. Generally, the terrain is less favorable to development, being much hillier and with less-favorable soils. Until recently,

the long commuter distances to major centers of employment, coupled with less-developed transportation systems and road networks, have not been conducive to residential development. The northern region of the watershed lacks any major city in contrast to Allentown, Bethlehem, and Easton in the southern portion. In the northern portion of the watershed, there is a relatively good east-west highway system (Interstate 80 and Route 209), but, except for the Northeast Extension of the Pennsylvania Turnpike and Pa. Route 33, a good north-south limited access highway is lacking. There is no major airport in or near the northern section of the watershed, while the southern portion is served by Lehigh Valley International Airport.

In the northern region, there has long been a trend toward second homes and country estates that is lacking in the southern portion of the watershed. Since the collapse of savings and loan financing in the late 1980s, this trend has diminished, with many second homes being converted to primary residences. Additionally, the events of September 11, 2001, resulted in a large influx of buyers looking for property at the far end of the commuting distances from New York City, eastern New Jersey and the Philadelphia areas. Conversely, with higher unemployment figures in the northern area, there is less demand for new residential development.

In the northern region, commercial and industrial development has not kept pace with its southern counterpart. In recent years, between the Delaware River and the eastern portion of the watershed, considerable commercial development has taken place in areas such as Tannersville, Monroe County, in the form of strip malls and outlet stores. Generally, this type of development has not yet spread westward into the watershed to any great degree.

For many decades, the driving force of the local economies in the northern region was the coal extraction. This is now a much-diminished industry, and much of the commercial development of the northern portion depends upon tourism. The mountainous areas, often forested, are considered scenic destination areas. A few communities stress their attractiveness for tourists and outdoor recreation opportunities such as mountain biking and river ventures.

Within the watershed as a whole, there is a growing realization that development of all kinds needs to be better planned. A number of municipalities in the southern portion of the watershed are working on regional comprehensive plans, instead of individual plans, with the hope of having more options and flexibility in their planning.

b. Development in the Southern Region of the Watershed

Residential development in the southern part of the watershed has been primarily in the suburban townships surrounding the cities of Allentown, Bethlehem and Easton, and to a lesser but significant degree, in the outlying townships. The cities themselves have stagnated due to economic and social factors as well as the lack of land. Most of the boroughs are entirely built out and have no land left for substantial development, so almost all-residential development is now occurring in the suburban and rural townships.

Sprawl continues unabated throughout the southern portion of the Lehigh River watershed. Greenfields disappear while many brownfields – old industrial sites – go unused in our cities and older boroughs.

A number of factors contribute to the high rate of residential development in the southern portion of the watershed. These factors include increasing birthrate, migration in exceeding migration out, continuing economic prosperity, an ever-improving transportation network, extensive well-drained and level lands suitable for residential development, a general decline in agricultural prosperity making farmland available for development, and the deteriorated current economic conditions in some urban areas relative to the more suburban communities that surround them. Another factor is the presence of a major airport with easy connections to the rest of the country and overseas.

These factors support the increase in commercial and industrial development. Businesses and employees locate in the area because the quality of life is so attractive, and they take advantage of quality housing, excellent transportation, exceptional recreational opportunities, and relatively short distances to the major metropolitan areas of New York and Philadelphia.

This fast rate of growth has had negative impacts on the land. Open space and farmland have been lost to other uses, urban and suburban sprawl has worsened, traffic congestion has increased, schools are overcrowded, and the cost to communities to provide services to residential homeowners has exceeded the tax revenues generated by residential development. In addition, septic and stormwater runoff problems are unresolved.

Residential development now encircles the major cities of the area due to substantial growth in most municipalities. In the past five years, some major events have occurred that have and will continue to spur residential development in the watershed:

1. The impact of the terrorist acts of September 11, 2001 is being felt in the increasing emigration of people from New York City and eastern New Jersey seeking homes away from these metropolitan areas. The Delaware River bridges are less than 70 miles from midtown Manhattan, and people are increasingly willing to live in eastern Pennsylvania and commute to jobs well to the east.

2. The completion of Pa. Route 33, linking Interstate 78 with U.S. Route 22, is bringing about rapid development in Northampton County along the Route 33 corridor. Completion of this road has reduced travel time between Philadelphia and the Lehigh Valley, as well as to the Pocono area, and has markedly reduced travel time to eastern New Jersey and New York.

3. The relatively low real-estate prices and real-estate taxes make eastern Pennsylvania attractive. In addition, extremely low mortgage rates have and will continue to fuel residential development.

4. In spite of the loss of Bethlehem Steel Corporation as a major employer, commercial and industrial development continues, particularly in the expansion of warehousing and other relatively "clean" industries, such as high technology manufacturing.

5. The increasing use of incentives to attract commercial and industrial development, such as Keystone Opportunity Zones (KOZs), has increased development. Redevelopment of brownfields has also begun to show results.

Residential development in the southern region has been mainly that of small lots (one acre or less) with single-family homes. There now appears to be an increasing trend towards townhouses and condominiums as a way of increasing density of units on a given tract of land. In certain areas, however, there has been substantial development of "executive homes" but still on relatively small lots (up to five acres).

THE TRUE COST OF DEVELOPMENT

Every day there are land-use changes all around us. Farm fields and woodlands are converted to malls and housing developments. These land-use changes can adversely affect our quality of life and place. Wildlife habitat is lost and fragmented. There are increased traffic problems, pollution, and loss of community connections.

Smart planning can help communities prevent the adverse changes caused by unmanaged growth. By closely examining the true costs of development, community planners can save both money and quality of place.

In Pennsylvania, land-use is regulated by state laws and local ordinances. Local officials can greatly influence how land is used in a community. The Municipal Planning Code is a state document that mandates how local land-use decisions are made. While local municipal officials cannot simply put a halt to all development, even if the majority of their citizens desire it, officials have tremendous power to plan for development and conservation as well.

One useful exercise is to compare the cost of converting a 100-acre farm to residential use versus protecting it from development. The following example uses information from a community in southeastern Pennsylvania experiencing heavy development pressure. In the Upper Perkiomen School District, the average cost to educate a public school student in the 1999/2000 school year was $7,995, and the average school tax revenues per household were $1,779. An average building lot size of 1.42 acres, or 0.66 homes per acre, was used.

A shortfall of $322,311 will be experienced annually if the 100-acre farm is converted to residential use (66 homes, 55 school students). In comparison, if the farm is preserved through either purchase of a perpetual conservation easement or through purchase of the property, the $322,311 shortfall could be realized in 1.3 years and 2.2 years respectively, a relatively short period of time in both cases.

Smart fiscal decision-making at the municipal level that also protects land and other natural resources needs to become a priority. Citizens can take action to protect their land and the quality of life in their communities by voting for candidates who will initiate land protection techniques. Nationally and locally, voters have voted yes for open space initiatives by wide margins, providing millions of dollars to protect land.

3. MUNICIPAL PLANNING AND GROWTH

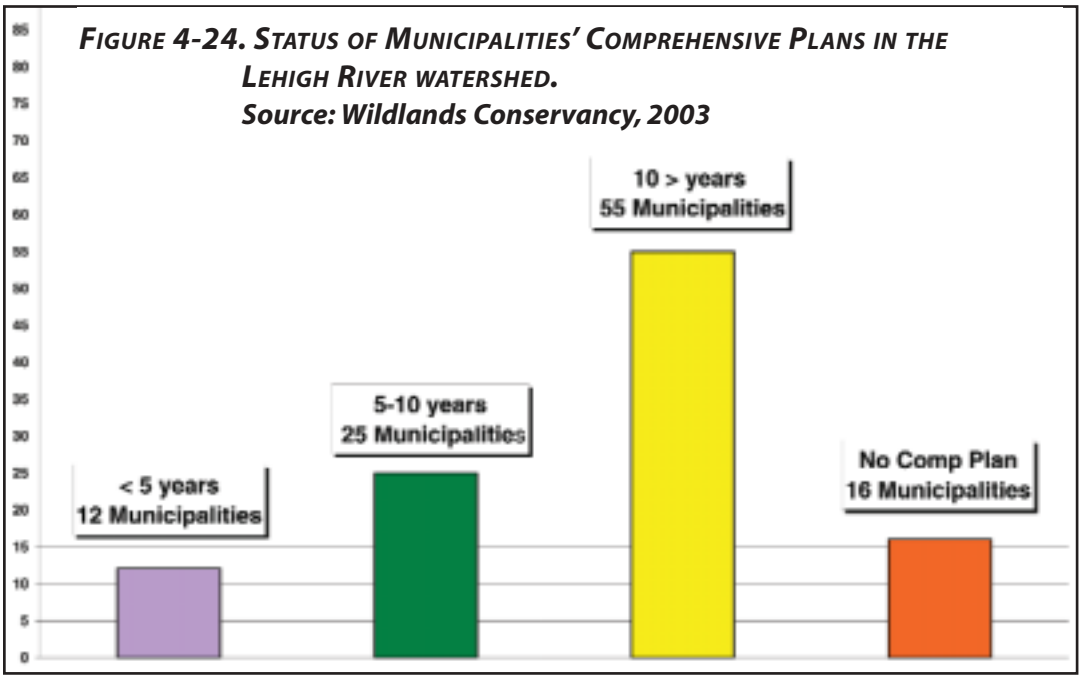
In Pennsylvania, land-use planning has been delegated by the state legislature to the 2,565 local governments or municipalities. The legislative vehicle by which this is done is the Municipalities Planning Code Act 247 of 1968 as amended (MPC). This legislation sets the rules to which local governments must adhere when adopting any form of planning program. The MPC does not require a municipality to plan, but if it does, then the MPC spells out how such planning must be done. The governing bodies (i.e., supervisors, commissioners, etc.) of municipalities may develop comprehensive plans, zoning ordinances, subdivision and land development ordinances (SALDO), a planning board, a zoning hearing board, and official maps. Counties, however, are required to develop a comprehensive plan.

In most Pennsylvania municipalities, the governing body created a planning commission, and the activities of the planning commissions are regulated by the MPC. Its main purpose is to carry out the mandates of the MPC, prepare comprehensive plans, zoning ordinances, as well as

subdivision and land development ordinances. The planning commission itself has no power to enact these plans and/or ordinances; such power is reserved to the governing body. The governing body may make such changes as deemed appropriate to anything prepared by the planning commission. The county has a limited power of review of most municipal planning activities and is primarily concerned with ensuring that the local plan is coordinated with the county plan. In the absence of municipal ordinances, the county can make its own zoning and/or subdivision regulations.

a. Comprehensive Plans

FIGURE 4-24. STATUS OF MUNICIPALITIES' COMPREHENSIVE PLANS IN THE LEHIGH RIVER WATERSHED.
Source: Wildlands Conservancy, 2003



The most important local planning document is the comprehensive plan. This sets out the land-use goals of the community and is the underlying basis for any zoning and/or SALDO ordinances. Ideally, the comprehensive plan should be revised every ten years to keep the plan current and to reflect the actual development activity and changes that have occurred in the municipality. The comprehensive plan is the basis for the regulatory zoning and SALDO that follow. While the comprehensive plan is advisory, not regulatory, these latter regulatory documents must be consistent with the comprehensive plan, or they may be overturned by appeal to the courts.

From a survey conducted in spring 2003, results indicated that 55 out of the 108 municipalities in the watershed are working with comprehensive plans that are 10 years old or older and 10 municipalities do not have comprehensive plans, as illustrated in Figure 4-24 and Map 4-9.

MONROE COUNTY 2020

In 1996, the Monroe County Commissioners and Planning Commission initiated "Monroe 2020"- a community partnership of Monroe County citizens, civic, business, educational, environmental and political leaders concerned about the quality of life in Monroe County. Monroe 2020 was a process designed to conceive and execute a cohesive plan of action for Monroe County. The process included five task forces which represented the entire county, the twenty municipalities and each of the four school districts. Using a community collaborative process, Monroe 2020 developed a County Comprehensive Plan to address environmental conservation, economic development, and quality of life.

The goals include:

- protection and enhancement of land and water resources
- economic development and fiscal balance
- enhancement of community character and community life
- planned development of public facilities, infrastructure, and services and more compact patterns of land-use that emphasize conservation subdivision principles.

Implementation of the Comprehensive Plan is now occurring through the Municipal Partnership Program (MPP) and the Financial Assistance Program (FAP). The FAP was adopted April 2002 and amended June 2003.

Monroe 2020 has also developed a Monroe County Open Space Plan to address protection and enhancement of heritage resources, open space and parks, recreation partnerships, greenways, and open space acquisition. The plan provides an analysis of land-use and recommends open space opportunities. The majority of the municipalities are responding to the development of the county plan with their own open space plans in collaboration with neighboring jurisdictions.

In addition, in May of 1998, voters in Monroe County approved a $25 million bond referendum to purchase undeveloped land over the next 10 years. Monroe County 2020, the Monroe County Open Space Plan, and the bond referendum are working in conjunction to secure open space in the county. (Monroe County Planning Commission).

b. Recreational and Open Space Plans

The definition of open space can vary from situation to situation. Generally, open space means undeveloped land areas that have important ecological functions, natural resources, or cultural resources that are worthy of conservation and protection. Such areas may contain, but are not limited to, forests, farmland, old fields, floodplains, wetlands, and riparian zones. Open space can also encompass scenic vistas, recreational areas, and historic sites.

Recreational and open space plans address the current and projected needs of the residents in regards to both of these topics. Whether treated separately or jointly, recreational and open space plans inventory existing resources and conditions, analyze the data, and provide recommendations for enhancement and/or improvement. The development of recreational and/or open space plans provides the opportunity for partnership between the municipality, residents, conservation groups, recreational groups and other interested parties.

Generally, the goals of an Open Space Plan are three-fold:

1. Identify large, unfragmented areas of undeveloped land ("open space") that are important as natural, scenic or cultural resources and a priority for protection;
2. Identify linkages between open space areas that are possible for protection or restoration to maintain an interconnected network of wildlife corridors; and
3. Act as both a regional planning tool and a reference document useful to local planning and conservation officials that can assist them in creating local land conservation strategies and plans.

Clarifying the goals and objectives at the onset of the planning process guides and organizes the participants. A sample list of goals is as follows:

1) Develop and operate a comprehensive program of recreation and park activities that serve the needs of all ages in the target area.

2) Organize and administer park and recreation services with year-round attention to both current and newly proposed programming and facility initiatives.

3) Pursue a program of gradual expansion of the existing park system in order to preserve dwindling open space within the municipality and maintain a balanced mix between sustained growth of the municipality and the current quality of life.

4) Expand current volunteer efforts to maximize programming and upkeep of key park facilities in a cost-effective manner.

5) Seek to utilize county, state, and federal grant programs along with private and local municipal resources in order to help provide the funding necessary for a parks and recreation system that meets the needs of the municipal residents.

6) Expand current publicity efforts to make municipal residents more aware of public park and recreation offerings, as well as the array of private, commercial, quasi-public, and neighboring municipality choices available to satisfy recreation needs.

7) Seek to preserve, protect and maintain, enhance or restore the scenic beauty, natural systems, wildlife, and cultural heritage of the municipality.

In addition, if considered on a regional basis, communities can coordinate local conservation efforts and take maximum advantage of adjoining conservation properties or potential linkages.

LACKAWANNA AND LUZERNE COUNTIES OPEN SPACE, GREENWAYS AND OUTDOOR RECREATION MASTER PLAN

As of September 2003, the Lackawanna & Luzerne Counties Open Space, Greenways and Outdoor Recreation Master Plan Draft is in the final stages of being completed by the Luzerne and Lackawanna County Planning Commissions. The Plan, when final, will provide a pro-active framework for the preservation of open spaces and the development of a network of greenways and outdoor recreation areas. It will provide local leaders at the municipal level a defensible blueprint for decision making. This Plan can also be used as the baseline for each municipality within the county to use to develop their own Open Space Master Plan, either individually or regionally. (Lackawanna County Regional Planning Commission).

c. Zoning Ordinances

The next most important planning tool is the zoning ordinance. The zoning ordinances set forth where certain land-uses will take place and what those uses may be. The zoning ordinances should be consistent with the goals set forth in the comprehensive plan, must be in conformance with many court rulings, and are considered the rules that back up the goals of the comprehensive plan.

While the zoning ordinance is the controlling document for land-use, it is less than permanent control, because the ordinance can be, and often is, changed at the direction of the governing body. The MPC requires that each municipality's zoning ordinances must provide a location for every conceivable land-use within a municipality. Failure to do so allows that use to be placed wherever land can be found for it. Multi-municipal zoning provides a larger area to strategically plan and provide for every conceivable land-use.

Figure 4-25 and Map 4-9 illustrate that 36 municipalities have zoning ordinances that are 10 years old or older, and four municipalities have no zoning ordinances.

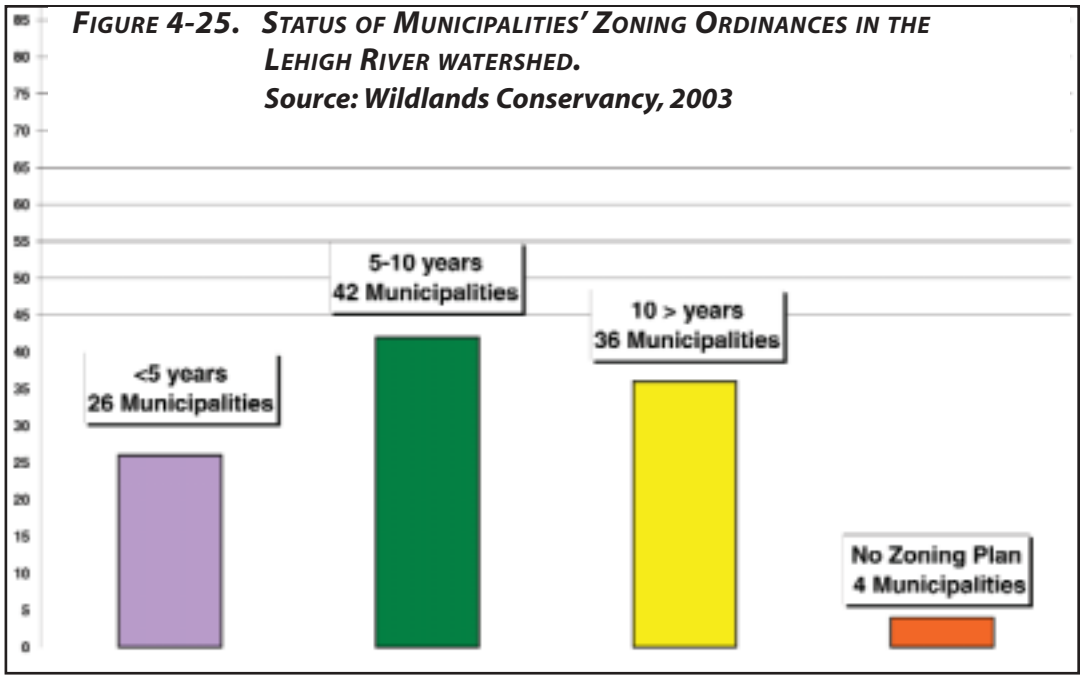


FIGURE 4-25. STATUS OF MUNICIPALITIES' ZONING ORDINANCES IN THE LEHIGH RIVER WATERSHED.
Source: Wildlands Conservancy, 2003

d. Subdivision and Land Development Ordinances

The Subdivision and Land Development Ordinance (SALDO) is much more specific in its intent. It controls the specifics of how land may be subdivided and how development may take place. It contains regulations on such items as streets, setbacks, sight lines, materials, and much more. This ordinance is less subject to change than the zoning ordinance.

From a survey conducted in spring 2003, results indicated that 90 out of the 108 municipalities in the watershed are working with SALDO plans that are 10 years old or older and 10 municipalities do not have SALDO plans, as illustrated in Figure 4-26 and Map 4-9.

e. Regional Planning

Due to the changes to the MPC in the year 2000, municipalities are now allowed to work together in their planning and to act regionally, as a group, with common ordinances. For planning and land-use regulatory purposes, this essentially creates a larger municipality. This is a critical change and it will have a major impact on planning for Pennsylvania communities. Because it is now possible to have one comprehensive plan and associated ordinances cover a region consisting of several municipalities. It is now easier to direct growth into areas best suited to receive such growth. Regional planning also promotes the development of joint zoning, transportation greenways, preserved lands, and open space across municipal boundaries. Additionally, services such as multi-municipal infrastructure management, waste management and recycling can be coordinated.

As of the end of 2003, 34% of the municipalities within the watershed are involved in multi-municipal planning groups in the watershed (Figure 4-25).

f. Environmental Advisory Councils (EAC)

An Environmental Advisory Council (EAC) is a voluntary citizen advisory committee, appointed by the governing body of each municipality, consisting of three to seven members, which serves as a useful planning resource for local governments regarding land-use and environmental issues. The location, design, and construction of residential developments, access points to streams and rivers, and suggestions for the location or relocation of heavy industry are only a few examples of issues on which EACs can provide valuable input. EACs also frequently publish informational

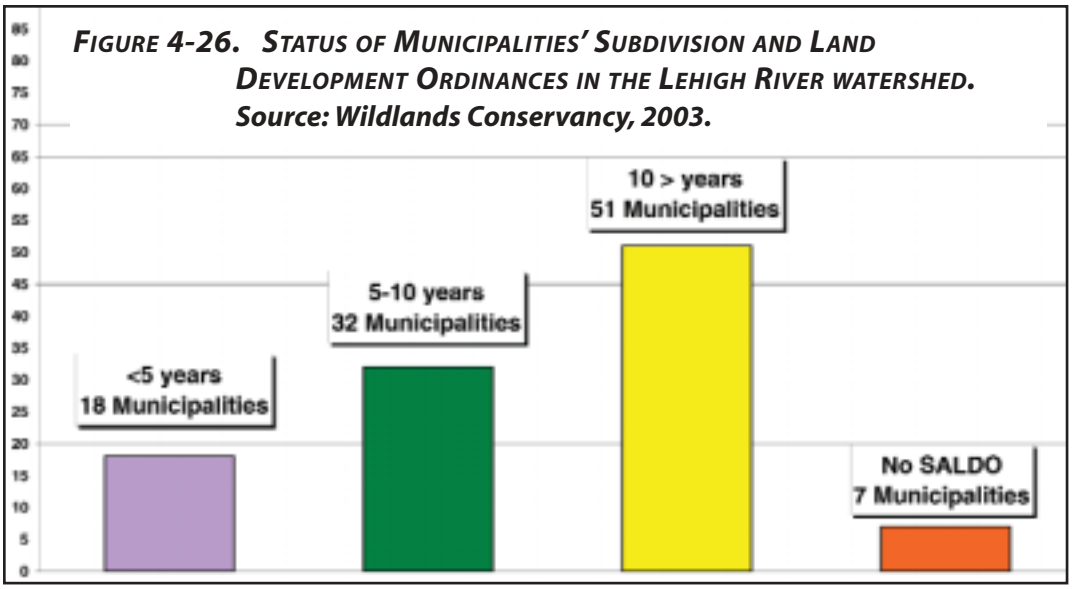


FIGURE 4-26. STATUS OF MUNICIPALITIES' SUBDIVISION AND LAND DEVELOPMENT ORDINANCES IN THE LEHIGH RIVER WATERSHED. Source: Wildlands Conservancy, 2003.

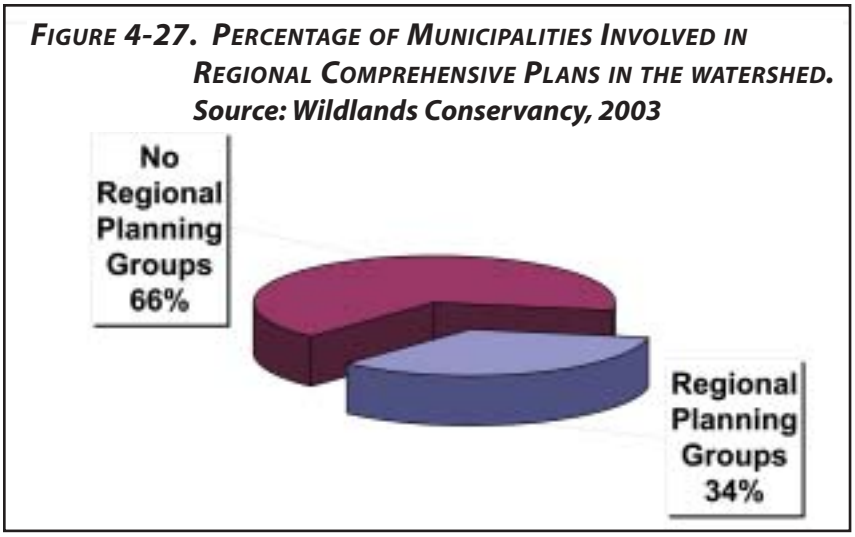


FIGURE 4-27. PERCENTAGE OF MUNICIPALITIES INVOLVED IN REGIONAL COMPREHENSIVE PLANS IN THE WATERSHED. Source: Wildlands Conservancy, 2003

newsletters for the residents in their municipality and implement fun projects to educate children about the environment.

- EACs help municipal officials make environmentally sound decisions because the EAC's primary attention is devoted to environmental issues.
- EACs serve as liaisons to represent both the community and decision makers.
- EACs are a focal point for funding and raise money for projects.
- EACs engage children, residents, community volunteers, and the private sector in natural resource protection.
- EACs work on a multi-municipal level to reflect natural rather than artificial municipal boundaries.

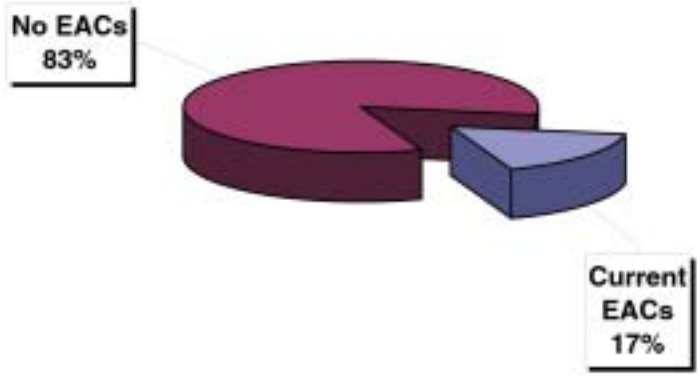
Ambitious EACs can complete an Environmental Resource Inventory (ERI) for the municipality to serve as a tool for planning development and protecting existing resources. An ERI is a report that documents the existing natural, cultural, recreational, historic, and other special features in a municipality. Typically, the ERI contains descriptions of these features, maps showing the locations, identifies the community's conservation areas, and can suggest areas that should be protected from development. This information can easily be documented on software called Geographic Information System (GIS), which allows tremendous flexibility and usefulness to the municipality. The inventory can be useful in the complex aspects of community planning and development plan review, to the designing of trails and greenways, and for the protection of open space.

There are over one hundred EACs in Pennsylvania and more are continuously being formed. Local EACs look to a statewide organization, the Pennsylvania Environmental Council, (PEC) to help them get started, for technical assistance, a variety of handbooks and guides, and the EAC Network. Through the EAC Network, the Council promotes the establishment of new municipal environmental advisory councils and assists existing EACs. The program provides EACs with tools, examples of projects, and opportunities to network (Pennsylvania Environmental Council).

Of the 108 municipalities in the watershed, 11 municipalities or 17% had EACs as of December 2003 (Figure 4-28).

The Borough of Alburtis EAC (Lehigh County) completed their ERI in 2003. The borough officials will utilize it not only to serve the borough at large, but also to amiably develop a master plan for a controversial 17-acre site within the community.

FIGURE 4-28. PERCENTAGE OF EACS INVOLVED IN THE WATERSHED.
Source: Wildlands Conservancy, 2003



g. County Open Space Fundraising efforts

Lehigh, Monroe, and Northampton Counties recognized the need for the preservation and enhancement of agricultural lands, park and recreational areas, and open space and have addressed these needs in the last five years with fundraising efforts.

LEHIGH COUNTY

In May 2002, voters in Lehigh County overwhelmingly approved the Green Future Fund (GFF), a $30 million county bond for land acquisition, to protect farmland and to develop and improve local parks. The measure passed with 14,907 'yes' votes (70.6 percent of the vote) to 6,201 'no' votes (29.4 percent). The $30 million will be distributed evenly between:

1. preservation of farmland and other types of working lands;
2. creation and improvement of parks and playgrounds, especially in boroughs and cities; and
3. creation and enhancement of nature trails, greenways and protection of natural habitat and waterways.

Each of the15 townships and 10 boroughs will be eligible for a percentage of the total funds based on their population.

MONROE COUNTY

Voters in Monroe County approved a $25 million bond referendum in May of 1998 to purchase undeveloped land over the next 10 years. The $25 million is earmarked for municipal open space, agricultural preservation, planning, and for county open space. The allotment for county open space is called the County Initiative Program and is divided into three categories:

- ***$2,436,280*** – Regional Active Use Recreational Lands (lands that are suitable for eventual use for active recreation)
- ***$2,436,280*** – Natural Area Land Trust Program (lands that are essential for critical biological habitat and/or for the protection of water quality)
- ***$4,872,560*** – County Natural Areas/Passive Recreation Land (lands that contain critical biological habitats and/or they will be necessary for water quality protection. They may be used for passive recreation.)

NORTHAMPTON COUNTY

In November 2002, 65 percent of Northampton County voters passed the $37 million Open Space Referendum. The $37 million will be distributed evenly between:

1. preservation of farmland;
2. protection of environmentally sensitive lands; and
3. parks acquisition and improvements.

The Lehigh Valley Planning Commission is in the process of developing the criteria that applicants will use to apply for the funds.

h. Brownfields

The Lehigh River has been an integral part of the industrial development of eastern Pennsylvania. From a starting point just south of the Kittatinny Ridge, the Lehigh River flows through some of the most heavily industrialized land in the state. By virtue of it being the conduit for the transportation of coal from the more northern counties in the watershed to the seaport of Philadelphia, countless industrial sites have grown up along the Lehigh River and its tributaries. As economic conditions and manufacturing techniques changed over the decades, many sites along the river and its tributaries became known as brownfields.

According to Public Law 107-118 (H.R. 2869)-"Small Business Liability Relief and Brownfields Revitalization Act" signed into law January 11, 2002, the definition of brownfields is stated: With certain legal exclusions and additions, the term `brownfield site' means real property, the expansion, redevelopment, or re-use of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant. Towns and cities are the most common location for brownfields. Some are more seriously polluted than other sites, perhaps to the level of being designated as superfund sites; however, all are lands that present problems to the community in which they are located. They are often abandoned, no economic use is made of the property, and consequently, markedly reduced or no property taxes flow to the community.

A number of community benefits result from restored lands returning to economic use: more tax revenue is received; more jobs are created in the community; unsightly properties become more attractive; and lands dangerous to humans and unfit for flora and/or fauna become safe and fit for human use. In addition, pressure decreases for development on "greenfields," or, in other words, property that is not currently developed (i.e., farmland and open space).

Within the Lehigh River watershed, there are several approaches to the problems associated with brownfields. The counties of Lehigh and Northampton created and continue to fund a joint agency, the Lehigh Valley Land Recycling Initiative (LVLRI), to clean up and restore to productive use the brownfields in those two counties. This initiative was sparked by public interest in cleaning up polluted lands and returning them to productive use. It is operated under the aegis of the Lehigh Valley Economic Development Corporation and has a full-time executive director. LVLRI is charged with identifying and prioritizing projects that qualify as brownfields, as well as assisting municipalities and private investors in obtaining federal and state grants for the clean-up of these properties and bringing them onto the market. The inventory developed by the LVLRI is not accessible by the public and/or developers.

Lackawanna and Luzerne Counties have a similar arrangement to address brownfields. The Counties of Berks and Bucks each have entered into a pilot program with the federal Environmental Protection Agency (EPA) and the Pennsylvania Department of Environmental Protection (DEP). Monroe County also has a similar pilot program, while Carbon, Schuylkill, and Wayne Counties do not have any formal, ongoing brownfields effort at this time, other than liaison with EPA and DEP.

Bethlehem Steel is no more. Its rich history covered 99 years, spanning – and helping to create – the emergence of the United States as a force in the world's economy.

Brownfields management, or returning to productive use lands once polluted, is an important factor in the health of the Lehigh River watershed. Such lands may be those occupied by old and/or failed industry, by dumping sites for hazardous waste, or lands that have suffered from any sort of pollution that needs to be remedied before the land can be used again. Work on brownfields sites is inconsistent across the Lehigh River watershed.

One brownfield created near Palmerton in Carbon County, from the now defunct manufacturing of zinc, has been called the "Badlands of Pennsylvania."

The largest brownfield in the watershed, and reputed to be one of the largest in the entire country, is the Bethlehem Steel site in Bethlehem and adjacent townships. The tract runs over 1,600 acres and has well over a mile of Lehigh River frontage. It is in the process of being redeveloped and subdivided for marketing purposes.

There are few openly identified brownfields in the watershed until the river passes through the Lehigh water gap into Lehigh and Northampton Counties because a great deal of the Lehigh River and its tributaries flows through relatively rural wooded and agricultural areas. According to information posted on the internet by the Department of Environmental Protection, the combined total acres for publicly-acknnowledged brownfields in all the counties in the watershed, save Northampton County, is 173.61 acres on 11 sites. In Northampton County there are three sites covering 1,610.5 acres, with the vast majority of acreage being attributed to the Bethlehem Steel Corporation's site, now subject to ongoing clean-up efforts. (These figures may be artificially low because the site only lists properties that the landowners have publicly identified as brownfields.)

The pace of clean-up of brownfields depends heavily on the funds available from federal, state and county sources, but almost exclusively from EPA (federal) and DEP (state). Most communities have little resources of their own to contribute. Larger municipalities, who have organized redevelopment authorities, are in a better position to reclaim brownfields. Not every brownfield in the watershed directly affects the Lehigh River, but the health of the watershed as a whole will be markedly improved by the continuing effort to eliminate brownfields.

F. Review of Lehigh River Watershed Land Components

Within the watershed, the land cover consists of 67.5% (905.7 square miles) natural conditions and 32.5% (437.4 square miles) human-influenced land cover. Past and current patterns of human land-use have caused considerable impacts to the Lehigh River watershed. The five main land-use types in the watershed are forest (64.9%), agriculture (23.9%), and urban (7.1%), with the remaining land cover consisting of wetlands (3.5%) and barren lands (1.5%).

For the Lehigh River watershed, forested land and open space, along with some abandoned mine land, dominate the headwater stream areas; agricultural and rural land-use characterizes the center of the watershed; and developed land-uses dominate the downstream urban areas of Allentown, Bethlehem, and Easton.

There are portions of two state forests and five state parks, owned by The Commonwealth of Pennsylvania, totaling 56,088 acres, in four of the counties in the watershed. There are 14 Pa. State Game Lands, totaling 109,327.64 acres. (Map 4-7) These parks, their location, and acreage are listed in Table 4-7.

There are two federally owned forests and parks, totaling more than 6,565 acres, in three of the counties in the watershed. All of these are located north of the Blue Mountain. Additionally, the Commonwealth of Pennsylvania owns seven forests and parks, totaling 56,088 acres, in four of the counties in the watershed. Additionally, the Commonwealth owns 14 Pa. State Game Lands, totaling more than 109,327 acres. As a result, the Lehigh River watershed possesses approximately 172,000 acres of federally and state-protected lands.

Additional lands are protected, through conservation easements and fee acquisition, by non-profit land conservation organizations or landowners in cooperation with conservation organizations. Wildlands Conservancy and The Nature Conservancy are the principal land conservation organizations actively preserving lands in the watershed, with 5,500 acres protected by Wildlands Conservancy, and 3,650 acres protected by The Nature Conservancy.

One of the principal ways to slow conversion of agricultural and silvicultural lands to development is to speed the process of urban renewal. If cities and larger towns address the issue of urban renewal, thus once again becoming desirable places in which to live and work, pressure on rural lands will decrease. Programs such as the Keystone Opportunity Zones (KOZs) , Main Street Program and Market Town Initiative help communities experience economic growth and investment.

According to the United States government, eight of the ten counties in the watershed (Luzerne and Lackawanna are excluded), will be experiencing population growth through the year 2020 (Figure 4-4). Projections show the counties of Berks, Bucks, Monroe, and Northampton seeing the largest population increases.

Past land-use is evident in the large number of the "Superfund Sites" that are located in the eastern portion of the state, including those in the Lehigh River watershed. Palmerton Zinc Piles and Tonolli Corporation are examples of two superfund sites located in Carbon County. The state has a statutory and regulatory system in place to manage the clean up of these sites. Pennsylvania's Land Recycling and Environmental Remediation Standards Act provide a framework for the clean-up standards within the state.

The largest brownfield in the watershed, and reputed to be one of the largest in the entire country, is the Bethlehem Steel site in Bethlehem and adjacent townships. The tract runs over 1,600 acres and has well over a mile of Lehigh River frontage. It is in the process of being redeveloped and subdivided for marketing purposes.

One hundred fifty-eight County Natural Area Inventories sites were identified in six of ten counties comprising the watershed (Map 4-8). Carbon County possesses the greatest number of sites compared to the other counties.

Due to the various impacts to the land, ranging from natural areas to superfund sites, land-use planning is extremely important. In Pennsylvania, land-use planning has been delegated by the state legislature to local governments. The legislative vehicle by which this is done is the Municipalities Planning Code (MPC). Many factors are considered during the planning process, including land-use patterns, community goals and objectives, demographics, population projections, transportation issues, economic issues, existing zoning and SALDO ordinances, and much more. Municipal and public participation in the planning is key.

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Part V

BIOLOGICAL COMPONENTS

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A. Watershed Biodiversity

There are three general kinds of biodiversity: habitat diversity, genetic diversity, and species diversity. The survival of each is linked to the health of the other two, and together they comprise the wealth of ecosystems.

Habitat diversity refers to the variety of places where life exists – forests, wetlands, etc. Each broad type of habitat is home for numerous species, most of which are utterly dependent on that habiatat. The genetic diversity within a speces is primarily the variety of populations that comprise it. Species reduced to a single population generally contain less genetic diversity than those consisting of many populations. Song sparrows, found over much of North America, occur in numerous populations and thus maintain considerable genetic diversity within that species. The survival of populations, as well as species, is important because of the unique genetic information contained within populations. Finally, species diversity describes the one and a half million named species on the earth and those that are currently unnamed.

Biodiversity is essential to the health of our natural environment and to sustaining the benefits that human beings derive from nature. The leading causes of biodiversity loss in Pennsylvania are loss and degradation/fragmentation of habitat, non-native invasive species, pollution, and the imbalance of native species such as the overabundance of white-tailed deer (DCNR, 2003).

Some useful definitions relating to species of concern in the watershed are listed below:

- ***Endangered:*** "Species in imminent danger of extinction or extirpation throughout their range in Pennsylvania."
- ***Threatened:*** "Species that may become endangered within the foreseeable future throughout their range in Pennsylvania."
- ***Extirpated:*** "Species that have disappeared from Pennsylvania but still exist elsewhere."
- ***Extinction:*** "Species that occurred in Pennsylvania, but no longer exist across their entire range."

1. FLORA

Pennsylvania has a diverse flora coupled with a long history of botanical work within the state dating from the 18th century. A variety of habitats and the occurrence of several physiographic provinces contribute to Pennsylvania's floristic diversity. Habitats range from freshwater tidal marshes to limestone barrens, and northern and southern forest types both occur within the state. Historically, the greatest threat to the native Pennsylvania flora have been land use practices that alter natural habitats, including deforestation, urban and suburban expansion, road-building through natural habitats, and draining of wetlands.

a. Forest Types

The vegetation of the watershed reflects the environmental conditions (geology, climate, and soils) associated with the different physiographic provinces and disturbance history, both natural and anthropogenic. The river crosses two major forest regions: the Hemlock-White Pine-Northern Hardwoods Forest Region and the Oak-Chestnut Forest Region. The Hemlock-White Pine-Northern Hardwoods Forest Region (or Northern Hardwoods) Allegheny Section, corresponds with the Pocono Plateau Section of the Appalachian Plateaus Physiographic Province.

The Mixed Oak Forest Region portion of the watershed encompasses the entire overland section from Wilkes-Barre to White Haven, the western portion from White Haven to Palmerton, and from Palmerton to Easton.

1. NORTHERN HARDWOOD FORESTS

The Northern Hardwoods Forest occurs in various forms from Minnesota to northern New England and eastern Canada and as far south as central Pennsylvania. The Allegheny Section of the Northern Hardwoods Forest covers the area from the source of the Lehigh River to White Haven and the highlands to the east of the Lehigh River Gap. Although most of the area is still forested, little of the current forest resembles the original forest cover. Sprout stands of sugar maple, beech, and red maple occupy much of the logged areas. Sugar Maple is probably more abundant now than in the original forest because of its ability to grow from stump sprouts and the quick growth of seedlings when exposed to open light after the canopy has been logged.

Topographic diversity has led to a variety of plant communities. Beech and sugar maple dominate the deciduous communities, while hemlock and white pine are dominant only on the steep ravine slopes now where they had once been common throughout. Because of the proximity of the Oak-Chestnut Forest Region and the Northern Hardwoods forest, species overlap and outliers can be found in either forest type due to aspect, moisture, and soils. Along valley floors, more southern species of the Oak-Chestnut Region have mixed with the species of the more northern forest. The dry ridges and south-facing slopes may have a large oak component.

2. MIXED OAK FOREST

Originally, the Oak-Chestnut Forest extended from southern New England to northern Georgia and was characterized by oaks and the American chestnut. Today, none of the original primary vegetation of this forest type remains because of the chestnut blight that eradicated a primary constituent of the forest community. The parasitic fungus *Endothia parasitica*, introduced to America in 1904, caused the demise of the chestnut. The Oak-Chestnut Forest region described by Braun in 1950 is now better classified Mixed Oak Forest (Oplinger and Halma, 1988).

As the name implies, oaks are the dominant forest trees. White, red, scarlet, and black oaks are the primary species of the forest. Sometimes these species occur together, but each prefers different moisture and nutrient conditions. White oaks do best on moist soils of the valleys, while red oaks prefer drier, better-drained soil conditions of lower slopes. Scarlet and black oaks thrive on exposed south-facing slopes. These driest sites typically have a shrub understory comprised almost entirely of lowbush blueberries and huckleberries. A mixed mesic (middle moisture) forest dominated by hemlock and white pine may occur where valley floors are narrow or on the lowest ravine slopes. Beech, maple, tulip poplar, and red oak may be common associates. These mixed mesic forests are transitional with the Northern Hardwoods Forest. The most mesic stands have great rhododendron as the dominant shrub species.

Where the watershed occurs within the Mixed Oak Forest region, three forest sections are recognized: the Glaciated, the Ridge and Valley, and the Piedmont. The Ridge and Valley Section extends from southern Tennessee to almost the southern glacial boundary near the Delaware River. The entire watershed from the Pocono Plateau to the Palmerton area is included. The valleys and steeply sloping ridges have a variety of distinctive plant communities. One of the most striking plant communities of the Ridge and Valley Section is the ridge top dwarf-tree forest. These communities occur only on the thin, dry soils of the ridges. Shallow, dry, nutrient-poor soils, fire, and wind have led to a stunted forest dominated by scrub oak and dwarf chestnut

oak. With pitch pine, sassafras, black gum and a variety of ericaceous shrubs, the forest is an almost impenetrable thicket that is often home to some of the rarest species in Pennsylvania.

The Glaciated Section of the Mixed Oak Forest reaches its southwestern edge in Pennsylvania just south of the glacial boundary. Most of Northampton County and eastern Lehigh County are in this section. This section is sometimes called "central hardwoods" or "sprout hardwoods" because of the preponderance of reproduction by sprouting from stumps after logging. Woodlands originating from seed are confined to abandoned farmland and pasture.

Black oak is common on the dry ridges, while red and white oaks tend to be on the moister sites, where tulip poplar is usually a common component. On these sites, there is usually a well-developed understory of dogwood, witch hazel, hop hornbeam and musclewood and a rich herbaceous layer. Pin oak, swamp white oak, and red maple occur on the poorly drained flood-plain soils.

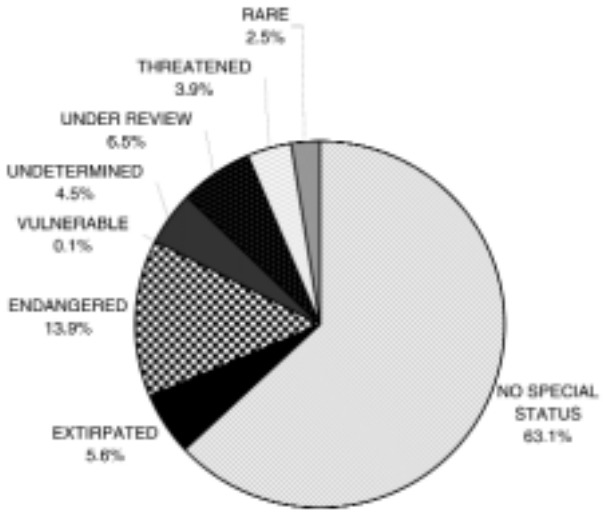
Very little of the original Piedmont Section forest remains. Much of the southern watershed is either agricultural or suburban/urban. In those stands that remain, historical logging for lumber and fuel has produced even-aged stands that range in age from 40 to 80 years (Keever, 1972). Tulip poplar, a minor component of the original forest, is now co-dominant with the oaks in most remaining woodlands. It is a species whose seedlings do not germinate well in the shade (Tyron, 1980). Tulip poplars only developed in the original forest where the canopy opened when trees died and fell. Beech is found on the north-facing slopes and in ravines along streams leading to the Delaware River. Red maple, tulip poplar, and beech may also be components in hemlock communities.

b. Plants

1. Status of Plants

Native plants comprise slightly less than 63% of the vascular flora of Pennsylvania. Of these native taxa, approximately 30% are currently listed as plants of special concern (Figure 5-1). More than 5% (116) of native plant species are believed to be extirpated in Pennsylvania, and an additional 20% are classified as endangered (288), threatened (80), rare (52), or vulnerable (3). Another 93 species are currently classified as undetermined, pending assignment to a specific status. The figure of 30% does not include the approximately 135 species that were under review as of July 1997 by the Pennsylvania Biological Survey (PABS) Vascular Plant Technical Committee for listing as species of special concern.

FIGURE 5-1. STATUS OF VASCULAR PLANTS NATIVE TO PENNSYLVANIA.



Thirty-seven Pennsylvania plant species are listed as Globally Rare (G3 rank), Threatened (G2 rank), or Endangered (G1 rank) (Pennsylvania Natural Diversity Inventory (PNDI). Two species that occurred in Pennsylvania, Schweinitz's waterweed (*Elodea schweinitzii*) and Nuttall's mud-flower (*Micranthemum micranthemoides*), are considered to be extinct throughout their ranges (Rhoads and Klein 1993).

TABLE 5-1. PLANTS OF SPECIAL CONCERN IN THE LEHIGH RIVER WATERSHED
(The Pennsylvania Flora Database, Morris Arboretum of the University of Pennsylvania, 2003)

Scientific Name	Common Name	State Status	Proposed State Status
AGALINIS AURICULATA	EARED FALSE-FOXGLOVE	PE	PE
AMELANCHIER BARTRAMIANA	OBLONG-FRUITED SERVICEBERRY	PE	PE
ARCEUTHOBIUM PUSILLUM	DWARF MISTLETOE	PT	PT
BARTONIA PANICULATA	SCREW-STEM	N	TU
CAREX COLLINSII	COLLIN'S SEDGE	PE	PT
CAREX EBURNEA	EBONY SEDGE	PE	PE
CAREX OLIGOSPERMA	FEW-SEEDED SEDGE	PT	PT
CAREX PAUPERCULA	BOG SEDGE	PT	PR
CAREX POLYMORPHA	VARIABLE SEDGE	PE	PT
CAREX PRAIREA	PRAIRIE SEDGE	PT	PT
CAREX TETANICA	A SEDGE	PT	PT
CHENOPODIUM FOGGII	FOGG'S GOOSEFOOT	PE	PE
CLADIUM MARISCOIDES	TWIG RUSH	PE	PE
CYPERUS SCHWEINITZII	SCHWEINITZ'S FLATSEDGE	PR	PR
ELATINE AMERICANA	LONG-STEMMED WATER-WORT	PX	PE
EPILOBIUM STRICTUM	DOWNY WILLOW-HERB	PE	PR
ERIOPHORUM TENELLUM	ROUGH COTTON-GRASS	PE	PE
GAULTHERIA HISPIDULA	CREEPING SNOWBERRY	PR	PR
GERANIUM BICKNELLII	CRANESBILL	PE	PE
GLYCERIA BOREALIS	SMALL-FLOATING MANNA-GRASS	PE	PT
GLYCERIA OBTUSA	BLUNT MANNA-GRASS	PE	PE
HUPERZIA POROPHILA	ROCK CLUBMOSS	PE	PE
HYPERICUM DENSIFLORUM	BUSHY ST. JOHN'S-WORT	PT	PR
JUNCUS FILIFORMIS	THREAD RUSH	PR	PR
JUNCUS TORREYI	TORREY'S RUSH	PT	PE
LYONIA MARIANA	STAGGER-BUSH	PE	PE
MUHLENBERGIA UNIFLORA	FALL DROPSEED MUHLY	PE	PT
MYRICA GALE	SWEET-GALE	PT	PT
MYRIOPHYLLUM FARWELLII	FARWELL'S WATER-MILFOIL	PE	PE
NAJAS GRACILLIMA	BUSHY NAIAD	PT	PT
NELUMBO LUTEA	AMERICAN LOTUS	PE	PE
ORYZOPSIS PUNGENS	SLENDER MOUNTAIN-RICEGRASS	PE	PE
PARNASSIA GLAUCA	CAROLINA GRASS-OF-PARNASSUS	PE	PE
PLATANTHERA BLEPHARIGLOTTIS	WHITE FRINGED-ORCHID	N	TU
POA PALUDIGENA	BOG BLUEGRASS	PT	PR
POLYGONUM CAREYI	CAREY'S SMARTWEED	PE	PE
POTAMOGETON CONFERVOIDES	TUCKERMAN'S PONDWEED	PT	PT
SALIX SERISSIMA	AUTUMN WILLOW	PT	PT
SCHOENOPLECTUS TORREYI	TORREY'S BULLRUSH	PE	PE
SCIRPUS ANCISTROCHAETUS	NORTHEASTERN BULLRUSH	PE	PT
SPARGANIUM ANDROCLADUM	BRANCHING BUR-REED	PE	PE
STREPTOPUS AMPLEXIFOLIUS	WHITE TWISTED-STALK	PE	PE
UTRICULARIA INTERMEDIA	FLAT-LEAVED BLADDERWORT	PT	PT
UTRICULARIA MINOR	LESSER BLADDERWORT	PT	PT

Notes:
N-no special status
U-undetermined
PE-PA endangered
PT-PA threatened
PX-PA extirpated
PC-PA candidate
PR – PA reported
T-Threatened
U-Candidate-Undetermined

The number of Pennsylvania Endangered and Threatened plants may be attributable to the geographic position of Pennsylvania straddling a number of physiographic regions and the diversity of habitats found in the state. Seventy-seven percent of Endangered and Threatened plants in Pennsylvania are at the edge of their geographic range (Walck 1996). Although water-dependent habitats occupy only about 2% of the land surface in Pennsylvania, 57% of Endangered and Threatened plant species grow in these habitats (Walck 1996). Not surprisingly, families with the largest number of Pennsylvania Endangered and Threatened plants, the sedges (Cyperaceae), grasses (Poaceae), and composites (Asteraceae), are the families with the greatest number of species in Pennsylvania.

Plants found in the northern ridges and slopes of the Lehigh River watershed include some Canadian, northern species that are near their southern limit such as gold thread, mountain ash, showy lady slipper, striped maple, toothwort, buckthorn, and sheep laurel (Schaffer, 1949). Similarly, a number of Carolinian or southern plants reach their northern extent near South mountain. These species include Jersey pine, lady fern, common persimmon, Virginia snakeroot, shiny coneflower, and winter grape (Schaffer, 1949). Some plants are limited to the limestone formations and soils in the lower portion of the watershed such as bladdernut, false solomon's seal, grass-of-parnassus, purple cliff-brake fern, stiff gentian, and yellow oak (Schaeffer, 1949).

A list of the plants of special concern in the Lehigh River Watershed are listed in table 5-1.

2. Exotic and Invasive Plants

A native plant is defined as one that occurred within the state before settlement by Europeans. Native plants include ferns and club mosses; grasses, sedges, rushes, and their kin; flowering perennials; annuals; biennials and the woody trees, shrubs and vines. There are over 2,100 native plant species known in Pennsylvania (Pennsylvania DCNR, 1998). An introduced or "exotic" plant is one that has been brought in and becomes established. In 1998, there were 1,300 species of exotic plants in Pennsylvania (Pennsylvania DCNR, 1998), and more introduced plants are identified every year. An "invasive" plant not only becomes established, but spreads aggressively into new areas and environments. Some native plants are aggressive in disturbed areas, but most invasive plants are introduced from other continents, leaving behind pests, diseases, predators, and natural controls.

Species that have flourished and spread on their own only after people transported them across barriers they could not otherwise surmount (such as oceans, mountain ranges and deserts) are considered non-natives or exotics. Non-native species populations are sometimes established on land that has been altered, such as by clearcutting. These changes disrupt the natural plant community and foster conditions for non-native plant propagation. In many areas, these plants have overwhelmed the native plants and animals. These species are considered invasive. Exotic species are responsible for most damaging invasions, but a far smaller number of natives also have invaded and degraded new habitats (Marinelli, 1996). Invasives reproduce rapidly and can form stands that exclude nearly all other plants. In the process, they damage natural areas, altering ecosystem processes, displacing native species, hybridizing with natives and changing their genetic makeup, and supporting other non-native plants, animals and pathogens (Marinelli, 1996).

More than any other group of organisms in Pennsylvania, the state's native flora has been impacted by the establishment of alien species (DCNR PABS). Over 37% of the vascular plant species now growing within the borders of Pennsylvania are not native. This figure is much higher in some groups, such as the mustard family (Brassicaceae), for which almost 80% of the species in Pennsylvania are introduced.

Humans have relocated hundreds of plant species from their native ranges to new areas. Many of the exotic plants that have been introduced, either by accident or by intention, have been beneficial and ecologically benign. However, a small percentage have run rampant. Gaining a foothold first in areas disturbed by human activities, these species then move into natural areas where they have not only driven out indigenous species but also in the worst cases radically altered the ecosystems they have invaded.

As shown in Table 5-2, a number of invasive and exotic species have been identified within the watershed. These species present a threat to the abundance and diversity of native vegetation within the watershed. Invasive species usually establish themselves first in disturbed areas and then quickly spread across the surrounding landscape. Some species that have been identified in abundance within the watershed include Multiflora rose, Russian and autumn olive, Tartarian honeysuckle, and purple loosestrife.

Some invasive species in the region, such as Norway maples, release toxins to the soil that inhibit growth and reproduction of native species. Invasive trees are often overlooked because they do not have the dense vine or shrub form typical of exotics. The threat of the Norway maple in many regions is unnoticed because most trees are still saplings. However, by the time these saplings mature, the forested land will be composed almost exclusively of Norway maple. These trees prevent the establishment of an herbaceous or shrub layer, leaving much of the soil bare and subject to erosion. The Norway maple is no longer recommended for planting, but a large demand still exists and it continues to be used on a widespread basis (Andropogon Associates, 1991).

In forested areas, trees such as Norway maple (*Acer platanoides*) grow into the canopy, as do vines like Japanese honeysuckle (*Lonicera japonica*), where they shade out or topple trees. In wetlands in the northern third of the United States and southern Canada, purple loosestrife (*Lythrum salicaria*) forms large, dense strands, eliminating the open water areas that waterfowl require and elsewhere displacing native plants that feed and shelter wildlife.

Invasive and exotic species are a major environmental threat to many naturally vegetated regions. Many natural lands, which are becoming more frequently disturbed and fragmented, are increasingly susceptible to invasive and exotic species. When introduced to a new region, invasive vegetation spreads rapidly, overtaking the native species. The introduction of just a few invasive species is sufficient to severely limit the diversity of a natural system, especially if that system is also stressed by other environmental factors. Limiting vegetative diversity ultimately limits wildlife diversity, as birds and animals require different vegetative species for cover and food (Andropogon Associates, 1991).

TABLE 5-2. SOME INVASIVE EXOTIC SPECIES FOUND IN THE LEHIGH RIVER WATERSHED

Common Name	***Scientific Name***
TREES	
Norway Maple	*Acer platanides*
Norway Spruce	*Picea glauca*
Russian Olive	*Eleangnus angustifolia*
Autumn Olive	*Eleangnus umbellatus*
SHRUBS AND SMALL TREES	
Tartarian Honeysuckle	*Lonicera tatarica*
Multiflora Rose	*Rosa multiflora*
VINES	
Japanese Honeysuckle	*Lonicera japonica*
HERBACEOUS PLANTS	
Purple Loosestrife	*Lythrum salicaria*
Japanese Knotweed	*Polygonum cuspidatum*
Canada Thistle	*Cirsium altissimum*
Timothy grass	*Phleum pratense*
Crabgrasses	*Digitaria sanguinalis*
Quackgrass	*Elytrigia repens*
Garlic Mustard	*Alliaria petiolata*

Invasive species have been and are abundantly and widely distributed as quick solutions to erosion problems. These invasive exotics have shallow root systems that spread quickly to provide ground cover for bare slopes. However, these roots do not effectively stabilize soil, streambanks or road cuts that, instead, continue to erode (Andropogon Associates, 1991).

Exotic species threaten the ecology of naturally vegetated areas, as they do not provide proper food and habitat for native wildlife. For example, if an aquatic macro-invertebrate did not evolve feeding on Norway maple, it will not be edible to that species now. Therefore, that macro-invertebrate species may relocate or be wiped out of the stream entirely, if it cannot find the feeding material on which it evolved eating. Since macro-invertebrates, diatoms and other microorganisms are basic building blocks in the food chain, a loss of them could disrupt the ecology within the riparian habitat.

Invasive species are a severe problem because there are no means of effectively controlling their spread. Many invasive species are spread very rapidly over great distances by animal and bird dispersal. The only means of control is to eliminate as many existing plants as possible and restrict planting of new species (Andropogon Associates, 1991). No species that is proven to be or even suspected of being a successful invader should be planted.

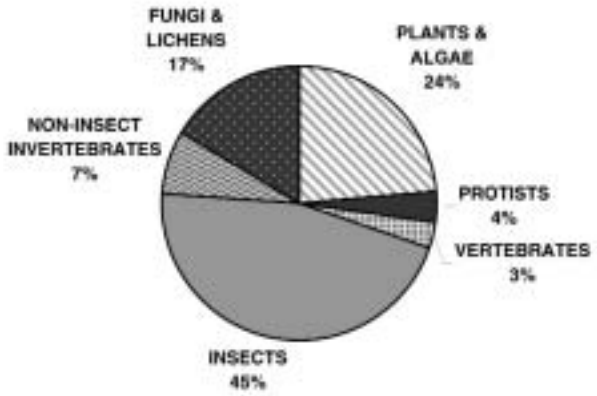
2. FAUNA

The fauna in the watershed is diverse and includes invertebrates, fish, amphibians, reptiles, birds, and mammals. Threats to watershed fauna include land use changes, deforestation, water pollution, introduction of nonnative species, fragmentation and or loss of habitat, and changes in vegetation due to overpopulation of species, such as the white-tailed deer.

a. Invertebrates

Invertebrates are present in every conceivable biotic habitat, and in most ecosystems, they constitute the groups with greatest species richness. Invertebrates are ecologically involved with virtually every biotic process occurring in natural communities, from pollination, herbivory, and predation to soil formation, disease transmission, nutrient cycling and decomposition to name only a few.

FIGURE 5-2. PENNSYLVANIA BIODIVERSITY, ESTIMATED SPECIES RICHNESS OF MAJOR GROUPS (Based on the 21,884 known species in Pennsylvania)



Invertebrates comprise the large majority of Pennsylvania's animals. It's been estimated that when all the sponges, planaria, snails, spiders, millipedes, moths, beetles and other insects are added, the total would be a staggering 15,000+ species--or roughly 70 % of all Pennsylvania's flora and fauna. Unfortunately, little is known about this large group.

The great diversity of invertebrates, especially insects, in natural systems makes their abundance or absence a powerful indicator of more than just the composition of biological communities, but also provides information on structural aspects of those systems (especially trophic relationships) and on the viability of processes influencing their

integrity and stability over time (Kim 1993, New 1993). Invertebrates as a group are the dominant element of biodiversity in natural systems, second only to plants in biomass and unsurpassed in terms of the nature and number of their ecological associations and interactions (Wilson 1987).

1. Status of Invertebrates

As shown in Figure 5-2, the total number of species of organisms in Pennsylvania is estimated to be 21,884, of which 11,702 (53.2%) are invertebrates, 5,143 (23.5%) are plants (including algae), 3,619 (16.5%) are fungi and lichens, and 710 (3.2%) are vertebrates. Insects constitute 46% of total biodiversity in the state, and at least 80% of those are terrestrial.

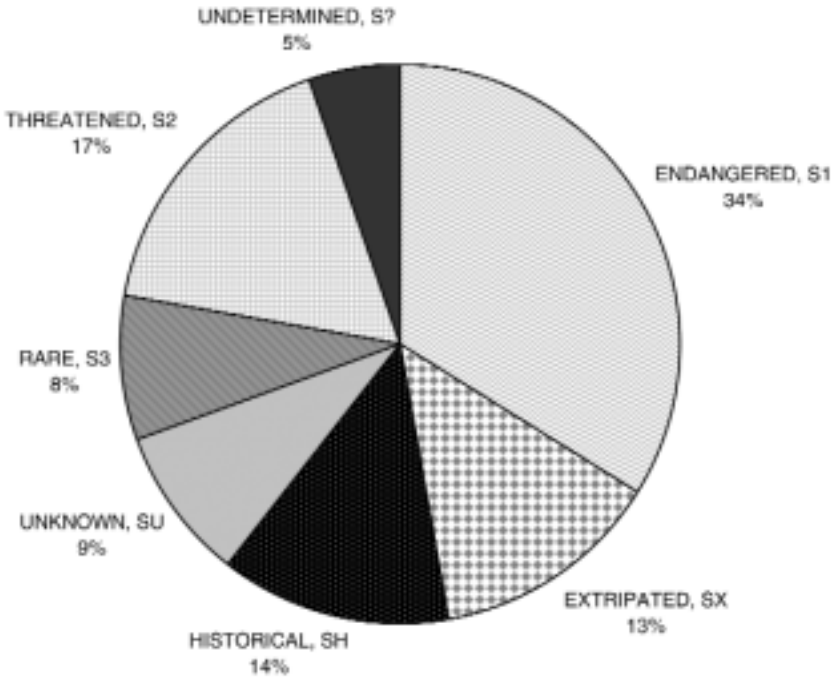
Aside from their sheer numbers, these invertebrate are a key foundation block upon which all ecological systems depend. Hundreds of different birds and mammals, for example, depend upon invertebrate populations as food sources, and many of the higher plants rely on invertebrate pollinators and seed dispersers. Yet with all of this tremendous--in fact, critical--importance, there is one animal in particular that has yet to fully appreciate invertebrates--people.

Current information regarding the conservation status of only a few invertebrate species is known, and those are limited almost entirely to aquatic groups of insects and mollusks. Modern surveys have been conducted in all drainage basins by the Academy of Natural Sciences in Philadelphia (ANSP) and the Western Pennsylvania Conservancy (WPC) in collaboration with the Carnegie Museum of Natural History (CMNH) and in conjunction with the Pennsylvania Fish and Boat Commission and the U.S. Fish and Wildlife Service (Bier 1994).

The only serious baseline inventories of insects to date for the entire state concentrate on aquatic lineages. Dragonflies and damselflies (Odonata) are relatively well known (170 species). Baseline inventories have been completed for other orders of aquatic insects, supported by the Pennsylvania Wild Resource Conservation Fund and Pennsylvania Fish and Boat Commission. These include 312 species of Trichoptera (caddisflies) and 136 species of Plecoptera (stoneflies) and a thorough treatment of Simuliidae (black flies). No terrestrial lineage of invertebrates in Pennsylvania has been adequately inventoried, including conspicuous lineages such as butterflies, tiger beetles, large moths, land snails, and spiders. Knowledge for some large groups is especially weak, and novices soon learn that even species-level identification is a major undertaking. Butterflies (*Lepidoptera: Papilionoidea*) and skippers (*Lepidoptera: Hesperioidea*) have never been thoroughly surveyed across the state. The Nature Conservancy (TNC) has been monitoring and protecting the critically imperiled regal fritillary butterfly (*Speyeria idali*a), and both TNC and WPC have investigated populations of other butterflies of special concern. Land snails (Mollusca: Gastropoda) remain unstudied except for county records recorded in Hubricht (1985). Spiders (Arachnida: Araneae) are virtually unknown outside collections and systematic revisions.

The nocturnal Macrolepidoptera ("larger moths") have been studied extensively in recent years by workers at CMNH, WPC, and TNC (Rawlins et al. 1997), but no general publication is available. Not a single family in the largest order of living invertebrates, the beetles (Coleoptera), has been thoroughly reviewed for Pennsylvania in recent decades. Coleopterists at CMNH have been studying several large families of ecological importance in Pennsylvania (e.g., ground beetles [Carabidae], carrion beetles [Silphidae], long horned beetles [Cerambycidae] and others), but no formal survey or inventory has been initiated. As for smaller orders of insects and minor lineages of arachnids (daddy longlegs, ticks and mites) and myriapods (centipedes and millipedes), the level of knowledge is quite low.

FIGURE 5-3. CONSERVATION STATUS OF PENNSYLVANIA INVERTEBRATES OF SPECIAL CONCERN (Adapted from PNDI, based on 282 species of special concern as of July 1998.)



The Pennsylvania Natural Diversity Inventory (PNDI) currently recognizes 282 species of invertebrates of real or potential special concern for conservation, only 2.4% of the estimated number of invertebrate species. PNDI recognition of these taxa is unofficial, and only two freshwater mussels are formally listed as Endangered for Pennsylvania. Of species on the PNDI list, 13.1% are thought to be extirpated from the state and an additional 13.5% are known from historical records only (see Figure 5-3). The Pennsylvania Biological Survey (PABS) Invertebrate Technical Committee concludes that: (1) little is known about Pennsylvania invertebrates and (2) invertebrates are poorly protected with respect to informed awareness of their conservation status. No Pennsylvania invertebrate is thought to be extinct globally, but so little is known about factors necessary to interpret occurrence data that few conclusions can be made with confidence (PABS). These factors include information on species ranges; data on habitat requirements and restrictions, especially those involving unusual or limiting habitats such as barrens, wetlands, viable watercourses, and caves; and information on obligatory ecological associations (food plants, pollinators, hosts for parasitoids, and fungal associates to name just a few). The invertebrates of special concern in the watershed are shown in Table 5-3.

2. Exotic Invertebrates

An increasing number of non-native invertebrates have been recorded in Pennsylvania, formally registered in the recently established North American Non-Indigenous Arthropod Database (NANIAD) developed at The Pennsylvania State University and soon to appear on the World Wide Web through the United States Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine (USDA/APHIS/PPQ). In August 1998, NANIAD listed 2,419 species of non-indigenous arthropods as having been reported from the United States, of which 152 species were cited specifically for Pennsylvania, and a few others listed only from the general region including Pennsylvania. Many European insects have long been known to have populations in Pennsylvania, but others are just being documented (i.e., *Idaea dimidiata*, Geometridae, was just noted in Rawlins et al., 1998). With more than a third of the vascular plants in Pennsylvania being alien, it is not surprising that many exotic insects in the state are herbivores or graminivores feeding on an introduced plant, e.g., *Calophasia lunula* (Noctuidae) feeding on *Linaria biennis* (Scrophulariaceae), and *Harpalus (Ophonus) puncticeps* (Carabidae) on seeds of *Daucus carota* (Apiaceae).

TABLE 5-3. INVERTEBRATES OF SPECIAL CONCERN IN THE LEHIGH RIVER WATERSHED
Source: (PNDI, 1998; William Gleason, County Natural Heritage Inventory Ecologist PA Science Office, The Nature Conservancy, 2003)

Scientific Name	Common Name	State Rank	Global Rank	Date Last Observed
Aeshna clepsydra	Spotted Blue Darner	S2S3	G4	1985
Amblyscirtes vialis	Roadside Skipper	S?	G5	1970 (H)
Apamea cristata	A Noctuid Moth	SU	G4	1985
Apharetra purpurea	A Noctuid Moth	S2	G4	1987
Aplectoides condita	A Noctuid Moth	S2S3	G4	1985
Atrytonopsis hianna	Dusted Skipper	S3	G4G5	1965 (H)
Chaetaglaea cerata	A Sallow Moth	S1	G3G4	1985
Chlosyne harrisii	Harris' Checherspot	S3	G4	1971(H)
Cuscuta cephalanthi	Button-Bush Dodder	SU	G5	
Dorocordulia lepida	Elegant Skimmer	S2	G5	1989
Enallagma boreale	Boreal Bluet	S2	G5	1979 (H)
Epiglaea apiata	Pointed Sallow	S3S4	G5	1991
Epirrita autumnata henshawi	November Moth	SU	G5T5	1985
Erynnis martialis	Mottled Duskywing	S1S2	G3G4	1971 (H)
Erynnis persius persius	Persius Duskywing	S1S2	G5T2T3	1971 (H)
Euphyes conspicuus	Black Dash	S3	G4	2001
Glena cognataria	Blueberry Gray	S1	G4	1985
Hemileuca maia	Barrens Buckmoth	S1S2	G5	1991
Hemipachnobia monochromatea	Sundew Cutworm Moth	S2S3	G4	
Hesperia metea	Cobweb Skipper	S2S3	G4G5	1965 (H)
Incisalia henrici	Henry's Elfin	S2S3	G5	1970 (H)
Incisalia henrici	Hoary Elfin	S1	G5	1970 (H)
Itame sp. 1	Barrens Itame	S1	G3	1987
Lasius minutis	An Ant	S?	G?	1997
Lithomoia solidaginis germana	A Moth	S3S4	G5T5	1991
Lycaena epixanthe	Bog Copper	S2	G4G5	2000
Lycia rachelae	Twilight Moth	S1	G4	1986
Metaxaglaea semitaria	Footpath Sallow Moth	S2	G5	1991
Papaipema sp. 1	Flypoison Borer Moth	S2	G2G3	2000
Polygonia progne	Gray Comma	SU	G5	1970 (H)
Psectraglaea carnosa	Pink Sallow	S1	G3	1999
Speyeria idalia	Regal Fritillary	S1	G3	1973 (H)
Zale curema	A Zale Moth	S1	G3G4	1985
Zale sp. 1	Pine Barrens Zale	S1	G3Q	1988
Zale submediana	A Zale Moth	S2	G4	1985
Zanclognatha martha	Pine Barrens Zanclognatha	S1S2	G4	1987

H = HISTORIC

Some additional exotic species are expected in Pennsylvania as they are known to be established elsewhere in North America (e.g., European *Noctua pronuba* [Noctuidae] gradually expanded its range southward from Canada [Passoa and Hollingsworth 1996], and was just recently established across Pennsylvania).

Several exotic species have become serious pests. Forests in the watershed have been barraged with a host of non-native insect outbreaks that constantly threaten the structure and health of our forests. The Hemlock wooly adelgid has caused severe dieback in many of the infested trees and the full impact is still unknown. Pennsylvania Bureau of forestry biologists are experimenting with releasing a non-native ladybug that feeds on the adelgid. Gypsy moths, found in the watershed, prefer oaks but feed on a wide array of trees and shrubs. Gypsy moth outbreaks can have short-term impacts on forest wildlife. For forest canopy nesting birds, the loss of cover can allow an increase in predation and nest parasitism. Small mammals have been known to feed on gypsy moth caterpillars, and other species may also take advantage of the food source. However, the defoliation can be severe and cause tree mortality. Suppression programs using an introduced fungus have helped limit tree mortality.

Some exotic species are considered beneficial (e.g., honey bees) and several were intentionally introduced for biocontrol of weeds and pest insects. As baseline inventories increase in rigor and taxonomic breadth, it is expected that viable populations of many additional alien species of invertebrates will be discovered in Pennsylvania.

b. Fish

Pennsylvania supports a diverse assemblage of fishes. Denoncourt (1975) and Cooper (1983) identified 27 and 24 families of fish, respectively, which represented nearly 160 species. More recent collections (e.g., by Jay Stauffer and by the Pennsylvania Fish and Boat Commission) indicate that there may be as many as 194 species representing approximately 40 families. This large increase is due primarily to the addition of many estuarine fishes that are known to occur in the Delaware River, an increased sampling effort among research scientists and fishery biologists and improvements in sampling equipment.

Indications are that there may be as many as 194 species representing approximately 40 families of fish in Pennsylvania. These trout are not among the 30% of the state's fishes which are of special concern.

The physiography and geology of six major drainages contribute to Pennsylvania's relatively high fish diversity. These drainages are the Delaware, Potomac, and Susquehanna (Atlantic Slope), Ohio (Mississippi Valley), and Erie and Genesee (Great Lakes). Historically, advancing glaciers influenced the dispersion and range of many species. Today, each drainage supports a distinctive species assemblage that is separated or influenced by the Appalachian Mountains.

1. Status of Fish

Approximately 30% of Pennsylvania's fishes are of special concern (Figure 5-4). Among the 194 species found in the state, the following 11 species are listed as State Endangered: brook lamprey, shortnose sturgeon, lake sturgeon, gravel chub, ironcolor shiner, longnose sucker, spotted darter, eastern sand darter, tippecanoe darter, longhead darter, and checkered sculpin. The tippecanoe darter and ironcolor shiner are the most recent additions to this list. Another nine are listed as State Threatened: Ohio lamprey, mountain brook lamprey, Atlantic sturgeon, mountain madtom, northern madtom, burbot, bluebreast darter, channel darter, and gilt darter. The shovelnose sturgeon, blacknose shiner, northern redbelly dace, bullhead minnow, river carpsucker, highfin carpsucker, lake chubsucker, longjaw cisco, lake herring, deepwater sculpin, mud sunfish, blackbanded sunfish, swamp darter, sharpnose darter, and blue pike are thought to be extirpated, bringing the potential species richness of the state to 209. Only the shortnose sturgeon is listed as Endangered under the Federal Endangered Species Act.

Table 5-4 lists the fish species in the Lehigh River watershed. In the Lehigh River, smallmouth and largemouth bass are well established in the lower stretches of the river. Other species in the river, as recorded by the Pa. Fish and Boat

FIGURE 5-4. STATUS OF PENNSYLVANIA FISHES
(Adapted from PABS)

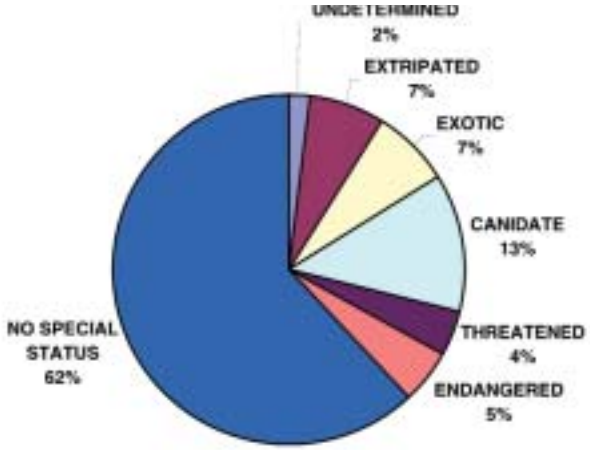


TABLE 5-4 FISH OF THE LEHIGH RIVER WATERSHED
(Data Source: Pennsylvania DCNR, www.dcnr.state.pa.us/pabs/fish; David Arnold, Pennsylvania Fish and Boat Commission, personal correspondence, 2003)

Family	*Common Name*	*Scientific Name*	*Status*
lampreys: Family Petromyzontidae	American brook lamprey	*Lampetra appendix*	N
	sea lamprey	*Petromyzon marinus*	N
eel: Family Anguillidae	American eel	*Anguilla rostrata*	N
herrings: Family Clupeidae	blueback herring	*Alosa aestivalis*	N
herrings: Family Clupeidae	alewife	*Alosa pseudoharengus*	N
	American shad	*Alosa sapidissima*	N
	gizzard shad	*Dorosoma cepedianum*	N
anchovies: Family Engraulidae	bay anchovy	*Anchoa mitchilli*	N
minnows: Family Cyprinidae	goldfish	*Carassius auratus*	I
	satinfin shiner	*Cyprinella analostanus*	N
	spotfin shiner	*Cyprinella spiloptera*	N
	common carp	*Cyprinus carpio*	I
	cutlips minnow	*Exoglossum maxillingua*	N
	common shiner	*Luxilus cornutus*	N
	pearl dace	*Margariscus margarita*	N
	hornyhead chub	*Nocomis biguttatus*	PC
	golden shiner	*Notemigonus crysoleucas*	N,I
minnows: Family Cyprinidae	spottail shiner	*Notropis hudsonius*	N
	swallowtail shiner	*Notropis procne*	N
	bluntnose minnow	*Pimephales notatus*	N
	blacknose dace	*Rhinichthys atratulus*	N
	longnose dace	*Rhinichthys cataractae*	N
	creek chub	*Semotilus atromaculatus*	N
	fallfish	Semotilus corporalis	N

Notes: *Fish Status*
N*-no special status* ***U****-undetermined* ***RE****-Recently extinct in PA* ***PE****-PA endangered*
PT*-PA threatened* ***PC****-Pennsylvania candidate* ***LE****-Federally endangered* ***I****-Introduced to non-native drainage*

continued on next page

TABLE 5-4 FISH OF THE LEHIGH RIVER WATERSHED (continued)

Family	Common Name	Scientific Name	Status
suckers: Family Catostomidae	quillback	*Carpiodes cyprinus*	N
	white sucker	*Catostomus commersoni*	N
	creek chubsucker	*Erimyzon oblongus*	N
catfishes: Family Ictaluridae	white catfish	*Ameirus catus*	N
	yellow bullhead	*Ameirus natalis*	N
	brown bullhead	*Ameirus nebulosus*	N
	channel catfish	*Ictalurus punctatus*	N
	stonecat	*Noturus flavus*	N
	margined madtom	*Noturus insignis*	N
pikes: Family Esocidae	redfin pickerel	*Esox americanus americanus*	N
	muskellunge	*Esox masquinongy*	N,I
	tiger muskellunge	*Esox masquinongy X Esox lucius*	I
	chain pickerel	*Esox niger*	N
smelt: Family Asmeridae	rainbow smelt	*Osmerus mordax*	N,I
trout: Family Salmonidae	kokanee, sockeye salmon	*Oncorhynchus nerka*	I
	rainbow trout	*Oncorhynchus mykiss*	I
	brown trout	*Salmo trutta*	I
	brook trout	*Salvelinus fontinalis*	N,I
	tiger trout	*Salmo trutta X Salvelinus fontinalis*	I
	lake trout	*Salvelinus namaycush*	I
killifishes: Family Cyprinodontidae	banded killifish	*Fundulus diaphanus*	N
sticklebacks: Family Gasterosteidae	fourspine stickleback	*Apeltes quadracus*	N
	threespine stickleback	*Gasterosteus aculeatus*	N
sculpins: Family Cottidae	slimy sculpin	*Cottus cognatus*	N
	mottled sculpin	*Cottus bairdi*	
temperate basses: Family Percichthydae	striped bass	*Morone saxatilis*	N,I
	striped bass hybrid		I
sunfishes: Family Centrarchidae	rock bass	*Ambloplites rupestris*	N
	bluespotted sunfish	*Enneacanthus gloriosus*	N
	redbreast sunfish	*Lepomis auritus*	
	green sunfish	*Lepomis cyanellus*	N
	pumpkinseed	*Lepomis gibbosus*	N
	bluegill	*Lepomis macrochirus*	N
	smallmouth bass	*Micropterus dolomieu*	N
	largemouth bass	*Micropterus salmoides*	N
	black crappie	*Pomoxis nigromaculatus*	N,I
perches: Family Percidae	greenside darter	*Etheostoma blenniodes*	
	tessellated darter	*Etheostoma olmstedi*	N
	yellow perch	*Perca flavescens*	N
	shield darter	*Percina peltata*	N
	walleye	*Stizostedion vitreum vitreum*	N

Notes: *Fish Status*

N*-no special status* ***U****-undetermined* ***RE****-Recently extinct in PA* ***PE****-PA endangered*
PT*-PA threatened* ***PC****-Pennsylvania candidate* ***LE****-Federally endangered* ***I****-Introduced to non-native drainage*

Commission, include brown and brook trout, chain pickerel, rock bass, bluegills, crappie, fallfish, darters, suckers, eels, bullheads, and some types of shiners and dace. In addition, muskellunge, which are stocked in the river below Bethlehem, are doing well. Attempts to bring shad back to the river are discussed below.

2. Exotic Fish

When discussing the number of exotic fish species in Pennsylvania, it is useful to analyze the state by drainage basin. For example, a species of fish native to the Susquehanna River basin that is moved to the Allegheny River basin is considered an exotic in the Allegheny River basin. Some exotic species of fish were purposely introduced, including Pacific salmon, rainbow trout, brown trout, Amur pike, goldfish, redear sunfish, and common carp. Other exotics were introduced accidentally or illegally. According to the Pennsylvania Biological Survey's Fish Technical Committee, there are 102 species of fish in the Delaware River basin, of which 18 are introduced species. Of the six Pennsylvania drainage basins, the Delaware is second only to the Susquehanna (with 22 species) in the number of introduced fishes.

3. Shad in the Lehigh River

The American shad, or Alosa sapidissima (which means "most delicious shad') have been an important resource for the inhabitants of the watershed. These shad ladders now make it possible for the anadromous shad to reach their breeding grounds upriver.

White Shad, or Alosa sapidissima meaning most delicious shad, have traditionally been an important resource to the inhabitants of the Lehigh River watershed. Shad and their roe have been considered a delicacy for all of the Lehigh Valley's historical inhabitants. The shad's life cycle is the primary reason the fish have become a valuable asset to the Lehigh Valley. As anadromous fish, shad live in oceans but migrate into freshwater to spawn. During spring, shad fry hatch from eggs in rivers. In the fall, young fish migrate down rivers to join oceanic populations that head south for the winter. The following spring the schools of fish migrate back north and the sexually mature individuals return to their rivers of origin to spawn. Most shad die following the spawn but some do survive to spawn again. The migrations of shad into rivers present an opportunity for humans and wildlife to harvest massive some of these fish.

The Lehigh Valley's first residents, the Lenni-Lenape, were dependent on the Lehigh's seemingly limitless supply of shad. The Lenni-Lenape perfected shad harvest with the use of large v-shaped rock dams that acted as a funnel. The dams were constructed with an opening in the middle covered by a net into which the Lenni-Lenape herded schools potentially containing thousands of shad. Learning fishing techniques from the Lenni-Lenape, shad also became a primary food source for the Lehigh Valley's European settlers. The dangerous job of Lehigh River shad fishing and distribution for the community became the duty of a group of adventurous young men called "The Single Brethren's Choir." Their records are important today for use in studying the historical fish populations.

The pinnacle of the Lehigh River's use as a shad fishery was the 1770s when a record 5,300 shad were caught in a day by the Single Brethren's Choir. Not long afterwards, industrialization at the beginning of the nineteenth century began to decimate the once seemingly innumerable shad. The shad population that appeared impervious to heavy commercial fishing for years could not withstand the sewage, factory, tannery, and slaughterhouse wastes; coal silt, sawdust, acid mine drainage, sedimentation, and a variety of other by-products of industrialization. Vital stream habitat was removed when the Lehigh was channelized to accommodate barges transporting coal. As a result, shad populations declined steadily until 1829 when shad were completely isolated from the Lehigh River. Construction of a dam at the river's confluence with the Delaware River controlled water levels for the Lehigh Canal, but it also completely blocked shad migrations. Eventually the Delaware River became so polluted that, by 1953, no shad were caught by commercial fishing corporations out of Lambertville, New Jersey. So much sewage and organic waste entered the Delaware River that nearly sixty miles of water around Philadelphia, Camden, and Wilmington had depleted levels of dissolved oxygen to the point that shad could not pass through without suffocating. The tragic loss of shad and other wildlife was not unique to the Lehigh River; the Schuylkill, Susquehanna, Hudson, and Connecticut Rivers experienced the same fate.

The beginning of shad restoration in the Delaware and Lehigh Rivers came from an unexpected source. In 1955, Hurricanes Connie and Diane caused massive flooding in the Delaware Valley. While the hurricanes caused tragic fatalities and property loss, it washed away years of accumulated pollutants from the Delaware River and its tributaries. In the early 1960s, reports of fisherman catching shad from the Delaware River sparked a great deal of interest from sportsmen, biologists, and commercial fisherman. Although shad made a strong comeback in the early sixties, shad runs varied greatly from year to year. When pollution levels drove dissolved oxygen below 4 mg/l, the river yielded practically no shad. One shad run however was estimated to contain up to 500,000 individuals. Finally, the Clean Water Act in 1970 required most cities within the Delaware River watershed to upgrade their sewage treatment facilities. The EPA increased policing of factory discharge. The result was a stable population of shad returning to the Delaware River yearly. Since then the shad population has increased steadily. By the 1990's, the Delaware River's shad population was estimated at nearly one million individuals. The final major victory for Delaware River Shad was when the United States Congress officially blocked an Army Corps of Engineers plan to construct a dam on the Delaware near Shawnee Pennsylvania in 1992. While the dam would have provided flood control, recreation, and drinking water, it would have had detrimental environmental effects including excluding shad from nearly 100 miles of historic spawning grounds.

Despite the Delaware's tremendous rejuvenation in the 1970s, its second largest tributary, the Lehigh River, was still without its historic shad run. The success realized in reestablishing shad into the Delaware prompted the Pennsylvania Fish Commission to begin a study in 1973 to see if the Lehigh River was capable of supporting shad reproduction. Shad eggs planted in the upper Lehigh showed high survival rates. It was concluded however that even if shad hatched from the river, they would not return into the Lehigh because water quality at its confluence with the Delaware was poor. The collapse of the steel and zinc industries along the Lehigh in the 1980s brought a dramatic improvement to the Lehigh River's water quality. Consequently, there was renewed interest in shad restoration. Local sportsmen and conservation organizations began an effort to restock shad within the Lehigh. After several failed efforts, juvenile shad attempting to return to the ocean were caught for the first time in decades from the Lehigh River near Bethlehem. Although the Lehigh River was now "clean enough," shad restoration was still impossible because there was no way for shad to enter the Lehigh River. Their passage was still blocked by the now obsolete canal dam. In 1984, a bill was introduced to the Pennsylvania Legislature to assign 3.3 million dollars for construction of fish passageways at the dams blocking the Lehigh's mouth and several miles upstream. Unfortunately, the bill that easily passed through Pennsylvania's Legislature died at the desk of the governor. In 1985 an economic study was released that theorized a shad fishery on the Lehigh similar to the Delaware's would bring about 2.1 million dollars annually to local business. In addition, a petition of nearly 40,000 signatures from across the state in support of the fish passages was delivered to Governor Casey. The following year Casey announced approval for the project. The completion of the fish passage in 1993 finally allowed shad and other fishes access to waters unused for decades.

TABLE 5-5. SHAD PASSAGE MONITORED AT EASTON AND ALLENTOWN DAMS

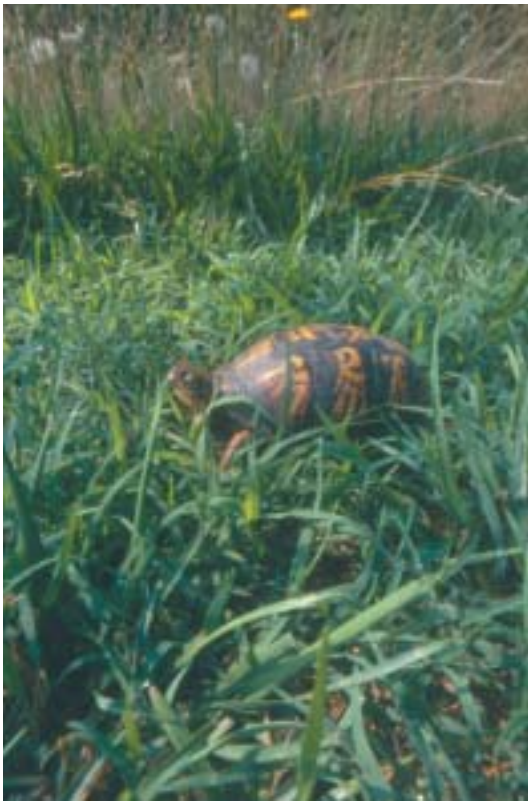
Year	*Allentown Dam*	*Easton Dam*
2002	1479	3314
2001	2057	4740
2000	508	2060
1999	479	2346
1998	694	3293
1997	126	1428
1996	496	1141
1995	873	N/A
1994	87	N/A

Shad have not only regained access to their native waters in the Lehigh Valley (see Table 5-5), but have also been reassimilated into

the culture of its residents. With a meager passage of 87 shad in its first year of use, the Lehigh's shad population has grown tremendously. Shad that make their yearly run into the Delaware and Lehigh Rivers are important to fisherman both as sport and commercially. They are also an important part of the river ecosystem. Many people actually go to the fish passage at Easton in the spring to view their yearly migration.

c. Reptiles and Amphibians

Amphibians and reptiles, (collectively called *herpetofauna*, or *herps*) are excellent indicators of stream and watershed health. Because many of these animals live part of their lives in water and part on land, their survival depends not only on water quality but also on the physical make-up of both environments.



Herps are excellent indicators of stream and watershed health.

1. Status of Reptiles and Amphibians

Pennsylvania possesses a diverse assemblage of amphibians and reptiles, including 4 orders, 17 families, 44 genera, and 74 species. Thirty-six species of amphibians are native, including 14 frogs and toads, and 22 salamanders. Pennsylvania is home to 38 species of reptiles: 13 turtles, 4 lizards, and 21 snakes. The varied physiography and presence of three major drainage systems contribute greatly to the diversity of Pennsylvania's herpetofauna.

Twenty-two percent of the species of amphibians and reptiles native to Pennsylvania are of special concern or have been extirpated from the state. The recently completed initial phase study by Ruhe et al (2004), found that based on observations and collections, almost half of all amphibian and reptile species in the Lower Lehigh River watershed are at critical levels of population occurrence and distribution. Of the Pennsylvania threatened and endangered species, the bog turtle (*Glyptemy muhlenbergi*), listed as "Endangered", is the only one that is known to have been observed in the watershed area; the bog turtle is also listed as "Threatened" under the Federal Endangered Species Act. In addition, the timber rattlesnake (Crotalus horridus) has candidate status for state listing as a "species of Concern." Amphibians and reptiles observed in the Lehigh River watershed are included in Table 5-6.

2. Exotic Reptiles and Amphibians

Primarily due to its temperate climate, Pennsylvania is home to few exotic species of amphibians and reptiles. Most species that would likely be introduced into the state either accidentally or intentionally would come from the pet trade. The vast majority of species in this trade are tropical or semi-tropical and cannot survive the harsh winter climate of Pennsylvania. For example, there have been numerous reports of alligators within Pennsylvania waters. Although some individuals might be able to survive for more than a year, the climate precludes the possibility of successful reproduction.

The red-eared slider (*Pseudemys scripta elegans*) has recently been reported in Lehigh County where numerous individuals of different sizes have been observed. At this time, it is not known if it is a breeding population or simply a group of individuals released over a period of several years. The red-eared slider has established successful introduced populations throughout most

TABLE 5-6. HERPETOFAUNA OF THE LEHIGH RIVER WATERSHED
Source: PNDI; Brandon Ruhe, personal communication, 2003)

CLASS AMPHIBIA	*Common Name*	*Scientific Name*
Order Caudata: Salamanders		
Family Ambystomatidae: Mole Salamanders	Jefferson Salamander	*Ambystoma jeffersonianum*
	Spotted Salamander	*Ambystoma maculatum*
	Marbled Salamander	*Ambystoma opacum*
Family Plethodontidae: Lungless Salamanders	Northern Dusky Salamander	*Desmognathus fuscus*
	Allegheny Dusky Salamander	*Desmognathus ochrophaeus*
	Northern Two-lined Salamander	*Eurycea bislineata*
	Longtail Salamander	*Eurycea l. longicauda*
	Northern Spring Salamander	*Gyrinophilus p. porphyriticus*
	Northern Redback Salamander	*Plethodon cinereus*
	Northern Slimy Salamander	*Plethodon glutinosus*
	Northern Red Salamander	*Pseudotriton r. ruber*
Family Salamandridae: Newts	Red-Spotted Newt	*Notophthalmus v. viridescens*
Order Anura: Frogs and Toads		
Family Bufonidae: True Toads	Eastern American Toad	*Bufo a. americanus*
	Fowler's Toad	*Bufo fowleri*
Family Ranidae: True Frogs	Wood Frog	*Rana sylvatica*
	Pickerel Frog	*Rana palustris*
	Northern Leopard Frog	*Rana pipiens*
	Bullfrog	*Rana catesbeiana*
	Green Frog	*Rana clamitans melanota*
Family Hylidae: Treefrogs, Chorus Frogs and Cricket Frogs	Northern Spring Peeper	*Pseudacris c. crucifer*
	Gray Treefrog	*Hyla versicolor*
	Northern Cricket Frog	*Acris c. crepitans*
CLASS REPTILIA		
Order Lacertilia: Lizards		
Family Scincidae: Skinks	Five-lined Skink	*Eumeces fasciatus*
Order Serpentes: Snakes		
Family Colubridae: Harmless Snakes	Northern Black Racer	*Coluber c. constrictor*
	Northern Ringneck Snake	*Diadophis punctatus edwardsii*
	Eastern Rat Snake	*Panthanophis alleghaniensis*
	Eastern Milk Snake	*Lampropeltis t. triangulum*
	Northern Water Snake	*Nerodia s. sipedon*
	Northern Brown Snake	*Storeria d. dekayi*
	Northern Redbelly Snake	*Storeria o. occipitomaculata*
	Eastern Garter Snake	*Thamnophis s. sirtalis*
Family Viperidae: Pit Vipers	Northern Copperhead	*Agkistrodon contortrix mokasen*
	Timber Rattlesnake	*Crotalus horridus*
CLASS CHELONIA		
Order Cryptodeira: Turtles		
Family Chelydridae: Snapping Turtles	Common Snapping Turtle	*Chelydra s. serpentina*
Family Emydidae: Water and Box Turtles	Midland Painted Turtle	*Chrsyemys picta marginata*
	Eastern Painted Turtle	*Chrysemys picta picta*
	Spotted Turtle	*Clemmys guttata*
	Wood Turtle	*Glyptemys insculpta*
	Bog Turtle	*Glyptemys muhlenbergii*
	Eastern Box Turtle	*Terrapene c. carolina*

of Maryland west of the Chesapeake Bay and east of the Allegheny Mountains (Conant and Collins 1991). Climatic conditions are not greatly different in southeastern Pennsylvania, so it is likely that the Lehigh County population is reproductive. In 1997, several volunteers for the Pennsylvania Herpetological Atlas Project reported observing red-eared sliders from several locations (i.e., Northampton, Crawford, and Philadelphia Counties).

Several species that are native to Pennsylvania have been moved to areas of the state where they did not naturally occur. These species that have been introduced to regions outside of their natural range can be considered exotic, but only in the regions where they have been introduced.

d. Birds

Since the advent of the *Peterson Field Guide to the Birds* in 1932, birdwatching has grown as a popular avocation across a broad spectrum of American society. As a result, public participation in the study of birds is enthusiastic and considerable. Volunteers are critical to the success of bird inventory and monitoring efforts.

The common presence of the great blue heron in the Lehigh River watershed indicates a relatively healthy habitat.

Many bird observers who engage in friendly competition to find rare birds have increased our understanding of Pennsylvania's bird diversity. The great dispersal ability of birds provides many opportunities to observe species that are peripheral to the state or visit it only occasionally. The taxonomy also has changed, adding species formerly considered subspecies. The American Ornithological Union (AOU) has split several species in recent years, adding to the potential state list (AOU, 1997). The Official List of Pennsylvania Birds is maintained by the Pennsylvania Ornithological Records Committee (PORC), a subcommittee of the Pennsylvania Biological Survey's Ornithological Technical Committee (OTC).

1. Status of Birds

Observers have identified 394 wild bird species in Pennsylvania (AOU 1997). This includes 186 species that regularly nest in the state and others that are winter residents, transients, or occasional visitors. At least 20 species have a history of nesting occasionally in the state, but have not been documented nesting in recent years with regularity. The high mobility and resourcefulness of birds make it difficult to make concrete classifications of species.

The PABS's Ornithology Technical Committee (OTC) proposes the list of Endangered and Threatened birds to the Pennsylvania Game Commission (PGC), and the OTC and PGC list only species that breed regularly in the state. As of December 1997, the OTC has proposed 11 species as Endangered in the state: American bittern, least bittern, great egret, yellow-crowned night heron, bald eagle, peregrine falcon, king rail, common tern, black tern, short-eared owl, and loggerhead shrike. Of these, the American bittern, least bittern, yellow-crowned night heron, peregrine falcon, and the bald eagle have been documented in the Lehigh River watershed area. Another five species are proposed as Threatened in Pennsylvania: osprey, upland sandpiper, yellow-bellied flycatcher, sedge wren, and dickcissel. Of these, the osprey and sedge wren have

TABLE 5-7 BIRDS OF THE LEHIGH RIVER WATERSHED (Saenger, Malt, and Crilley, 2002)

Family	Common Name	Scientific Name	Status	Special Concern Code
LOONS: FAMILY GAVIIDAE				
	red-throated loon	*Gavia stellata*	N	
	common loon	*Gavia immer*	N	
GREBES: FAMILY PODICIPEDIDAE				
	pied-billed grebe	*polilymbus podiceps*	B	R
	horned grebe	*Podiceps auritus*	N	
	red-necked grebe	*Podiceps grisegena*	N	
	eared grebe	*Podiceps nigricollis*	N	
CORMORANTS: FAMILY PHALACROCORACIDAE				
	great cormorant	*Phalacrocorax carbo*	A	
	double-crested cormorant	*Phalacrocorax auritus*	I	
HERONS AND BITTERNS: FAMILY ARDEIDAE				
	American bittern	*Botaurus lentiginosus*	B	E
	least bittern	*Ixobrychus exilis*	B	E
	great blue heron	*Ardea herodias*	B	
	great egret	*Ardea alba*	B	E
	snowy egret	*Egretta thula*	B	A
	little blue heron	*Egretta caerulea*	N	
	tricolored heron	*Egretta tricolor*	N	
	cattle egret	*Bubulcus ibis*		I
	green heron	*Butorides virescens*	B	
	black-crowned night-heron	*Nycticorax nycticorax*	B	A
	yellow-crowned night-heron	*Nyctanassa violacea*	B	E
IBISES: FAMILY THRESKIORNITHIDAE				
	glossy ibis	*Plegadis falcinellus*	N	
VULTURES: FAMILY CATHARTIDAE				
	black vulture	*Coragyps atratus*	B	
	turkey vulture	*Cathartes aura*	B	
SWANS: FAMILY CYGNINAE				
	tundra swan	*Cygnus columbianus*	N	
	mute swan	*Cygnus olor*	B	O
GEESE: FAMILY ANSERINAE				
	greater white-fronted goose	*Anser albifrons*	N	
	snow goose	*Chen caerulescens*	N	
	Ross' goose	*Chen rossii*	N	
	brant	*Branta bernicla*	N	
	Canada goose	*Branta canadensis*	B	
MARSH DUCKS: FAMILY ANATINAE				
	wood duck	*Aix sponsa*	B	
	green-winged teal	*Anas crecca*	B	R
	American black duck	*Anas rubripes*	B	
	mallard	*Anas platrhynchos*	B	
	northern pintail	*Anas acuta*	B	
	blue-winged teal	*Anas discors*	B	
	northern shoveler	*Anas clepeata*	N	
	gadwall	*Anas strepera*	N	
	Eurasian wigeon	*Anas penelope*	N	
	American widgeon	*Anas americana*	N	

TABLE 5-7 BIRDS OF THE LEHIGH RIVER WATERSHED (continued)

Family	Common Name	Scientific Name	Status	Special Concern Code
DIVING DUCKS: FAMILY AYTHYINAE				
	canvasback	*Aythya visineria*	N	
	redhead	*Aythya americana*	B	
	ring-necked duck	*Aythya collaris*	N	
	greater scaup	*Aythya marila*	N	
	lesser scaup	*Aythya affinis*	N	
	black scoter	*Melanitta nigra*	N	
	surf scoter	*Melanitta perspicillata*	N	
	white-winged scoter	*Melanitta fusca*	N	
	common goldeneye	*Bucephala clangula*	N	
	bufflehead	*Bucephala albeola*	N	
MERGANSERS: FAMILY MERGINAE				
	hooded merganser	*Lophodytes cucullatus*	B	
	common merganser	*Mergus merganser*	B	
	red-breasted merganser	*Mergus serrator*	N	
STIFFTAILS: FAMILY OXYURINAE				
	ruddy duck	*Oxyura jamaicensis*	B	
OSPREYS: FAMILY PANDIONIDAE				
	osprey	*Pandion haliaetus*	B	T
KITES: FAMILY ELANINAE				
	Mississippi kite	*Ictinia mississippiensis*	A	
HARRIERS: FAMILY CIRCINAE				
	northern harrier	*Circus cyaneus*	B	A
BUTEOS AND EAGLES: FAMILY BUTEONINAE				
	bald eagle	*Haliaeetus leucocephalus*	B	E
	sharp-shinned hawk	*Accipiter striatus*	B	
	Cooper's hawk	*Accipiter cooperii*	B	
	northern goshawk	*Accipiter gentilis*	B	R
	red-shouldered hawk	*Buteo lineatus*	B	
	broad-winged hawk	*Buteo platypterus*	B	
	Swainson's hawk	*Buteo swainsoni*	N	
	red-tailed hawk	*Buteo jamaicensis*	B	
	rough-legged hawk	*Buteo lagopus*	N	
	golden eagle	*Aquila chrysaetos*	N	
FALCONS: FAMILY FALCONINAE				
	American kestrel	*Falco sparverius*	B	
	merlin	*Falco columbarius*	N	
	peregrine falcon	*Falco peregrinus*	B	
	gyrfalcon	*Falco rusticolus*	N	

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Notes:

Status Codes:

***A**-Accidental,* ***B**-Breeding,* ***N**-Non-breeding,* ***X** – Extinct*

Special Concern Codes:

***E**-Endangered,* ***T**-Threatened,* ***A**-Candidate-At Risk,* ***R**-Candidate-Rare,*
***U**-Candidate-Undetermined,* ***X**-Extirpated,* ***O**-Established Exotic.*

TABLE 5-7 BIRDS OF THE LEHIGH RIVER WATERSHED (continued)

Family	Common Name	Scientific Name	Status	Special Concern Code
QUAIL: FAMILY PHASIANIDAE				
	ring-necked pheasant	*Phasianus colchicus*	B	O
	northern bobwhite	*Colinus virginianus*	B	R
GROUSE: FAMILY TETRAONIDAE				
	ruffed grouse	*Bonasa umbellus*	B	
TURKEYS: FAMILY MELEAGRIDADAE				
	wild turkey	*Meleagris gallapavo*	B	
RAILS: FAMILY RALLIDAE				
	yellow rail	*Coturnicops noveboracensis*	A	
	black rail	*Laterallus jamaicensis*	A	
	king rail	*Rallus elegans*	B	E
	Virginia rail	*Rallus limicola*	B	
	sora	*Porzana carolina*	B	
	spotted rail	*Pardirallus maculatus*	A	
	purple gallinule	*Porphyrula martinica*	A	
	American coot	*Fulica americana*	B	R
CRANES: FAMILY GRUIDAE				
	sandhill crane	*Grus canadensis*	B	
PLOVERS: FAMILY CHARADRIIDAE				
	black-bellied plover	*Pluvialis squatarola*	N	
	American golden-plover	*Pluvialis dominica*	N	
	Wilson's plover	*Charadrius wilsonia*	A	
	semipalmated plover	*Charadrius semipalmatus*	N	
	killdeer	*Charadrius vociferus*	B	
SANDPIPERS: FAMILY SCOLOPACIDAE				
	greater yellowlegs	*Tringa melanoleuca*	N	
	lesser yellowlegs	*Tringa flavipes*	N	
	solitary sandpiper	*Tringa solitaria*	N	
	willet	*Catoptrophorus semipalmatus*	N	
	spotted sandpiper	*Actitis macularia*	B	
	upland sandpiper	*Bartramia longicauda*	B	T
	Eskimo curlew	*Numenius borealis*	X	
	whimbrel	*Numenius phaeopus*	N	
	ruddy turnstone	*Arenaria interpres*	N	
	sanderling	*Calidris alba*	N	
	semipalmated sandpiper	*Calidris pusilla*	N	
	western sandpiper	*Calidris mauri*	N	
	least sandpiper	*Calidris minutilla*	R	
	white-rumped sandpiper	*Calidris fuscicollis*	N	
	pectoral sandpiper	*Calidris malanotos*	N	
	dunlin	*Calidris alpina*	N	
	short-billed dowitcher	*Limnodromus griseus*	N	
	long-billed dowitcher	*Limnodromus scolopaceus*	N	
	common snipe	*Gallinago gallinago*	B	T
	American woodcock	*Scolopax minor*	B	
	Wilson's phalarope	*Phalaropus tricolor*	N	
	red-necked phalarope	*Phalaropus lobatus*	N	
	red phalarope	*Phalaropus fulicaria*	N	
GULLS AND TERNS: FAMILY LARIDAE				
	laughing gull	*Larus atricilla*	N	
	little gull	*Larus minutus*	A	
	ring-billed gull	*Larus delawarensis*	B	
	herring gull	*Larus argentatus*	B	
	Iceland gull	*Larus glaucoides*	A	
	lesser black-backed	*Larus fuscus*	N	

TABLE 5-7 BIRDS OF THE LEHIGH RIVER WATERSHED (continued)

Family	Common Name	Scientific Name	Status	Special Concern Code
GULLS AND TERNS: FAMILY LARIDAE *(continued)*				
	glaucous gull	*Larus hyperboreus*	N	
	great black-backed gull	*Larus marinus*	N	
	Sabine's gull	*Xema sabini*	A	
TERNS: FAMILY STERNINAE				
	Arctic tern	*Sterna paradisaea*	A	
	Forster's tern	*Sterna forsteri*	N	
	least tern	*Sterna antillarum*	A	
	black tern	*Sterna niger*	B	E
SKIMMERS: FAMILY RYNCHOPIDAE				
	black skimmer	*Rynchops niger*	A	
PIGEONS AND DOVES: FAMILY COLUMBIDAE				
	rock dove	*Columba livia*	B	0
	mourning dove	*Zenaida macroura*	B	
CUCKOOS: FAMILY CUCULIDAE				
	black-billed cuckoo	*Coccyzus erythropthalmus*	B	
	yellow-billed cuckoo	*Coccyzus americanus*	B	
BARN OWLS: FAMILY TYTONIDAE				
	barn owl	*Tyto alba*	B	A
	eastern screech-owl	*Otus asio*	B	
TYPICAL OWLS: FAMILY STRIGIDAE				
	great horned owl	*Bubo virginianus*	B	
	snowy owl	*Nyctea scandiaca*	N	
	barred owl	*Strix varia*	B	C
	long-eared owl	*Asio otus*	B	U
	short-eared owl	*Asio flammeus*	B	E
	northern saw-whet owl	*Aegolius acadicus*	B	U
GOATSUCKERS: FAMILY CAPRIMULGIDAE				
	common nighthawk	*Chordeiles minor*	B	
	whip-poor-will	*Caprimulgus vociferus*	B	
SWIFTS: FAMILY APODIDAE				
	chimney swift	*Chaetura pelagica*	B	
HUMMINGBIRDS: FAMILY TROCHILIDAE				
	ruby-throated hummingbird	*Archilochus colubris*	B	
KIGFISHERS: FAMILY ALCEDINIDAE				
	belted kingfisher	*Ceryle alcyon*	B	
WOODPECKERS: FAMILY PICIDAE				
	red-headed woodpecker	*Melanerpes erythrocephalus*	B	
	red-bellied woodpecker	*Melanerpes carolinus*	B	
	yellow-bellied sapsucker	*Sphyrapicus varius*	B	
	downy woodpecker	*Picoides pubescens*	B	
	hairy woodpecker	*Picoides villosus*	B	
	northern flicker	*Colaptes auratus*	B	
	pileated woodpecker	*Dryocopus pileatus*	B	

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TABLE 5-7 BIRDS OF THE LEHIGH RIVER WATERSHED (continued)

Family	Common Name	Scientific Name	Status	Special Concern Code
FLYCATCHERS: FAMILY TYRANNIDAE				
	olive-sided flycatcher	*Contopus cooperi*	B	X
	eastern wood-pewee	*Contopus virens*	B	
	yellow-bellied flycatcher	*Empidonax flaviventris*	B	E
	acadian flycatcher	*Empidonax virescens*	B	
	alder flycatcher	*Empidonax alnorum*	B	
	willow flycatcher	*Empidonax traillii*	B	
	least flycatcher	*Empidonax minimus*	B	
	eastern phoebe	*Sayornis phoebe*	B	
	great crested flycatcher	*Myiarchus crinitus*	B	
	eastern kingbird	*Tyrannus tyrannus*	B	
SHRIKES: FAMILY LANIIDAE				
	northern shrike	*Lanius excubitor*	N	
	loggerhead shrike	*Lanius ludovicianus*	B	E
VIREOS: FAMILY VIREONIDAE				
	white-eyed vireo	*Vireo griseus*	B	
	blue-headed vireo	*Vireo solitarius*	B	
	yellow-throated vireo	*Vireo flavifrons*	B	
	warbling vireo	*Vireo gilvus*	B	
	Philadelphia vireo	*Vireo philadelphicus*	N	
	red-eyed vireo	*Vireo olivaceus*	B	
JAYS, CROWS: FAMILY CORVIDAE				
	blue jay	*Cyanocitta cristata*	B	
	American crow	*Corus brachyrhynchos*	B	
	fish crow	*Corus ossifragus*	B	
	common raven	*Corus corax*	B	
LARKS: FAMILY ALAUDIDAE				
	horned lark	*Eremophila alpestris*	B	
SWALLOWS: FAMILY HIRUDINIDAE				
	purple martin	*Progne subis*	B	
	tree swallow	*Tachycineta bicolor*	B	
	northern rough-winged swallow	*Stelgidopteryx serripennis*	B	
	bank swallow	*Riparia riparia*	B	
	cliff swallow	*Hirundo pyrrhonota*	B	
	barn swallow	*Hirundo rustica*	B	
TITMICE: FAMILY PARIDAE				
	Carolina chickadee	*Poecile carolinensis*	B	
	black-capped chickadee	*Poecile atricapillus*	B	
	boreal chickadee	*Poecile hudsonicus*	A	
	tufted titmouse	*Baeolophus bicolor*	B	
NUTHATCHES: FAMILY SITTIDAE				
	red-breasted nuthatch	*Sitta canadensis*	B	
	white-breasted nuthatch	*Sitta carolinensis*	B	
CREEPERS: FAMILY CERTHIIDAE				
	brown creeper	*Certhia americana*	B	
WRENS: FAMILY TROGLODYTIDAE				
	Carolina wren	*Thryothorus ludovicianus*	B	
	Bewick's wren	*Thryomanes bewickii*	A	X
	house wren	*Troglodytes aedon*	B	
	winter wren	*Troglodytes troglodytes*	B	
	sedge wren	*Cistothorus platensis*	B	T
	marsh wren	*Cistothorus palustris*	B	R

TABLE 5-7 BIRDS OF THE LEHIGH RIVER WATERSHED (continued)

Family	Common Name	Scientific Name	Status	Special Concern Code
KINGLETS: FAMILY SYLVIIDAE				
	golden-crowned kinglet	*Regulus satrapa*	B	
	ruby-crowned kinglet	*Regulus calendula*	N	
	blue-gray gnatcatcher	*Polioptila caerulea*	B	
THRUSHES: FAMILY TURDIDAE				
	eastern bluebird	*Sialia sialis*	B	
	veery	*Catharus fuscescens*	B	
	gray-checked thrush	*Catharus minimus*	N	
	Swainson's thrush	*Catharus ustulatus*	B	R
	hermit thrush	*Catharus guttatus*	B	
	wood thrush	*Hylocichla mustelina*	B	
	American robin	*Turdus migratorius*	B	
MIMIC THRUSHES: FAMILY MIMIDAE				
	gray catbird	*Dumetella*	B	
	northern mockingbird	*Mimus polyglottos*	B	
	brown thrasher	*Toxostoma rufum*	B	
STARLINGS: FAMILY STURNIDAE				
	European starling	*Sturnus vulgaris*	B	O
PIPITS: FAMILY MOTACILLIDAE				
	American pipit	*Anthus rubescens*	N	
WAXWINGS: FAMILY BOMBYCILLIDAE				
	cedar waxwing	*Bombycilla cedrorum*	B	
WOOD WARBLERS: FAMILY PARULIDAE				
	blue-winged warbler	*Vermivora pinus*	B	
	golden-winged warbler	*Vermivora chrysoptera*	B	
	Tennessee warbler	*Vermivora peregrina*	B	
	orange-crowned warbler	*Vermivora celata*	N	
	Nashville warbler	*Vermivora ruficapilla*	B	
	northern parula warbler	*Parula americana*	B	
	yellow warbler	*Dendroica petechia*	B	
	chestnut-sided warbler	*Dendroica pensylvanica*	B	
	magnolia warbler	*Dendroica magnolia*	B	
	Cape May warbler	*Dendroica tigrina*	N	
	black-throated warbler	*Dendroica caerulescens*	B	
	yellow-rumped warbler	*Dendroica coronata*	B	
	black-throated gray	*Dendroica nigrescens*	N	
	black-throated green warbler	*Dendroica virens*	B	
	blackburnian warbler	*Dendroica fusca*	B	
	yellow-throated warbler	*Dendroica dominica*	B	
	pine warbler	*Dendroica pinus*	B	
	prairie warbler	*Dendroica discolor*	B	
	palm warbler	*Dendroica palmarum*	N	

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Notes:

Status Codes:

***A**-Accidental,* ***B**-Breeding,* ***N**-Non-breeding,* ***X** – Extinct*

Special Concern Codes:

***E**-Endangered,* ***T**-Threatened,* ***A**-Candidate-At Risk,* ***R**-Candidate-Rare,*
***U**-Candidate-Undetermined,* ***X**-Extirpated,* ***O**-Established Exotic.*

TABLE 5-7 BIRDS OF THE LEHIGH RIVER WATERSHED (continued)

Family	Common Name	Scientific Name	Status	Special Concern Code
WOOD WARBLERS: FAMILY PARULIDAE *(continued)*				
	palm warbler	*Dendroica palmarum*	N	
	bay-breasted warbler	*Dendroica castanea*	N	
	blackpoll warbler	*Dendroica striata*	B	
	cerulean warbler	*Dendroica cerulea*	B	
	black-and-white warbler	*Mniotilta varia*	B	
	American redstart	*Setophaga ruticilla*	B	
	prothonotary warbler	*Protonotaria citrea*	B	R
	worm-eating warbler	*Helmitheros vermivorus*	B	
	ovenbird	*Seiurus aurocapillus*	B	
	northern waterthrush	*Seiurus noveboracensis*	B	
	Louisiana waterthrush	*Seiurus motacilla*	B	
	Kentucky warbler	*Oporornis formosus*	B	
	Connecticut warbler	*Oporornis agilis*	N	
	mourning warbler	*Oporornis philadelphia*	B	
	common yellowthroat	*Geothlypis trichas*	B	
	hooded warbler	*Wilsonia citrina*	B	
	Wilson's warbler	*Wilsonia pusilla*	N	
	Canada warbler	*Wilsonia canadensis*	B	
	yellow-breasted chat	*Icteria virens*	B	
TANGERS: FAMILY THRAUPIDAE				
	summer tanager	*Piranga rubra*	B	R
	scarlet tanager	*Piranga olivacea*	B	
	western tanager	*Piranga ludoviciana*	A	
FINCHES: FAMILY FRINGILLIDAE				
	northern cardinal	*Cardinalis cardinalis*	B	
	rose-breasted grosbeak	*Pheucticus ludovicianus*	B	
	blue grosbeak	*Guiraca caerulea*	B	
	indigo bunting	*Passerina cyanea*	B	
	dickcissel	*Spiza americana*	B	T
	eastern towhee	*Pipilo erythrophthalmus*	B	
	American tree sparrow	*Spizella arborea*	N	
	chipping sparrow	*Spizella passerina*	B	
	clay-colored sparrow	*Spizella pallida*	N	
	field sparrow	*Spizella pusilla*	B	
	vesper sparrow	*Pooecetes gramineus*	B	
	lark sparrow	*Chondestes grammacus*	A	
	Savannah sparrow	*Passerculus sandwishensis*	B	
	grasshopper sparrow	*Ammodramus savannarum*	B	
	Henslow's sparrow	*Ammodramus henslowii*	B	
	fox sparrow	*Passerella iliaca*	N	
	song sparrow	*Melospiza melodia*	B	
	Lincoln's sparrow	*Melospiza lincolnii*	N	
	swamp sparrow	*Melospiza georgiana*	B	
	white-throated sparrow	*Zonotrichia albicollis*	B	
	white-crowned sparrow	*Zonotrichia leucophrys*	N	
	dark-eyed junco	*Junco hyemalis*	B	

continued on next page

TABLE 5-7 BIRDS OF THE LEHIGH RIVER WATERSHED (continued)

Family	Common Name	Scientific Name	Status	Special Concern Code
FINCHES: FAMILY FRINGILLIDAE *(continued)*				
	lapland longspur	*Calcarius lapponicus*	N	
	snow bunting	*Plectrophenax nivalis*	N	
	bobolink	*Dolichonyx oryzivorus*	B	
	red-winged blackbird	*Agelaius phoeniceus*	B	
	eastern meadowlark	*Sturnella magna*	B	
	rusty blackbird	*Euphagus carolinus*	N	
	brewer's blackbird	*Euphagus cyanocephalus*	N	
	common grackle	*Quiscalus quiscula*	B	
	brown-headed cowbird	*Molothrus ater*	B	
	orchard oriole	*Icterus spurius*	B	
	Baltimore oriole	*Icterus galbula*	B	
	purple finch	*Carpodacus purpureus*	B	
	house finch	*Carpodacus mexicanus*	B	
	red crossbill	*Loxia curvirostra*	B	U
	white-winged crossbill	*Loxia leucoptera*	N	
	common redpoll	*Carduelis flammea*	N	
	hoary redpoll	*Carduelis hornemanni*	A	
	pine siskin	*Carduelis pinus*	B	
	American goldfinch	*Carduelis tristis*	B	
	evening grosbeak	*Coccothraustes vespertinus*	B	
	house sparrow	*Passer domesticus*	B	O

Notes:

Status Codes:

***A**-Accidental,* ***B**-Breeding,* ***N**-Non-breeding,* ***X** – Extinct*

Special Concern Codes:

***E**-Endangered,* ***T**-Threatened,* ***A**-Candidate-At Risk,* ***R**-Candidate-Rare,*
***U**-Candidate-Undetermined,* ***X**-Extirpated,* ***O**-Established Exotic.*

been observed in the watershed. Only two Pennsylvania breeding bird species are listed under the Federal Endangered Species Act: the peregrine falcon and bald eagle are threatened.

The OTC also lists Candidates to the Pennsylvania Endangered and Threatened bird species list. The Breeding Bird Species of Special Concern list (SSC) comprises the Endangered and Threatened species list and the Candidates to that list. It includes only species with a regular history of nesting in the state. The Candidate list has no legal authority, but serves as an indication of species that deserve attention for inventory, management, research, and conservation efforts. Most Candidate species have declining or low populations that merit concern for their continued existence in the state. Fifty-six % of the SSC list are wetland obligates and an even higher percentage of these species use wetlands as a significant part of their life cycle (Brooks and Croonquist, 1990). Most birds on the SSC list are relatively large with substantial feeding ranges or specialized foraging or nesting requirements. Many SSC birds need extra efforts for population monitoring and are not currently tracked for population trends by standardized surveys.

The bird species present in the watershed are listed in Table 5-7. In addition, there is a wealth of information available specific to the Lehigh River watershed area including *Birds of the Lehigh Valley* (Saenger, Malt, and Crilley, 2002), *A Century of Bird Life in Berks County, Pennsylvania* (Ulrich, 1997), *The Atlas of Breeding Birds in Pennsylvania* (Brauning, 1992), and *The Lehigh Valley, A Natural and Environmental History* (Halma and Oplinger, 2001). Finally, a searchable database of breeding birds is available at http://www.pasda.psu.edu.

The Important Bird Area (IBA) Program was started by Birdlife International in Europe in the 1980s.

Birdlife International is a global coalition of partner organizations in over 100 countries. The National Audubon Society is the United States partner designate and administers the IBA program in the U.S. The IBA program was established to reverse the declining trend in bird populations. The mission of Audubon Pennsylvania is "To restore natural ecosystems, focusing on birds, other wildlife, and their habitats for the benefit of humanity and the earth's biological diversity."

Pennsylvania formed the first statewide IBA program in the country in 1996. A group of scientific advisors has identified 78 IBAs encompassing over one million acres of public and private lands. This list is by no means an entire directory of important bird habitat areas. The list will be modified as new areas are nominated and habitats and species are documented.

IBAs are part of a global network of places recognized for their value for bird conservation. An IBA can be large or small, public or private, and must meet several objective criteria. IBAs are voluntary and thus there are no legal or regulatory restrictions. Once a site is designated as an IBA, volunteer monitoring efforts are initiated, focusing on nesting seasons, to track the numbers and varieties of birds utilizing the site. Currently, there are four designated IBAs in the Lehigh River Watershed: the Kittatinny Ridge/Blue Mountain, Hickory Run State Park, Pocono Lake Preserve, and Long Pond Preserve.

Exotic Bird Species

There have been many attempts to introduce exotic birds in the state, especially by sportsmen and those who admired European birdlife. However, only five exotic bird species regularly nest in Pennsylvania. Three of these are abundant and widespread pests: rock dove (pigeon), European starling, and house sparrow. The remaining exotics are mute swan, an ornamental waterfowl, and ring-necked pheasant, an upland gamebird. Starlings and house sparrows compete with native birds for cavities and prey on eggs and nestlings. Mute swans can alter wetlands to the disadvantage of native waterfowl and other water birds.

While it has been determined that 71 species of mammals are native to Pennsylvania, 11 of them appear to have been extirpated. Extirpation does not seem to be a threat with the white-tailed deer, however. Currently, numbers are on the increase despite measures to reduce the state's herds.

e. Mammals

Status of Mammals

Seventy-one species of mammals are native to Pennsylvania. These represent 7 orders and 16 families. As a group, mammals are only a small percentage of the state's native species of plants and animals. However, because mammals are familiar to so many citizens of Pennsylvania, they are important as symbols of the Commonwealth's native biological diversity.

Of the 71 native species, 11 appear to have been extirpated in historic times. Most of these are large mammals, including the gray wolf, mountain lion, lynx, bison, wolverine, moose, and marten (Williams et al. 1985). Three other large species that were once extirpated--the beaver, elk, and most recently, fisher--have been successfully re-established. The only inconspicuous species that is presumed extirpated is the marsh rice rat.

Three species, or subspecies, of mammals are state-listed as Endangered within the Commonwealth: Indiana bat, Delmarva fox squirrel and least shrew (Pennsylvania Game Commission 1995). Both the Indiana bat and the Delmarva fox squirrel are also listed as Endangered under the Federal Endangered Species Act. Another three are state-listed as Threatened: small-footed myotis (bat), West Virginian water shrew, and the Eastern woodrat. Of these threatened and endangered species, the least shrew (Halma and Oplinger, 2001) and the eastern woodrat (Pa. Game Commission, 1995) are the only mammals to have been observed in the watershed area.

Despite the breadth of our knowledge of the mammals of Pennsylvania, a considerable amount of research remains to be done in order to ascertain the status and distribution of many species. These include Threatened and Endangered mammals, and those identified in a review by Kirkland and Krim (1990) as species or subspecies "at risk" or "status undetermined". This set includes the least weasel, the New England cottontail; several bat species, and the eastern spotted skunk.

Compared to other taxonomic groups, the status of most mammal species in Pennsylvania can be relatively well understood with data that already exist. There are some inventorying gaps to fill, and it will be important to continue monitoring both overall mammal diversity and the dynamics of select species in relation to environmental variables. Current efforts by the Pennsylvania Biological Survey, including the Important Mammal Areas Project (see http://www.pawildlife.org/imap.htm) and a developing Biodiversity Monitoring Network, highlight the importance of accessible databases. With increasing consensus about the importance of such resources, and newly emerging practical guidelines to build them, there is good reason to be optimistic about the stewardship of mammal biodiversity in Pennsylvania's future.

FIGURE 5-5 DEER DENSITIES EXCEED ABILITY OF FOREST HABITAT TO SUSTAIN HEALTHY POPULATIONS IN MUCH OF THE STATE (data from Pennsylvania Game Commission 2000).

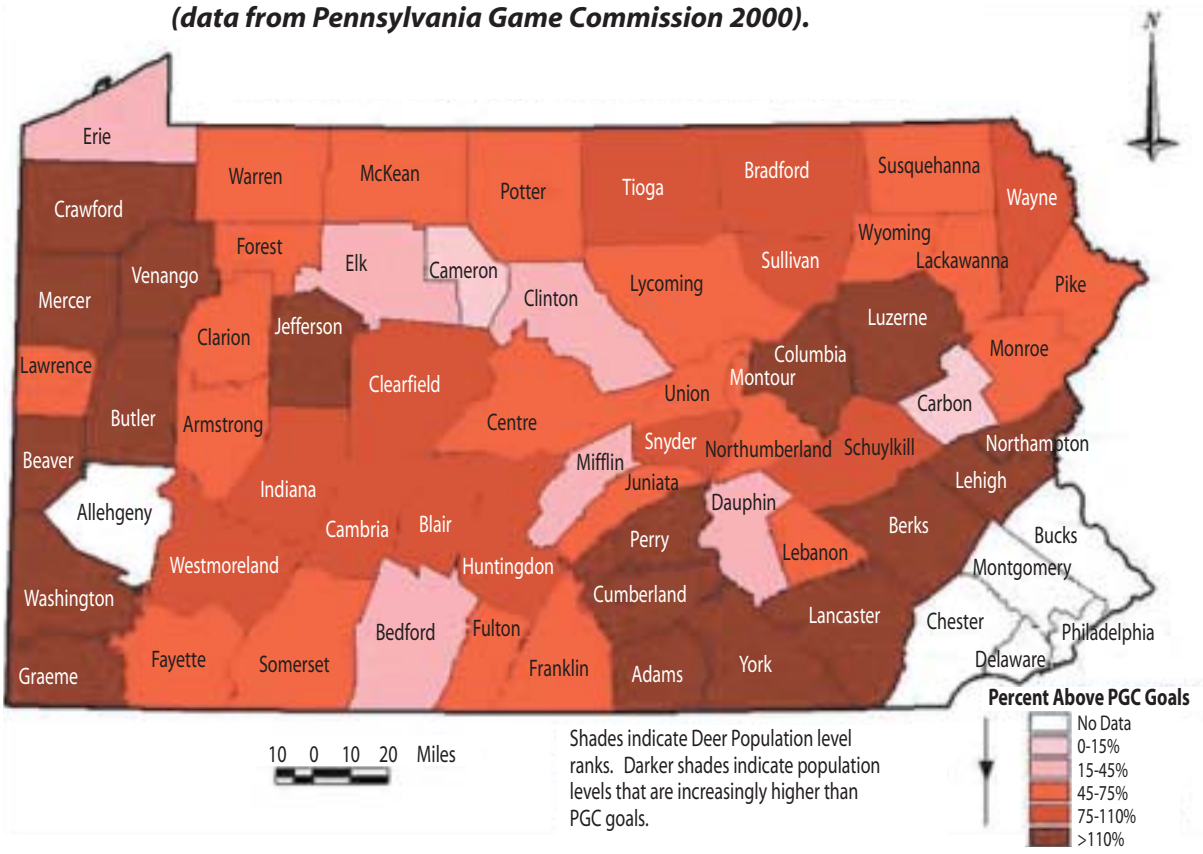

TABLE 5-8 MAMMALS OF THE LEHIGH RIVER WATERSHED (Pennsylvania DCNR, www.dcnr.state.pa.us/pabs/mammals; Tom Fegley, personal communication, 2003)

Family	Common Name	Scientific Name	Status	Habitat	Behavior
NEW WORLD OPOSSUMS: DIDELPHIDAE					
	Virginia oppossum	*Didelphis virginiana*	C	G	N,C
SHREWS: SORICIDAE					
	masked shrew	*Sorex cinereus*	C	M,B,	N,C
	water shrew	*Sorex palustris*	R,T	M,S	A
	smokey shrew	*Sorex fumeus*	C	M	A
	long-tailed shrew	*Sorex dipar*	I	M,R	U
	pygmy shrew	*Sorex hoyi*	S	G	A
	northern short-tailed shrew	*Blarina brevicauda*	C	G	A
	least shrew	*Cryptotis parva*	E	A,N	A
	Maryland shrew	*Sorex fontinalis*	U	M, B, N	U
MOLES: TALPIDAE					
	hairy-tailed mole	*Parascalops breweri*	C	G	A,Y
	eastern mole	*Scalopus aquaticus*	C	G,R	A,Y
	star-nosed mole	*Condylura cristata*	C	W,S	A,Y
PLAIN-NOSED BATS: VESPERTILIONIDAE					
	little brown bat	*Myotis licifugus*	C	C,S	H
	long-eared bat	*Myotis keenii*	R	C,S	H
	pink-faced bat	*Myotis sodalis*	E	C,S	H
	small-footed bat	*Myotis leibii*	T	C,S	H
	silver-haired bat	*Lasionycteris noctivagans*	R	X	M
	eastern pipistrelle	*Pipistrellus subflavus*	S	C,S	H
	big brown bat	*Eptesicus fuscus*	C	C	H
	red bat	*Lasiurus borealis*	U	X	M
	hoary bat	*Lasiurus cinereus*	U	X	M
	evening bat	*Nycticeius humeralis*	R	G	T,H
	Seminole bat	*Lasiurus seminolus*	U	?	Y
RABBITS AND HARES: LEPORIDAE					
	eastern cottontail	*Sylvilagus floridanus*	C	B,G	A,C,Y
	New England cottontail	*Sylvilagus transitionalis*	A	M	U,Y
	snowshoe hare	*Lepus americanus*	A	M	N,Y
SQUIRRELS: SCIURIDAE					
	eastern chipmunk	*Tamias straitus*	C	G	D,H
	woodchuck	*Marmota monax*	C	W,A,R	D,H
	gray squirrel	*Sciurus carolinensis*	C	D,G	D,T
	fox squirrel	*Sciurus niger*	R,E,C	D,A	D,T
	red squirrel	*Tamiasciurus hudsonicus*	C	D,X	D,T
	southern flying squirrel	*Glaucomys volans*	C	D,X	N,T
	northern flying squirrel	*Glaucomys sabrinus*	I	X,C	N,T
BEAVERS: CASTORIDAE					
	beaver	*Castor canadensis*	C	S,L	N,Y
NATIVE RATS, MICE, AND VOLES: CRICETIDAE					
	deer mouse	*Peromyscus maniculatus*	C	G	N
	white-footed mouse	*Peromyscus leucopus*	C	G	N
	eastern woodrat	*Neotoma magister*	T	M,R	N
	southern red-backed vole	*Clethrionomys gapperi*	C	X,C,R	N

TABLE 5-8 MAMMALS OF THE LEHIGH RIVER WATERSHED (continued)

Family	Common Name	Scientific Name	Status	Habitat	Behavior
NATIVE RATS, MICE, AND VOLES: CRICETIDAE (continued)					
	rock vole	*Mictotus chrotorrhinus*	A	X,R	D,Y
	pine vole	*Microtus pinetorum*	C	G	A,Y
	southern bog lemming	*Synaptomys cooperi*	I	N,W	A,Y
	muskrat	*Ondatra zibethicus*	C	W,L,S	N
OLD WORLD RATS AND MICE: MURIDAE					
	Norway rat	*Rattus norvegicus*	C	H,A	N
	house mouse	*Mus musculus*	C	H,A	H
JUMPING MICE: ZAPODIDAE					
	meadow jumping mouse	*Zapus hudsonius*	C	N,S	H,N
	woodland jumping mouse	*Napeozapus insignis*	C	M,C,	H,N,C
NEW WORLD PORCUPINES: ERETHIZONTIDAE					
	porcupine	*Erethizon dorsatum*	C	M,C,	N,Y
DOGS AND FOXES: CANIDAE					
	eastern coyote	*Canis latrans*	S	G	A
	red fox	*Vulpes vulpes*	C	B, A	N
	gray fox	*Urocyon cinerecargenteus*	C	B,D	N
BEARS: URSIDAE					
	black bear	*Ursus americanus*	C	M,C,D	N
RACCOONS: PROCYONIDAE					
	raccoon	*Procyon lotor*	C	G	N
WEASELS, SKUNKS, AND OTTERS: MUSTELIDAE					
	ermine	*Mustela erminea*	I	B,A	N
	least weasel	*Mustela nivalis*	U	B,A	N
	long-tailed weasel	*Mustela frenata*	C	G?	N
	mink	*Mustela vison*	C	W,S	C
	striped skunk	*Mephitis mephitis*	C	G	N
	river otter	*Lutra canadensis*	C	G	C,A
CATS: FELIDAE					
	bobcat	*Felis rufus*	A	M,B,A, R	N
DEER: CERVIDAE					
	white-tailed deer	*Odocoileus virginianus*	C	G	C,A

Notes:

Status:
U*(Undetermined)-Species of concern for which insufficient data are available for adequate assessment*
R*(Rare)-Species found in either a few restricted areas or over a broad area at low numbers*
A*(At Risk)-Species particularly vulnerable to further habitat modifications or exploitation*
T*(Threatened)-Species that are likely to become Endangered within the foreseeable future*
E*(Endangered)-Species of imminent danger of extinction in Pennsylvania*
X*(Extirpated)-Species that disappeared from Pennsylvania since 1600*

Habitats:
M*-mountain woodlands*
R*-rocky areas*
B*-brush thickets, hedgerows*
W*-marshes*
S*-streams, rivers*
L*-lakes, ponds*
N*-grasslands*
C*-coniferous forests*
D*-deciduous forests*
X*-mixed forests*
A*-agricultural lands, old fields*
H*-near human/suburban areas (barns, attics)*
G*-generalized habitat requirements (found in a variety of habitats)*

Behavior:
N*-nocturnal (active at night)*
D*-diurnal (active in day)*
C*-crepuscular (active at dawn and dusk)*
A*-active day and night*
T*-nests in tree hollows*
M*-migratory*
H*-hibernator*
Y*-active year-round*

Mammals present in the Lehigh River watershed are shown in Table 5-8. Some relatively common mammals that are found in the watershed include the opossum, eastern mole, star-nosed mole, short-tailed shrew, least shrew, little and big brown bats, raccoon, long-tailed weasel, mink, striped skunk, red fox, woodchuck, eastern chipmunk, eastern gray squirrel, red squirrel, southern flying squirrel, white-footed mouse, deer mouse, meadow vole, muskrat, house mouse, Norway rat, meadow jumping mouse, woodland jumping mouse, eastern cottontail rabbit, and white-tailed deer.

Forest regeneration is impacted in the watershed in part due to deer overbrowsing. Deer populations have grown significantly since the turn of the century (Kosack 1995, Yahner, 1995), and in some regions may be inhibited due to deer foraging on acorns and oak seedlings. Deer also have direct impact on saplings, browsing most vegetation within reach. As populations of deer have burgeoned in recent years, the impact on forest growth has grown increasingly critical (see Figure 5-5).

The Important Mammal Areas (IMAs) Project mentioned above is being carried out by a broad-based alliance of sportsmen, conservation organizations, wildlife professionals, and scientists. The primary concern is to help ensure the future of Pennsylvania's wild mammals, both game and non-game species. The focus is on species of concern and habitats that have high mammalian diversity. Several Important Mammal Areas (IMAs) are currently being identified for the first time in Pennsylvania and a map of these areas will be made available for review in late 2003 or early 2004. A few IMAs have been selected in the watershed and include an area near the Lehigh Gorge (eastern woodrat), a location near Hickory Run State Park (northern flying squirrel), an area near Two-Mile Run/Pocono Lake (northern flying squirrel/good wildlife habitat), an area near Tobyhanna and Gouldsboro State Parks (river otter/large carnivores/good wildlife habitat), and a location near Long Pond Preserve (beaver/muskrats/large carnivores/good wildlife habitat) (personal communication with Alicia Linzey, Project Director, Indiana University, October 2003).

Exotic Mammals

Of the mammal species in Pennsylvania today, only two, the Norway rat and house mouse, are exotic species. Two previously introduced species-the European hare and black rat-apparently are now extirpated (Doutt et al. 1973).

B. Wildlife Habitat

Wild animals require four basic habitat components—food, water, cover and space. The amount and distribution of these will influence the types of wildlife that can survive in an area. As the quantity, type and distribution of habitat components change, so do the types of wildlife species found within the habitat. Wildlife management often involves manipulating components of the habitat to favor a particular species or group of species.

Succession is the predictable change in a plant community over time. For example, a field left untouched will become covered with shrubs and eventually with a forest. As the plant community changes, so do the habitat components available for wildlife.

Bare soil, if left alone will become vegetated over time. Seeds are present in the soil and others arrive by wind, wildlife or other means. As a result, the unattended bare soil eventually becomes a grassy field, an early successional stage. Fields provide herbaceous food and cover as well as insects and seeds for small mammals such as meadow voles and cottontail rabbits. Red-tailed

hawks and red fox, which feed on small mammals, often hunt in open fields. Birds such as indigo buntings and field sparrows also are attracted to the food and cover found in fields.

The next stage in plant succession occurs when shrubs and small trees invade an old field. The resulting brushy habitat provides low cover and woody browse, as well as blackberry, sumac, elderberry, and hawthorne berries and seeds. This brush-stage forest is ideal for white-tailed deer, providing habitat components they need for reproducing, resting and feeding. Brush-stage forests also provide cover for cottontail rabbits and many other small mammals. Game birds like ruffed grouse and songbirds also find food and cover in brushy habitat.

Although these early successional stage habitats provide a variety of important habitat components, they typically do not include some critical elements. Large seeds, such as acorns and hickory nuts, produced by overstory trees and used as food by many species of wildlife, are generally absent. Cavity trees, which provide cover for birds and small animals, are also not present. Young habitats simply have not had time to develop some of the features present in more mature forest areas.

An un-managed brush-stage forest will become a pole-stage forest in 15 to 20 years. This type of forest contains trees 4 to 10 inches in diameter at breast height. Pole-stage forests are generally considered the least productive forest habitats for wildlife. They are a transitional stage between brush-stage and mature forests, and generally lack the thick understory cover and browse so abundant in the brush-stage forest. They also lack the large overstory and cavity trees associated with mature forests.

As a pole stage forest matures, cavity trees become more abundant, overstory trees produce more nuts, acorns and fruit; and dead wood and leaf litter collect on the ground. Woodpeckers, chickadees, squirrels and other small animals nest in tree cavities, and gray squirrels and wild turkey eat acorns and hickory nuts produced by mature forest trees. Species as large as the black bear and small as the masked shrew forage for insects in dead wood on the ground, and amphibians such as the red-spotted newt and the northern red salamander thrive in the moist environment created by the closed canopy overhead and the deep leaf litter underfoot.

In addition to the successional stage of the habitat, the size of the area influences which species will be found there. Many species are area sensitive, which means that they are absent from or rare in small patches of habitat and more abundant within extensive areas of undisturbed land. Some have large home ranges, whereas others must travel a considerable distance to meet mates. The northern goshawk, for example, does not inhabit small woodlots because it has a large home range and requires large forested areas free from human disturbance. Many songbirds are also sensitive. Although they do not have large home ranges, they rarely nest successfully in small patches of forest, where nest predation and parasitism occur more frequently than in large unfragmented forests. These species, including ovenbirds, scarlet tanagers and many warblers, are often called forest interior species because they need the insulating effect provided by the forest interior. Many forest-dwelling amphibians also require large tracts of mature forest in which to survive and reproduce successfully. In the Lehigh River watershed, large expanses of continuous forest are often found on ridge tops. These forests provide critical areas of habitat for species that cannot survive in small woodlots.

The arrangement of habitat patches also influences the presence of certain types of wildlife. Some species require large tracts of similar habitats, whereas others use a variety of habitats at different stages in their life cycle and require multiple habitat types in close proximity to one another. The scarlet tanager, for example, feeds and reproduces in continuous tracts of mature

forest habitat. Conversely, ruffed grouse use a variety of different habitats, including herbaceous open areas for feeding their young, brushy habitat for cover, pole stage forests for drumming, mature forested areas for nesting and evergreen habitat for winter cover.

Sometimes a habitat may seem suitable for a species, but that species is not abundant there or even is entirely absent from the area. This may be due to the type of habitat in the surrounding landscape. For example, a wetland, stream, or pond surrounded by mowed and manicured lawn probably will not support the wildlife that it could if it were surrounded by a buffer of grasses, shrubs, and trees. The surrounding landscape may also influence habitats on a larger scale. Small woodlots within an agricultural landscape will support a community of wildlife different from that found in woodlots surrounded by commercial or industrial areas.

1. Riparian Buffers/Corridor Characteristics

Riparian buffers are vegetated zones of protection located along streams or rivers. These strips of grass, shrubs, and/or trees along the banks of rivers and streams filter polluted runoff and provide a transition zone between water and human land use. Buffers are also complex ecosystems that provide habitat and improve the stream communities they shelter. Protection or establishing a forest buffer along a stream is the single most important thing streamside landowners can do to improve and protect our aquatic resources. Map 5-1 shows the portion of the river and streams in the watershed with and without a forest riparian buffer. Riparian buffers serve several very important functions for wildlife protection as described below:

Food Source: Streambank vegetation provides food and energy for aquatic insects when leaves, woody debris and seeds fall into the stream. Preserving buffers to maintain an aquatic insect food source is important, as these insects are critical links in the food chain.

Habitat: Streambank vegetation provides habitat not only for terrestrial life, but also for aquatic life. Overhanging branches and fallen logs from trees often provide much needed shelter to protect fish from predators. In addition, deep pools are frequently created when streambanks are scoured below the root mass of vegetation, which holds the upper streambank in place. These pools are the preferred habitat of fish as the water is cooler and they have protection from the overhanging bank and vegetation. Macro-invertebrates also use the vegetation for habitat purposes. Many insects build homes out of detritus that enters the stream from the surrounding buffer zone.

Temperature Moderation: The establishment of riparian buffers is a key to the fight against thermal pollution. Buffers shade the stream from sunlight and therefore help to keep water temperatures below levels that are detrimental to the life, growth, and reproduction of coldwater fishes. Maintaining buffers in urban areas is extremely important because they can help mitigate the negative impact of stormwater runoff from heated surfaces such as paved roads, parking lots, sidewalks, and roofs.

Streambank Stabilization: The roots of vegetation act as an anchor for the soil and hold soil particles together to help resist erosion. When located along a stream, the roots will help preserve the structural integrity of the streambank and prevent accelerated rates of erosion and scouring of the banks.

Sediment and Nutrient Reduction: The extensive root system of vegetated buffers helps prevent sediment and nutrients contained in stormwater runoff and overland

flow from entering the stream. The roots and vegetation impede the flow of runoff, slowing down the water and allowing sediments to drop out and be deposited on the floodplain. Riparian buffers also reduce nutrient loading in the creek. Once deposited in the riparian zone, these nutrients are available for uptake by the vegetation, which needs nutrients to grow. Plants in a forest community play a major role in the retention of nutrient elements and a natural forest can be extremely efficient in conserving its mineral elements. In the nitrogen cycle the tissues of dead plants and animals is decomposed to ammonia or ammonium ions, which are then acted on by nitrifying bacteria to produce nitrates, the form in which nitrogen is usually assimilated by plants. If there are not enough plants present near a waterway, nitrate ions are not held in the soil and eventually enter the stream. As a side effect, the stream polluted with nitrates supports an algal bloom, which blocks sunlight from reaching more beneficial forms of aquatic plants. Excessive algal growth may result in rapid dissolved oxygen and pH fluctuations in the stream due to the processes of photosynthesis, decomposition, and respiration.

2. Forest Fragmentation

Forest fragmentation and parcelization have become serious concerns throughout the country, and especially in the urban-suburban corridor of the northeastern United States. Fragmentation is the disruption of the forested landscape into smaller blocks by the increasing proximity of human development. Parcelization, while maintaining the biological extent of the forest, fragments it into increasingly smaller tract sizes of diverse ownerships that create difficulties from a management perspective.

Biodiversity in our forests is threatened by many things, some of which we can control through proper management. Some threats, however, seem to be beyond our ability to craft a solution. The management of our white-tailed deer population continues to be one of the most significant deleterious impacts on our forests.

C. Species of Special Concern

Some species listed as endangered or threatened in Pennsylvania are so distinguished because their range barely extends into the state, or their population has a fragile foothold here. Common terns, for example, have really only ever nested at Erie County's Presque Isle State Park. They are listed as endangered to ensure additional management considerations for these habitat specialists, as well as to heighten awareness of their very limited population status. The common tern's listing helps to ensure the state's wildlife species diversity.

There have also been tremendous success stories in Pennsylvania's endangered/threatened species management program. Pennsylvania's bald eagle population numbers more than 40 nesting pairs – up from three in 1980 – because of bald eagle reintroduction program in the 1990s. Other beneficiaries of specialized management include the osprey and peregrine falcon.

The last word in ignorance is the man who says of an animal or plant "what good is it?". If the land mechanism as a whole is good, then every part is good, whether we understand it or not. If the biota, in the course of eons has built something we like but do not understand, then who but a fool would discard seemingly useless parts? To keep every cog and wheel is the first precaution of intelligent tinkering.

—Aldo Leopold (1949)

Profiles of the Lehigh River Watershed Species of Concern

The following information is from http://www.pgc.state.pa.us/wildlife/endangered/index.asp.

BOG TURTLE

Current Status: Pennsylvania Endangered, Federally Endangered

Biology-Natural History: Mating takes place in May and early June. Each female then digs a nest and lays a clutch of three to five eggs during June or July. Eggs receive no parental care, and hatchlings leave the nest several months later. Adults and young feed on a variety of plant and animal food, such as berries, insects, and even carrion. They do not wander far from hibernating sites in spring seepage, which they leave in April or May and return to in late summer. Summer hibernation (aestivation) may occur during July and August; individuals are otherwise encountered basking on sedge tussocks or moving slowly about in spring runs under concealing vegetation. When danger threatens, individuals burrow rapidly into the mucky bottom of spring runs.

Preferred Habitat: Bog turtles live in relatively open portions of sphagnum bogs, swamps or marshy meadows with slow moving, spring fed streams or spring runs with soft bottoms.

Reasons for Being Endangered: The primary reason for the bog turtle's status is the draining or other destruction of its habitat. Because bog turtles have always been considered the rarest of North American turtles, they are highly valued by turtle fanciers in this country, and possibly twice as much overseas. Many, therefore, have been illegally removed for commercial purposes. Since their habitats are widely separated, other turtles are not likely to move in and replace those removed.

Management Practices: Informal agreements concerning the continued occurrence of the turtles have been made with owners of private property where bog turtles exist. Field surveys have determined the status of historical and new sites. Also, permit review and commentary concerning public use projects where bog turtle habitat is involved is ongoing.

LEAST SHREW

Current Status: In Pennsylvania, endangered; nationally, no special protection.

Population Trend: The least shrew was thought to be widespread throughout much of Pennsylvania, albeit mainly in localized populations, during the mid 1900s. During that period, surveys conducted across the state by mammalogists found this mid-sized insectivore in every region of Pennsylvania except the north-central. Recent surveys now suggest, however, the least shrew has disappeared from many of the sites where it was once present and is now restricted to southeastern counties. Post 1970s surveys have found the least shrew at isolated sites within York and Adams counties with possibly one of the most extensive populations occurring within the Eisenhower National Historic Site near Gettysburg. Isolated populations may occur at other sites across Pennsylvania but remain in jeopardy of localized extinction from myriad factors ranging

from changing landscapes and land-use patterns to loss of habitat. The least shrew was listed as endangered in 1990.

Identifying Characteristics: The total length of the least shrew is from 3 to 3 _ inches. Its tail length ranges from _ to _ inches, which is the shortest tail of all Pennsylvania shrews. It has a black to ash-gray belly. The only other species of shrew with a short tail, the more common northern short-tailed shrew, is larger (total length is 4 to 5 inches) and is dark slate-gray colored.

Biology-Natural History: The least shrew is found throughout much of the eastern United States, ranging from New York south to Florida and through the midwest into Central America. A grassland species, the least shrew is restricted to non-forested habitats that are free from grazing and intensive agricultural practices. Although much of the biology of this species in Pennsylvania remains unknown, it is believed to have up to three litters per year, averaging five young per litter, between March and November. Like other insectivores, they feed primarily on insects and their larva, earthworms, spiders and sometimes snails. Several researchers have noted that the least shrew appears to be a colonial or somewhat social shrew in forming nests occupied by several adults, rather than occurring singly. In Indiana, it is sometimes referred to as the "bee mole" as it has been found to infrequently enter bee hives and feed on the brood.

Preferred Habitat: Unlike other shrews, the least shrew prefers non-forested habitats. It is often found in old sedge meadows and non-agricultural fields. Although the soil substrate of an area does not appear to be important, this species occupies subsurface runways and uses areas where building such runways is easier. In many cases, the areas where these shrews are found are in loose shales and non-compacted soils.

Reasons for Being Endangered: Intensive agricultural methods are practiced throughout much of the least shrew's former Pennsylvania range. In many areas, the use of rotation practices has lessened and untilled or non-pastured fields are lacking. This coupled with the regeneration of forestlands and development of other lands has reduced the amount of the least shrew's preferred habitat. In many cases, where the habitat does exist, the populations remain isolated, increasing the possibility of chance events leading to localized eradication of these populations.

Management Practices: Management practices beneficial for grassland species should also benefit the least shrew. Surveys to find this species need to be intensified and populations found should be protected. Habitat studies in the vicinity of known populations on public lands should be carried out before any restoration efforts are planned.

EASTERN WOODRAT

Current Status: In Pennsylvania, threatened; nationally, status change pending.

Population Trends: The eastern woodrat was once considered a common resident of Pennsylvania's mountains. The species, first discovered among specimens taken from a cave near Carlisle in 1858, has disappeared from the southeastern portion of the state and has declined in much of the rest of the state. At present, populations exist throughout much of Pennsylvania's south-central and southwestern counties, with a few remnant populations in eastern counties. The reasons for these declines are not well understood, but may be the result of a combination of several factors including fragmentation of habitat by road-building, increased susceptibility to parasitic infestations and the loss of primary food sources such as the American chestnut.

Biology-Natural History: The eastern woodrat occurs along the Appalachian Mountains from southwestern New York and northern New Jersey through most of Pennsylvania and southwest into Tennessee and northeastern Alabama. A resident of caves, rock outcrops and talus slopes along mountains, this animal is one of the state's more interesting woodland inhabitants. Colonies of woodrats can be recognized by the large fecal piles, called latrines, these rodents deposit on protected flat rocks scattered throughout the colony area. Another feature common to areas inhabited by woodrats is the large caches of foodstuffs found crumpled and stuffed into cracks and crevices in the rocks. These caches, which used as winter food supplies, are built by woodrats during summer. The nests of woodrats are spherical balls of shredded bark generally found within an area of leaves, twigs, and materials gathered by woodrats that may include tinfoil, bottlecaps, and other discarded junk. Although the woodrat is nocturnal and appears to be rather shy, hikers have noted that it will sometimes appear above ground and chew at packs left lying around. The breeding season runs from February until September but may begin a bit later at the northern limits of distribution. Two to three litters of from one to six young are produced annually.

Preferred Habitat: The eastern woodrat prefers rock outcrops, caves and talus slopes with a southerly exposure. Surrounding forest vegetation is usually deciduous in nature, although several populations have been noted to occur in areas composed predominately of hemlock. Preferred food consists of grapes, acorns, tulip poplar heads and many other common items found throughout the forest. In several instances, large acorn mounds have been found in caves occupied by woodrats.

Management Practices: Although there is relatively little existing information concerning the eastern woodrat's requirements, it is believed that fragmentation of habitat, which increases the isolation of individual populations, may be one of several contributing factors to the woodrats' decline. Small, localized populations disappear through time and are not repopulated because other woodrats are unable to cross barriers such as multi-lane roads, large clearcuts, and other large-scale forest openings. More research is needed to understand the relationships between these factors, possible increases in parasitic infestation and changes in overall foodtypes before any long-term management can be initiated.

BALD EAGLE

Current Status: In Pennsylvania, endangered; nationally, threatened.

Population Trend: Pennsylvania's nesting bald eagle population has been on the rise in recent years. As recently as 1980, the state's known nesting population numbered three pairs. From 1997 to 1999, the nesting population doubled from 20 to 43 pairs. Despite this remarkable recovery, which was fueled by the Game Commission's eagle reintroduction program from 1983-89, bald eagles remain an endangered species in Pennsylvania because eagles still are not occupying significant portions of available habitat. Still, the bald eagle's future in the commonwealth is brighter than ever.

Identifying Characteristics: Bald eagles (Haliaeetus leucocephalus) are among the largest birds of prey. They may weigh up to 14 pounds and have seven-foot wingspans. Bald eagles are most readily identified by their white heads and tails, however, they don't attain this characteristic plumage until five years of age. Until that time, they are dark brown with varying amounts of white mottling.

History: Bald eagles are found throughout North America, most often around water where they catch and scavenge fish. Other carrion, and live, small animals are also among their prey. Eagles don't reach adulthood and begin nesting until age four or five. They nest in large trees near water, and normally produce one to three young per year. Adults will continue using and seasonally add to the same nest for years. Today, thanks to recovery efforts, bald eagles are nesting across the state. Non-breeding adults and sub-adults may be found throughout the state at any time of year. In winter, dozens of eagles are typically found along the Delaware River between Matamoras and Hancock, NY. Other concentration points include the lower Susquehanna River – south of Harrisburg – and Pymatuning Reservoir in Crawford County.

Preferred Habitat: Bald eagles thrive around bodies of water where adequate food exists and human disturbance is limited. Nesting eagles are particularly sensitive to human intrusions or disturbances. These activities could compel eagles to abandon a nest.

Reasons For Being Endangered: Water pollution made many areas of the state-and continent-unsuitable for eagles, and many former nesting sites have been lost to human development and encroachment. But the primary reason for the eagle's decline was the effect of the pesticide DDT and its derivatives on eagle reproduction. It accumulated in eagles and caused their eggs to be too thin to withstand the hen's weight during incubation. As a result, the bald eagle population plummeted. In 1972, the use of this pesticide in the United States was outlawed, and this drastic decline bottomed out.

Management Programs: The Game Commission annually monitors bald eagle nests – both existing and new – to measure nesting population trends. Since 1990, more than 200 eaglets have taken flight from Pennsylvania nests. During the reintroduction effort in the 1980s, the Game Commission captured, raised and released 88 eaglets from Saskatchewan. A good number of these birds have since returned to build nests and raise young. When discovered, new nest sites are protected and production is monitored.

OSPREY

Current Status: In Pennsylvania, threatened; nationally, no special protection.

Population Trend: Pennsylvania's nesting osprey population has been on the rise in recent years. As recently as 1986, the state had one known nesting pair of ospreys. Today, about 40 pairs have established nests in the state. The osprey was listed as extirpated in Pennsylvania in 1979. Reintroduction attempts in the Poconos prompted a reclassification as endangered. Ospreys were downlisted from endangered to threatened in 1998.

Biology-Natural History: The osprey is one of the world's most widely distributed birds. They are found along seacoasts and major waterways on every continent except Antarctica. They prey almost exclusively on fish. Ospreys nest in colonies and singly. Their stick nests are large and usually built near water. A breeding pair adds to the nest every year it is occupied. They usually nest in large trees, but they may be found nesting on channel markers, telephone poles, chimneys, and manmade platforms built specifically for their use. Usually three eggs are laid.

Preferred Habitat: Ospreys prefer lakes, ponds, rivers, and marshes bordered by trees. They require open water containing adequate fishing opportunities. In recent years, ospreys have produced young near lakes and rivers across most of the state. During spring and summer, non-breeding sub-adults can be found throughout the state. The world's largest nesting population of ospreys – approaching 2000 pairs – occurs in the

Chesapeake Bay area each spring. Osprey pairs typically return to Pennsylvania in late March to early April to nest.

Reasons for Being Threatened: In the early 1900s, ospreys nested along the state's larger waterways, but habitat destruction and water pollution made these areas unsuitable. Shootings also seem to have played some role in the bird's decline. Osprey populations were further decimated through the effects of insecticides such as DDT on their reproductive capabilities. Use of DDT in the late 1940s had a dramatic negative impact on ospreys and other birds of prey. By eating contaminated prey, the birds ingested the insecticide that, in turn, induced them to lay eggs with extremely thin shells – shells often so fragile, they broke when sat upon. Unable to reproduce, ospreys, which historically were never found in large numbers here, soon disappeared.

Management Programs: Between 1980 and 1996, 265 ospreys – obtained as nestlings from Chesapeake Bay nests – were released in Pennsylvania. The reintroductions occurred in three geographic areas: the Poconos, Tioga County reservoirs, and Morraine State Park (Butler County). Management plans include monitoring and protecting nest sites and continued erection of artificial nest platforms where needed.

AMERICAN BITTERN

Current Status: In Pennsylvania, endangered; Migratory bird of special concern in the Northeast.

Population Trend: American bitterns are uncommon to rare regular migrants in most of Pennsylvania. In Crawford County, however, they are regular breeding residents in scattered large wetlands, especially Geneva Marsh on State Game Lands 213. Nesting activity has been confirmed or suspected in 17 counties in the twentieth century. The American bittern has suffered greatly from the loss of wetland habitat, especially in southeastern Pennsylvania, where many marshes once used by breeding bitterns have been filled for development or choked by sedimentation. This species was listed as a threatened species from 1979 until 1997, when it was downgraded to endangered.

Biology-Natural History: American bitterns nest in marshes across the northern United States and southern Canada. They winter across the southern United States, through Mexico and into Central America. They nest singly, not in colonies like many other herons. This bird may be found year-round in Pennsylvania, but bitterns are most often seen here during spring and fall migrations. A few nest in scattered marshes across Pennsylvania, particularly, in the Pymatuning region. American bitterns build platform nests of reeds and grasses near the water, and normally lay a clutch of three to seven buff or olive-brown eggs. Young hatch in 24 to 28 days and leave the nest after another two weeks. They are often seen stalking along shorelines and marshes where they prey on frogs, fish, snakes, crayfish, insects, and other aquatic organisms.

Preferred Habitat: American bitterns require large wetland habitats. They are most likely found in marshes and wetland borders along lakes, ponds, rivers and streams. American bitterns seem to prefer to breed in extensive freshwater marshes, especially those with dense stands of cattails and thick patches of bulrushes, grasses, and sedges and pockets of open water.

Reasons for Being Endangered: The American bittern is endangered because of its dependency on specialized marshes; wetlands have declined by more than 50% in Pennsylvania over the past two centuries. Marshes remain at risk from sedimentation

and, to a lesser degree, encroachment. Habitat is key to any population augmentation of this species.

Management Programs: Areas in Pennsylvania where American bitterns regularly nest have been identified and are being protected when possible from development. Protection efforts include easements, land acquisition, and public education. Game Commission biologists and others who routinely perform bird survey/census work monitor the species for changes in distribution and nesting occurrences.

LEAST BITTERN

Current Status: In Pennsylvania, endangered; Migratory Bird of Management Concern in the Northeast.

Population Trend: Least bitterns are locally uncommon breeders in the Tinicum area in Philadelphia County; at Presque Isle State Park in Erie County; and in larger emergent wetlands in the state's northwestern counties. They are rare in suitable habitat elsewhere in the state. Least bitterns are declining in areas where their largest historical populations have been found. At Tinicum, only a few pairs have been nesting in recent years. In the late 1950s, however, as many as 27 nests were recorded there. Least bitterns were first designated as a threatened species in 1979. In 1997, the species was downgraded to endangered.

Identifying Characteristics: The smallest member of the heron family, the least bittern is 11 to 14 inches in length and has a 16- to 18-inch wingspan. This primarily black and tan bird has a blackish-green cap and back, brown neck and underparts, and a white throat. The least bittern is most readily identified in flight by conspicuous, chestnut-colored wing patches. A rare, darker phase also exists. When disturbed, the least bittern is more likely to run than fly, and like its relative, the American bittern, it also has the habit of freezing with its bill pointed straight up when alarmed.

Biology-Natural History: The least bittern nests in wetland areas throughout the eastern United States and along the Pacific coast. It spends the winter from our southern states south to Colombia, South America. This species is a regular migrant through the state, but it nests regularly in our northwest and southeast corners only, and possibly in a few other scattered locations, but not regularly or in significant numbers. The least bittern arrives in Pennsylvania in April and builds its platform nest of reeds and grasses near open water. Four or five pale blue or green eggs are laid in the six-inch nest in mid or late May. The young hatch in just under three weeks.

Preferred Habitat: Least bitterns thrive in dense marshland environments containing cattails and reeds, along the coast and inland, where they feed primarily on small fish, amphibians, insects and small mammals. They frequent brushy wetlands more frequently than their larger cousin, the American bittern.

Reasons For Being Endangered: Nesting opportunities for this species in Pennsylvania are limited and decreasing as the wetland habitat it needs has been extensively drained or impounded. Loss of tidal marshes along the Delaware River has been key to the bird's decline in the state. Its future is largely dependent upon safeguarding the state's remaining large marshes.

Management Programs: Areas where this species is known to nest should be protected. Surveys to further determine where least bitterns nest are ongoing. Marshland habitats, when possible, should be managed to provide additional nesting habitat.

SEDGE WREN

Current Status: In Pennsylvania, threatened; Migratory bird of management concern in the Northeast.

Population Trends: Sedge wrens may appear and possibly breed in Pennsylvania almost any time from late spring to early fall. They are absent from much of their historic range in the state, even where there is suitable habitat. Sedge wrens are rare, irregular migrants and breeders, not known to occur at any particular location in Pennsylvania on a regular basis. Their apparent decline in Pennsylvania seems to parallel a slipping population in the northeastern United States. This presumed decline may be attributable to habitat loss, but could also be related to the difficulty in seeing them in their preferred habitat, dense grass. The bird was designated threatened in 1985's Species of Special Concern in Pennsylvania, published by the Pennsylvania Biological Survey. Its status has not changed since then.

Biology-Natural History: In summer, sedge wrens are found from southern Saskatchewan and Minnesota across the Great Lake states to the east. They winter along the Atlantic and Gulf coasts, as far south as Mexico. Sedge wrens arrive in Pennsylvania in April and May, and migrate south to brackish coastal marshes from August to October. Among the last birds to nest in the state, sedge wrens may be found nesting here as late as August. They nest in wetland areas; a typical clutch of six or seven white eggs is laid in a globular nest built up to two feet off the ground. Young hatch in 12 to 14 days, and leave the nest at two weeks of age. Two broods can be produced each year.

Preferred Habitat: For nesting, sedge wrens require damp meadows and marshes where sedges and grasses are interspersed with small shrubs. They apparently do not do well in cattail marshes.

Reasons for Being Threatened: Sedge wrens are rare throughout their range. They used to be found nesting in scattered locations across Pennsylvania. Over the past several decades, however, they have disappeared from many of their former haunts, and numbers have dropped significantly in others. The loss of habitat and changing agricultural practices are thought to be responsible for this decline.

Management Practices: The specific locations where sedge wrens currently nest in the state need to be determined and then, where feasible, protected.

YELLOW-CROWNED NIGHT HERON

Current Status: In Pennsylvania, endangered; nationally, no special protection.

Population Trend: Yellow-crowned night herons are rare, regular visitors or residents in the Piedmont Region of southeastern Pennsylvania, where they breed locally. In the coastal plain area along the Delaware River near Philadelphia, they are rare, irregular visitors. They are casual to accidental visitors elsewhere in the state. Most summer sightings are reported along the tributaries of the Susquehanna River in Cumberland, Lancaster and York counties. They nest singly and in loose colonies regularly along Conodoquinet Creek near its confluence with the Susquehanna. Nests are also found along Conestoga and Little Conestoga creeks in Lancaster County. Surveys in the 1990s counted not more than eight to 12 nests in any year in the state. Yellow-crowned night heron were first listed as threatened species in 1990 because of their limited population and restricted range. They were downgraded to endangered in 1999 because of their small population.

Identifying Characteristics: Adults are 22 to 28 inches in length, from bill tip to tail tip, gray with black head and a whitish cheek patch and crown. Eyes are red and legs yellowish. Their name identifies a distinguishing characteristic – the yellowish crown, or top of the head. Immature birds are brown, finely spotted and streaked with white buff.

Biology-Natural History: Pennsylvania lies at the northern fringe of this species' breeding range, which is mainly in the south-central United States. It nests singly or in small groups in the lower reaches of the Susquehanna River. A typical clutch contains three or four eggs. Nesting starts as early as April. By mid-summer most young have fledged. Crayfish are a major part of this bird's diet.

Preferred Habitat: Feeds mainly along small shallow streams. Nests in brush or trees, usually sycamores, found on islands or along streams. Most nests found in recent years are along the Susquehanna River and its tributaries in Lancaster County. Birds seem tolerant of human activities. They are known to nest within 100 yards of houses and roads.

Reasons For Being Endangered: As a breeding bird, the combination of rarity and tendency to nest in small groups makes this species particularly vulnerable to local habitat disturbance or loss. The largest nesting colony known in Pennsylvania, representing more than half the state's known breeding population, was on a small Susquehanna River island, located offshore of the Governor's Residence. It subsequently moved to the mouth of the Conodoquinet, but disturbance there appears to have dispersed the colony. The integrity of this site and nearby shallow-water feeding areas are threatened by a proposed dam. Degradation of water quality, along with loss of the primary food source – crayfish – is an ever-present threat.

Management Practices: Known nest sites for this species are monitored and potential new sites need to be surveyed. Whenever possible, nesting habitats need to be protected.

D. Review of Lehigh River Watershed Biological Components

Biodiversity is essential to the health of our natural environment and to sustaining the benefits that human beings derive from nature. The leading causes of biodiversity loss in Pennsylvania are loss and degradation/fragmentation of habitat, non-native invasive species, pollution, and the imbalance of native species such as the overabundance of white-tailed deer (DCNR, 2003).

The river crosses two major forest regions: the Hemlock-White Pine-Northern Hardwoods Forest Region and the Oak-Chestnut Forest Region. The northern ridges and slopes of the Lehigh River watershed contain some Canadian, northern plant species that are near their southern limit and a number of Carolinian or southern plants reach their northern extent near South mountain.

In the Lehigh River, smallmouth and largemouth bass are well established in the lower stretches of the river as well as other species. In addition, shad have been successfully reintroduced to the Lehigh River.

Diversity among invertebrates, reptiles, amphibians, birds, and mammals is good within the watershed. Invertebrates are ecologically involved with virtually every biotic process occurring in natural communities, from pollination, herbivory, and predation to soil formation, disease

transmission, nutrient cycling and decomposition to name only a few. Amphibians, reptiles, and birds are excellent indicators of stream and watershed health. As a group, mammals are only a small percentage of the state's native species of plants and animals. However, because mammals are familiar to so many citizens of Pennsylvania, they are important as symbols of the Commonwealth's native biological diversity. It will be important to continue monitoring both overall diversity and the dynamics of select species in relation to environmental variables.

Species of concern in the watershed, which are either threatened or endangered, include the bald eagle, yellow-crowned night heron, American bittern, least bittern, least shrew, eastern woodrat, osprey, and sedge wren.

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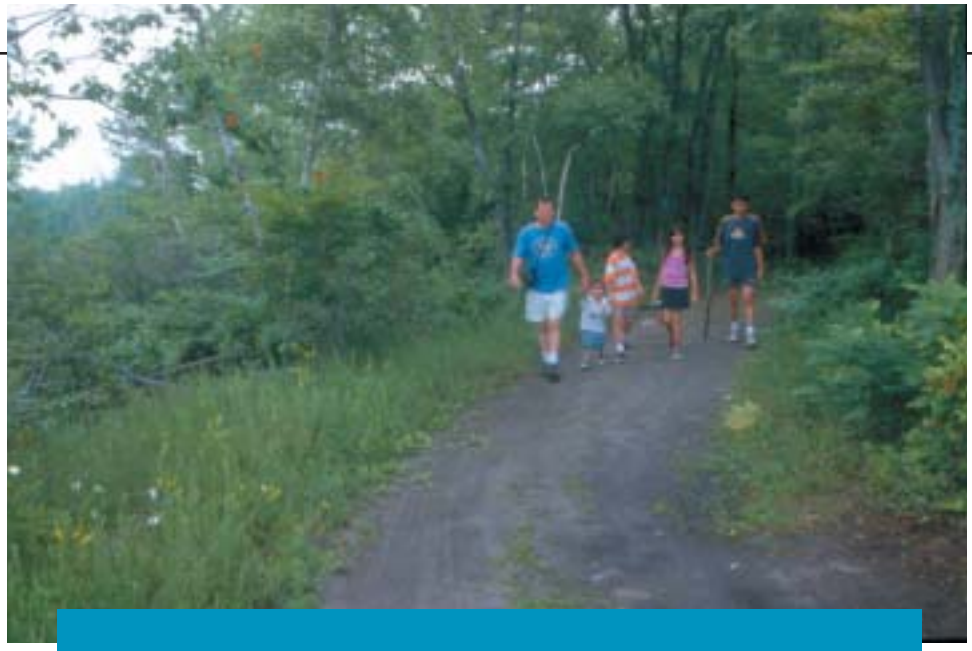

Part VI

RECREATION COMPONENTS

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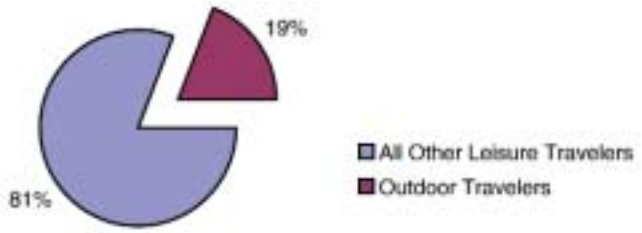
A. Outdoor Recreation

1. Economic Value and Visitor Profile of Outdoor Recreation

In 1997, 15.89 million visitors traveled in Pennsylvania for outdoor recreational vacations (Figure 6-1). This amount accounts for nearly one-fifth of the total leisure travel with Pennsylvania as the destination. Fifty-nine percent of outdoor recreation travelers visited state lands including the five state parks in the Lehigh River watershed. Forty-four percent of the total outdoor visitors are residents of Pennsylvania. Residents from New York, New Jersey, Ohio, Maryland, and Virginia comprised another thirty-nine percent of the visitors. A survey conducted by the Pennsylvania Department of Conservation and Natural Resources indicated that forty-one percent of these travelers chose Pennsylvania for its beautiful landscape and scenery.

Figure 6-1. 1997 Volume of Pennsylvania Outdoor Recreation Vacation Travel: Person-Trips (Pa. DCNR, 1999)



Those traveling for an outdoor recreation experience spent one-third of the total direct expenditures by leisure travels. The amount spent for this specific purpose totaled close to $4.03 billion. In total, $7.92 billion was generated both directly and indirectly from these travelers (Pa. DCNR, 1999).

The Lehigh River watershed is home to many outdoor recreation experiences. Interested individuals visiting the watershed can enjoy whitewater boating on the longest section (26 miles) of continuous whitewater on the East Coast. They can enjoy fishing throughout the watershed including many special regulation fishing areas or guided fishing experiences on the Lehigh River. Skiing is available at four locations throughout the watershed. Several premiere mountain biking destinations are within the watershed and there are numerous trails and recreation areas in the form of local, county, neighborhood, community parks/centers, and open spaces listed in Appendix C-1.

2. State Parks

Pennsylvania's state parks feature an array of recreational opportunities, provide a forum for multiple environmental education programs, and conserve thousands of acres of unique natural areas, among many other features. There is a state park within 25 miles of nearly every Pennsylvanian. The 116 state parks in Pennsylvania cover roughly 283,000 acres. (Pa. DCNR web site, 2003).

The Pennsylvania Department of Conservation and Natural Resources, Bureau of State Parks is the state agency and bureau responsible for management of state parks within the Commonwealth of Pennsylvania. The bureau's mission is "To provide opportunities for enjoying healthful outdoor recreation and to serve as outdoor classrooms for environmental education. In meeting these purposes, the conservation of the natural, scenic, aesthetic, and historical values of the parks should be given first consideration. Stewardship responsibilities should be carried out in a way that protects the natural outdoor experience for the enjoyment of current and future generations." (Pa. DCNR web site. 2003).

A total of five of the 116 state parks in Pennsylvania are located within the Lehigh River watershed. These state parks include Beltzville, Gouldsboro, Hickory Run, Lehigh Gorge, and Tobyhanna. The parks occupy a total of approximately 31,460 acres of land within Carbon, Monroe, Luzerne, and Wayne counties. A description of the overnight facilities, day-use facilities, and recreational activities available within these parks is provided Appendix C-2.

A map depicting the spatial distribution of state parks within the Lehigh River watershed can be found in Map 6-1. Detailed maps of individual state parks and continually updated information regarding overnight facilities, day-use facilities, and recreational activities available at these parks can be obtained by contacting the Pennsylvania Department of Conservation and Natural Resources, Bureau of State Parks.

The state's park at Beltzville covers nearly 3,000 acres, and surrounds the U. S. Army Corps of Engineer's 970-acre flood-control dam and lake.

3. STATE FORESTS

Pennsylvania's state forests provide an almost endless list of outdoor activities including hiking, biking, ATV and snowmobile riding, fishing and hunting. State forests also provide natural habitats for thousands of plant and animal species. State forestlands comprise 2.1 million acres of "Penn's Woods." (Pa. DCNR web site, 2003).

The Pennsylvania Department of Conservation and Natural Resources (DCNR), Bureau of Forestry is the state agency and bureau responsible for management of state forests within the Commonwealth of Pennsylvania. The bureau's mission is "To ensure the long-term health, viability, and productivity of the Commonwealth's forests and to conserve native wild plants." (Pa. DCNR web site 2003)

Portions of two of Pennsylvania's total of 20 state forests are located within the Lehigh River watershed. These state forests include Weiser State Forest (19,200 acres) in Dauphin, Carbon, Schuylkill and Berks Counties, and Lackawanna State Forest (8,400 acres) in Lackawanna and Luzerne Counties. A description of the recreational activities available within each of these state forests is provided below in Table 6-1.

TABLE 6-1. STATE FOREST RECREATIONAL INFORMATION
Source: Pennsylvania Recreational Guide and Highway Map. Pennsylvania Department of Conservation and Natural Resources. 2003.

Recreational Information	*Weiser State Forest*	*Lackawanna State Forest*
District Number	18	11
District Office Telephone Number	570-385-7800	570-963-4561
Acres of State Forest	19,200	8,400
Natural and Wild Areas	N	N
Fishing (C-Cold Water), (W-Warm Water)	C	C
Hunting	YES	YES
Primitive Camping	YES	YES
National and State Hiking Trails (miles)	4	23
Cross Country Ski Trails (miles)	0	24
Mountain Biking	YES	YES
State Forest Picnic Areas	2	1
Snowmobile Trails (miles)	40	24
Horseback Riding	YES	YES
ATV Trails	0	0

This remarkable boulder field was left when rock-bearing glaciers melted 20,000 years ago. Today, it is a National Natural Landmark.

A map depicting the spatial distribution of state forests within the Lehigh River watershed can be found in Map 6-1. Detailed maps of individual state forests and continually updated information regarding trails and other recreational activities available at these forests can be obtained by contacting the Pennsylvania Department of Conservation and Natural Resources, Bureau of Forestry.

4. State Game Lands

Hunters, anglers, hikers, birdwatchers and other wildlife and outdoor recreation enthusiasts are welcome on State Game Lands. The Pennsylvania Game Commission is the state agency responsible for managing all of Pennsylvania's State Game Lands, in addition to the management of game and other wildlife populations. To ensure wild animals always have food and shelter, the agency, since 1920, has been purchasing lands for inclusion in its State Game Lands system, which currently contains about 300 separate tracts comprising a total of about 1.4 million acres. (Pa. Game Commission web site, 2003.)

Access to 16 of Pennsylvania's state game lands can be found within the Lehigh River watershed. These game lands occupy a total of approximately 127,230 acres of land within Berks, Carbon, Lackawanna, Lehigh, Luzerne, Monroe, Northampton, Schuylkill and Wayne counties. A listing of these individual State Game Lands, the counties in which they are located, and each individual Game Lands' total acreage is provided in Table 6-2.

Table 6-2. State Game Lands Information
Source: Pennsylvania Game Commission web site 2003.

State Game Lands #	County/Counties	Total Acres
38	Monroe	5,488.61
40	Carbon	6,118.51
91	Lackawanna/Luzerne	16,659.20
119	Luzerne	7,967.29
127	Monroe	25,518.95
129	Carbon/Monroe	3,518.40
135	Lackawanna	3,430.54
141	Carbon	17,047.91
149	Luzerne	1,989.69
168	Northampton/Carbon/Monroe	5,802.85
205	Lehigh	1,302.80
217	Lehigh/Carbon/Schuylkill	7,122.30
257	Schuylkill	3,448.47
312	Lackawanna/Monroe/Wayne	3,912.12

A map depicting the spatial distribution of state game lands within the Lehigh River Watershed can be found in Map 6-1. Detailed maps of individual state game lands and continually updated information regarding hunting and trapping regulations, wildlife management information and other information can be obtained by contacting the Pennsylvania Game Commission.

5. Delaware and Lehigh National Heritage Corridor

Lehigh Gorge State Park is in the Audubon's Lehigh Reach of the Delaware and Lehigh National Heritage Corridor. The Corridor stretches more than 150 miles from Wilkes-Barre to Bristol, in eastern Pennsylvania, and follows the historic routes of the Lehigh &

Susquehanna Railroad, the Lehigh Navigation, and the Delaware Canal. The Corridor highlights the extraordinary natural, cultural, and recreational resources and works in partnership to conserve the heritage and enhance the quality of life for its many residents. Visitor centers are available throughout the region to direct visitors to many opportunities that tell the stories that make the region so nationally significant.

Lehigh Gorge State Park and Hickory Run State Park are featured in a unique "Auto Tour" entitled "Exploring Audubon's Lehigh." The tour focuses on famed naturalist John James Audubon's 1829 visit to the Rockport area of the Lehigh River Valley and looks at the valley's natural and historical landscapes. Brochures and cassette tapes are available at several locations along the 53-mile route. Signs mark the route and identify tour stops. The tour begins at Jim Thorpe at the Old Mauch Chunk Landing or at White Haven at the Lehigh Canal Depot.

6. TRAILS IN THE LEHIGH RIVER WATERSHED

Trails provide places for cyclists, hikers, walkers, runners, inline skaters, cross-country skiers, and physically challenged individuals to exercise. Trails not only serve as independent community amenities, they also enhance existing recreational resources by linking neighborhoods and schools to parks, waterfronts, recreational centers, and other facilities. Trail users also experience and are educated about the many natural and cultural wonders of the region's urban, suburban, and rural environments. Additionally, trails can greatly help to improve public health.

Trails create healthy recreation and transportation opportunities by providing people of all ages with attractive, safe, accessible places to cycle, walk, hike, jog, or skate. Trails help people of all ages incorporate exercise into their daily routines by connecting them with places they want or need to go.

In a recent report on physical activity and health, the U.S. Department of Health and Human Services (HHS) concluded: "approximately 300,000 U.S. deaths a year are associated with obesity and overweight (compared with 400,000 deaths a year associated with cigarette smoking)."

Environmentally, trails can support the health of watersheds in various and numerous ways. Foremost, the health of the watershed will be enhanced by preserving trails and greenways, and thus avoiding developing these areas. This allows intact natural systems to act as erosion controls, flood controls and pollution filters, as well as important sources of food and habitat for wildlife. These natural systems, enhanced by trails constructed of permeable materials, slow down rainfall and storm water runoff to allow for ground infiltration and ground water recharge. Greenways along trails can reduce public expenditures by lowering flood and other natural hazard costs. Additionally, trails and greenways improve air quality by protecting the plants that naturally create oxygen and filter out air pollutants such as ozone, sulfur dioxide, carbon monoxide, and airborne particles of heavy metals, and by providing enjoyable and safe options for transportation, which reduces air pollution.

The scenic trails located in the Lehigh River watershed are shown in Map 6-2. Many trails are still waiting to be established.

a. Appalachian National Scenic Trail

The Appalachian National Scenic Trail is a 2,167-mile (3,488 km) footpath along the ridge crests and across the major valleys of the Appalachian Mountains from Katahdin in Maine to Springer

When there is an abundance of ground and surface water, waterfalls can be found throughout the Lehigh Gorge.

Mountain in north Georgia. The trail traverses Maine, New Hampshire, Vermont, Massachusetts, Connecticut, New York, New Jersey, Pennsylvania, Maryland, West Virginia, Virginia, Tennessee, North Carolina, and Georgia. Day, weekend and other short-term hikers, section hikers and thru-hikers use the Appalachian Trail (A.T.). Thru-hikers hike the entire length of the Trail in one season. (United States Department of the Interior, National Park Service web site. 2003).

The A.T. began as a vision of forester Benton MacKaye, and was developed by volunteers and opened as a continuous trail in 1937. The National Trails System Act of 1968 designated it as the first National Scenic Trail. The trail is currently protected along more than 99 % of its course by federal or state ownership of the land or by rights-of-way. Annually, more than 4,000 volunteers contribute over 175,000 hours of effort on the Appalachian Trail. (United States Department of the Interior, National Park Service web site 2003.)

As shown in Map 6-2, approximately 32 miles of the 229.4 total miles of the Appalachian Trail crossing through the Commonwealth of Pennsylvania cross through the Lehigh River watershed. The Lehigh River watershed segment of the Appalachian Trail is located on the ridge top of Blue Mountain, crossing through Schuylkill, Carbon, Lehigh, Northampton, and Monroe County boundaries. Elevations within this segment of the trail range from approximately 400 to 1,600 feet.

There are opportunities for the public to enjoy several short "day hikes" through scenic portions of the Appalachian Trail that cross through the Lehigh River watershed. Brief descriptions of these trail segments are provided below.

Hawk Mountain to Pa. Rt. 309

This moderately difficult segment of the trail is approximately 13.3 miles in length. Hike duration is approximately seven and one-half hours. An overnight backpacking hike is optional. Camping shelters are provided at Eckville and Allentown. Natural History features include Hawk Mountain and Hawk Mountain Sanctuary. Social History features include Dan's Pulpit and Tri-County Corner. (Glenn Scherer and Don Hopey, 1998).

The Cliffs and Bear's Rocks

This moderately difficult segment of the trail is approximately 4.9 miles in length. Hike duration is approximately three hours. Camping shelters are provided at New Tripoli. Natural History features include The Cliffs and Bear's Rocks. (Glenn Scherer and Don Hopey, 1998).

Bake Oven Knob to Lehigh Gap

This moderately difficult segment of the trail is approximately 9.5 miles in length. Hike duration is approximately five hours. Natural History features include Bake Oven Knob.

Social History features include Lehigh Furnace and Lehigh Gap Superfund Site. (Glenn Scherer and Don Hopey, 1998).

Detailed maps of these and all segments of the Appalachian Trail can be obtained by contacting the Appalachian Trail Conference. The Appalachian Trail Conference is a volunteer-based organization dedicated to the preservation and management of the natural, scenic, historic, and cultural resources associated with the Appalachian Trail, in order to provide primitive outdoor-recreation and educational opportunities for trail visitors. (Appalachian Trail Conference web site 2003)

The world-famous, 2,160-mile Appalachian Trail slices through the eastern portion of the state on the Blue Mountain from the Delaware Water Gap to the Maryland line, and provides access to some of the commonwealth's most beautiful vistas.

b. Rail-Trails

Abandoned railroad corridors give people the opportunity to enjoy such things as hiking, biking, horseback riding, skiing, and snowmobiling. Over the past few years interest in improving these abandoned railroad corridors has grown. In 1990, the Pennsylvania Rails-to-Trails Program was established in order to protect and preserve these abandoned railways for public recreational use. This program converts abandoned railroad corridors into hiking, biking, and jogging trails. The Rails-to-Trails program has already converted many miles of abandoned railroad corridors into public trails.

Converting an abandoned rail corridor into a trail is not always an easy task, but it is one whose rewards to your community and region will continue far into the future.

—Peter Harnick, Converting Rails to Trails, 1989

There are several existing Rail-Trails within the Lehigh River watershed. Additional Rail-trails are currently under construction or have recently been proposed. Brief descriptions of these trails are provided below:

LEHIGH GORGE STATE PARK RAIL-TRAIL (26 MILES)

This beautiful nature trail includes small waterfalls, dense hemlock stands, and continuous views of the Lehigh River. The main path is 21 miles and extends to 26 miles when the extensions above White Haven and below Glen Onoko are included. Trail endpoints are Jim Thorpe and White Haven.

THE SWITCHBACK RAILROAD RAIL-TRAIL (16 MILES)

The world's first Gravity Railroad is now a mountain bike trail. The path is approximately 18 miles in length when both the upper and lower tracks are combined. This is a very interesting trail, with a unique history and wonderful scenery. There are two trails, the upper and lower trails. Endpoints of the trail are Jim Thorpe and Summit Hill.

IRONTON RAIL-TRAIL (9 MILE LOOP)

This trail begins in North Whitehall Township, and within one and one-half miles the trail branches off into a northern and a southern loop within the Whitehall Parkway. The Parkway includes ten historic sites including the remains of the limestone and cement

Among a growing number of rail-trail conversions in the country, the Ironton Rail-Trail is popular, accessible, and well-maintained.

industry that first brought wealth to the Lehigh Valley and surrounding areas. The path winds past quarry and kiln ruins.

THE CANAL TRAIL (9 MILES)

The Canal Trail is part of the huge network of trails called the Delaware and Lehigh Canal Heritage Trail. This trail will encompass 165 miles when completed. With the Lehigh River on the south side and the canal on the north side there is much variety and scenery on this winding trail. Pick up the trail in Canal Park off the Hamilton Street Bridge in Allentown.

NOR-BATH TRAIL (5.2 MILES)

This trail is located in an entirely rural setting with farm fields, woods, and wild apple trees. It is a newly constructed trail with a wide berth and an extremely smooth surface. There are a few historical markers showing the area of the walking purchase, one of the earliest Scotch-Irish settlements, and the Indian defense called Fort Franklin. The trails endpoints are Weaversville and Jacksonville. For 77 years, the Northampton Bath Railroad traveled the seven miles between the two towns sending out cement and bringing in limestone, gypsum, and coal to the area. There are currently plans to extend the trail into both the Boroughs of Northampton and Bath.

> *Rail-trails are a perfect means of telling community stories. Their long and colorful history make perfect greenways. They combine that history with a respect for the environment, and recreation, and allow us to live life on a human scale, maintaining contact with each other and with nature.*
>
> *—David Burwell, President, Rails-to-Trails Conservancy, 1998*

TOWPATH BIKE TRAIL (5 MILES)

This trail begins at South 25th Street in Palmer Township, runs north to William Penn Highway, West to Bethlehem, and back down to Palmer Township. The trail follows the Eastern Northern Rail Bed. The trail surface is paved. Three additional miles of trail are currently being planned. This trail is open for public use.

BUCKWA CREEK TRAIL (2.5 MILES UNDER CONSTRUCTION)

The trail is located in Carbon and Monroe Counties. All non-motorized uses will be permitted. The trail surface will be crushed limestone.

NORTHERN LEHIGH SLATE TRAIL (3.3 MILES PROPOSED)

Slatington and Washington Townships have pursued the acquisition and planning of the Northern Lehigh Slate Trail along the former Lehigh Valley Railroad right-of-way from the site of the old train depot in lower Slatington (adjacent to the Lehigh River) to the Slatedale Fire Company's ball fields. This proposed trail will offer opportunities to hike, walk, jog, bicycle, fish, ride horse-back, bird watch and explore the slate history along the scenic Trout Creek.

A map depicting the spatial distribution of existing rail-trails within the Lehigh River watershed can be found in Map 6-2. Detailed and continually updated information regarding the status of existing, currently under construction, and proposed rail-trails projects can be obtained by contacting the Pennsylvania Department of Conservation and Natural Resources.

In addition to the above-mentioned rail-trails, several abandoned railroad lines exist in the watershed. These abandoned rail lines, shown in Map 6 – 2, provide great opportunities for potential recreational corridors.

c. Lehigh River Water Trail

"Water trails are boat routes suitable for canoes, kayaks and small, motorized watercraft. Like conventional trails, water trails are recreational corridors between specific locations. Water trails are comprised of access points, boat launches, day-use sites, and in some cases, overnight camping areas. Each water trail is unique, a reflection of Pennsylvania's diverse geology, ecology and communities. Water trail guides show "trail heads" (boat launch and take-out points) and provide background about the scenic, historic and geologic points of interest along the way." (Pa Fish & Boat Commission Pennsylvania Water Trail's web site 2003) The Pennsylvania Fish and Boat Commission is the agency responsible for designating Official Pennsylvania Water Trails. However, individual trails and trail corridors are conceived and maintained by a network of volunteers, property owners, civic groups, and associations.

Wildlands Conservancy has worked with the Pennsylvania Fish and Boat Commission to develop an Official Pennsylvania Water Trail for a 75-mile portion of the Lehigh River from Francis E. Walter Reservoir to Easton (see Map 6-3). The web-based version of the Lehigh River Water Trail can be accessed at www.wildlandspa.org. Water trail maps and continually updated information regarding the status of existing and proposed Water trail projects can be obtained by contacting the Pennsylvania Fish and Boat Commission.

d. Other Trails

There are several additional recreational trails found within the Lehigh River watershed, in addition to those previously discussed. These trails are located within several of the county, neighborhood and community parks/centers and open spaces within the Lehigh River watershed. Information regarding these recreation opportunities is located in Appendix C-3.

7. Other Outdoor Recreation Opportunities in the Watershed

a. Fishing

The Lehigh River and its tributaries offer year-round opportunities for public fishing for several species of warm-water, cool-water and cold-water fish. The Pennsylvania Fish and Boat Commission is the primary state agency responsible for managing fisheries and for developing and enforcing fishing and boating regulations within the Commonwealth of Pennsylvania. The agency's goals are to protect, conserve and enhance aquatic resources, provide for the protection of aquatic resource users, address the expectations of anglers and boaters, and advocate the wise, safe use of Pennsylvania's aquatic resources. Popular game fish found within the Lehigh River watershed are listed in Table 6 – 3.

People come from other states to join locals who fish the Lehigh and its tributaries for prize-winning wild trout.

American shad, brook trout, brown trout, and rainbow trout are among the most popular game fish species sought by anglers within the Lehigh River watershed. The Pennsylvania Fish and Boat Commission have documented portions of the Lehigh River and several of its tributaries to contain naturally reproducing populations of trout.

TABLE 6-3. POPULAR GAME FISH WITHIN THE LEHIGH RIVER WATERSHED

Scientific or Latin Name	Common Name
Alosa sapidissima	American shad
Ictalurus punctatus	channel catfish
Esox masquinongy	muskellunge
Esox niger	chain pickerel
Oncorhynchus mykiss	rainbow trout
Salmo trutta	brown trout
Salvelinus fontinalis	brook trout
Micropterus dolomieu	smallmouth bass
Micropterus salmoides	largemouth bass
Pomoxis nigromaculatus	black crappie
Stizostedion vitreum vitreum	walleye

"Class A" wild trout populations represent the most productive of Pennsylvania's naturally reproducing trout fisheries. The Pennsylvania Fish and Boat Commission's policy is to manage self-sustaining "Class A" wild trout populations as a renewable natural resource, in order to conserve that resource and the angling opportunities that it provides. Criteria developed for "Class A" wild trout fisheries are species specific. The commission manages these stream segments solely for the perpetuation of a wild trout fishery with no stocking.

Table 6-4 includes a listing of stream segments within the Lehigh River watershed that have been classified by the Pennsylvania Fish and Boat Commission as "Class A" Wild Trout Waters. More detailed information regarding specific limits and ownership status of "Class A" Wild Trout Waters is located within Appendix C-4. Continually updated information regarding "Class A" Wild Trout Waters can be obtained by contacting the Pennsylvania Fish and Boat Commission.

TABLE 6-4. "CLASS A" WILD TROUT WATERS WITHIN THE LEHIGH RIVER WATERSHED
Source: Pennsylvania Fish and Boat Commission 2003 List of Class A Wild Trout Waters

County	Stream Name	Designation	Section Length (miles)	Nearest Town
Carbon	Aquashicola Creek	Mixed Wild Brook/ Brown Trout	2.4	Wind Gap
Carbon	Little Bear Creek	Wild Brook Trout	1.9	Jim Thorpe
Carbon	Black Creek	Wild Brown Trout	3	White Haven
Carbon	Hickory Run	Wild Brown Trout	1.6	White Haven
Lackawanna	Ash Creek	Wild Brook Trout	1.9	Clifton
Lehigh	Cedar Creek	Wild Brown Trout	1.1	Emmaus
Lehigh	Little Lehigh Creek	Wild Brown Trout	1.6	Breinigsville
Lehigh	Trout Creek	Wild Brown Trout	1.6	Allentown
Monroe	Pohopoco Creek	Wild Brown Trout	8	Brodheadsville
Monroe	Singer Run	Wild Brook Trout	1	Tobyhanna
Northampton	Monocacy Creek	Wild Brown Trout	1.9	Bethlehem
Northampton	Monocacy Creek	Wild Brown Trout	1.9	Bethlehem
Northampton	Nancy Run	Wild Brown Trout	1.6	Freemansburg
Northampton	Saucon Creek	Wild Brown Trout	2.1	Hellertown
Total number of miles of "Class-A" Wild Trout Waters:			**31.6**	

Certain waters that do not meet the species specific "Class A" wild trout fisheries criteria have been classified by the Pennsylvania Fish and Boat Commission as "Approved Trout Waters." These waters meet specific water quality and habitat related criteria to be stocked with trout so that they may support a "put-and-take" fishery, in order to provide public fishing opportunities.

Table 6 – 5 provides a listing of Approved Trout Waters within the Lehigh River watershed. Additional

TABLE 6-5. APPROVED TROUT WATERS WITHIN THE LEHIGH RIVER WATERSHED
Source: Pennsylvania Fish and Boat Commission 2003 Summary of Fishing Regulations and Laws and Personal Communication, 2003.

County	Stream	County	Stream
Berks/Lehigh	Little Lehigh Creek	Lehigh	Big Trout Creek
Carbon	Aquashicola Creek	Lehigh	Cedar Creek
Carbon	Buckwa Creek	Lehigh	Coplay Creek
Carbon	Drakes Creek	Lehigh	Jordan Creek
Carbon	Francis E. Walter Reservoir	Lehigh	Saucon Creek-South Branch
Carbon	Hickory Run	Lehigh	Swabia Creek
Carbon/Northampton	Lehigh Canal	Lehigh	Switzer Creek
Carbon/Lackawanna/Monroe	Lehigh River	Luzerne	Wrights Creek
Carbon/Schuylkill	Lizard Creek	Monroe	Tobyhanna Creek
Carbon/Schuylkill	Mahoning Creek	Monroe	Tobyhanna Lake
Carbon	Mauch Chunk Creek	Northampton	Hokendauqua Creek
Carbon	Mud Run	Northampton	Monocacy Creek
Carbon/Monroe	Pohopoco Creek	Northampton	Saucon Creek
Carbon	Sand Spring Run		

TABLE 6-6. SPECIAL REGULATION AREAS WITHIN THE LEHIGH RIVER WATERSHED
Source: Pennsylvania Fish and Boat Commission 2003 Summary of Fishing Regulations and Laws.

County	Stream Name	Special Regulation Category	Special Regulation Area Length (miles)
Carbon	Hickory Run	Catch and Release	2.88
Carbon	Mud Run	Delayed Harvest Artificial Lures Only	2.5
Lehigh	Little Lehigh Creek	Heritage Trout Angling	1.0
Lehigh	Little Lehigh Creek	Delayed Harvest Fly Fishing Only	1.8
Monroe	Tobyhanna Creek	Delayed Harvest Artificial Lures Only	1.0
Northampton	Monocacy Creek	Trophy Trout	1.9
Northampton	Saucon Creek	Selective Harvest	2.1
Total number of miles of Special Regulation Waters:			**13.18**

up-to-date information concerning Approved Trout Waters can be obtained within the Summary of Fishing Regulations and Laws, which is published annually and updated regularly by the Pennsylvania Fish and Boat Commission, or by contacting that agency.

In addition to the Pennsylvania Fish and Boat Commission, several private stocking associations such as Lehigh River Stocking Association (LRSA) and Northampton-Lehigh-Carbon Outdoor Sportsmen Association (NLC) stock tens of thousands of trout into the river each year to help maintain a thriving sport fishing recreational outlet on the Lehigh River.

The Pennsylvania Fish and Boat Commission has developed a series of Special Regulation Areas, which are designed to allow that agency to achieve its fisheries management objectives and to protect, conserve and enhance the Commonwealth's aquatic resources. Table 6-6 includes a listing of Special Regulation Areas within the Lehigh River Watershed. More detailed information regarding specific Special Regulation Area boundaries is located within Appendix C-5. A description of Special Regulations and additional up-to-date information about Special Regulation Areas can be obtained within the Summary of Fishing Regulations and Laws or by contacting the Pennsylvania Fish and Boat Commission.

TABLE 6-7. FISH CONSUMPTION ADVISORIES WITHIN THE LEHIGH RIVER WATERSHED
Source: Pennsylvania Fish and Boat Commission 2003 Summary of Fishing Regulations and Laws.

County	Waterway	Area Under Advisory	Contaminant
Carbon	Beltzville Lake	Entire Lake	Mercury
Carbon, Monroe	Tobyhanna Creek	Pocono Lake Dam to mouth	Mercury
Northampton	Lehigh River	Conf. of Saucon Creek to mouth	Mercury

The Pennsylvania Fish and Boat Commission has established Fish Consumption Advisories that are designed to provide guidance to individuals or segments of the population at risk from exposure to contaminants in fish. Advisories are not regulatory standards, but are recommendations intended to provide information of particular interest to high-risk groups such as pregnant women and young children.

Listed in Table 6-7 are the Fish Consumption Advisories within the Lehigh River watershed. More detailed information regarding specific species and suggested meal frequencies is located within Appendix C-6. Additional up-to-date information regarding Fish Consumption Advisories can be obtained within the Summary of Fishing Regulations and Laws or by contacting the Pennsylvania Fish and Boat Commission.

b. Skiing

Downhill skiing, cross-country skiing, and snowboarding are among popular forms of winter outdoor recreation available in the Lehigh River watershed. Ski recreation areas provide opportunities for the public to pursue these and other forms of winter outdoor recreation including, but not limited to, snow mobiling, snow tubing, and snow shoeing.

Four ski areas are located within the watershed. These areas include Jack Frost and Big Boulder Ski Areas in Blakeslee, Blue Mountain Ski Area in Palmerton, and Bear Creek Ski and Recreation Area in Macungie. These ski areas provide a total of approximately 341 acres of terrain for novice, intermediate and expert skiers, and snowboarders of all ages. The vertical drops (differences in summit elevations and base elevations) of these ski areas range from 475 to 1,065 feet. Each ski area is equipped with 100% snowmaking capabilities, and several of the ski areas provide lighted trails over 100% of their terrain for night skiing and snowboarding. Detailed maps of individual ski recreation areas and additional continually updated information regarding ski and snowboarding programs and packages, season specials, ski area services, accommodations, hours of operation, and other information can be obtained by contacting the individual ski areas. (Jack Frost Ski Area Web site. 2003, Big Boulder Ski Area Web site. 2003, Blue Mountain Ski Area Web site. 2003, Bear Creek Ski & Recreation Area Web site. 2003).

c. Non-motorized boating

The Lehigh River watershed provides an array of recreational opportunities for the non-motorized boater. The Lehigh River, especially, is a popular destination for non-motorized boaters interested in pursuing whitewater rafting, kayaking, and canoeing.

The section of the Lehigh River between Francis E. Walter Dam near White Haven and the mouth in Easton is a popular section of the river that is enjoyed by various types of non-motorized boaters with varying levels of experience. This section of the Lehigh River is approximately 75 miles in length and ranges from Class I (easy) waters with small riffles and

waves and courses that are easy to find, to Class III (difficult) waters that include high irregular waves, courses that are not easy to recognize, and waters that may require complex maneuvering.

The Lehigh River's changeable character provides thrills, as well as tranquility. Some of the best white-water rafting in the East can be found on the upper Lehigh River.

Six whitewater outfitters are located in the watershed. These outfitters include Lehigh Rafting Rentals in White Haven, Lehigh Gorge Outfitters in White Haven, Whitewater Challengers in White Haven, Whitewater Rafting Adventures in Nesquehoning, Jim Thorpe River Adventures in Jim Thorpe and Pocono Whitewater Adventures in Jim Thorpe. Continually updated information regarding rafting, kayaking, and canoeing trips, rentals and instruction, whitewater conditions and other information can be obtained by contacting the individual outfitters.

In addition, several local companies provide guided fishing trips on the Lehigh River using drift boats. This is a relatively new recreational activity on the Lehigh River. The increase in the guiding fishing opportunities on the Lehigh River speaks to the return of the river as a recreational resource and to the efforts of groups who stock trout in the river. Information regarding guided fishing trips can be obtained at the Lehigh River Stocking Associations web site at LRSA.org.

d. Bicycling

The Lehigh River watershed offers opportunities for the different types of bicycling be it touring, cross country, road, mountain, freeride, marathon, tandem, etc. Additionally, the Velodrome in Trexlertown, Lehigh County, annually attracts thousands of cycling enthusiasts.

There are six major bike routes for touring cyclists. Called BicyclePA routes, they were designed by experienced bicyclists to provide bicycling members of the traveling public who wish to traverse the state with a guide to some of the Commonwealth's highways and rail-trails. Few of these routes contain bike lanes or other facilities designed specifically for bicyclists traveling within the four corners of the Commonwealth.

Every bicyclist is responsible for his or her personal safety, and for remaining alert and mindful of conditions on the roads or trails. BicyclePA users are expected to be licensed drivers or persons at least sixteen years of age who have several years of road bicycling experience.

To tour the heart of the Lehigh River watershed, cyclist can use Route L. This route extends 225 miles from Susquehanna County in the north (just south of Binghamton, NY) to Chester County in the south (just north of Wilmington, DE), and basically parallels Rt. 476. It manages to pass close to the major metropolitan areas of Scranton, Allentown, and Philadelphia, while retaining all of the rural charm that characterizes Pennsylvania. (www.bikepa.com/).

A velodrome is a bicycle-racing track where the fastest events in cycling are held. The tracks are oval shaped with banked turns that allow spectators an incredible view of the speed and color

of the sport. Races on a velodrome require special bikes that are single speed, direct drive, and have no brakes. The bicycles are strong and built for speed. At one point velodrome racing was one of the most popular sports in the U.S. Top professional cyclists at the turn of the century were better paid than the professional baseball players of the day. Today there are 20 permanent velodromes located around the United States.

The Lehigh Valley Velodrome is the premier bicycle-racing track in North America. Located at 1151 Mosser Road, Trexlertown, Pennsylvania, it is a 333.3 meter concrete oval with 28 degree banked turns. It has complete facilities for athletes and spectators. Originally built in 1975, "T-town" as it's known, underwent major improvements and additions in preparation for the 1996 U.S. Olympic Trials-Cycling. In addition to the trials, the Lehigh Valley Velodrome has been host to numerous national championships, world cup events, and world championship events. (Lehigh Valley Velodrome web site, 2004).

Mountain bike trails and facilities are also readily available in the Lehigh River watershed. For example, the existing mountain bike trails near Jim Thorpe, Carbon County Pocono Mountains are outlined in Table 6-8.

e. Off-Road Recreational Vehicles

Pennsylvania has a beautiful and challenging landscape for snowmobile and all-terrain vehicle (ATV) riding. Many trails have been established on public and private lands to accommodate these recreation pursuits. The Pa. DCNR web site contains valuable information on off-road recreational vehicles and should be consulted for detailed information about where to ride, registration, and other rules and regulations.

Every effort should be made to minimize the impact of snowmobiles and ATVs on designated trails and the surrounding environment.

TABLE 6–8. MOUNTAIN BIKE TRAILS NEAR JIM THORPE, CARBON COUNTY
Source: http://www.mountainbikepa.com/jimthorpe/#trails

Name of Trail	*Length*	*Level of Ability*
Switchback Trail	11-18 miles	Beginner to Intermediate
The Lehigh Canal	8-13 miles	Beginner
Flagstaff Mountain		Energetic Beginner
Mount Pisgah		Intermediate
Mauch Chunk Ridge		Advanced Singletrack
Twin Peaks		Advanced
Lehigh Gorge Rail Trail	21-26 miles	Beginner to Advanced
The Coal Cracker		Beginner to Intermediate
The Uranium Road		Advanced Singletrack
The Broad Mountain Loop		Intermediate
The Deer Path		Advanced Singletrack
Buzzard's Point		Energetic Beginner
Weiser State Forest		Intermediate
Drake's Creek		Advanced

B. Cultural Recreation

The Lehigh River watershed offers more than just outdoor recreation. Between its rich history and its proximity to the major metropolitan centers of Philadelphia and New York, the watershed offers a vast array of cultural opportunities as well.

1. Historic City Tours

a. Jim Thorpe

New Jersey Central Railroad Station

This was once a former major rail station used by many people. Now the rail station has been converted into a tourist-welcoming center, where you can find information on everything to do with Jim Thorpe. Pocono Mountain Vacation Bureau operates the facility.

Lehigh Coal and Navigation Company

You can visit the building that held the famous Lehigh Coal and Navigation Company. This company built and ran the Lehigh Canal, mined the coal in Jim Thorpe and was the main reason Jim Thorpe was turned into a thriving town.

St. Mark's Episcopal Church

The people of Jim Thorpe built this beautiful church in 1869. It is the oldest church in Jim Thorpe and is listed as one of the state's more unique buildings in Harold Dickson's A Hundred Pennsylvania Buildings.

Opera House

The town opera house called the Capitol Theatre was built in 1882. It was used as an opera house, borough hall, and market place. Today it is owned by the Mauch Chunk Historical Society and is used to host events such as concerts, art shows, and children's theater.

Asa Packer Mansion

Probably one of the more famous landmarks located in Jim Thorpe, this mansion was the home to Asa Packer. Asa Packer was one of the most influential people in the area and he founded Lehigh University. Touring the mansion one can see a chair belonging to Robert E. Lee, a solid ebony Steinway piano, and a center table given by the Queen of England.

Harry Packer Mansion

Harry Packer was the eldest son of Asa Packer. Asa gave his son this mansion as a wedding gift. It is now open to the public as a bed and breakfast.

Carbon County Jail

Built in 1869, this jail was the sight of many public hangings. One of the more famous ones was the hanging of the Molly Maguires, forerunners of the present day labor unions, who used murder as their means to right wrongs done to coal workers. The last man hung, Tom Fisher, claimed his innocence, and left his handprint on the wall of his cell. Legend claims his handprint can still be seen today.

MAUCH CHUNK LAKE PARK

This is a park, located in Jim Thorpe, which offers swimming, boating, camping, fishing, and hiking.

LEHIGH GORGE STATE PARK

This is a state park, located in Jim Thorpe, which offers many hiking trails, biking trails, and offers many whitewater-rafting trips down the Lehigh.

GLEN ONOKO

This is a famous and beautiful waterfall found on the west side of Jim Thorpe, in Lehigh Gorge State Park.

b. Allentown

OLD COURT HOUSE COUNTY MUSEUM

Located at the corner of Fifth and Hamilton Streets, this museum exhibit provides background to the history of Lehigh County.

ALLENTOWN SYMPHONY HALL

Located on Sixth Street, this is the home of the famous Allentown Symphony Orchestra.

CENTER SQUARE

Located at Seventh and Hamilton Streets the square contains many stores and shops. It also has the Soldiers and Sailors Monument, which stands 99 feet high and recognizes the Lehigh Valley's largest Civil War Unit.

REVOLUTIONARY WAR PLAQUE

Located on North Eighth Street, this large plaque marks the site of a hospital used for wounded Revolutionary War soldiers.

OLD ALLENTOWN CEMETERY

Located on Linden Street, one can visit one of the oldest cemeteries, built in 1846, in Allentown.

c. Bethlehem

BRETHREN'S HOUSE

Located on Main Street, this house is now a part of Moravian College's South Campus. It was first used as a Continental Hospital in the Revolutionary War. George Washington himself once toured this house. The house is now open to the public.

GEMEIN HAUS

This building located in Bethlehem was declared a National Historic Landmark. It is a five story log building, which is now the oldest building located in Bethlehem. The house is open to the public.

d. Easton

State Theater

Located in downtown Easton, the historical State Theater is a place where many different events take place ranging from concerts to ballet programs.

Center Square

Located in the middle of Easton, its center square held many historical events. One of three public readings of the Declaration of Independence happened here on July 5, 1776. The square also holds many shops and restaurants.

D&L Landing and National Canal Museum

Easton's downtown is host to the distinguished Two Rivers Landing and home of the National Canal Museum.

2. Vineyards

There are eight award-winning vineyards and wineries in the Lehigh River watershed (Map 6-2). Fertile farmland and shale and limestone geology, rolling hills and valleys, along with a moderate climate, provide an excellent growing environment for vineyards. The Lehigh Valley Wine Trail is a non-profit organization formed by the wineries to promote regional tourism and agriculture.

Big Creek Vineyard

Keller Road, R 5 Box 5270
Kresgeville, Pennsylvania 18333

610-681-3959

Blue Mountain Vineyards

7627 Grape Vine Drive, PO Box 492
New Tripoli, Pennsylvania 18066

610-298-3068

Clover Hill Vineyard and Winery

9580 Newton Road
Breinigsville, Pennsylvania 18031

610-395-2468

Galen Glen Vineyard and Winery

Winter Mountain Drive, R1, Box 82-1
Andreas, Pennsylvania 18211

570-386-3682

Vynecrest Vineyards and Winery

172 Arrowhead Lane

Breinigsville, Pennsylvania 18031

610-398-7525

3. GALLERIES AND MUSEUMS

The arts community of the Lehigh River watershed encompasses a wide variety of music and theater, film and dance, visual arts, festivals and museums. Dozens of organizations offer performances, exhibits, and events throughout the region. Some of these organizations are described here.

LEHIGH VALLEY ARTS COUNCIL

1633 Allen Street
Allentown, Pennsylvania 18102

610-437-5915

The Lehigh Valley Arts Council is a non-profit organization that serves as a regional advocate and ambassador for the Lehigh Valley arts community. Their mission is to promote the arts; to encourage and support artists and their development; to assist arts organizations; and to facilitate communication and cooperation among artists, arts groups and the community. The Council's services include informational publications, professional development, workshops, artist residencies and arts-in-education programming, and cooperative regional marketing initiatives.

BANANA FACTORY

25 W. Third Street
Bethlehem, Pennsylvania 18015

610-332-1300

The Banana Factory, located in the heart of Bethlehem's revitalized South Side, is a gateway to the visual arts. The non-profit arts center, which opened in 1998, is home to two stunning galleries, 24 artists' studios, a quaint Gallery Shoppe, and art classes and programs for children and adults throughout the year.

THE DISCOVERY CENTER OF SCIENCE AND TECHNOLOGY

511 East Third Street
Bethlehem, Pennsylvania 18015

610-865-5010

The Discovery Center of Science and Technology offers programs that promote hands-on, inquiry-based learning while helping students meet new state science standards. Discovery Center science education professionals train teachers and conduct laboratory programs in area schools-bringing specialized expertise and equipment into classrooms. At the center, students explore over 100 interactive exhibits demonstrating real world applications of science and technology.

MUSEUM OF INDIAN CULTURE

Fish Hatchery Road
Allentown, Pennsylvania 18103

610-797-2121

Native American culture and history are displayed in an eighteenth-century farmhouse. The museum holds many exhibits of Native American crafts and holds seasonal outdoor Native American ceremonies.

ALLENTOWN ART MUSEUM

Fifth and Court Streets
Allentown, Pennsylvania 18105

610-432-4333

The museum contains a large collection of European paintings and sculpture from the collection of Samuel Kress, Pennsylvania-born dime-store entrepreneur. The museum has changing exhibits, concerts, films, lectures, and demonstrations.

LEHIGH COUNTY HISTORICAL SOCIETY

Old Courthouse
Hamilton and Fifth Streets
Allentown, Pennsylvania 18101

610-435-4664

A showcase of the history of Lehigh County, and particularly its industrial heritage, the courthouse also hosts special exhibits on geology, Lenape Indians, immigration, and urban growth.

HISTORIC BETHLEHEM INC.

459 Old York Road
Bethlehem, Pennsylvania 18018

610-691-5300

The Historic Bethlehem Partnership operates the unique properties of the Burnside Plantation, the Colonial Industrial Quarter, 1810 Goundie House, HistoryWorks!, the Kemerer Museum of Decorative Arts, and the Moravian Museum of Bethlehem to interpret the cultural, religious, and industrial heritage of Bethlehem through quality programs and activities that reflect the community's diversity. A collection of restored industrial structures including the 1762 Waterworks, the 1761 Tannery, and the 1869 Luckenbach Mill where traditional Moravian crafts are on display. Important buildings and sites, irreplaceable artifacts, and written documents are preserved and maintained to help explain the changes that occurred in Bethlehem's first 250 years.

ANNIE S. KEMERER MUSEUM

427 North New Street
Bethlehem, Pennsylvania 18018

610-868-6868

Decorative arts of the eighteenth, nineteenth, and twentieth centuries in a fashionable townhouse. Other displays are oriental rugs, landscape paintings, Bohemian and other glass, silver, ceramics, and tall case clocks.

LEHIGH UNIVERSITY ART GALLERIES

Ralph Wilson Gallery at Alumni Memorial Building
DuBois Gallery at Maginnes Hall
Bethlehem, Pennsylvania 18015

610-758-3615

The gallery houses a broad collection of the arts of the world, has regularly changing exhibits, and contains numerous sculpture gardens.

CANAL MUSEUM AND HUGH MOORE PARK

200 S. Delaware Drive
Easton, Pennsylvania 18044

610-250-6700

The museum features the history and artifacts of the canal era. The park offers a seasonal canal boat ride, going through a lock near the site of the Glendon Iron Works. Hugh Moore was the founder of the Dixie Cup Company in Easton.

THE BAUM SCHOOL OF ART

510 Linden Street
P.O. Box 653
Allentown, Pennsylvania 18105

610-433-0032

The Baum School of Art is a non-profit community art school located in center city Allentown. It has enriched the lives of thousands of adults and children throughout the Lehigh Valley for the past 76 years. The school contains nine classrooms, a black and white photography darkroom, computer lab, metalsmithing studio, ceramics studio, gallery, and the Charles C. Dent Sculpture Garden.

4. THEATERS AND PERFORMING ARTS

The performing arts community in the region draws from its proximity to Philadelphia and New York and is enhanced by its concentration of colleges and universities, all of which offer excellent artistic galleries, performances, and education.

ZOELLNER ARTS CENTER

420 East Packer Avenue
Bethlehem, Pennsylvania 18015

Phone: 610-758-2787

Voted Best Performing Arts Center in the Lehigh Valley, Zoellner Arts Center at Lehigh University presents vibrant opera, musical theater, dance, jazz, orchestral and choral music, drama and art exhibitions to capture everyone's imagination.

STATE THEATER

453 Northampton Street
Easton, Pennsylvania 18040

610-252-3132

This Beaux-Arts theatre, a former vaudeville palace built in 1926, was designed by Philadelphia architect William H. Lee. The State Theatre is a 501(c) (3) non-profit center for the arts and hosts both local and international talents in the performing arts.

PENNSYLVANIA PLAYHOUSE

Illicks Mill Road
Bethlehem, Pennsylvania 18002-0122

610-865-6665

The Pennsylvania Playhouse is a non-profit organization where patrons can enjoy the atmosphere of an intimate theater. No seat is more than nine rows from the stage and one can see enthusiastic performances by volunteers who enjoy the thrill of creating an excellent show.

Touchstone Theater

321 E. Fourth Street
Bethlehem, Pennsylvania 18015

610-867-1689

Touchstone is a nationally recognized homegrown Lehigh Valley tradition: a professional ensemble theatre creating original work, presenting outstanding artists and companies from around the world working with schools and community groups in innovative partnerships

Civic Theatre of Allentown

527 N. Nineteenth Street
Allentown, Pennsylvania 18104

610- 433-8903

Civic Theatre of Allentown is the Lehigh Valley's oldest community theatre. Residing in Allentown's historic 19th Street Theatre, a 1928 art deco vaudeville house, Civic presents five professionally directed stage productions each year. Between plays, Civic hosts the 19th Street Film Series, the Lehigh Valley's exclusive source for independent and international films.

Repertory Dance Theatre

1402 Linden Street
Allentown, Pennsylvania 18102

610-433-680

Since its inception in 1987, Repertory Dance Theater has brought superb dance performances to the Lehigh Valley, and high quality professional training to young people interested in dance. Its focus is the youth of the Lehigh Valley. One of the company's purposes is to prepare gifted and dedicated young dancers for entry into the ranks of professional dance. Another goal is to expose area youth to dance to encourage their interest.

The Ballet Guild of the Lehigh Valley / Pennsylvania Youth Ballet

556 Main Street
Bethlehem, Pennsylvania 18018

610-865-0353

The Ballet Guild of the Lehigh Valley / Pennsylvania Youth Ballet is a non-profit organization dedicated to fostering the art of theatre dance, primarily classical ballet, through education and performances. The school takes a serious approach to the study of ballet and is directed by internationally known teachers and choreographers. A variety of yearlong outreach and performance activities is highlighted by The Nutcracker each December.

The Pennsylvania Shakespeare Festival

The Pennsylvania Shakespeare Festival is a professional theatre in residence at DeSales University, and is dedicated to presenting passionate and imaginative productions of Shakespeare and other great writers. The summer season consists of at least two works by Shakespeare, two other works by major playwrights, a production for youth and families in

the mornings, and a free Green Show presented on the lawn in front of the Labuda Center before each evening performance. During the rest of the year, PSF sends its Will Power educational outreach tour across Pennsylvania, New Jersey and Delaware and works with school districts in the Lehigh Valley to enhance their curriculum on language arts, history, and drama.

LEHIGH VALLEY CHAMBER ORCHESTRA

P.O. Box 20641
Lehigh Valley, Pennsylvania 18002-0641

610-266-8555

The Lehigh Valley Chamber Orchestra (LVCO) is known for its spirited performances of great music, both from the traditional repertoire as well as works from contemporary composers. Founded in 1979, the orchestra was established as a classical ensemble composed of about 35 professional musicians from the Lehigh Valley, New York and Philadelphia. Educational programs ("Educational Encores") for students and adults also play an important part in the orchestra's activities. To that end, the LVCO performs school concerts in Allentown, Bethlehem, Easton, and Nazareth and provides "Open Rehearsals," a pre-concert lecture series and Sunday Brunch Lectures.

ALLENTOWN SYMPHONY ORCHESTRA

23 North Sixth Street
Allentown, Pennsylvania 18101

610-432-6715

Founded in 1951, the Allentown Symphony Orchestra remains one of the leading cultural institutions in the Lehigh Valley. The orchestra helps develop the audiences of tomorrow through the Symphony's Youth Concert Series each spring and through a wide variety of outreach programs involving the entire Lehigh Valley community. Overall, the Allentown Symphony's mission is to provide a first class symphony orchestra and hall, quality performing arts and cultural education in partnership with the community. Symphony Hall, once known as the Lyric Theatre, serves as a community asset, presenting concerts by the Allentown Symphony, other community music groups, as well as special events and touring productions. Designed by J.B. McElfatrick, Symphony Hall first opened in 1899 and, over the years, has featured many operas, plays, and music performances.

PENNSYLVANIA SINFONIA ORCHESTRA

1524 West Linden Street
Allentown, Pennsylvania 18102

610-434-7811

This all-professional ensemble offers an appealing diversity of repertoire, combined with outstanding soloists. Popular year-round programs include the summer Valley Vivaldi Series, an annual all-Mozart concert, and the dynamic Choral Masterpiece Series with the Camerata Singers. Pennsylvania Sinfonia Orchestra, as the preeminent orchestral ensemble in the Lehigh Valley, has set the regional standard since its inception in 1982. Frequently praised for its innovative and interesting programs, the orchestra features many of its own first-chair virtuosi in solo performances as well as guest soloists recognized for their ability to communicate with the audience.

BACH CHOIR OF BETHLEHEM

423 Heckewelder Place
Bethlehem, Pennsylvania 18018

610-866-4382

The Bach Choir of Bethlehem is the oldest Bach choir in America. Founded in 1898, The Bach Choir gave the first complete performances in the United States of The Mass in B Minor and The Christmas Oratorio. The 95 volunteer members sing with the dedication and enthusiasm of The Bach Choir of a century ago, but today's performances, featuring the finely honed vocal ensemble, a fully professional orchestra, and world-renowned soloists, reveal a new level of musicianship and understanding of Bach's choral universe. During the past decade, The Choir has received critical acclaim for performances at the Thomaskirche in Leipzig, the Herkulessaal at Munich's Royal Residence, The Kennedy Center in Washington, and Carnegie Hall in New York, as well as for its recordings on the Dorian label. The choir has presented its outstanding "Bach to School" program to nearly 50,000 children. Other educational programs include the annual Family Concert, a Choral Scholars program for gifted high-school seniors who sing with The Choir for one year, and a Philadelphia High School Bach Weekend.

5. SPECIAL EVENTS

There is always something to do in the Lehigh River watershed. There are events on nearly every weekend all year round. The varying array of things to do will keep any visiting person busy during their stay. Some of the traditional events that take place every year in the watershed are listed in Table 6-9.

C. Review of Lehigh River Watershed Recreational Components

There are a total of five state parks located within the Lehigh River watershed, occupying a land area of approximately 45 square miles. Lehigh Gorge State Park is in the Audubon's Lehigh Reach of the Delaware and Lehigh National Heritage Corridor. The Corridor stretches more than 150 miles from Wilkes-Barre to Bristol, in eastern Pennsylvania, and follows the historic routes of the Lehigh & Susquehanna Railroad, the Lehigh Navigation, and the Delaware Canal. There are many scenic trails located in the Lehigh River watershed and many trails are still waiting to be established. Abandoned railroad rights-of-way provide opportunities to enjoy recreational pursuits such as hiking, biking, horseback riding, fishing, skiing, and snowmobiling. Interest in obtaining and improving these abandoned railroad rights-of way has grown over the past few years. In 1990, the Pennsylvania Rails-to-Trails Program was established in order to protect and preserve these abandoned railways for public recreational use. The goal of this program is to convert abandoned railroad right-of-ways into multi or designated use trails. Several ski resorts are located within the Pocono Mountain area within the watershed, which provide opportunities for several forms of summer and winter recreation. Whitewater rafting, kayaking, and canoeing opportunities are all available in the Lehigh River watershed. The Lehigh River contains several whitewater classifications, ranging from Class I whitewater for novice boaters to Class III whitewater for the more advanced boaters. Wildlands Conservancy's Lehigh River Sojourn and Bike and Boat Program are family and group oriented educational adventures

TABLE 6-9. SPECIAL EVENTS WITHIN THE LEHIGH RIVER WATERSHED

Event	Month(s)	Location	City/Town	Phone # for General Info.
Banff Mountain Film Festival	March	Contact Wildlands Conservancy for information.	Contact Wildlands Conservancy for information.	(610) 965-4397
Greater Lehigh Valley Auto Show	March	Stabler Arena & Rauch Field house – Lehigh University	Bethlehem	(610) 758-9691 or (877) 606-8998
The Bach Festival	May	Packer Church, Lehigh University	Bethlehem	(610) 866-4382
Mayfair Festival of the Arts	May	Allentown Parks	Allentown	(610) 437-6900
Schnecksville Community Fair	June		Schnecksville	(610) 767-5026
Lehigh River Sojourn	June	Lehigh River	Stoddartsville to Walnutport	(610) 965-4397
Allentown Sports Fest	July	Allentown Parks	Allentown	(610) 439-8978
Easton Heritage Day	July	Downtown Area	Easton	(610) 250-0745
Blueberry Festival	July	Burnside Plantation	Bethlehem	(610) 882-0450
Drum Corps International Eastern Regional Championships	July	J. Birney Crum Stadium	Allentown	(800) 495-7469
Philadelphia Eagles Summer Training Camp	July-August	Goodman Campus, Lehigh University	Bethlehem	(610) 758-6868
Das Awkscht Fescht	August	Macungie Memorial Park	Macungie	(610) 967-2317
Musikfest	August	Downtown Area	Bethlehem	(610) 861-0678
Glass Visions Stained Glass Expo			Allentown	(610) 264-1100
The Great Allentown Fair	August-September		Allentown	(610) 435-SHOW or (610) 433-7541
Shad Fishing Festival	April-June		Easton	(610) 597-7423
Great Lehigh Valley Soccer Festival	September	Lehigh County Soccer Complex	Allentown	(800) 747-0561
Grim's Fall Festival, Corn Maze and Pumpkin Patch	September-October	9941 Schantz Rd.	Breinigsville	(610) 395-5655
Celtic Classic Highland Games and Festival	September-October	Historic Downtown Area	Bethlehem	(610) 868-9599
Leonardo's Imagination			Allentown	(610) 433-9200
HalloWeekends at Dorney Park			Allentown	(610) 395-3724
Lights in the Parkway	December-January	Little Lehigh Parkway	Allentown	(610) 439-5959
The Crayola FACTORY Gingerbread Festival	November-December	30 Center Square	Easton	(610) 515-8000
Christkindlmarkt	November-December	25 West Third Street	Bethlehem	(610) 861-0678
First Night	December-January	Historic Downtown Area	Bethlehem	(610) 332-1050

designed to promote awareness and stewardship of the Lehigh River and its watershed and to promote the use of the river as a valuable recreational and educational resource.

The Lehigh River watershed offers more than just outdoor recreation. The arts community of the Lehigh River watershed is alive and well and encompasses a wide variety of opportunities. Between its rich history and its proximity to the major metropolitan centers of Philadelphia and New York, the watershed offers a vast array of cultural possibilities as well as historic city tours, vineyards, music and theater, film and dance, visual arts, festivals and museums. Dozens of organizations offer performances, exhibits, and events throughout the region.

References

Recreation Components

Appalachian Trail Conference. 2003. http://www.appalachiantrail.org.

Bear Creek Ski & Recreation Area. 2003. www.skibearcreek.com.

Big Boulder Ski Area. 2003. www.big2resorts.com.

Blue Mountain Ski Area. 2003. www.skibluemt.com.

Jack Frost Ski Area. 2003. www.big2resorts.com.

Lehigh Valley Velodrome. 2004. www.lvvelo.org.

List of Class A Wild Trout Waters. Pennsylvania Fish and Boat Commission, 2003.

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Pa. Department of Conservation and Natural Resources. 2003. http://www.dcnr.state.pa.us.

Pa. Department of Conservation and Natural Resources. Pa. Recreational Guide and Highway Map. 2003.

Pa. Fish & Boat Commission Pennsylvania Water Trails. 2003. http://www.fish.state.pa.us.

Pa. Game Commission. 2003. http://www.pgc.state.pa.us.

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Scherer, Glenn and Don Hopey. Exploring the Appalachian Trail. 1998.

Summary of Fishing Regulations and Laws and Personal Communication. Pennsylvania Fish and Boat Commission, 2003.

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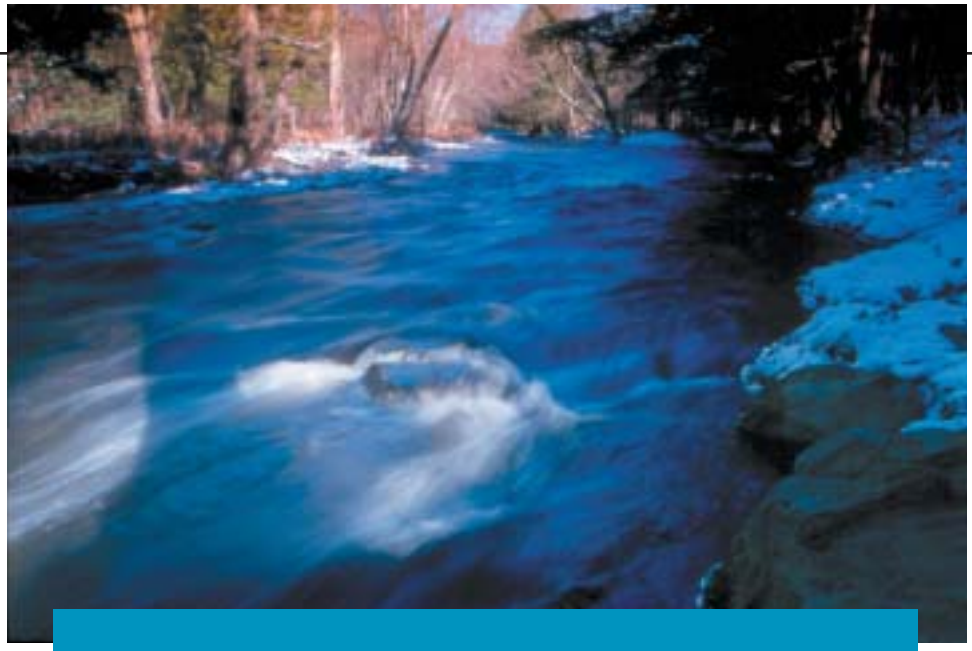

Part VII

CONSERVATION RESOURCES AND TOOLS

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This section of the Lehigh River Watershed Conservation Management Plan is designed to provide tools, resources and contacts to aid in the implementation of the recommendations listed in the Plan. Organizational contact information was collected from a wide variety of resources including, The Pennsylvania Department of Environmental Protection's Conservation Directory, official web sites, Personal References and numerous environmental listings. Due to the vast amount of contact information available and the continually changing personnel of the listed agencies, Wildlands Conservancy would like to apologize for any oversight or missed listings of organization involved in the Lehigh River Watershed.

A. Lehigh River Watershed Organizations and Entities

1. Alphabetical List of Organizations of the Lehigh River Watershed

1. Agricultural Land Preservation Program – Berks County
2. Agricultural Land Preservation Program – Bucks County
3. Agricultural Land Preservation Program – Carbon County
4. Agricultural Land Preservation Program – Lackawanna County
5. Agricultural Land Preservation Program – Lehigh County
6. Agricultural Land Preservation Program – Luzerne County
7. Agricultural Land Preservation Program – Monroe County
8. Agricultural Land Preservation Program – Northampton County
9. Agricultural Land Preservation Program – Schuylkill County
10. Agricultural Land Preservation Program – Wayne County
11. Agshen, Inc.
12. Alburtis Borough Environmental Advisory Council
13. Alburtis-Lockridge Historical Society
14. Allentown Hiking Club
15. Alliance for Sustainable Communities- of the Lehigh Valley
16. Alliance for the Little Lehigh Creek
17. American Farmland Trust – New England Field Office
18. American Rivers
19. Appalachian Mountain Club (AMC) / Delaware Valley Chapter
20. Appalachian Mountain Club (AMC) / Main Office
21. Appalachian Trail Conference
22. Aquashicola/Pohopoco Watershed Conservancy
23. Arrowhead Lakes
24. Audubon Society – Bucks County Chapter
25. Audubon Society – Greater Wyoming Valley
26. Audubon Society – Lehigh Valley Chapter
27. Audubon Society – Northeast Pennsylvania

28. Audubon Society – Pocono Mountain Chapter
29. Berks County Conservancy
30. Berks County Conservation District
31. Berks County Environmental Organization Network
32. Berks Recycling Coalition
33. Bethlehem Works
34. Bucks County Conservation District
35. Bucks County Historical Society
36. Bushkill Township Environmental Advisory Council
37. Canaan Valley Institute
38. Carbon County Conservation District
39. Carbon County Environmental Advisory Council
40. Carbon County Environmental Education Center
41. Carbon County Groundwater Guardians
42. Carbon County Planning Department
43. Cedar Crest College / Biology Department
44. Center for Watershed Protection
45. City of Allentown Bureau of Water Resources
46. Clean Water Action / Lehigh Office
47. Coalition for Alternative Transportation
48. Conservation Fund
49. Coolbaugh Township Environmental Advisory Council
50. Coopersburg Environmental Committee
51. DCNR / Delaware Canal State Park
52. DCNR / Hickory Run State Park
53. DCNR / Lehigh Gorge State Park
54. DCNR / Jacobsburg State Park / Environmental Education Center
55. Delaware & Lehigh National Heritage Corridor Commission
56. Delaware Highlands Conservancy
57. Delaware River Basin Commission (DRBC) / Pennsylvania Commission
58. Delaware River Greenway Partnership
59. Delaware River Shad Fishermen's Association
60. Delaware Riverkeeper Network
61. DeSales University / Biology Department
62. Ducks Unlimited, Inc.
63. Earth and Environmental Sciences – Lehigh University
64. Earth Conservancy
65. Easton Heritage Alliance
66. Economic Development Council of Northeastern Pennsylvania
67. Emmaus Historical Society
68. ENACT of Muhlenberg College

69. Environmental Action Committee
70. Friends of the Delaware Canal
71. Governor's Center for Local Government Services / Northeast Regional Office
72. Governor's Center for Local Government Services / State Office
73. Greater Lehigh Valley Chamber of Commerce
74. Green Valley Coalition
75. Hawk Mountain Sanctuary Association
76. Hazleton City Water Authority
77. Heidelberg Township Environmental Advisory Council
78. Heritage Conservancy
79. Highlands Coalition
80. Historic Bethlehem Partnership
81. Historic Catasauqua
82. Historical Society of Berks County
83. Historical Society of Schuylkill County
84. Hugh Moore Park
85. Kalmbach Memorial Park
86. Kittatinny Ridge Coalition
87. Kutztown University Environmental Science Forum
88. Lacawac Sanctuary
89. Lackawanna County Conservation District
90. Lackawanna County Recycling & Solid Waste
91. Lackawanna Historical Society
92. Lackawanna River Corridor Association
93. Lackawanna Valley Conservancy
94. Lafayette College / Biology Department
95. Lake Harmony
96. League of Women Voters of Pennsylvania
97. Lehigh County Conservation District
98. Lehigh County Historical Society
99. Lehigh Gap Historical & Preservation Society
100. Lehigh River Stocking Association
101. Lehigh River Watch
102. Lehigh University / Earth Observatory (LEO)
103. Lehigh Valley Canoe Club
104. Lehigh Valley Coalition for a Safe Environment
105. Lehigh Valley Convention & Visitors Bureau
106. Lehigh Valley Economic Development Corporation
107. Lehigh Valley Greens
108. Lehigh Valley Land Recycling Initiative
109. Lehigh Valley Planning Commission
110. Lehigh Valley Water Suppliers, Inc.

111. Lehighton Water Authority
112. Leibert Creek Watershed Group
113. Lenni Lenape Historical Society
114. Litter Control & Beautification Program of Monroe County
115. Little Lehigh Creek Watershed Coalition
116. Local Environmental Awareness Development Group (LEAD)
117. Lower Macungie Township Historical Society
118. Lower Nazareth Township Environmental Advisory Council
119. Lower Saucon Township Environmental Advisory Council
120. Luzerne County Community College Science Club
121. Luzerne County Conservation District
122. Luzerne County Convention & Visitors Bureau
123. Luzerne County Historical Society
124. Macungie Historical Society
125. Mariton Wildlife Sanctuary and Wilderness Trust
126. Mauch Chunk Historical Society of Carbon County
127. Monocacy Creek Watershed Association, Inc.
128. Monroe County Conservation District
129. Monroe County Historical Association
130. Monroe County Planning Commission
130a. Montgomery County Lands Trust
131. Moravian College / Biology Department
132. Moravian Historical Society
133. NLC Outdoor Sportsman Association
134. National Canal Museum
135. National Museum of Industrial History
136. Natural Lands Trust
137. Nature Conservancy, Pennsylvania Chapter – Headquarters
138. Nature Conservancy, Pennsylvania Chapter – Northeastern Pa. Field Office
139. Nazareth Environmental Council
140. North Branch Land Trust
141. Northampton Borough Municipal Authority
142. Northampton County Conservation District
143. Northampton County Environmental Advisory Council
144. Northampton County Historical & Genealogical Society
145. Northampton County Junior Conservation School
146. Northampton Greenway Partnership
147. Northeast Pennsylvania Convention & Visitors Bureau
148. Old Allentown Preservation Association
149. Palmer Township Environmental Advisory Council
150. Palmer Township Environmental Steering Committee
151. Palmerton Citizens for a Clean Environment

152. Penn State Cooperative Extension Office – Berks County
153. Penn State Cooperative Extension Office – Bucks County
154. Penn State Cooperative Extension Office – Carbon County
155. Penn State Cooperative Extension Office – Lackawanna County
156. Penn State Cooperative Extension Office – Luzerne County
157. Penn State Cooperative Extension Office – Monroe County
158. Penn State Cooperative Extension Office – Northampton County
159. Penn State Cooperative Extension Office – Schuylkill County
160. Penn State Cooperative Extension Office – Wayne County
161. Penn State Lehigh Valley / Biology Department
162. Pennsylvania Association of Environmental Professionals
163. Pennsylvania Council of Professional Foresters
164. Pennsylvania Department of Community and Economic Development (DCED)
165. Pennsylvania Department of Conservation and Natural Resources (DCNR) / State Office
166. Pennsylvania Department of Conservation and Natural Resources (DCNR) / NE Regional Office
167. Pennsylvania Department of Environmental Protection (DEP)
168. Pennsylvania Environmental Council – Northeast Pennsylvania Office
169. Pennsylvania Environmental Council (PEC) – Headquarters / Philadelphia County
170. Pennsylvania Federation of Sportsman Clubs / Northeast Chapter
171. Pennsylvania Federation of Sportsman Clubs / Southeast Chapter
172. Pennsylvania Federation of Sportsman Clubs / State Office
173. Pennsylvania Fish & Boat Commission
174. Pennsylvania Game Commission
175. Pennsylvania Historical and Museum Commission
176. Pennsylvania Organization for Watershed and Rivers (POWR)
177. Pennsylvania Raptor & Wildlife Association, Inc.
178. Pennsylvania Spatial Data Access (PASDA)
179. Pennsylvania State Association of Township Supervisors
180. Pocono Heritage Land Trust
181. Pocono Mountain Vacation Bureau
182. Pocono Northeast Resource Conservation & Development Council
183. Rails to Trails Conservancy
184. Retired & Senior Volunteer Program (RSVP)
185. Rush Township Environmental Advisory Council
186. Schuylkill County Conservation District
187. Schuylkill County Environmental Advisory Council
188. Schuylkill County Office of Solid Waste Management
189. Sierra Club – Berks County Group
190. Sierra Club – Bucks County Group
191. Sierra Club – Lehigh Valley Group
192. Sierra Club – Northeastern Group

193. Slate Belt Museum
194. Southeastern Pennsylvania Resource Conservation & Development Council
195. South Whitehall Township Environmental Advisory Council
196. Southern Wayne Trail Riders Association, Inc.
197. Sterling Township Environmental Advisory Council
198. Stroud Water Research Center
199. The Bear Creek Lake's Watershed Association
200. The Center for Rural Pennsylvania
201. The Roving Nature Center
202. Tobyhanna / Tunkhannock Creeks Watershed Association
203. Trexler-Lehigh County Game Preserve
204. Trout Unlimited – Forks of the Delaware Chapter 482
205. Trout Unlimited – Hokendauqua 535
206. Trout Unlimited – Little Lehigh 070
207. Trout Unlimited – Monocacy 491
208. Trout Unlimited – National Office
209. Trout Unlimited – Pennsylvania Council
210. Trout Unlimited – Saucon Creek 724
211. Trout Unlimited – Schuylkill County Chapter 537
212. Trust for Public Land – Washington Office
213. Two Rivers Area Chamber of Commerce
214. U.S. Geological Survey
215. U.S. Army Corps of Engineers
216. U.S. Environmental Protection Agency
217. U.S. Fish and Wildlife Service
218. Upper Saucon Environmental Advisory Council
219. U.S. EPA Region III
220. USDA/Farm Service Agency – Berks County
221. USDA/Farm Service Agency – Bucks County
222. USDA/Farm Service Agency – Carbon/Monroe County
223. USDA/Farm Service Agency – Lackawanna/Wayne/Pike County
224. USDA/Farm Service Agency – Lehigh County
225. USDA/Farm Service Agency – Luzerne County
226. USDA/Farm Service Agency – Northampton County
227. USDA/Farm Service Agency – Schuylkill County
228. Walnutport Canal Association
229. Water Resources Association Of The Delaware River Basin
230. Wayne County Conservation District
231. Wayne County Department of Planning
232. Wayne County Historical Society Museum
233. Weisenberg Township Environmental Advisory Council
234. Whitehall Township Environmental Advisory Council

235. Wildlands Conservancy, Inc.
236. Wildlife Information Center
237. Wilkes University

2. ALPHABETICAL LIST OF CONSERVATION ORGANIZATIONS OF THE LEHIGH RIVER WATERSHED BY COUNTY

BERKS COUNTY

1. Agricultural Land Preservation Program– Berks County
13. Alburtis-Lockridge Historical Society
29. Berks County Conservancy
30. Berks County Conservation District
31. Berks County Environmental Organization Network
32. Berks Recycling Coalition
69. Environmental Action Committee
75. Hawk Mountain Sanctuary Association
82. Historical Society of Berks County
116. Local Environmental Awareness Development Group (LEAD)
152. Penn State Cooperative Extension Office – Berks County
189. Sierra Club – Berks County Group
220. USDA/Farm Service Agency – Berks County

BUCKS COUNTY

2. Agricultural Land Preservation Program – Bucks County
24. Audubon Society-Bucks County Chapter
34. Bucks County Conservation District
35. Bucks County Historical Society
78. Heritage Conservancy
153. Penn State Cooperative Extension Office – Bucks County
190. Sierra Club-Bucks County Group
221. USDA/Farm Service Agency – Bucks County

CARBON COUNTY

3. Agricultural Land Preservation Program – Carbon County
38. Carbon County Conservation District
39. Carbon County Environmental Advisory Council
40. Carbon County Environmental Education Center
41. Carbon County Groundwater Guardians
42. Carbon County Planning Department
52. DCNR / Hickory Run State Park
53. DCNR / Lehigh Gorge State Park
99. Lehigh Gap Historical & Preservation Society
111. Lehighton Water Authority
126. Mauch Chunk Historical Society of Carbon County

151. Palmerton Citizens for a Clean Environment
154. Penn State Cooperative Extension Office – Carbon County
199. The Bear Creek Lake's Watershed Association
222. USDA/Farm Service Agency – Carbon/Monroe County

Lackawanna County

4. Agricultural Land Preservation Program – Lackawanna County
89. Lackawanna County Conservation District
90. Lackawanna County Recycling & Solid Waste
91. Lackawanna Historical Society
92. Lackawanna River Corridor Association
93. Lackawanna Valley Conservancy
147. Northeast Pennsylvania Convention & Visitors Bureau
155. Penn State Cooperative Extension Office – Lackawanna County
182. Pocono Northeast Resource Conservation & Development Council
192. Sierra Club – Northeastern Group
223. USDA/Farm Service Agency – Lackawanna/Wayne/Pike County

Lehigh County

5. Agricultural Land Preservation Program – Lehigh County
12. Alburtis Borough Environmental Advisory Council
15. Allentown Hiking Club
16. Alliance for the Little Lehigh Creek
26. Audubon Society – Lehigh Valley Chapter
43. Cedar Crest College / Biology Department
45. City of Allentown Bureau of Water Resources
46. Clean Water Action – Lehigh Office
50. Coopersburg Environmental Council
61. DeSales University / Biology Department
67. Emmaus Historical Society
68. ENACT of Muhlenberg College / Biology Department
74. Green Valley Coalition
77. Heidelberg Township Environmental Advisory Council
81. Historic Catasauqua
85. Kalmbach Memorial Park
97. Lehigh County Conservation District
98. Lehigh County Historical Society
101. Lehigh River Watch
113. Lenni Lenape Historical Society
115. Little Lehigh Creek Watershed Coalition
117. Lower Macungie Township Historical Society
124. Macungie Historical Society
148. Old Allentown Preservation Association

161. Penn State Lehigh Valley / Biology Department
173. Pennsylvania Fish & Boat Commission
184. Retired & Senior Volunteer Program (RSVP)
191. Sierra Club – Lehigh Valley Group
195. South Whitehall Township Environmental Advisory Council
203. Trexler-Lehigh County Game Preserve
206. Trout Unlimited – Little Lehigh
218. Upper Saucon Environmental Advisory Council
224. USDA/Farm Service Agency – Lehigh County
233. Weisenberg Township Environmental Advisory Council
234. Whitehall Township Environmental Advisory Council
235. Wildlands Conservancy, Inc.
236. Wildlife Information Center

LUZERNE COUNTY

6. Agricultural Land Preservation Program – Luzerne County
25. Audubon Society – Greater Wyoming Valley
64. Earth Conservancy
66. Economic Development Council of Northeastern Pennsylvania
120. Luzerne County Community College Science Club
121. Luzerne County Conservation District
122. Luzerne County Convention & Visitors Bureau
123. Luzerne County Historical Society
140. North Branch Land Trust
156. Penn State Cooperative Extension Office – Luzerne County
168. Pennsylvania Environmental Council – Northeast Pennsylvania Office
170. Pennsylvania Federation of Sportsman Clubs / Northeast Chapter
225. USDA/Farm Service Agency – Luzerne County
236. Wilkes University

MONROE COUNTY

7. Agricultural Land Preservation Program – Monroe County
23. Arrowhead Lakes
28. Audubon Society – Pocono Mountain Chapter
49. Coolbaugh Township Environmental Advisory Council
95. Lake Harmony
114. Litter Control & Beautification Program of Monroe County
128. Monroe County Conservation District
129. Monroe County Historical Association
130. Monroe County Planning Commission
138. Nature Conservancy of Pennsylvania – Northeastern Pa. Office
157. Penn State Cooperative Extension Office – Monroe County
181. Pocono Mountain Vacation Bureau

202. Tobyhanna / Tunkhannock Creek Watershed Association
217. U.S. Fish and Wildlife Service
222. USDA/Farm Service Agency – Carbon/Monroe County

Northampton County

8. Agricultural Land Preservation Program – Northampton County
11. Agshen, Inc.
33. Bethlehem Works
36. Bushkill Township Environmental Advisory Council
47. Coalition for Alternative Transportation
54. DCNR / Jacobsburg State Park/Environmental Education Center
65. Easton Heritage Alliance
80. Historic Bethlehem Partnership
84. Hugh Moore Park
94. Lafayette College / Biology Department
102. Lehigh University / Earth Observatory (LEO)
104. Lehigh Valley Coalition for a Safe Environment
105. Lehigh Valley Convention & Visitors Bureau
107. Lehigh Valley Greens
118. Lower Nazareth Township Environmental Advisory Council
119. Lower Saucon Township Environmental Advisory Council
125. Mariton Wildlife Sanctuary and Wilderness Trust
127. Monocacy Creek Watershed Association, Inc.
131. Moravian College / Biology Department
132. Moravian Historical Society
134. National Canal Museum
135. National Museum of Industrial History
139. Nazareth Environmental Council
141. Northampton Borough Municipal Authority
142. Northampton County Conservation District
143. Northampton County Environmental Advisory Council
144. Northampton County Historical & Genealogical Society
145. Northampton County Junior Conservation School
146. Northampton Greenway Partnership
149. Palmer Township Environmental Advisory Council
150. Palmer Township Environmental Steering Committee
158. Penn State Cooperative Extension Office – Northampton County
171. Pennsylvania Federation of Sportsman Clubs / Southeast Chapter
177. Pennsylvania Raptor & Wildlife Association, Inc.
201. The Roving Nature Center
204. Trout Unlimited – Forks of the Delaware Chapter
205. Trout Unlimited – Hokendauqua 535
207. Trout Unlimited-Monocacy 491

210. Trout Unlimited – Saucon Creek 724
213. Two Rivers Area Chamber of Commerce
226. USDA/Farm Service Agency – Northampton County
228. Walnutport Canal Association

SCHUYLKILL COUNTY

9. Agricultural Land Preservation Program – Schuylkill County
83. Historical Society of Schuylkill County
159. Penn State Cooperative Extension Office – Schuylkill County
185. Rush Township Environmental Advisory Council
186. Schuylkill County Conservation District
187. Schuylkill County Environmental Advisory Council
188. Schuylkill County Office of Solid Waste Management
211. Trout Unlimited – Schuylkill County Chapter
227. USDA/Farm Service Agency – Schuylkill County

WAYNE COUNTY

10. Agricultural Land Preservation Program – Wayne County
27. Audubon Society – Northeast Pennsylvania
56. Delaware Highlands Conservancy
88. Lacawac Sanctuary
160. Penn State Cooperative Extension Office – Wayne County
196. Southern Wayne Trail Riders Association, Inc.
197. Sterling Township Environmental Advisory Council
223. USDA/Farm Service Agency – Lackawanna/Wayne/Pike County
230. Wayne County Conservation District
231. Wayne County Department of Planning
232. Wayne County Historical Society Museum

3. REGIONAL CONSERVATION ORGANIZATIONS ACTIVE IN THE LEHIGH RIVER WATERSHED

15. Alliance for Sustainable Communities of the Lehigh Valley
17. American Farmland Trust – New England Field Office
18. American Rivers
19. Appalachian Mountain Club / Delaware Valley Chapter
20. Appalachian Mountain Club / Main Office
21. Appalachian Trail Conference
22. Aquashicola/Pohopoco Watershed Conservancy
37. Canaan Valley Institute (CVI)
44. Center for Watershed Protection
48. Conservation Fund
51. DCNR / Delaware Canal State Park
55. Delaware & Lehigh National Heritage Corridor Commission

57. Delaware River Basin Commission (DRBC) / Pennsylvania Commission
58. Delaware River Greenway Partnership
59. Delaware River Shad Fishermen's Association
60. Delaware Riverkeeper Network
62. Ducks Unlimited, Inc.
70. Friends of the Delaware Canal
71. Governor's Center for Local Government Services / Northeast Regional Office
72. Governor's Center for Local Government Services / State Office
73. Greater Lehigh Valley Chamber of Commerce
76. Hazleton City Water Authority
79. Highlands Coalition
86. Kittatinny Ridge Coalition
87. Kutztown University Environmental Science Forum
96. League of Women Voters of Pennsylvania
100. Lehigh River Stocking Association
103. Lehigh Valley Canoe Club
106. Lehigh Valley Economic Development Corporation
108. Lehigh Valley Land Recycling Initiative
109. Lehigh Valley Planning Commission
110. Lehigh Valley Water Suppliers, Inc.
130a. Montgomery County Land Trust
133. NLC Outdoor Sportsman Association
136. Natural Lands Trust
137. The Nature Conservancy, Pennsylvania Chapter – Headquarters
138. The Nature Conservancy, Pennsylvania Chapter – Northeastern Pa. Field Office
140. North Branch Land Trust
162. Pennsylvania Association of Environmental Professionals
163. Pennsylvania Council of Professional Foresters
164. Pennsylvania Department of Community and Economic Development (DCED)
165. Pennsylvania Department of Conservation and Natural Resources (DCNR) / State Office
166. Pennsylvania Dept of Conservation and Natural Resources (DCNR) / NE Regional Office
167. Pennsylvania Department of Environmental Protection (DEP)
169. Pennsylvania Environmental Council – Headquarters / Philadelphia County (PEC)
172. Pennsylvania Federation of Sportsman Clubs / State Office
174. Pennsylvania Game Commission
175. Pennsylvania Historical and Museum Commission (PHMC)
176. Pennsylvania Organization for Watershed and Rivers (POWR)
178. Pennsylvania Spatial Data Access (PASDA)
179. Pennsylvania State Association of Township Supervisors (PSATS)
180. Pocono Heritage Land Trust
183. Rails to Trails Conservancy
193. Slate Belt Museum

194. Southeastern Pennsylvania Resource Conservation & Development Council
198. Stroud Water Research Center
200. The Center for Rural Pennsylvania
208. Trout Unlimited – National Office
209. Trout Unlimited – Pennsylvania Council
212. Trust for Public Land – Washington Office
214. U.S. Geological Survey
215. U.S. Army Corps of Engineers
216. U.S. Environmental Protection Agency
219. U.S. EPA Region III / Philadelphia
229. Water Resources Association Of The Delaware River Basin

4. Conservation Organizations of the Lehigh River Watershed

a. Local Conservation Organizations

1. Watershed Associations

16. ALLIANCE FOR THE LITTLE LEHIGH CREEK

4184 Dorney Park Road, Allentown, Pennsylvania 18104

Contact: *Rebecca Hayden / Lehigh County Watershed Specialist*

Phone: *610-391-9583 ext. 18 Fax: 610-391-1131*

E-Mail Address: *rebecca-hayden@pa.nacdnet.org*

Group Type: *Non-Profit Organization*

Mission: *Watershed alliance focused on the protection, preservation and enhancement of the Little Lehigh Creek.*

Region Served: *Multi-County*

46. CLEAN WATER ACTION / LEHIGH OFFICE

37 N. 8th St., Allentown, Pennsylvania 18101

Contact: *Patricia Smith / Regional Director*

Phone: *610-434-9223 Fax:*

Group Type: *Public Interest; Advocacy*

E-Mail Address: *allentowncwa@cleanwater.org*

Web Site: *www.cleanwateraction.org*

Publications: *"Clean Water Action Pennsylvania Newsletter" / Bi-monthly*

Mission: *To safeguard public health and the environment by lobbying for environmental legislation, enforcing existing laws, and working to elect environmental candidates to public office.*

Issues: *Wetlands; Air Pollution; Water Pollution; Pollution Prevention; Recycling; Municipal Waste; Hazardous Waste; and Pesticides and Toxics.*

Region Served: *State*

Membership Count: *80,000*

59. DELAWARE RIVER SHAD FISHERMEN'S ASSOCIATION

4110 Shannon Ave., Bethlehem, Pennsylvania 18020

Contact: *John Scholl / Financial Secretary*

Phone: *610-838-0132 Fax:*

Group Type: *Advocacy; Public Interest*

E-Mail Address: *SHADFISHERMAN@AOL.COM*

Web Site: *www.GEOCITIES.COM/SHADHOTLINE*

Publications: *"The Shad Times" Newsletter*

Mission: *To protect the environment and the beautiful Delaware River, its tributaries, and the American Shad.*

Issues: *Environmental Education; Hunting or Fishing; Heritage Preservation; and River, Stream or Watershed Protection.*

Region Served: *Multi-state*

Membership Count: *1,250*

92. LACKAWANNA RIVER CORRIDOR ASSOCIATION

P.O. Box 368, Scranton, Pennsylvania 18501-0368

Contact: *Bernard McGurl / Executive Director*

Phone: *570-207-7608 Fax: 570-207-7590*

Group Type: *Public Interest; Education; Conservation*

E-Mail Address: *lrc2@epix.net*

Publications: *"Lackawanna River Currents" / Quarterly*

Mission: *To encourage the restoration, protection and appropriate management of the Lackawanna River and its watershed through public education and active involvement with river-related issues.*

Issues: *Wetlands; Water Pollution; Mining & Reclamation; Environmental Education; Local Land Use; Industrial Site Re-use; Forestry Issues; Outdoor Recreation; Heritage Preservation; and River, Stream or Watershed Protection.*

Region Served: *Multi-County*

Membership Count: *600*

100. LEHIGH RIVER STOCKING ASSOCIATION

P.O. Box 54, Walnutport, Pennsylvania 18088

Contact: *Frank Bostick / President*

Group Type: *Non-Profit Preservation*

E-Mail Address: *info@lrsa.org*

Web Site: *www.lrsa.org*

Mission: *Our goal is the continuous improvement of this waterway and its tributaries. Our objectives are to insure clean water, a healthy and balanced ecosystem, and abundant fishery and access points for all citizens to enjoy.*

Issues: *Water Pollution; Hunting or Fishing; and River, Stream, or Watershed Protection.*

Region Served: *Multi-county*

Membership Count: *2,100*

101. LEHIGH RIVER WATCH

1231 Clearview Road, Coplay, Pennsylvania 18037

Contact: *Robert Miller*

Phone: *610-262-6127*

E-Mail Address: *LRWatch@aol.com*

Web Site: *www.lrsa.org*

112. LEIBERT CREEK WATERSHED GROUP

4184 Dorney Park Rd., Ste. 102, Allentown, Pennsylvania 18104

Contact: *Rebecca Hayden*

Phone: *610-391-9583 ext. 18*

E-Mail Address: *rebecca-hayden@pa.nacdnet.org*

115. LITTLE LEHIGH WATERSHED COALITION

11 West Pine St., Emmaus, Pennsylvania 18049

Contact: *Mike Siegel / President; Jan Keim / Secretary*

Phone: *610-366-8466; 610-965-2361*

127. MONOCACY CREEK WATERSHED ASSOCIATION, INC.

P.O. Box 1041, Bethlehem, Pennsylvania 18016

Contact: *Philip Burtner / President*

Phone: *610-861-5152 Fax: 215-257-5711*

Group Type: *Advocacy; Conservation; Environmental Advisory Council*

E-Mail Address: *phil_burtner@hotmail.com*

Publications: *"The Bulletin" / Bi-annually*

Mission: *To promote and protect the water quality and related resources of the Monocacy Creek Watershed.*

Issues: *Wetlands; Water Pollution; Pollution Prevention; Environmental Education; Local Land Use; Land Conservation; Industrial Site Re-use; Hunting or Fishing; Outdoor Recreation; Heritage Preservation; Wildlife Conservation & Management; and River, Stream or Watershed Protection.*

Region Served: *Multi-county*

Membership Count: *300*

199. THE BEAR CREEK LAKE'S WATERSHED ASSOCIATION

167 North Lake Drive, Jim Thorpe, Pennsylvania 18229

Contact: *Jake McGeehan*

E-Mail Address: *jakemc@ptd.net*

202. TOBYHANNA / TUNKHANNOCK CREEK WATERSHED ASSOCIATION

P.O. Box 796, Pocono Lake, Pennsylvania 18347

Contact: *Wes Shirk / President*

Phone: *570-643-2001 Fax: 570-643-1295*

Group Type: *Public Interest*

E-Mail Address: *whip@epix.org*

Web Site: *www.tctcwa.org*

Publications: *Newsletter / Tri-annually; Educational Brochures*

Mission: *To educate the community in ways to protect the waters, wetlands, woodlands and wildlife within our watershed.*

Issues: *Wetlands; Water Pollution; Pollution Prevention; Environmental Education; Recycling; Local Land Use; Land Conservation; Forestry Issues; State-Owned Land; Hunting or Fishing; Outdoor Recreation; Wildlife Conservation & Management; and River, Stream or Watershed Protection.*

Region Served: *Local Community*

Membership Count: *240*

204. TROUT UNLIMITED-FORKS OF THE DELAWARE CHAPTER 482

828 Cibby Street, Easton, Pennsylvania 18045

Contact: *Tom Rumore / President*

Phone: *610) 252-7301 ext. 3174*

Phone 2: *(610) 258-8341*

Group Type: *Conservation; Public Interest*

E-Mail Address: *TRUMORE@fast.net*

Web Site: *www.tu.org/newsstand/search_result.asp?rec_id=482*

Publications: *"Forks Forum" / Ten Times annually*

Mission: *To conserve, protect and restore North America's trout and salmon fisheries and their watersheds.*

Issues: *Wetlands; Environmental Education; Recycling; Local Land Use; Land Conservation; Hunting or Fishing; Outdoor Recreation; Wildlife Conservation Management; and River, Stream, or Watershed Protection.*

Region Served: *Multi-state*

Membership Count: *85*

205. TROUT UNLIMITED – HOKENDAUQUA CHAPTER 535

3917 Shirley Drive, Schnecksville, Pennsylvania 18078-2643

Contact: *Dale Steventon*

Phone: *610-770-8643*

Phone 2: *610-767-1213 Fax:*

Group Type: *Conservation*

E-Mail Address: *adms@enter.net*

Mission: *To conserve, protect and restore North America's trout and salmon fisheries and their watersheds.*

Issues: *Youth education programs; Outdoor Recreation; and River, Stream, or Watershed Protection.*

206. TROUT UNLIMITED – LITTLE LEHIGH CHAPTER 070

444 Schantz Rd., Allentown, Pennsylvania 18104

Contact: *Lincoln Parmer*

Phone: *610-395-5119*

Phone 2: *610-395-1606*

Group Type: *Conservation*

E-Mail Address: *jparmer@rcn.com*

Mission: *To conserve, protect and restore North America's trout and salmon fisheries and their watersheds.*

Issues: *Youth education programs; Outdoor Recreation; and River, Stream, or Watershed Protection.*

207. TROUT UNLIMITED – MONOCACY CHAPTER 491

3119 Red Lawn Drive, Bethlehem, Pennsylvania 18017-1834

Contact: *Steve Vanya*

Phone: *610-691-8028*

Phone 2: *610-691-1371*

Group Type: *Conservation; Public Interest*

Email: *van0087@enter.net*

Mission: *To conserve, protect and restore North America's trout and salmon fisheries and their watersheds.*

Issues: *Youth education programs; Outdoor Recreation; and River, Stream, or Watershed Protection.*

210. TROUT UNLIMITED – SAUCON CREEK CHAPTER 724

140 Tumble Creek Road, Easton, Pennsylvania 18042

Contact: *Andrew Cuttic*

Phone: *610-559-5534*

Phone 2: *908-429-4431 Fax: 908-203-1194*

Group Type: *Conservation*

Email: *andrew.cuttic@akerkvaerner.com*

Website: *www.sauconcreektu.org*

Publications: *Newsletter*

Mission: *To conserve, protect and restore North America's trout and salmon fisheries and their watersheds.*

Issues: *Youth education programs; Outdoor Recreation; and River, Stream, or Watershed Protection.*

211. TROUT UNLIMITED-SCHUYLKILL COUNTY CHAPTER 537

403 Nichols Street, P.O. Box 1387, Pottsville, Pennsylvania 17901

Contact: *Robert Brower / President*

Phone: *570-622-9611 Fax: 570-622-9611*

Group Type: *Conservation*

E-Mail Address: *schuylkilltu@hotmail.com*

Publications: *Newsletter / Monthly*

Mission: *To conserve, protect and restore North America's trout and salmon fisheries and their watersheds.*

Issues: *Wetlands; Air Pollution; Water Pollution; Oil & Gas Issues; Pollution Prevention; Mining Reclamation; Environmental Education; Recycling; Local Land Use; Municipal Waste; Hazardous Waste; Land Conservation; LLW Radioactive Waste; Forestry Issues; State-Owned Land; Hunting or Fishing; Outdoor Recreation; Heritage Preservation; Wildlife Conservation & Management; and River, Stream or Watershed Protection.*

Region Served: *Single County*

Membership Count: *141*

236. WILDLIFE INFORMATION CENTER

P.O. Box 198, Slatington, Pennsylvania 18080

Contact: *Dan R. Kunkle / Executive Director*

Phone: *610-760-8889 Fax: 610-760-8889*

Group Type: *Non-Profit Conservation*

E-Mail Address: *wildlife@fast.net*

Web Site: *www.wildlife.org*

Publications: *"Wildlife Activist" / Three times per year; "American Hawkwatcher" / Annually*

Mission: *To preserve wildlife and habitat through conservation, education, and research for the benefit of the earth and all its inhabitants.*

2. Conservation, Preservation and Sanctuary Organizations

22. AQUASHICOLA/POHOPOCO WATERSHED CONSERVANCY

P.O. Box 360, Kresgeville, Pennsylvania 18333

Contact: *Dominic Strohlein / President*

Phone: *610-681-3959*

Group Type: *Citizen-based, volunteer organization*

E-Mail Address: *aquapoco@hotmail.com*

Mission: *Dedicated to the conservation, protection and improvement of our watershed resources.*

Issues: *Water Pollution; Recycling; Local Land Use; Land Conservation; Wetlands; Pollution; Pollution Prevention; Environmental Education; and River, Stream, or Watershed Protection.*

Region Served: *Carbon/Monroe counties*

29. BERKS COUNTY CONSERVANCY

25 North 11th Street, Reading, Pennsylvania 19601

Contact: *Verlin Renner, Jr. / Executive Director*

Phone: *610-372-4992 Fax: 610-372-2917*

Group Type: *Public Interest; Advocacy; Advisory; Conservation*

E-Mail Address: *verlin@berks-conservancy.org*

Web Site: *www.berks-conservancy.org*

Publications: *"Conservancy News" Newsletter / Quarterly*

Mission: *To preserve the natural, history and agricultural resources of Berks County through effective land-use planning watershed improvements, farmland open space acquisition, and easement and historic site recognition and protection.*

Issues: *Wetlands; Air Pollution; Water Pollution; Pollution Prevention; Environmental Education; Recycling; Local Land Use; Land Conservation; Industrial Site Re-use; Forestry Issues; State-Owned Land; Hunting or Fishing; Outdoor Recreation; Heritage Preservation; Wildlife Conservation Management; and River, Stream, or Watershed Protection.*

Region Served: *Single County*

Membership Count: *600+*

56. DELAWARE HIGHLANDS CONSERVANCY

River Rd. – HC 1, Box 1926, Milanville, Pennsylvania 18443-9743

Contact: *Barbara Yeaman / President*

Phone: *570-729-7053 Fax: 570-729-7053*

Group Type: *Land Trust*

E-Mail Address: *byeaman@ezaccess.net*

Web Site: *www.rdz.acor.org/lists/sullcounty/landtrust*

Publications: *Newsletter / Quarterly*

Mission: *To acquire, protect and preserve, for the benefit of the general public, natural and scenic resources and provide education to further these goals.*

Issues: *Wetlands; Pollution Prevention; Environmental Education; Local Land Use; Land Conservation; Forestry Issues; Wildlife Conservation & Management; and River, Stream and Watershed Protection.*

Region Served: *Multi-State*

Membership Count: *150*

58. DELAWARE RIVER GREENWAY PARTNERSHIP

85 Old Dublin Pike, Doylestown, Pennsylvania 18901

Contact: *Clifford C. David, Jr. / Executive Director*

Phone: *215-345-7020 Fax: 215-345-4328*

Publications: *"Delaware River Greenway News" / Quarterly*

Mission: *To promote public and private stewardship of a regional greenway as a continuous corridor of natural, historic, scenic and recreational resources along the Delaware River and its tributaries.*

64. EARTH CONSERVANCY

101 South Main Street, Ashley, Pennsylvania 18706

Contact: *Michael A. Dziak / President and CEO*

Phone: *570 823.3445 Fax: 570 823.8270*

Group Type: *Conservation; Non-Profit Organization*

E-Mail Address: *earthcon@intergrafix.net*

Web Site: *www.earthconservancy.org*

Publications: *Newsletter / Quarterly*

Mission: *Earth Conservancy is a non-profit organization committed to revitalizing abandoned lands into productive assets for the communities in which they lie. Planning for the most productive use and management of the land, over 10,000 acres of Earth Conservancy land will be committed for open spaces and recreational purposes.*

69. ENVIRONMENTAL ACTION COMMITTEE

Box 200, Lenhartsville, Pennsylvania 19534

Contact: *Mathew Polis / Chair*

Phone: *610-756-6855 Fax: 610-756-6855*

Group Type: *Public Interest; Education; Advisory*

E-Mail Address: *faschng@fast.net*

Mission: *To protect and preserve wildlife habitat and to stop suburban sprawl.*

Issues: *Wetlands; Air Pollution; Water Pollution; Pollution Prevention; Environmental Education; Local Land Use; Municipal Waste; Hazardous Waste; Land Conservation; (LLW) Radioactive Waste; Forestry Issues; State-Owned Land; Hunting or Fishing; Outdoor Recreation; Wildlife Conservation Management; and River, Stream, or Watershed Protection.*

Region Served: *Multi-state*

Membership Count: *75*

75. HAWK MOUNTAIN SANCTUARY ASSOCIATION

1700 Hawk Mountain Rd., Kempton, Pennsylvania 19529-9449

Contact: *Cynthia Lenhart / Executive Director*

Phone: *610-756-6961 Fax: 610-756-4468*

Group Type: *Conservation*

E-Mail Address: *info@hawkmountain.org*

Web Site: *www.hawkmountain.org*

Publications: *"Hawk Mountain News" / Bi-annually*

Mission: *To foster the conservation of raptors worldwide and to create a better understanding of the natural environment, particularly in the central Appalachian region.*

Issues: *Environmental Education and Wildlife Conservation and Management.*

Region Served: *Multi-state*

Membership Count: *8,900*

78. HERITAGE CONSERVANCY

85 Old Dublin Pike, Doylestown, Pennsylvania 18901

Contact: *Clifford C. David Jr. / President*

Phone: *215-345-7020 ext. 112 Fax: 215-345-4328*

Group Type: *Preservation*

E-Mail Address: *hconserv@heritageconservancy.org*

Web Site: *heritageconservancy.org*

Publications: *"Environs" / Quarterly*

Mission: *Heritage Conservancy is a non-profit organization dedicated to preserving our natural and historic heritage. Founded in 1958, it was concern for the rapid loss of open space in Bucks County which led to the formation of the Bucks County Park Foundation, known today as Heritage Conservancy.*

86. KITTATINNY RIDGE COALITION

Audubon Pennsylvania, 100 Wildwood Way, Harrisburg, PA 17110

Contact: *Paul Zeph*

Phone: *717-213-6880 ext. 18 Fax: 717-213-6883*

E-Mail Address: *pzeph@audubon.org*

Web Site: *http://pa.audubon.org*

Mission Statement: *Conserve and restore natural ecosystems in Pennsylvania, focusing on birds, other wildlife, and their habitats through science, education and advocacy, for the benefit of humanity and the earth's biological diversity.*

Issues: *Bird Habitat; Forest Health; Land Conservation; Greenways; and Watershed Protection.*

88. LACAWAC SANCTUARY

R.R. 1, Box 518, Lake Ariel, Pennsylvania 18436

Contact: *Janice Poppich / Director*

Phone: *570-689-9494 Fax: 570-689-5299*

Group Type: *Public Interest; Environmental Education*

E-Mail Address: *director@lacawac.org*

Web Site: *www.lacawac.org*

Publications: *Newsletter / Quarterly*

Mission: *To preserve a unique glacial lake, and to provide a community center for education and a field station for environmental research.*

Issues: *Pollution Prevention; Environmental Education; Land Conservation; Wildlife Conservation and Management; and River, Stream or Watershed Protection.*

Region Served: *State*

93. LACKAWANNA VALLEY CONSERVANCY

P.O. Box 368, Scranton, Pennsylvania 18501

Contact: *Bernard McGurl / Scretary*

Phone: *570-876-6199 Fax: 570-207-7590*

Group Type: *Education; Conservation*

E-Mail Address: *lrn2@epix.net*

Mission: *To conserve, protect and manage natural, cultural and historic resources in the Lackawanna Valley and nearby areas of northeastern Pennsylvania.*

Issues: *Wetlands; Mining & Reclamation; Environmental Education; Local Land Use; Land Conservation; Industrial Site Re-use; Forestry Issues; Hunting or Fishing; Outdoor Recreation; Heritage Preservation; Wildlife Conservation and Management; and River, Stream or Watershed Protection.*

Region Served: *Multi-County*

125. MARITON WILDLIFE SANCTUARY AND WILDERNESS TRUST

240 Sunnyside Road, Easton, Pennsylvania 18042

Contact: *Polly Ivenz / Program Director*

Phone: *610-749-2379*

Phone2: *610-749-0515 Fax:*

E-Mail Address: *pat@fieldtrip.com*

Web Site: *www.fieldtrip.com/pa/07492379.htm*

Group Type: *Conservation; Education*

Publications: *"Friends of Mariton Newsletter" / Bi-annually*

Mission: *To protect wildlife, preserve the land in as natural a state as possible, and provide a place for scientific study and educational programs.*

Issues: *Wetlands; Water; Environmental Education; Recycling; Land Conservation; Forestry Issues; and Wildlife Conservation and Management.*

Region Served: *Single County and muti-state*

Membership Count:

140. NORTH BRANCH LAND TRUST

11 Carveton Rd., Trucksville, Pennsylvania 18708

Contact: *Linda Thoma / Executive Director*

Phone: *570.696.5545 Fax: 570.696.5546*

Email: *thoma@nblt.org*

Web Site: *www.nblt.org*

Publications: *"The Horizon"*

Mission: *A non-profit organization protecting and preserving lands of special natural and historic value, including farmland, wildland, forest, and open space.*

177. PENNSYLVANIA RAPTOR & WILDLIFE ASSOCIATION, INC.

7 Allegheny Rd., Mt. Bethel, Pennsylvania 18343

Contact: *Tom Nelson / Hope Anwyll / Co-Directors*

Phone: *570-897-6659 Fax:*

Group Type: *Other*

Publications: *Newsletter / Bi-annually*

Mission: *To educate the public with regard to the current and future needs of wildlife for continued survival in our shared ecosystems.*

Issues: *Environmental Education and Wildlife Conservation and Management*

Region Served: *Multi-state*

Membership Count:

182. POCONO NORTHEAST RESOURCE CONSERVATION & DEVELOPMENT COUNCIL

1300 Old Plank Rd., Mayfield, Pennsylvania 18433

Contact: *Ron Phelps / Coordinator*

Phone: *570-282-8732*

Group Type: *Publicly supported non-profit*

Web Site: *home.ptd.net/~pnercd*

Mission: *Develop selected natural and cultural resources of the region into economically viable and environmentally friendly enterprises. Conserve, improve, and protect the environment and natural resources of the Pocono Northeast. Develop the rural community while protecting and maintaining a desirable resource base.*

Issues: *Sustainable and Alternative Agriculture; Composting; Abandoned Mine Reclamation; Soil Health; Wood Products; Forestry; and Farmers Markets*

194. SOUTHEASTERN PENNSYLVANIA RESOURCE CONSERVATION & DEVELOPMENT COUNCIL

824 Main Street, Pennsburg, PA 18073

Contact: *John Metrick / Coordinator*

Phone: *215-541-7930*

E-Mail Address: *chairman@separcd.org*

Web Site: *www.separcd.org*

Mission: *To create regional partnerships to deliver programs of land conservation, water management, community development and environmental enhancement in a predominantly mixed rural and urban land-use area, stressed by a rapid rate of change.*

196. SOUTHERN WAYNE TRAIL RIDERS ASSOCIATION, INC.

P.O. Box 323, Greentown, Pennsylvania 18426

Contact: *June Reed / Secretary*

Group Type: *Advocacy; Other*

Publications: *Newsletter / Monthly*

Mission: *To promote equestrian trails within the Commonwealth and to maintain those in existence.*

Issues: *Environmental Education; Forestry; State-Owned Land; and Outdoor Recreation.*

Region Served: *Multi-County*

Membership Count: *135*

203. TREXLER-LEHIGH COUNTY GAME PRESERVE

5150 Game Preserve Road, Schnecksville, Pennsylvania 18078

Contact: *Tony Mazziotta / Director*

Phone: *610-799-4171 Fax: 610-799-4170*

E-Mail Address: *tonymazziotta@lehighcounty.org*

Web Site: *www.gamepreserve.org*

235. WILDLANDS CONSERVANCY, INC.

3701 Orchid Pl., Emmaus, Pennsylvania 18049-1637

Contact: *Thomas J. Kerr / President*

Phone: *610-965-4397*

Group Type: *Public Interest; Advocacy; Conservation*

E-Mail Address: *tkerr@wildlandspa.org*

Web Site: *www.wildlandspa.org*

Publications: *"Wildlands" / Bi-monthly*

Mission: *To preserve, protect, and enhance the land, water, ecological, and recreational resources of the region.*

Issues: *Wetlands; Water Pollution; Pollution Prevention; Mining & Reclamation; Environmental Education; Local Land Use; Land Conservation; Forestry Issues; State-Owned Land; Outdoor Recreation; Heritage Preservation; Wildlife Conservation & Management; and River, Stream or Watershed Protection.*

Region Served: *Multi-county*

Membership Count: *1,500*

3. Civic Organizations

32. BERKS RECYCLING COALITION

960 Old Mill Rd., Wyomissing, Pennsylvania 19610

Contact: *William Litvin / President*

Phone: *610-779-6960*

Group Type: *Public Interest*

Publications: *"About and About" / Quarterly*

Mission: *To encourage awareness of solid waste issues and action to make changes in what we buy, dispose of and daily environmental impact by promoting re-use and recycling of materials.*

Issues: *Pollution Prevention; Environmental Education; Recycling; Municipal Waste; and Hazardous Waste.*

Region Served: *Single county*

Membership Count: *50*

41. CARBON COUNTY GROUNDWATER GUARDIANS

P.O. Box 104, Palmerton, Pennsylvania 18071

Contact: *Frank Waksmunski*

Phone: *570-645-8597*

Group Type: *Non-Profit; Public Interest*

E-Mail Address: *grndwatr@aol.com*

Web Site: *www.webdesignpros.net/groundwater*

Publications: *"The Watering Whole"*

Mission: *The Carbon County Groundwater Guardians is a non-profit, volunteer organization dedicated to the conservation of groundwater resources in Carbon County, Pennsylvania. The Guardians advance good groundwater stewardship through their efforts to educate local residents on a variety of groundwater issues, endorse a county-wide recycling program for household hazardous waste, and encourage increased awareness and involvement of county residents by providing private well water testing at a reduced cost.*

Issues: *Conservation of groundwater resources.*

70. FRIENDS OF THE DELAWARE CANAL

145 South Main Street, New Hope, Pennsylvania 18938

Contact: *Susan Taylor*

Phone: *215-862-2021 Fax: 215-862-2021*

Group Type: *Independent Non-Profit*

E-Mail Address: *fodc@erols.com*

Web Site: *www.fodc.org*

Publications: *"Friends of the Delaware Canal" Newsletter/ Quarterly*

Mission: *Working to restore, preserve, and improve the Delaware Canal and its surroundings. Our primary goals are to ensure that the Canal is fully-watered and the towpath trail is continuous.*

Issues: *Advocacy; Community Volunteerism; and Educational and Recreational Programs.*

Region Served: *Delaware Canal*

74. GREEN VALLEY COALITION

P.O. Box 3407, Wescosville, Pennsylvania 18106

Contact: *Diane Hill / President*

Phone: *610-767-6335*

Group Type: *Non-Profit*

Mission: *Intelligent Land Use; Growth and Development of working land in agriculture and sustainable forestry; Preservation of natural areas important to biodiversity in the eco-region; Sustainability of communities, large and small, in the Lehigh Valley and its watersheds.*

Issues: *Environmental Education; Local Land Use; Sustainable Growth; Preservation; and Conservation.*

85. KALMBACH MEMORIAL PARK

200 Cotton Street, Macungie, Pennsylvania 18062

Phone: *610-965-1140 Fax: 610-966-2017*

Group Type: *Community Interest*

E-Mail Address: *mail@KalmbachPark.com*

Web Site: *www.kalmbachpark.com*

108. LEHIGH VALLEY LAND RECYCLING INITIATIVE

P.O. Box 21750, Lehigh Valley, Pennsylvania 18002

Contact: *Chad Helmer / Director*

Phone: *610-266-7179.*

E-Mail: *chelmer@lehighvalley.org*

Web Site: *www.lehighvalley.org/default.aspx?pageid=73*

Mission: *The Lehigh Valley Land Recycling Initiative (LVLRI) is a project of LVEDC and is focused on promoting economic development through the reuse of abandoned and under-utilized commercial and industrial properties, also known as brownfields.*

Issues: *Local Land Use; Land Conservation; Industrial Site Re-use.*

Region Served: *Lehigh Valley*

114. LITTER CONTROL & BEAUTIFICATION PROGRAM OF MONROE COUNTY

38 N. 7th Street, Stroudsburg, Pennsylvania 18360

Contact: *Jacquelyn A. Hakim / Coordinator*

Phone: *570-420-3754*

Phone 2: *570-420-3525 Fax: 570-420-3754*

Group Type: *Education; Advocacy*

E-Mail Address: *jahakim@ptd.net*

Mission: *To eliminate litter in Monroe County through the vigilant enforcement of litter laws, clean-up activities, and educational programs, in an effort to maintain a clean and beautiful Monroe County.*

Issues: *Environmental Education; Recycling; Municipal Waste; and Litter and Beautification.*

Region Served: *County*

151. PALMERTON CITIZENS FOR A CLEAN ENVIRONMENT

P.O. Box 131, Aquashicola, Pennsylvania 18012

Contact: *Louise Calvin / President*

Phone: *610-826-3369 Fax:*

Group Type: *Public Interest*

Publications: *Newsletter / Bi-annually*

Mission: *To secure a U.S. EPA Superfund cleanup that will decontaminate the heavy metals at the site, educate the community about the risks and remedies available to residents and to make sure the responsible hazardous waste industry complies with all regulations.*

Issues: *Air Pollution; Environmental Education; and Hazardous Waste.*

Region Served: *Local Community*

184. RETIRED & SENIOR VOLUNTEER PROGRAM (RSVP)

Senior Environment Corps, 800 Hausman Road, Allentown, Pennsylvania 18104

Contact: *Brian Hartman*

Phone: *610-391-8031 Fax: 610-391-8495*

Group Type: *Community Development*

E-Mail Address: *rsvpoflnc@enter.net*

Web Site: *www.seniorcorps.org*

Publications: *"National Service News" E-Newsletter*

Mission: *RSVP volunteers serve in a diverse range of non-profit organizations, public agencies, and faith-based groups. Among other activities, they mentor at-risk youth, organize neighborhood watch programs, test drinking water for contaminants, teach English to immigrants, and lend their business skills to community groups that provide critical social services.*
Issues: *Water Quality Monitoring; and River, Stream, or Watershed Protection.*

b. County Agencies

1. COUNTY SOIL CONSERVATION DISTRICTS

30. BERKS COUNTY CONSERVATION DISTRICT

Berks County Ag Ctr. – P.O Box 520, Leesport, Pennsylvania 19533-0520

Contact: *John Ravert / District Manager;*

E-Mail Address: *c-jravert@state.pa.us*

Contact: *Pamela Spayd / Watershed Manager*

E-Mail Address: *pspayd@countyofberks.com*

Phone: *610-372-4657 Fax: 610-478-7058*

Group Type: *Government*

Web Site: *www.co.berks.pa.us/conservation/site/default.asp*

Publications: *Annual Report*

Mission: *To protect and conserve the natural resources within the county through various programs to educate the citizens.*

Issues: *Wetlands; Air Pollution; Water Pollution; Pollution Prevention; Environmental Education; Recycling; Local Land Use; Municipal Waste; Land Conservation; Forestry Issues; Wildlife Conservation Management; and River, Stream, or Watershed Protection.*

Region Served: *Single county*

34. BUCKS COUNTY CONSERVATION DISTRICT

924 Town Center, New Britain, Pennsylvania 18901

Contact: *Frederick S. Groshens / District Manager*

E-Mail Address: *fredgroshens@bucksconservation.org*

Phone: *215-345-7577 ext. 106 Fax: 215-345-7584*

Contact: *Gretchen Schatschneider / Watershed Specialist*

Phone: *215-345-7577 ext. 106*

E-Mail Address: *gretchenschats@bucksconservation.org*

Group Type: *Government*

Web Site: *www.bucksconservation.org*

Publications:

Mission: *To protect and conserve the natural resources within the county, and provide for the wise use of these resources, while concentrating upon soil conservation and sediment pollution control.*

Issues: *Water Pollution; Pollution Prevention; Land Conservation; Local Land Use; Heritage Preservation; Wildlife Conservation Management; and River, Stream, or Watershed Protection.*

Region Served: *Community*

38. CARBON COUNTY CONSERVATION DISTRICT

5664 Interchange Road, Lehighton, Pennsylvania 18235

Contact: *James J. Clauser / District Manager*

Phone: *610-377-4894 Fax: 610-377-5549*

Group Type: *Government*

E-Mail Address: *carboncd@ptd.net*

Mission: *To protect and conserve the natural resources within the county.*

Issues: *Wetlands; Air Pollution; Water Pollution; Oil & Gas Issues; Pollution Prevention; Mining & Reclamation; Environmental Education; Recycling; Local Land Use; Municipal Waste; Hazardous Waste; Land Conservation; Industrial Site Re-use; Forestry Issues; State-Owned Land; Hunting or Fishing; Outdoor Recreation; Wildlife Conservation and Management; and River, Stream or Watershed Protection.*

Region Served: *Single County*

89. LACKAWANNA COUNTY CONSERVATION DISTRICT

1300 Old Plank Rd., Mayfield, Pennsylvania 18411

Contact: *Ernest Keller / District Manager*

E-Mail Address: *keller@lccd.net*

Contact: *John William Clune / Watershed Specialist*

E-Mail Address: *jwclune@lccd.net*

Phone: *570-281-9495 Fax: 570-281-9497*

Group Type: *Government*

Web Site: *www.lccd.net*

Publications: *Annual Report*

Mission: *To promote the wise use, protection and conservation of natural resources, soil and water.*

Issues: *Wetlands; Water Pollution; Pollution Prevention; Mining & Reclamation; Environmental Education; Recycling; Local Land Use; Land Conservation; Forestry Issues; Wildlife Conservation and Management; and River, Stream or Watershed Protection.*

Region Served: *Single County*

97. LEHIGH COUNTY CONSERVATION DISTRICT

Lehigh Agricultural Ctr., 4184 Dorney Park Rd., Ste. 102, Allentown, Pennsylvania 18104

Contact: *Paul Sell / District Manager*

E-Mail Address: *paul-sell@pa.nacdnet.org*

Phone: *610-391-9583 ext. 16 Fax: 610-391-1131*

Contact: *Rebecca Hayden / Watershed Specialist*

Phone: *610-391-9583 ext. 18*

E-Mail Address: *rebecca-hayden@pa.nacdnet.org*

Group Type: *Government*

Web Site: *www.lehighconservation.org*

Publications: *"Conservationally Speaking" / Quarterly*

Mission: *To protect and conserve the natural resources within the county, focusing on soil and water resources through erosion and sedimentation pollution control.*

Issues: *Pollution Prevention and Environmental Education.*

Region Served: *Single County*

121. LUZERNE COUNTY CONSERVATION DISTRICT

485 Smith Pond Rd., Shavertown, Pennsylvania 18708

Contact: *Walter Chamberlain / District Manager*

Phone: *570-674-7991 Fax: 570-674-7989*

E-Mail Address: *Info@LuzerneConservationDistrict.org*

Contact: *Josh Longmore / Watershed Specialist*

Phone: *570-674-3412*

E-Mail Address: *jlongmore@epamr.org*

Contact: *Robert E. Hughes / Regional Coordinator Eastern PA Coalition for Abandoned Mine Reclamation*

Phone: *570-674-7993 Fax: 570-674-7989*

E-Mail Address: *epcamr@ptd.net*

Group Type: *Government*

Web Site: *www.luzerneconservationdistrict.org/index.html*

Publications:

Mission: *To protect and conserve the natural resources of Luzerne County.*

Issues: *Wetlands; Water Pollution; Pollution Prevention; Environmental Education; Local Land Use; Land Conservation; Wildlife Conservation Management; and River, Stream, or Watershed Protection.*

Region Served: *Single county*

128. MONROE COUNTY CONSERVATION DISTRICT

8050 Running Valley Rd., Stroudsburg, Pennsylvania 18360-0917

Contact: *Craig Todd / District Manager*

Contact: *Darryl Speicher / R.C.S./Watershed Specialist*

Phone: *570-629-3060 Fax: 570-629-3063*

Group Type: *Government*

E-Mail Address: *monroecd@ptd.net*

Web Site: *www.mcconservation.org*

Mission: *To protect and conserve the natural resources within the county.*

Issues: *Wetlands; Water Pollution; Pollution Prevention; Environmental Education; Local Land Use; Land Conservation; and River, Stream or Watershed Protection.*

Region Served: *Single county*

142. NORTHAMPTON COUNTY CONSERVATION DISTRICT

Gracedale Complex – Greystone Bldg., Nazareth, Pennsylvania 18064

Contact: *Bruce Pysher / District Manager*

Phone: *610-746-1971 Fax: 610-746-1926*

E-Mail Address: *northamptoncd@pa.nacdnet.org*

Web Site: *www.northampton.pacd.org*

Mission: *To protect, manage and conserve the natural resources within the county through soil conservation and soil and sedimentation pollution control.*

Region Served: *Single county*

186. SCHUYLKILL COUNTY CONSERVATION DISTRICT

1206 Ag Center Dr., Pottsville, Pennsylvania 17963

Contact: *Craig R. Morgan / District Manager*

Phone: *570-622-3742 ext. 112*

Contact: *Ryan Koch / Watershed Specialist*

Phone: *570-622-3742 ext. 122 Fax: 570-622-4009*

Group Type: *Government; Conservation*

E-Mail Address: *rkoch@co.schuylkill.pa.us*

Web Site: *www.co.schuylkill.pa.us/Offices/Conservation/conservation.asp*

Publications: *"Seedling" Newsletter / Quarterly*

Mission: *To protect and conserve the county's resources.*

Issues: *Wetlands; Water Pollution; Pollution Prevention; Mining & Reclamation; Environmental Education; Recycling; Local Land Use; Land Conservation; Forestry Issues; State-Owned Land; Hunting or Fishing; Outdoor Recreation; Heritage Preservation; Wildlife Conservation and Management; and River, Stream or Watershed Protection.*

Region Served: *Single County*

230. WAYNE COUNTY CONSERVATION DISTRICT

Ag Service Ctr. – 470 Sunrise Ave., Honesdale, Pennsylvania 18431

Contact: *Robert Muller Jr. / District Manager*

Contact: *Grant Turano / Watershed Specialist*

Phone: *570-253-0930 Fax: 570-253-9741*

Group Type: *Conservation*

E-Mail Address: *waynecd@ptd.net*

Web Site: *www.co.wayne.pa.us/conservation.asp*

Mission: *For the cub scouts to value what they can do to make the earth a better and cleaner place.*

Issues: *Wetlands; Water Pollution; Pollution Prevention; Environmental Education; Land Conservation; Forestry Issues; Hunting or Fishing; and River, Stream or Watershed Protection.*

Region Served: *Single County*

Membership Count: *100*

2. AGRICULTURAL LAND PRESERVATION PROGRAMS

1. AGRICULTURAL LAND PRESERVATION PROGRAM – BERKS COUNTY

Berks County Agricultural Center, 1238 County Welfare Road, P.O. Box 520
Leesport, Pennsylvania 19533

Contact: *Tami Hildebrand*

Phone: *610-378-1844*

Group Type: *Government; Conservation*

E-Mail Address: *thildebrand@countyofberks.com*

2. AGRICULTURAL LAND PRESERVATION PROGRAM – BUCKS COUNTY

Bucks County Planning Commission, 1260 Almshouse Rd., Neshaminy Manor Complex
Doylestown, Pennsylvania 18901

Contact: *Rich Harvey*

Phone: *215-345-3409*

Group Type: *Government; Conservation*

Email Address: *rbharvey@co.bucks.pa.us*

3. AGRICULTURAL LAND PRESERVATION PROGRAM – CARBON COUNTY

490 Ore Street, Suite 2, P.O. Box 219, Bowmanstown, Pennsylvania 18030

Contact: *Duane Dellecker*

Phone: *610-852-5111*

Group Type: *Government; Conservation*

E-Mail Address: *ccrecycl@ptd.net*

4. AGRICULTURAL LAND PRESERVATION PROGRAM – LACKAWANNA COUNTY

Lackawanna Conservation District, 1300 Old Plank Road, Mayfield, Pennsylvania 18433

Contact: *Bill Lange*

Phone: *570-282-9495 Fax: 570-281-9497*

5. AGRICULTURAL LAND PRESERVATION PROGRAM – LEHIGH COUNTY

Lehigh County Agriculture Center, Suite 102, 4184 Dorney Park Road
Allentown, Pennsylvania 18104-5728

Contact: *Jeff Zehr; Beverly Weaver*

Phone: *610-391-9583*

Group Type: *Government; Conservation*

E-Mail Address: *jeff-zehr@pa.nacdnet.org; beverly-weaver@pa.nacdnet.org*

6. AGRICULTURAL LAND PRESERVATION PROGRAM – LUZERNE COUNTY

Luzerne County Planning Commission, Luzerne County Courthouse
200 N. River Street, Wilkes-Barre, Pennsylvania 18711

Contact: *Adrian Merolli / Director*

Phone: *570-825-1564*

Group Type: *Government; Conservation*

E-Mail Address: *planzone@epics.net*

7. AGRICULTURAL LAND PRESERVATION PROGRAM – MONROE COUNTY

Monroe County Planning Commission, Administration Center
1 Quaker Plaza, Room 106, Stroudsburg, Pennsylvania 18360-2135

Contact: *Eric Bartolacci / Environmental Planner*

Phone: *570-517-3151*

Group Type: *Government; Conservation*

E-Mail Address: *ebartolacci@co.monroe.pa.us*

8. AGRICULTURAL LAND PRESERVATION PROGRAM – NORTHAMPTON COUNTY

Gracedale Complex, Greystone Building, Nazareth, Pennsylvania 18064

Contact: *Maria Bentzoi / Land Preservation Administrator*

Phone: *610-746-1993 Fax: 610-746-1980*

Group Type: *Government; Conservation*

E-Mail Address: *mbentzon@northamptoncounty.org*

9. AGRICULTURAL LAND PRESERVATION PROGRAM – SCHUYLKILL COUNTY

Schuylkill County Conservation District, 1206 Agriculture Center Drive
Pottsville, Pennsylvania 17901

Contact: *Ryan Koch / Watershed Specialist*

Phone: *570-622-3742 ext. 122 Fax: 570-622-4009*

Group Type: *Government; Conservation*

E-Mail Address: *rkoch@co.schuylkill.pa.us*

10. AGRICULTURAL LAND PRESERVATION PROGRAM – WAYNE COUNTY

P.O. Box 134, Prompton, Pennsylvania 18456

Contact: *Krista O'Dell*

Phone: *570-253-8904*

Group Type: *Government; Conservation*

3. DEVELOPMENT COUNCILS, VISITOR BUREAUS, COUNTY PLANNING AND ECONOMIC DEVELOPMENT GROUPS

42. CARBON COUNTY PLANNING DEPARTMENT

P. O. Box 210, Jim Thorpe, PA 18229-0210

Contact: *Fred Osifat / Director*

Phone: *570-325-3671 Fax: 570-325-3303*

E-Mail Address: *cchompro@ptd.net*

Web Site: *www.carboncounty.com/planning.htm*

Mission: *Administers Community Development Block Grant (CDBG) Program for County and Five Entitlement Communities-Borough's of Jim Thorpe, Lehighton, Lansford, Palmerton, and Franklin Township. Administers County-Wide Housing Rehabilitation Program. Provides technical support to County Planning Commission-Reviews all Sub-division and Land Development Plans in County.*

66. ECONOMIC DEVELOPMENT COUNCIL OF NORTHEASTERN PENNSYLVANIA

1151 Oak St., Pittston, Pennsylvania 18640-3795

Contact: *Leonard Carlin / Regional Planner*

Phone: *570-655-5581 Fax: 570-654-5137*

Group Type: *Public Interest; Advocacy; Advisory*

E-Mail Address: *edcnp@microserve.com*

Web Site: *http://www.microserve.net/edcnp*

Publications: *Newsletter / Quarterly & Annual Report*

Mission: *To act as a catalyst in diversifying the economy and quality of life in Northeastern Pennsylvania.*

Issues: *Wetlands; Air Pollution; Water Pollution; Pollution Prevention; Mining & Reclamation; Environmental Education; Recycling; Local Land Use; Municipal Waste; Hazardous Waste; Land Conservation; Industrial Site Re-use; (LLW) Radioactive Waste; Forestry Issues; Outdoor Recreation; Heritage Preservation; and River, Stream, or Watershed Protection.*

Region Served: *Multi-county*

Membership Count: *1,000+*

73. GREATER LEHIGH VALLEY CHAMBER OF COMMERCE

Corporate Office, PO Box 20812, Lehigh Valley, Pennsylvania 18002-0812

Contact: *T. Anthony Iannelli / President*

Phone: *610-841-4582:*

Group Type: *Chamber of Commerce*

E-Mail Address: *tonyi@lehighvalleychamber.org*

Web Site: *www.lehighvalleychamber.org*

Mission: *Delivers value to our members through superior programs and services; Advocates advancing business interests; Unifies the business community to leverage regional resources and strengthen our collective voice; Creates opportunities for businesses to grow*

90. LACKAWANNA COUNTY RECYCLING & SOLID WASTE

3400 Boulevard Ave., Scranton, Pennsylvania 18512

Contact: *Joyce Hatala / Recycling and Solid Waste*

Phone: *570-963-6868 Fax: 570-963-6553*

Group Type: *Government*

E-Mail Address: *lackswa@sunlink.net*

Web Site:

Publications:

Mission: *To promote responsible solid waste management, recycling and environmental concerns in Lackawanna County.*

Issues: *Environmental Education; Recycling; Local Land Use; and Municipal Waste.*

Region Served: *Single County*

105. LEHIGH VALLEY CONVENTION & VISITORS BUREAU

2200 Avenue A, Bethlehem, Pennsylvania 18017

Phone: *800-747-0561 Fax: 610-882-0343*

Group Type: *Independent, non-profit corporation*

E-Mail Address: *geninfo@lehighvalleypa.org*

Web Site: *www.lehighvalleypa.org*

Publications: *Valley Map and Guide; Promotional Literature*

106. LEHIGH VALLEY ECONOMIC DEVELOPMENT CORPORATION

P.O. Box 21750, Lehigh Valley, Pennsylvania 18002

Contact: *Tammy Ferguson / Communications Director*

Phone: *610-266-6775 ext. 7682 Fax: 610-266-7623*

Group Type: *Not-for-profit business and economic development agency*

E-Mail Address: *lvedc@lehighvalley.org*

Web Site: *www.lehighvalley.org*

Publications: *"at-a-glance" / Quarterly*

Mission: *The Lehigh Valley Economic Development Corporation will promote and foster economic prosperity in the Lehigh Valley.*

109. LEHIGH VALLEY PLANNING COMMISSION

961 Marcon Blvd., Ste. 310, Allentown, Pennsylvania 18103-2616

Contact: *Frederic H. Brock / Assistant Director*

Phone: *610-264-4544 Fax: 610-264-2616*

Group Type: *Government*

E-Mail Address: *lvpc@early.com*

Publications: *"LVPC Newsletter" / Bi-monthly*

Mission: *To promote the health, safety and general welfare of the two-county region in accordance with the provisions of the Pennsylvania Municipalities Planning Code.*

Issues: *Wetlands; Air Pollution; Water Pollution; Pollution Prevention; Recycling; Local Land Use; Municipal Waste; Land Conservation; Industrial Site Re-use; Outdoor Recreation; Wildlife Conservation and Management; and River, Stream or Watershed Protection.*

Region Served: *Multi-County*

122. LUZERNE COUNTY CONVENTION & VISITORS BUREAU

56 Public Square, Wilkes-Barre, Pennsylvania 18701

Phone: *1-888-905-2872*

Group Type: *Information; Recreation*

E-Mail Address: *tournepa@tournepa.com*

Web Site: *www.tournepa.com*

Publications: *Promotional Literature*

Mission: *Nestled in the heart of Northeastern Pennsylvania, Luzerne County and the Greater Wilkes-Barre, Hazleton and Pittston areas offer visitors an area of natural beauty-with mountains, streams, lakes and valleys providing outdoor recreational opportunities year-round.*

130. MONROE COUNTY PLANNING COMMISSION

1 Quaker Plaza, Rm 106, Stroudsburg, Pennsylvania 18360

Contact: *Dave Albright / Open Space Coordinator*

Phone: *(570) 517-3100 Fax: (570) 420-3564*

E-Mail: *mcpc@co.monroe.pa.us*

Web Site: *www.monroe2020.org*

Publications: *Newsletter / Quarterly*

Mission: *The citizens of Monroe County will continue working together to sustain and improve our quality of life by ensuring that the county's natural environment, economic and cultural assets are within reach of all its people.*

147. NORTHEAST PENNSYLVANIA CONVENTION & VISITORS BUREAU

99 Glenmaura National Boulevard, Scranton, Pennsylvania 18507

Contact: *Tracy Barone / Executive Director*

Phone: *570-963-6363 Fax: 570-963-6852*

Group Type: *Information; Recreation*

E-Mail Address: *info@visitnepa.org*

Web Site: *www.visitnepa.org*

Publications: *Vacation Guides*

181. POCONO MOUNTAIN VACATION BUREAU

1004 Main Street, Stroudsburg, Pennsylvania 18360

Phone:*-570-421-5791 Fax: 570-476-8959*

Group Type: *Information; Recreation*

E-Mail Address: *pocomts@poconos.org*

Web Site: *www.800poconos.com*

Publications: *Vacation Guides*

Mission: *The Pocono Mountains Vacation Bureau, Inc. is to enhance the economic and environmental well-being of our region and members through the promotion of tourism and the comprehensive marketing of our destination.*

188. SCHUYLKILL COUNTY OFFICE OF SOLID WASTE MANAGEMENT

401 N. 2nd St., Pottsville, Pennsylvania 17901

Contact: *Wayne Brown / County Environmental Coordinator*

Phone: *570-628-1220 Fax: 570-628-1210*

Group Type: *Government*

E-Mail Address: *wbowen@ptd.net*

Publications: *Newsletter /Quarterly*

Issues: *Wetlands; Water Pollution; Mining & Reclamation; Environmental Education; Recycling; Municipal Waste; (LLW) Radioactive Waste; Forestry Issues; Outdoor Recreation; Heritage Preservation; Wildlife Conservation and Management; and River, Stream or Watershed Protection.*

Region Served: *Single County*

213. TWO RIVERS AREA CHAMBER OF COMMERCE

1 South 3rd Street, 9th Floor, Easton, Pennsylvania 18042

Contact: *Michael G Moorehead*

Phone: *610 253 -4211 Fax: 610 253-6114*

Group Type: *Chamber of Commerce*

E-Mail Address: *Tracc@eastonareachamber.org*

Web Site: *www.eastonareachamber.org*

231. WAYNE COUNTY DEPARTMENT OF PLANNING

925 Court St., Honesdale, Pennsylvania 18431

Contact: *Edward J. Coar / Director*

Phone: *570-253-5970 Fax: 570-253-5432*

Group Type: *Government*

Publications: *Annual Report*

Issues: *Local Land Use and Community Planning Agency.*

Region Served: *County*

4. PENN STATE COOPERATIVE EXTENSION OFFICES

152. PENN STATE COOPERATIVE EXTENSION OFFICE – BERKS COUNTY

Berks County Ag Center, P.O. Box 520 1238 County Welfare Rd., Leesport, Pennsylvania 19533

Contact: *Richard S. Kauffman / County Extension Director*

Phone: *610-378-1327 Fax: 610-378-7961*

Email Address: *BerksExt@psu.edu*

Web Site: *http://berks.extension.psu.edu*

153. PENN STATE COOPERATIVE EXTENSION OFFICE – BUCKS COUNTY

Neshaminy Manor Center, 1282 Almshouse Rd., Doylestown, Pennsylvania 18901

Contact: *Michael P. Fournier / County Extension Director*

Phone: *215-345-3283 Fax: 215-343-1653*

Email Address: *BucksExt@psu.edu*

Web Site: *http://bucks.extension.psu.edu*

154. PENN STATE COOPERATIVE EXTENSION OFFICE – CARBON COUNTY

P.O. Box 60, 4 Broadway, 3rd Floor, Jim Thorpe, Pennsylvania 18229

Contact: *Paul A. Shealer / County Extension Director*

Phone: *570-325-2788 Fax: 570-325-2805*

Email Address: *CarbonExt@psu.edu*

Web Site: *http://carbon.extension.psu.edu*

155. PENN STATE COOPERATIVE EXTENSION OFFICE – LACKAWANNA COUNTY

200 Adams Ave., Lower Level, Scranton, Pennsylvania 18503-1695

Contact: *Terry M. Schettini / County Extension Director*

Phone: *570-963-6842 Fax: 570-963-6853*

Email Address: *LackawannaExt@psu.edu*

Web Site: *http://lackawanna.extension.psu.edu*

156. PENN STATE COOPERATIVE EXTENSION OFFICE – LUZERNE COUNTY

16 Luzerne Ave., Suite 200, West Pittston, Pennsylvania 18643-2817

Contact: *Christine A. Tomascik / County Extension Director*

Phone: *570-825-1701 Fax: 570-825-1709*

Email Address: *luzerneExt@psu.edu*

Web Site: *http:/Luzerne.extension.psu.edu*

157. PENN STATE COOPERATIVE EXTENSION OFFICE – MONROE COUNTY

4499 Route 611, Stroudsburg, Pennsylvania 18360-9807

Contact: *Dawn M. Olson / County Extension Director*

Phone: *570-248-9618 Fax: 570-424-1984*

Email Address: *MonroeExt@psu.edu*

Web Site: *http://monroe.extension.psu.edu*

158. PENN STATE COOPERATIVE EXTENSION OFFICE – NORTHAMPTON COUNTY

Greystone Building, Gracedale Complex, Nazareth, Pennsylvania 18064-9212

Contact: *Phyllis Laufer / County Extension Director*

Phone: *610-746-1970 Fax: 610-746-1973*

Email Address: *NorthamptonExt@psu.edu*

Web Site: *http://northampton.extension.psu.edu*

159. PENN STATE COOPERATIVE EXTENSION OFFICE – SCHUYLKILL COUNTY

1202 Ag Center Drive, Pottsville, Pennsylvania 17901

Contact: *Duane L. Stevenson / County Extension Director*

Phone: *570-622-4225 Fax: 570-622-4481*

Email Address: *SchuylkillExt@psu.edu*

Web Site: *http://schuylkill.extension.psu.edu*

160. PENN STATE COOPERATIVE EXTENSION OFFICE – WAYNE COUNTY

Courthouse, 925 Court Street, Honesdale, Pennsylvania 18341-1996

Contact: *Peter T. Wulfhorst / County Extension Director*

Phone: *570-253-5970 ext. 239 Fax: 570-253-9478*

Email Address: *WayneExt@psu.edu*

Web Site: *http://wayne.extension.psu*

c. Federal and State Agencies;

1. Federal Agencies

220. USDA/FARM SERVICE AGENCY – BERKS COUNTY

Berks County Service Center, 1238 County Welfare Road, P.O. Box 520
Leesport, Pennsylvania 19533-0520

Contact: *Josephine Bodock / County Executive Director*

Phone: *610-371-4655 ext.2 Fax: 610-371-8640*

Web Site: *www.fsa.usda.gov/PA*

221. USDA/FARM SERVICE AGENCY – BUCKS COUNTY

Bucks County Service Center, 530 W. Butler Ave., Chalfont, Pennsylvania 18914-3201

Contact: *Darrell Tribue / County Executive Director*

Phone: *215-822-5630 Fax: 215-997-6685*

Web Site: *http://www.fsa.usda.gov/PA*

222. USDA/FARM SERVICE AGENCY – CARBON/MONROE COUNTY

Carbon/Monroe Service Center, 5664 Interchange Road, Lehighton, Pennsylvania 18235-5114

Contact: *DanaDee Miller-Boyle / County Executive Director*

Phone: *610-377-6143 Fax: 610-377-6665*

Web Site: *www.fsa.usda.gov/PA*

223. USDA/FARM SERVICE AGENCY – LACKAWANNA/WAYNE/PIKE COUNTY

1300 Old Plank Road, Mayfield, Pennsylvania 18433

Contact: *Elizabeth Kotkiewicz / County Executive Director*

Phone: *570-282-8732 Fax: 570-281-5379*

Web Site: *www.fsa.usda.gov/PA*

224. USDA/FARM SERVICE AGENCY – LEHIGH COUNTY

Lehigh County Service Center, 2211 Mack Boulevard, Allentown, Pennsylvania 18103-5623

Contact: *Michael Macker / County Executive Director*

Phone: *610-791-9810 Fax: 610-791-9820*

Web Site: *http://www.fsa.usda.gov/PA*

225. USDA/FARM SERVICE AGENCY – LUZERNE COUNTY

Luzerne County Service Center, 911 West Main Street, Plymouth, Pennsylvania 18651-2799

Contact: *DanaDee Miller Boyle / County Executive Director*

Phone: *570-779-0645 Fax: 570-779-5714*

Web Site: *http://www.fsa.usda.gov/PA*

226. USDA/FARM SERVICE AGENCY – NORTHAMPTON COUNTY

Northampton County Service Center, 1068 Bushkill Center Road
Nazareth, Pennsylvania 18064-9578

Contact: *Michael Macker / County Executive Director*

Phone: *(610) 759-9570 ext 3 Fax: 610-759-0754*

Web Site: *http://www.fsa.usda.gov/PA*

227. USDA/FARM SERVICE AGENCY – SCHUYLKILL COUNTY

Schuylkill County Service Center, 1104 Ag. Center Drive, Pottsville, Pennsylvania 17901

Contact: *Terry Stehr / County Executive Director*

Phone: *570-622-1312 ext. 3 Fax: 570-622-1593*

Web Site: *www.fsa.usda.gov/PA*

216. U.S. ENVIRONMENTAL PROTECTION AGENCY

Environmental Protection Agency, Ariel Rios Building, 1200 Pennsylvania Avenue, N.W.
Washington, DC 20460

Administrator: *Michael O. Leavitt*

Phone: *202-272-0167*

Web Site: *www.epa.gov*

214. U.S. GEOLOGICAL SURVEY / HEADQUARTERS

John W. Powell Federal Building, 12201 Sunrise Valley Drive, Reston, Virginia 20192

Contact: *Robert M Hirsch / Associate Director for Water*

Phone: *703-648-5215*

E-Mail Address: *rhirsch@usgs.gov*

Web Site: *www.usgs.gov*

Mission: *USGS is a world leader in the natural sciences through our scientific excellence and responsiveness to society's needs. The USGS serves the Nation by providing reliable scientific information to: Describe and understand the Earth; Minimize loss of life and property from natural disasters; Manage water, biological, energy, and mineral resources; and Enhance and protect our quality of life.*

219. U.S. ENVIRONMENTAL PROTECTION AGENCY REGION III

1650 Arch Street (3PM52), Philadelphia, Pennsylvania 19103-2029

Phone: *215-814-5000 Fax: 215-814-5103*

Toll free: *(800) 438-2474*

Email: *r3public@epa.gov*

Web Site: *www.epa.gov/region03*

217. U.S. FISH AND WILDLIFE SERVICE

Eastern Pennsylvania Field Office, Tobyhanna Army Depot, P.O. Box H
11 Hap Arnold Blvd., Bldg. 1015, Tobyhanna, Pennsylvania 18466-0800

Contact: *Anthony Tur / Office Contact; Jared Brandwein / Project Leader*

Phone: *570-894-1275 Fax: 570-894-1281*

E-Mail Address: *FW5ES_EPFO@fws.gov*

Web Site: *northeast.fws.gov/index.html*

2. State Agencies

71. GOVERNOR'S CENTER FOR LOCAL GOVERNMENT SERVICES/ NORTHEAST REGIONAL OFFICE

4184 Dorney Park Road, Suite 101, Allentown, Pennsylvania 18104

Contact: *Joseph Krumsky*

Phone: *610-530-5718 Fax: 610-530-5596*

Web Site: *www.inventpa.com*

Group Type: *Government*

Mission: *Be the principal advocate for local governments. Provide vital programs, services and training to local officials and municipal employees. Cut through red tape expeditiously to solve problems at the local level.*

72. GOVERNOR'S CENTER FOR LOCAL GOVERNMENT SERVICES/STATE OFFICE

4th Floor, Commonwealth Keystone Building, 400 North Street
Harrisburg, Pennsylvania 17120-0225

Contact: *Kenneth Klothen / Executive Director*

Phone: *888-223-6837*

Group Type: *Government*

E-Mail Address: *ra-dcedclgs@state.pa.us*

Web Site: *www.inventpa.com*

Mission: *Be the principal advocate for local governments. Provide vital programs, services and training to local officials and municipal employees. Cut through red tape expeditiously to solve problems at the local level.*

51. DCNR / DELAWARE CANAL STATE PARK

11 Lodi Hill Road, Upper Black Eddy, Pennsylvania 18972-9540

Contact: *Ken Lewis / Manager*

Phone: *610-982-5560Fax:*

Group Type: *Government*

E-Mail Address: *delawarecanalsp@state.pa.us*

Web Site: *www.dcnr.state.pa.us*

Mission: *DCNR maintains Pennsylvania's largest environmental education program, which includes staff and facilities at 56 state parks as well as staff from the bureaus of Forestry, Topographic & Geologic Survey, and Recreation & Conservation. DCNR staff provide a variety of educational, interpretive and technical assistance services, including teacher workshops and school programs like Watershed Education, Project Learning Tree, and Project WET.*

52. DCNR / HICKORY RUN STATE PARK

RR 1 Box 81, White Haven, Pennsylvania 18661-9712

Contact: *Manager*

Phone: *570-443-0400*

Group Type: *Government*

E-Mail Address: *hickoryrunsp@state.pa.us*

Web Site: *www.dcnr.state.pa.us*

Mission: *DCNR maintains Pennsylvania's largest environmental education program, which includes staff and facilities at 56 state parks as well as staff from the bureaus of Forestry, Topographic & Geologic Survey, and Recreation & Conservation. DCNR staff provide a variety of educational, interpretive and technical assistance services, including teacher workshops and school programs like Watershed Education, Project Learning Tree, and Project WET.*

53. DCNR / LEHIGH GORGE STATE PARK

RR #1 Box 81, White Haven, Pennsylvania 18661

Contact: *Kevin Fazzini / Manager*

Phone: *570-443-0400*

E-Mail Address: *hickoryrunsp@state.pa.us*

Web Site: *www.dcnr.state.pa.us/stateparks/parks/lehighgorge.asp*

54. DCNR / JACOBSBURG ENVIRONMENTAL EDUCATION CENTER

835 Jacobsburg Rd., Wind Gap, Pennsylvania 18091

Contact: *Bill Sweeney / Environmental Educator*

Phone: *610-746-2801*

Web Site: *jacobsburgsp@state.pa.us*

Mission: *The primary purpose of Pennsylvania State Parks is to provide opportunities for enjoying healthful outdoor recreation and serve as outdoor classrooms for environmental education.*

162. PENNSYLVANIA ASSOCIATION OF ENVIRONMENTAL PROFESSIONALS

P.O. Box 7202, Mechanicsburg, Pennsylvania 17050

Contact: *Jarrold McCormick / President*

E-Mail Address: *paep@earthlink.net*

Web Site: *www.paep.org*

Publications: *Quarterly Newsletter*

Mission: *The mission of Pennsylvania Association of Environmental Professionals is to promote environmental education, research, planning, assessment, review, and management through the formation and operation of a nonpolitical multidisciplinary professional society.*

164. PENNSYLVANIA DEPARTMENT OF COMMUNITY AND ECONOMIC DEVELOPMENT (DCED)

400 North Street, 4th Floor, Commonwealth Keystone Building
Harrisburg, Pennsylvania 17120-0225

Contact: *Office of the Secretary*

Phone: *717-787-3003*

Group Type: *Government*

E-Mail Address: *ra-DCEDCS@state.pa.us*

Web Site: *www.inventpa.com*

Mission: *The mission of the Department of Community and Economic Development (DCED) is to foster opportunities for businesses and communities to succeed and thrive in a global economy, thereby enabling Pennsylvanians to achieve a superior quality of life.*

165. PENNSYLVANIA DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES (DCNR) / STATE OFFICE

400 Market St. – P.O. Box 8767, Harrisburg, Pennsylvania 17105-8767

Contact: *Director, Office of Environmental Education & Information*

Phone: *717-787-2869 Fax: 717-772-9106*

Group Type: *Government*

Web Site: *www.dcnr.state.pa.us*

Publications: *The Resource / Monthly*

Mission: *DCNR maintains Pennsylvania's largest environmental education program, which includes staff and facilities at 56 state parks as well as staff from the bureaus of Forestry, Topographic & Geologic Survey, and Recreation & Conservation.*

Issues: *Environmental Education*

Region Served: *Mid-Atlantic Region*

Membership Count: *The Public*

166. PENNSYLVANIA DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES (DCNR) / NE REGIONAL OFFICE

201 Samters Building, 101 Penn Avenue, Scranton, PA 18503-2025

Contact: *Michele Breslin / Recreation & Park Advisor*

Phone: *570-963-4157 Fax: 570-963-3439*

Group Type: *Government*

Web Site: *www.dcnr.state.pa.us*

Publications: *The Resource / Monthly*

Mission: *DCNR maintains Pennsylvania's largest environmental education program, which includes staff and facilities at 56 state parks as well as staff from the bureaus of Forestry, Topographic & Geologic Survey, and Recreation & Conservation.*

Issues: *Environmental Education*

Region Served: *Mid-Atlantic Region*

Membership Count: *The Public*

167. PENNSYLVANIA DEPARTMENT OF ENVIRONMENTAL PROTECTION (PA DEP)

P.O. Box 8775, Harrisburg, Pennsylvania 17105

Contact: *Christopher Allen / Public Participation Coordinator*

Phone: *717-787-9580 Fax: 717-783-8926*

E-Mail Address: *allen.christopher@dep.state.pa.us*

Web Site: *www.dep.state.pa.us*

Publications: *Multiple*

Mission: *The Department of Environmental Protection's mission is to protect Pennsylvania's air, land and water from pollution and to provide for the health and safety of its citizens through a cleaner environment. We will work as partners with individuals, organizations, governments and businesses to prevent pollution and restore our natural resources.*

Issues: *Wetlands; Air Pollution; Water Pollution; Oil & Gas Issues; Pollution Prevention; Mining Reclamation; Environmental Education; Recycling; Local Land Use; Municipal Waste; Hazardous Waste; Land Conservation; Industrial Site Re-use; LLW Radioactive Waste; and River, Stream, or Watershed Protection.*

Region Served: *State*

173. PENNSYLVANIA FISH & BOAT COMMISSION HEADQUARTERS

1601 Elmerton Avenue, P.O. Box 67000, Harrisburg, Pennsylvania 17106-7000

Contact: *Teresa Erdman / Executive Secretary*

Phone: *717-705-7801*

Web-Site: *www.fish.state.pa.us*

173. PENNSYLVANIA FISH & BOAT COMMISSION NORTHEAST REGION

5565 Main Road, PO Box 88, Sweet Valley, Pennsylvania 18656

Contact: *Walt Dietz / Aquatic Resources Program Specialists (ARPS)*

Phone: *570-477-2206 Fax: 570-477-3221*

E Mail Address: *Wdietz@State.Pa.Us*

Web Site: *www.fish.state.pa.us*

173. PENNSYLVANIA FISH & BOAT COMMISSION SOUTHEAST REGION

Brubaker Valley Road, Po Box 9, Elm, Pennsylvania 17521

Contact: *Carl Haensel / Aquatic Resources Program Specialists (ARPS)*

Phone: *717-626-9081 Fax: 717-626-0486*

E-Mail Address: *chaenel@state.pa.us*

173. PENNSYLVANIA FISH & BOAT COMMISSION LAW ENFORCEMENT / WATERWAYS CONSERVATION OFFICER NORTHEAST REGION

5565 Main Road, PO Box 88, Sweet Valley, Pennsylvania 18656

Contact: *Sally Corl*

Phone: *570-477-5717 Fax: 570-477-3221*

E-Mail Address: *scorl@state.pa.us*

Serves Counties: Bradford, Carbon, Columbia, Lackawanna, Luzerne, Monroe, Pike, Sullivan, Susquehanna, Wayne, Wyoming

173. PENNSYLVANIA FISH & BOAT COMMISSION LAW ENFORCEMENT/ WATERWAYS CONSERVATION OFFICER SOUTHEAST REGION

Brubaker Valley Road, Po Box 9, Elm, Pennsylvania 17521

Contact: *Jeffrey S. Bridi*

Phone: *717-626-0228 Fax: 717-626-0486*

E-Mail Address: *jbridi@state.pa.us*

Serves Counties: *Berks, Bucks, Chester, Delaware, Lancaster, Lehigh, Montgomery, Northampton, Philadelphia, Schuylkill*

174. PENNSYLVANIA GAME COMMISSION HEADQUARTERS

2001 Elmerton Ave., Harrisburg, Pennsylvania 17110-9797

Contact: *Roland Bergner / Chief, Federal/State Coordination Division*

Phone: *717-787-9612 Fax: 717-787-6957*

Group Type: *Government*

Web Site: *www.pgc.state.pa.us*

Mission: *To protect, conserve and manage the diversity of wildlife and their habitats; to provide wildlife-related education, services and recreational opportunities for both consumptive and non-consumptive uses of wildlife; and to maintain and promote Pennsylvania's hunting and trapping heritage.*

Issues: *Hunting or Fishing; Outdoor Recreation; and Wildlife Conservation Management.*

Region Served: *State*

174. SOUTHEAST REGION

P.O. Box 516, Fogelsville, Pennsylvania 18051

Contact: *David E. Mitchell / Land Management Supervisor*

Phone: *610-285-2460 (h) 610-285-6434 (w)*

175. PENNSYLVANIA HISTORICAL AND MUSEUM COMMISSION

300 North St., Harrisburg, Pennsylvania 17120

Contact: *John C. Wesley / Interim Executive Director*

Phone: *717-787-2891 Fax: 717-783-9924*

Web Site: *www.phmc.state.pa.us*

Mission: *The Pennsylvania Historical and Museum commission was created by Act No. 446, approved June 6, 1945, amending the Administrative Code to consolidate the functions of the Pennsylvania Historical Commission, The State Museum and the State Archives.*

179. PENNSYLVANIA STATE ASSOCIATION OF TOWNSHIP SUPERVISORS

4855 Woodland Drive, Enola, Pennsylvania 17025

Contact: *Keith R. Hite / Executive Director*

Phone: *717-763-0930 Fax: 717-763-9732*

E-Mail Address: *psatsweb@psats.org*

Web Site: *www.psats.org*

Mission: *The mission of the Pennsylvania State Association of Township Supervisors is to preserve and strengthen township government and to secure greater visibility and involvement for townships in the state and federal political arenas.*

D. CITIZEN ENVIRONMENTAL ADVISORY COMMITTEES

12. ALBURTIS BOROUGH ENVIRONMENTAL ADVISORY COUNCIL

260 Franklin St. PO Box 435, Alburtis, Pennsylvania 18011

Contact: *Dave Kuczur*

Phone: *610-966-4777 Fax: 610-965-5517*

Group Type: *Community Advisory Panel*

E-Mail Address: *office@alburtis.org*

Web Site: *www.alburtis.org*

31. BERKS COUNTY ENVIRONMENTAL ORGANIZATION NETWORK

Berks County Agricultural Ctr., P.O. Box 520, Leesport, Pennsylvania 19533

Contact: *John Ravert / County Environmental Office*

Phone: *610-374-0129 Fax: 610-478-7058*

Group Type: *Environmental Education*

Mission: *To promote environmental awareness by providing a forum for the exchange of information and through coordination and sponsorship of planned activities.*

Issues: *Advisory; and Environmental Education.*

Region Served: *Single county*

Membership Count: *15 organizations*

36. BUSHKILL TOWNSHIP ENVIRONMENTAL ADVISORY COUNCIL

1114 Bushkill Center, Nazareth, Pennsylvania 18064

Contact: *Jason Smith, EAC Chair*

Phone: *610-759-1250*

Group Type: *Community Advisory Panel*

E-Mail Address: *jsmith@fxbrowne.com*

Web Site: *bushkilltownship.com*

39. CARBON COUNTY ENVIRONMENTAL ADVISORY COUNCIL

Court House Annex, Jim Thorpe, Pennsylvania 18229-0129

Contact: *Daunt Delrecker / Planning Officer*

Phone: *570-325-3611*

Group Type: *Environmental Advisory Council*

49. COOLBAUGH TOWNSHIP ENVIRONMENTAL ADVISORY COUNCIL

5550 Memorial Boulevard, Tobyhanna, Pennsylvania 18466

Contact: *Dan Ferguson, Chair*

Phone: *570-894-8490*

Group Type: *Community Advisory Panel*

E-Mail Address: *coolbaugh@ezaccess.net*

Web Site: *www.coolbaughtwp.org*

50. COOPERSBURG ENVIRONMENTAL COMMITTEE

5 N. Main St., Coopersburg, Pennsylvania 18036

Contact: *Dennis M. Balascak / Borough Councilman*

Phone: *610-282-3307 Fax: 610-252-4668*

Group Type: *Government*

E-Mail Address: *coopersburg@enter.net*

Mission: *To protect our borough from all forms of pollution; to enhance our park and recreation lands and to conserve wildlife.*

Issues: *Pollution Prevention; Recycling; Local Land Use; Hazardous Waste; Outdoor Recreation; Wildlife Conservation and Management; and River, Stream or Watershed Protection.*

Region Served: *Local Community*

Membership Count:

77. HEIDELBERG TOWNSHIP ENVIRONMENTAL ADVISORY COUNCIL

6825 Phillips Road, Germansville, Pennsylvania 18053

Contact: *Allison C. Moreland*

Phone: *610-767-6188*

Group Type: *Community Advisory Panel*

E-Mail Address: *Allison_C_Moreland@knoll.com*

118. LOWER NAZARETH TOWNSHIP ENVIRONMENTAL ADVISORY COUNCIL

406 Manor Dr., Nazareth, Pennsylvania 18064

Contact: *Joan Garrett / Chairperson*

Phone: *610-746-0893*

Group Type: *Environmental Advisory Council*

E-Mail Address: *JTGARR@email.msn.com*

Region Served: *Local Community*

119. LOWER SAUCON TOWNSHIP ENVIRONMENTAL ADVISORY COUNCIL

3700 Old Philadelphia Pike, Bethlehem, Pennsylvania 18015

Contact: *Glenn Kern*

Phone: *610-865-3291 Fax: 610-867-3580*

Group Type: *Community Advisory Panel*

Web Site: *www.lowersaucontownship.org*

139. NAZARETH ENVIRONMENTAL COUNCIL

Nazareth Borough Hall, Church and Center St., Nazareth, Pennsylvania 18064

Contact: *Paul Kokolus / Secretary*

Phone: *610-759-0202*

Group Type: *Environmental Advisory Council*

143. NORTHAMPTON COUNTY ENVIRONMENTAL ADVISORY COUNCIL

669 Washington St., Easton, Pennsylvania 18042-7475

Contact: *Frank E. Flisser / Chief Clerk*

Phone: *610-559-3195*

Group Type: *Environmental Advisory Council*

149. PALMER TOWNSHIP ENVIRONMENTAL ADVISORY COUNCIL

2635 Spring Garden Street, Palmer, Pennsylvania 18045

Contact: *Rob Reese/Tom Ganssle, Co-Chair*

Phone: *610-253-7191 Fax: 610-253-9957*

Group Type: *Community Advisory Panel*

E-Mail Address: *tganssle@earthlink.net*

Web Site: *www.greenworks.tv/eac/index.asp*

150. PALMER TOWNSHIP ENVIRONMENTAL STEERING COMMITTEE

3 Weller Pl., Palmer, Pennsylvania 18045

Contact: *Robin Reese / Chairman*

Phone: *610-253-7191 Fax: 610-253-9957*

Web Site: *www.palmertwp.com*

Group Type: *Government; Community Advisory Panel*

Issues: *Pollution Prevention; Environmental Education; Recycling; and Municipal Waste.*

Region Served: *Local Community*

Membership Count: *15*

185. RUSH TOWNSHIP ENVIRONMENTAL ADVISORY COUNCIL

RD1 Box 1326, 104 Mahanoy Avenue, Tamaqua, Pennsylvania 18252

Contact: *Bruce Schimpf, Chair*

Phone: *570-668-2938 Fax: 570-668-3129*

Group Type: *Community Advisory Panel*

Email Address: *schimpf@barnesville.pa.net*

187. SCHUYLKILL COUNTY ENVIRONMENTAL ADVISORY COUNCIL

401 N. 2nd St., Pottsville, Pennsylvania 17901-1210

Contact: *Wayne Bowen / County Environmental Coordinator*

Phone: *570-628-1204 Fax: 570-628-1210*

Group Type: *Environmental Advisory Group*

195. SOUTH WHITEHALL TOWNSHIP ENVIRONMENTAL ADVISORY COUNCIL

444 Walbert Ave., Allentown, Pennsylvania 18104

Contact: *Barry Search / Chairman*

Phone: *610-398-0337*

Group Type: *Environmental Advisory Council*

197. STERLING TOWNSHIP ENVIRONMENTAL ADVISORY COUNCIL

PO Box 100, Sterling, Pennsylvania 18463

Phone Number: *570-689-2911*

Group Type: *Community Advisory Panel*

218. UPPER SAUCON ENVIRONMENTAL ADVISORY COUNCIL

5500 Camp Meeting Rd., Center Valley, Pennsylvania 18034

Contact: *Charles V. Ruppert / Supervisor of Plan & Development*

Phone: *610-282-1171 Fax: 610-282-3557*

Group Type: *Environmental Advisory Council*

233. WEISENBERG TOWNSHIP ENVIRONMENTAL ADVISORY COUNCIL

7923 Holbens Valley Rd., New Tripoli, Pennsylvania 18066

Contact: *Dianne Mathews-Gehringer / Raymond C. Rosenberger*

Phone: *610-298-2352*

Group Type: *Environmental Advisory Council*

234. WHITEHALL TOWNSHIP ENVIRONMENTAL ADVISORY COUNCIL

3219 MacArthur Rd, Whitehall, Pennsylvania 18052

Contact: *Bill Car / Chairperson*

Phone: *610-437-5524*

Group Type: *Environmental Advisory Council*

E-Mail Address: *dwott@enter.net*

E. REGIONAL CONSERVATION ORGANIZATIONS

17. AMERICAN FARMLAND TRUST – NEW ENGLAND FIELD OFFICE

1 Short Street, Suite 2, Northampton, Massachusetts 01060-3952

Contact: *Cris Coffin / New England Policy Manager*

Phone: *413-586-9330 ext 29 Fax: 413-586-9332*

Email Address: *ccoffin@farmland.org*

18. AMERICAN RIVERS

1025 Vermont Ave., N.W. Suite 720, Washington, DC 20005-3516

Contact: *Kristen N. McDonald*

Phone: *202-347-7550 ext. 3020 Fax: 202-347-9240*

Group Type: *Non-Profit Conservation Organization*

E-Mail Address: *kmcdonald@amrivers.org*

Web Site: *www.amrivers.org*

Publications: *"River Currents" / Weekly Newsletter*

Mission: *Conservation organization dedicated to protecting and restoring rivers nationwide.*

Issues: *River Restoration; Advocacy; and River, Stream or Watershed Protection.*

Region Served: *National*

19. APPALACHIAN MOUNTAIN CLUB (AMC) / DELAWARE VALLEY CHAPTER

104 Gaither Drive, Mt. Laurel, New Jersey 08054

Contact: *Mr. Chris Rapacki / Chapter Chair*

E-Mail Address: *chair@amcdv.org*

Web Site: *www.amcdv.org*

Publications: *Appalachian Footnotes / Quarterly*

Mission: *Founded in 1876, the Appalachian Mountain Club is America's oldest conservation and recreation organization. Our members actively enjoy, appreciate, and protect the mountains, rivers, and trails of America's Northeast...*

20. APPALACHIAN MOUNTAIN CLUB (AMC) / MAIN OFFICE

5 Joy Street, Boston, Massachusetts 02108

Contact: *Friendly, knowledgeable staff*

Phone: *617-523-0636 Fax: 617-523-0722*

Group Type: *Conservation; Recreation*

E-Mail Address: *information@outdoors.org.*

Web Site: *www.outdoors.org*

Mission: *Founded in 1876, the Appalachian Mountain Club is America's oldest conservation and recreation organization. We promote the protection, enjoyment, and wise use of the mountains, rivers, and trails of the Appalachian region.*

21. APPALACHIAN TRAIL CONFERENCE

P.O. Box 807, Harpers Ferry, West Virginia 25425-0807

Phone: *304-535-6331 Fax: 304-535-2667*

Group Type: *Non-Profit; Preservation*

Email Address: *info@appalachiantrail.org*

Web Site: *www.appalachiantrail.org*

Publications: *"Appalachian Trailway News" (ATN) / Quarterly*

Mission: *The Appalachian Trail Conference (ATC) is a volunteer-based, private, non-profit organization dedicated to the preservation, management, and promotion of the Appalachian Trail as a primitive setting for outdoor recreation (on foot) and for learning.*

37. CANAAN VALLEY INSTITUTE (CVI)

650 Leonard Street, Clearfield, Pennsylvania 16830

Contact: *Janie French / State Coordinator*

Phone: *888-549-7640 Fax: 814-768-9587*

Group Type: *Community Planning and Sustainability; Professional Organization*

E-Mail Address: *Janie.french@canaanvi.org*

Web Site: *www.canaanvi.org*

Mission: *Since 1995, The Canaan Valley Institute (CVI) has been fostering local decision making in support of sustainable communities in the Mid-Atlantic Highlands. Canaan Valley Institute is a dedicated and diverse team of scientists, landscape ecologists, economists and business professionals, watershed resources specialists, geographic information systems analysts, software developers, community and program developers, grant writers, and a highly skilled support staff, all working for the sustainability of communities in the Mid-Atlantic Highlands.*

Issues: *GIS; Local Land Use; and Land Conservation.*

44. CENTER FOR WATERSHED PROTECTION

8390 Main Street, 2nd floor, Ellicott City, Maryland 21043

Contact: *Anne Kitchell / Watershed Planner*

Phone:*410-461-8323 Fax: 410-461-8324*

E-Mail Address: *ack@cwp.org*

Web Site: *www.cwp.org*

Mission: *provides local governments, activists, and watershed organizations around the country with the technical tools for protecting some of the nation's most precious natural resources: our streams, lakes and rivers. The Center has developed and disseminated a multi-disciplinary strategy to watershed protection*

Issues: *Watershed planning, Watershed Restoration, Stormwater Management, Watershed Research, Better Site Design, Education and Outreach, and Watershed Training*

48. CONSERVATION FUND

105 North Front Street, Harrisburg, Pennsylvania 17101

Contact: *Todd NcNew*

Phone: *717-230-8166 Fax: 717-230-8167*

Group Type: *Conservation*

Email Address: *bwilliams@atconf.org*

Web Site: *www.conservationfund.org*

Publications: *"Common Ground" / Quarterly*

Mission: *The Conservation Fund forges partnerships to preserve our nation's outdoor heritage -- America's legacy of wildlife habitat, working landscapes and community open-space.*

57. DELAWARE RIVER BASIN COMMISSION (DRBC)
PENNSYLVANIA COMMISSION
WATER PLANNING OFFICE

P.O. Box 2063, 400 Market Street, 15th Floor, Harrisburg, PA 17105-2063

Contact: *John Hines / Executive Director*

Phone: *717-772-4785 Fax: 717-783-4690*

Email: *johines@state.pa.us*

Web Site: *www.dep.state.pa.us/river/river_basin.htm*

Mission: *The Commission will be the leader in protecting, enhancing, and developing the water resources of the Delaware River Basin for present and future generations.*

60. DELAWARE RIVERKEEPER NETWORK

Main Office, P.O. Box 326, Washington Crossing, Pennsylvania 18977-0326

Contact: *Maya K. Van Rossum / Executive Director*

Phone: *609-397-4410 (executive director); 215-369-1188 Fax: 215-369-1181 (main office)*

Group Type: *Advocacy; Conservation*

E-Mail Address: *maya@comcat.com (executive director); drkn@delawareriverkeeper.org (main office)*

Web Site: *www.delawareriverkeeper.org*

Publications: *"River Rapids" / Quarterly*

Mission: *The Delaware Riverkeeper Network is a non-profit, membership organization that has worked since 1988 to strengthen citizen protection of the Delaware River and its tributary watersheds. An affiliate of the American Littoral Society, a national conservation group, Riverkeeper works throughout the Delaware's entire 13,000 square-mile watershed which includes portions of N.Y., N.J., Pa. and De.*

Issues: *Public Interest; and River, Stream or Watershed Protection.*

62. DUCKS UNLIMITED, INC.

RR 2 Box 337, Thompson, Pennsylvania 18465

Contact: *Scott Reinhart – Program Biologist*

Phone: *570-727-2537*

Web Site: *www.ducks.org*

Publications: *"Ducks Unlimited" Magazine / Bi-monthly*

Mission: *Ducks Unlimited conserves, restores, and manages wetlands and associated habitats for North America's waterfowl. These habitats also benefit other wildlife and people.*

79. HIGHLANDS COALITION

P.O. Box 118, Titusville, New Jersey 08560

Contact: *Dawn Serra – Program Assistant*

Phone: *609-737-7263 Fax: 609-737-7264*

Group Type: *Conservation; Land Stewardship*

Email Address: *highlandsco@earthlink.net*

Web Site: *www.highlandscoalition.org*

Publications: *"High Ground" / Quarterly*

Mission: *The more than two-million-acre Highlands region provides a green buffer, providing clean drinking water, vital open spaces and abundant outdoor recreation opportunities to some 25 million people who live within an hour of this nationally significant and threatened region.*

130A. MONTGOMERY COUNTY LAND TRUST

P.O. Box 300, Lederach, Pennsylvania 19450

Phone: *215-513-0100 Fax: 215-513-0150*

Group Type: *Non-Profit*

Email: *dflaharty@mclt.com*

Web Site: *www.mclt.com*

Publications: *"Open Spaces"*

Mission: *The mission of Montgomery County Lands Trust is to permanently preserve land and to foster the wise stewardship of open space in our county.*

200. THE CENTER FOR RURAL PENNSYLVANIA

200 N. Third St., Suite 600, Harrisburg, PA 17101

Contact: *Barry L. Denk / Director*

Phone: *717-787-9555 Fax: 717-772-3587*

E-Mail Address: *info@ruralpa.org*

Web Site: *www.ruralpa.org*

Mission: *The Center for Rural Pennsylvania is a bipartisan, bicameral legislative agency that serves as a resource for rural policy within the Pennsylvania General Assembly. The Center works with executive agencies and federal, regional and community organizations to maximize resources and strategies that can better serve the needs of Pennsylvania's 2.8 million rural residents.*

137. THE NATURE CONSERVANCY, PENNSYLVANIA CHAPTER – HEADQUARTERS

500 North 3rd Street, 6th Floor, Harrisburg, Pennsylvania 17101

Contact: *Ron Ramsey / Director of Government Relations*

Phone: *717-232-6001 Fax: 717 232-6061*

Web Site: *www.nature.org/pennsylvania*

Publications: *"Nature Conservancy" Magazine / Every three months*

Mission: *To preserve the plants, animals and natural communities that represent the diversity of life on Earth by protecting the lands and waters they need to survive.*

138. THE NATURE CONSERVANCY, PENNSYLVANIA CHAPTER – NORTHEASTERN PENNSYLVANIA FIELD OFFICE

PO Box 55, Long Pond Road, Long Pond, Pennsylvania 18334

Contact: *Ralph 'Bud' Cook*

Phone: *570-643-7922 Fax: 570-643-7925*

Web Site: *www.nature.org*

Mission: *To preserve the plants, animals and natural communities that represent the diversity of life on Earth by protecting the lands and waters they need to survive.*

133. NORTHAMPTON – LEHIGH – CARBON OUTDOOR SPORTSMEN ASSOCIATION

P.O. Box 302, Northampton, PA 18067

Contact: *Club Secretary*

Phone: *610-760-9650*

E-Mail Address: *rick@nlcosa.com*

Web Site: *www.nlcosa.com*

Publications: *Quarterly Newsletter*

Mission: *Northampton – Lehigh – Carbon (NLC) Outdoor Sportsman Association was founded in 1999 to raise money for stocking trout in the Lehigh River and pheasants on surrounding game lands. NLC Outdoor Sportsman Association has been involved with trout and pheasant raising and stocking as well as general outdoor conservation projects. NLC Outdoor Sportsman Association is a 501 [c] [3] certified non-profit organization which relies on raffles, donations, and weekly ticket sales to fund our stockings*

136. NATURAL LANDS TRUST

1031 Palmers Mill Rd., Media, Pennsylvania 19063

Contact: *Oliver P. Bass / Director of Development & Communications*

Phone: *610-353-5587 Fax: 610-353-0517*

Group Type: *Non-Profit*

Email Address: *obass@natlands.org*

Web Site: *www.natlands.org*

Publications: *"Natural Lands"*

Mission: *Natural Lands Trust, a non-profit regional land trust, has been working with our region's communities to protect these vital resources since 1953. Through acquisition, conservation easements, planning and education, we work with others to ensure that our natural and cultural resources are here for future generations.*

146. NORTHAMPTON GREENWAY PARTNERSHIP

Northampton Middle School, 1617 Laubach Ave., Northampton, Pennsylvania 18067

Contact: *John Mauser*

Phone: *610-262-7817*

169. PENNSYLVANIA ENVIRONMENTAL COUNCIL – HEADQUARTERS / PHILADELPHIA COUNTY

117 South 17th Street, Suite 230, Philadelphia, Pennsylvania 19103-5022

Contact: *Brian Hill / Senior Vice President for Watersheds*

Phone: *215-563-0250 Fax: 215-563-0528*

Email: *bhill@pecpa.org / pecphila@libertynet.org*

Web Site: *www.pecpa.org*

Publications: *"Great Places with Transit"*

Mission: *The Pennsylvania Environmental Council improves quality of life for all Pennsylvanians by enhancing the Commonwealth's natural and built environments by integrating advocacy, education and implementation of community and regional action projects.*

168. PENNSYLVANIA ENVIRONMENTAL COUNCIL-NORTHEAST REGIONAL OFFICE

175 Main St., Luzerne, Pennsylvania 18709

Contact: *Ellen M. Ferretti / Director*

Phone: *570-718-6507 Fax: 570-718-6508*

Group Type: *Advocacy; Advisory; Education; Conservation*

E-Mail Address: *ellen@pecnepa.org*

Web Site: *www.libertynet.org/pecphila*

Mission: *The Pennsylvania Environmental Council improves quality of life for all Pennsylvanians by enhancing the Commonwealth's natural & build environments by integrating advocacy, education & implementation of community & regional action projects.*

Issues: *Wetlands; Water Pollution; Pollution Prevention; Mining Reclamation; Environmental Education; Recycling; Local Land Use; Land Conservation; Industrial Site Re-use; Outdoor Recreation; and River, Stream or Watershed Protection.*

172. PENNSYLVANIA FEDERATION OF SPORTSMAN CLUBS / STATE OFFICE

2426 North Second Street, Harrisburg, Pennsylvania 17110

Contact: *Melody Zullinger / Executive Director*

Phone: *717-232-3480 Fax: 717-231-3524*

Group Type: *Sportsman Organization; Advocacy*

E-Mail Address: *info@pfsc.org*

Web-Site: *www.pfsc.org*

Publicaitons: *"On Target" Newsletter*

Mission: *The mission of The Pennsylvania Federation Of Sportsmen's Clubs Inc. is to provide a statewide, united voice for the concerns of all sportsmen and conservationists; to insure their rights and interests are protected, and to protect and enhance the environment and our natural resources.*

171. PENNSYLVANIA FEDERATION OF SPORTSMAN CLUBS / SOUTHEAST CHAPTER

1363 N. Cottonwood, Danielsville, Pennsylvania 18038

Contact: *Lee Marsh*

Phone: *610-767-7543*

Web Site: *www.pfsc.org*

Group Type: *Sportsman Organization; Advocacy*

Counties Served: *Berks, Bucks, Chester, Delaware, Lehigh, Montgomery, Northampton, Philadelphia, Schuylkill*

Mission: *The mission of The Pennsylvania Federation Of Sportsmen's Clubs Inc. is to provide a statewide, united voice for the concerns of all sportsmen and conservationists; to insure their rights and interests are protected, and to protect and enhance the environment and our natural resources.*

170. PENNSYLVANIA FEDERATION OF SPORTSMAN CLUBS / NORTHEAST CHAPTER

32 Valley View Dr., Pringle, Pennsylvania 18704

Contact: *Gerard Schutz*

Phone: *570-288-2931*

Web Site: *www.pfsc.org*

Group Type: *Sportsman Organization; Advocacy*

Counties Served: *Carbon, Lackawanna, Luzerne, Monroe, Pike, Susquehanna, Wayne, Wyoming*

Mission: *The mission of The Pennsylvania Federation Of Sportsmen's Clubs Inc. is to provide a statewide, united voice for the concerns of all sportsmen and conservationists; to insure their rights and interests are protected, and to protect and enhance the environment and our natural resources.*

176. PENNSYLVANIA ORGANIZATION FOR WATERSHED AND RIVERS (POWR)

610 North Third St., Harrisburg, PA 17101

Contact: *Judith Jordan, Executive Director*

Phone: *717-234-7910 Fax: 717-234-7929*

E-Mail Address: *info@pawatersheds.org*

Group Type: *Non-Profit*

Web Site: *www.pawatersheds.org*

Mission: *POWR advocates for the protection, restoration and enjoyment of our common wealth of water resources, and conducts programs that foster stewardship, communication, leadership and action.*

178. PENNSYLVANIA SPATIAL DATA ACCESS (PASDA)

117 Land & Water Research Bldg, Penn State University, University Park, Pennsylvania 16802

Contact: *Maurie Caitlin Kelly / PASDA Coordinator*

Phone: *814-863-0104*

E-Mail Address: *mck4@psu.edu*

Contact: *James Spayd / Watershed & Conservation Resources Coordinator & Developer; Metadata Specialist*

E-Mail Address: *pasda@psu.edu.*

Web Site: *www.pasda.psu.edu*

Mission: *The Pennsylvania Spatial Data Access system (PASDA) is Pennsylvania's official geospatial information clearinghouse and the Commonwealth's node on the National Spatial Data Infrastructure (NSDI). The PASDA clearinghouse provides for the widespread sharing of geospatial data, eliminates the creation of redundant data sets, and serves as a resource for locating data throughout the Commonwealth through its data storage, interactive mapping/webgis applications, and metadata/documentation efforts.*

180. POCONO HERITAGE LAND TRUST

P.O. Box 292, Bartonsville, Pennsylvania 18321

Phone: *570-646-8448*

Email: *poconoheritage@yahoo.com*

183. RAILS TO TRAILS CONSERVANCY

105 Locust St., Harrisburg, Pennsylvania 17101

Contact: *Tom Sexton / Director*

Phone: *717.238.1717 Fax: 717-238-7566*

Email: *tsexton@transact.org*

Web Site: *www.railtrails.com*

Publications: *"Rails to Trails" Magazine / Quarterly*

Mission: *The purpose of Rails-to-Trails Conservancy (RTC) is to enrich America's communities and countryside by creating a nationwide network of public trails from former rail lines and connecting corridors.*

198. STROUD WATER RESEARCH CENTER

970 Spencer Road, Avondale, Pennsylvania 19311

Contact: *James V. McGonigle*

Phone: *610-268-2153 Fax: 610-268-0490*

E-Mail Address: *jmcgonigle@stroudcenter.org*

Web Site: *www. Stroudcenter.org*

Publications: *"Upstream", Spring and Fall*

Mission: *To advance knowledge of stream and river ecosystems through interdisciplinary research; to develop and communicate new ecological ideas; to provide solutions for water resource problems worldwide; and to promote public understanding of fresh water ecology through education programs, conservation leadership and professional service.*

208. TROUT UNLIMITED – NATIONAL OFFICE

1500 Wilson Blvd., #310, Arlington, Virginia 22209-2404

Contact: *Charles Gauvin / President and Chief Executive Officer*

Phone: *(800) 834-2419 Fax: 703-284-9400*

E-Mail Address: *trout@tu.org*

Web Site: *www.tu.org*

209. TROUT UNLIMITED – PA COUNCIL

RD #2, Box 520, Greensburg, Pennsylvania 15601

Contact: *George M. Mellinger / President*

Phone: *724-423-8428 Fax: 724-423-3728*

E-Mail Address: *president@patrout.org*

Web Site: *www.patrout.org*

212. TRUST FOR PUBLIC LAND – WASHINGTON OFFICE

Federal Affairs Department – National Programs, 660 Pennsylvania Ave. S.E., Suite 401
Washington, D.C. 20003

Contact: *Katherine Rowe*

Phone: *202-543-7552 Fax: 202-544-4723*

Email: *katherine.rowe@tpl.org*

Website: *www.tpl.org*

Publications: *"Land and People"*

Mission: *Land conservation is central to TPL's mission. Founded in 1972, the Trust for Public Land is the only national non-profit working exclusively to protect land for human enjoyment and well-being.*

215. U.S. ARMY CORPS OF ENGINEERS

100 Penn Square East, Philadelphia, Pennsylvania 19107-3390

Contact: *Gregory Wacik*

Phone: *215-656-6561*

Web Site: *www.usace.army.mil*

229. WATER RESOURCES ASSOCIATION OF THE DELAWARE RIVER BASIN

P.O. Box 867, Valley Forge, Pennsylvania

Contact: *Robert F. Molzahn / President*

Phone: *610-917-0090 Fax: 610-917-0091*

Group Type: *Non-Profit Advocacy*

E-Mail Address: *wra@wradrb.org*

Web Site: *www.wradrb.org*

Publications: *Newsletter*

Mission: *To promote sound water resources management within the Delaware River Basin. The Water Resources Association represents you—the water user and anyone dependent or interested in the Basin's water resources.*

F. Water Suppliers and Authorities

45. CITY OF ALLENTOWN BUREAU OF WATER RESOURCES

Water Resources-Distribution, 1242 Martin Luther King Jr. Drive
Allentown, Pennsylvania 18102

Contact: *Lou Stalsitz / Manager*

Phone: *610-437-7515 Fax: 610-437-8744*

Phone 2: *610-437-7751 (after-hours emergencies)*

E-Mail Address: *stalsitz@allentowncity.org*

76. HAZLETON CITY WATER AUTHORITY

400 East Author Gardener Highway, Hazleton City, Pennsylvania 18201

Contact: *Randy Cahalan / Manager*

Phone: *570-454-2401*

E-Mail: *rcahalan@amwater.com*

111. LEHIGHTON WATER AUTHORITY

Municipal Offices, Post Office Box 29, Constitution Avenue, Lehighton, Pennsylvania 18235

Contact: *Kenneth Sterling / Supervisor*

Phone: *610-377-1912*

E-Mail Address: *waterlwa@ptd.net*

110. LEHIGH VALLEY WATER SUPPLIERS, INC.

P.O. Box 3348, Allentown, Pennsylvania 18106-0348

Contact: *Liesel Smull*

Phone: *610-398- 2503 ext 128*

E-Mail Address: *mail4dewey@yahoo.com*

Web Site: *www.lvwater.org*

141. NORTHAMPTON BOROUGH MUNICIPAL AUTHORITY

Lehigh Valley Water Suppliers, Inc., 1 Clear Springs Drive
P.O. Box 156, Northampton, Pennsylvania 18067

Contact: *Steve Kerbacher / Operations Manager*

Phone: *610-262-6711 Fax: 610-262-6796*

E-Mail Address: *nbmawater@aol.com*

Web Site: *www.nbma.org*

G. EDUCATIONAL INSTITUTIONS,

40. CARBON COUNTY ENVIRONMENTAL EDUCATION CENTER

151 E. White Bear Dr., Summit Hill, Pennsylvania 18250

Contact: *Susan Gallagher / Chief Naturalist*

Phone: *570-645-8597 Fax: 570-645-8499*

Group Type: *Government*

Publications: *"Reflections From the Lake" Newsletter / Tri-Annually*

Mission: *To educate the general public about natural systems and the way they function; to instill values, attitudes and behaviors that will best conserve and improve our environment.*

Issues: *Wetlands; Water Pollution; Pollution Prevention; Environmental Education; Recycling; Local Land Use; Forestry; Issues; Hunting or Fishing; Outdoor Recreation; Wildlife Conservation and Management; River, Stream or Watershed Protection; Gardening; and Wildlife Rehabilitation.*

Membership Count: *600*

43. CEDAR CREST COLLEGE / DEPARTMENT OF BIOLOGICAL SCIENCES

Science Center, Allentown, Pennsylvania 18104

Contact: *Alan B. Hale, Ph.D / Department Chair*

Phone: *610-606-4666 ext 3510 Fax: 610-606-4616*

E-Mail Address: *abhale@cedarcrest.edu*

Web Site: *www2.cedarcrest.edu/academic/bio*

61. DESALES UNIVERSITY / BIOLOGY DEPARTMENT

Department of Natural Science, Center Valley, Pennsylvania 18034

Contact: *Dr. Robert Blumenstein / Department Chair; Dr. Joseph C. Colosi / Environmental Sciences*

Phone: *610-282-1100*

Web Site: *www.desales.edu*

87. KUTZTOWN UNIVERSITY ENVIRONMENTAL / SCIENCE FORUM

Boehm Science Bldg., Ofc. 219, Kutztown, Pennsylvania 19530

Contact: *Dr. Donald Mellinger / Advisor*

Phone: *610-683-4318 Fax: 610-683-1352*

Group Type: *Environmental Education*

Mission: *To strive for awareness which will complement and complete the academic aspect of the environmental science major and to supplement the classroom experience of other interested students.*

Issues: *Wetlands; Air Pollution; Water Pollution; Oil & Gas Issues; Pollution Prevention; Mining & reclamation; Environmental Education; Recycling; Local Land Use; Municipal Waste; Hazardous Waste; Land Conservation; Industrial Site Re-use; (LLW) Radioactive Waste; Forestry Issues; State-Owned Land; Hunting or Fishing; Outdoor Recreation; Heritage Preservation; Wildlife Conservation Management; and River, Stream, or Watershed Protection.*

Membership Count: *25*

94. LAFAYETTE COLLEGE / DEPARTMENT OF GEOLOGY AND ENVIRONMENTAL GEOSCIENCES

101B Van Wickle Hall, Easton, Pennsylvania 18042

Contact: *Dr. Dru Germanoski, Ph. D., P.G.*

Phone: *610-250-5196 Fax: 610-252-3904*

E-Mail Address: *germanod@lafayette.edu*

Web Site: *www.lafayette.edu*

102. LEHIGH UNIVERSITY / LEHIGH EARTH OBSERVATORY (LEO)

Lehigh University, 31 Williams Drive, Bethlehem, Pennsylvania 18015

Contact: *George Yasko*

Phone: *610-758-4840*

E-Mail Address: *leo@lehigh.edu*

Web Site: *www.leo.lehigh.edu*

Mission: *Focusing study on earth and environmental systems and society.*

63. LEHIGH UNIVERSITY / EARTH AND ENVIRONMENTAL SCIENCES

31 Williams Drive, Bethlehem, Pennsylvania 18105

Contact: *Dr. Frank Pazzaglia*

Phone: *610-758-3667*

E-Mail Address: *fjp3@lehigh.edu*

Group Type: *Education*

120. LUZERNE COUNTY COMMUNITY COLLEGE / SCIENCE CLUB

1333 S. Prospect St., Nanticoke, Pennsylvania 18634

Contact: *W. Brooke Yeager, III / Advisor*

Phone: *570-740-0288 Fax: 570-740-0295*

E-Mail Address: *byeager@luzerne.edu*

Mission: *To further environmental education of students by promoting recycling on campus, doing highway cleanup, birth control and frequent hands-on field trips.*

Issues: *Pollution Prevention; Environmental Education; Recycling; Land Conservation; and Outdoor Recreation.*

Membership Count: *10*

68. MUHLENBERG COLLEGE / ENACT / BIOLOGY DEPARTMENT

Muhlenberg College – 2400 Chew St., Allentown, Pennsylvania 18104

Contact: *Dr. Carl. S. Oplinger / Biology Professor*

Phone: *610-821-3257 Fax: 610-821-9809*

Group Type: *Environmental Education*

E-Mail Address: *oplinger@muhlenberg.edu*

Mission: *To promote student awareness and action on local and regional issues of environmental concern.*

Issues: *Pollution Prevention; Environmental Education; Recycling; Land Conservation; Wildlife Conservation and Management; and River, Stream or Watershed Protection.*

Membership Count: *20*

131. MORAVIAN COLLEGE / BIOLOGY DEPARTMENT

Hall of Science, Rm 305, 1200 Main Street, Bethlehem, Pennsylvania 18018

Contact: *Professor Frank Kuserk / Department Chair*

Phone: *610-861-1300 ext.1429*

E-Mail Address: *meftk01@moravian.edu*

Web Site: *home.moravian.edu/public/bio*

145. NORTHAMPTON COUNTY JUNIOR CONSERVATION SCHOOL

206 West Third Street, Pennsburg, Pennsylvania 18073

Contact: *Andrew R. Curtis/ Director*

Phone: *610-391-9840 Fax: 610-391-0683*

Phone 2: *215-679-6984*

Group Type: *Environmental Education*

E-Mail Address: *arc10@psu.edu*

Web Site: *www.ncjcs.org*

Mission: *In a continuing effort to install a positive attitude, leadership skills, and a conservation ethic among our youth, the Northampton County Junior Conservation School provides a week long hands-on outdoor learning experience for youth.*

Issues: *Wetlands; Air Pollution; Water Pollution; Pollution Prevention; Environmental Education; Recycling; Local Land Use; Municipal Waste; Hazardous Waste; Land Conservation; Industrial Site Re-use; Forestry Issues; Hunting or Fishing; Outdoor Recreation; Heritage Preservation; Wildlife Conservation Management; and River, Stream, or Watershed Protection.*

Region Served: *Single county to multi-state*

161. PENN STATE LEHIGH VALLEY / BIOLOGY DEPARTMENT

8380 Mohr Lane, Fogelsville, Pennsylvania 18051

Contact: *Dr. Jackie McGlauglin / Assistant Professor Biology*

Phone: *610-285-5109*

E-Mail Address: *jxm57@psu.edu*

Web Site: *www.lv.psu.edu*

201. THE ROVING NATURE CENTER

2572 Mountain Rd., Bath, Pennsylvania 18014

Contact: *Timothy Herd / Executive Director*

Phone: *800-284-0973 Fax: 610-837-6225*

Group Type: *Education*

E-Mail Address: *programs@rovingnature.com*

Web Site: *www.rovingnature.com*

Mission: *To "rove" the mid-Atlantic region bringing resources, equipment and staff of a reputable environmental education facility to various indoor or outdoor sites.*

Issues: *Environmental Education and Outdoor Recreation.*

237. WILKES UNIVERSITY / GEOENVIRONMENTAL SCIENCES AND ENGINEERING DEPARTMENT

School of Science and Engineering, Wilkes-Barre, Pennsylvania 18766

Contact: *Bill Toothill / GeoEnvironmental Scientist / GIS/GPS, Remote Sensing, Landuse Planning*

Phone: *570-408-4616*

E-Mail Address: *btoothil@wilkes.edu*

Web Site: *www.wilkes.edu*

H. Historical Preservation Organizations;

13. ALBURTIS-LOCKRIDGE HISTORICAL SOCIETY

Headquarters and Museum at Lockridge Church, Church and Franklin Street
Alburtis, Pennsylvania 18011

Phone: *610-966-3534 Fax: 610.965.5517*

E-Mail Address: *office@alburtis.org*

Web Site: *www.alburtis.org*

33. BETHLEHEM WORKS

530 E. 3rd Street, Bethlehem, Pennsylvania 18015

Phone: *610-694-2000 Fax: 610-694-6641*

E-Mail Address: *nmih@fast.net*

Web Site: *www.bethlehemworks.com*

Publications: *Proposed*

Mission: *Rising from the ground where Bethlehem Steel once stood will be Bethlehem Works, a multi-use cultural, recreational, educational, entertainment and retail development-including the National Museum of Industrial History, in affiliation with the Smithsonian Institution.*

35. BUCKS COUNTY HISTORICAL SOCIETY

84 S. Pine Street, Doylestown, Pennsylvania 18901

Contact: *Douglas C. Dolan / Executive Director*

Phone: *215-345-0210 Fax: 215 230 0823*

Group Type: *Private Non-Profit*

Email Address: *info@mercermuseum.org*

Website: *www.mercermuseum.org/*

Mission: *As the County Historical Society, it is charged with collecting, preserving and interpreting the rich history and culture of Bucks County and the Delaware Valley region.*

55. DELAWARE AND LEHIGH NATIONAL HERITAGE CORRIDOR COMMISSION

1 South Third Street, 8th Floor, Easton, Pennsylvania 18042

Contact: *Allen Sachse / Executive Director*

Phone: *610-923-3548 Fax: 610.923.0537*

Email Address: *nr_travel@nps.gov*

Group Type: *Heritage Corridor*

Web Site: *www.nps.gov/dele*

Website: *www.cr.nps.gov/nr/travel/delaware*

Publications: *Newsletter / Quarterly*

Mission: *To conserve the historic canals and amplify the recreational and educational opportunities based on them; conserve the natural and cultural environments; and establish a framework for stewardship to preserve historic sites and enhance recreation.*

Issues: *Environmental Education; Recycling; Local Land Use; Land Conservation; Industrial Site Re-use; Heritage Preservation; and River, Stream or Watershed Protection.*

Region Served: *Muti-county*

65. EASTON HERITAGE ALLIANCE

P.O. Box 994, Easton, PA

Phone: *610-258-1612*

E-Mail Address: *bph@fast.net*

67. EMMAUS HISTORICAL SOCIETY

563 Chestnut Street, Emmaus, Pennsylvania 18049

Phone: *610-966-6591*

Website: *www.emmaus-historic.org*

Mission: *The Emmaus Historical Society preserves the culture and history of the area through a variety of educational programs and community activities.*

80. HISTORIC BETHLEHEM PARTNERSHIP

459 Old York Road, Bethlehem, Pennsylvania 18018

Phone: *610-691-6055 Fax: 610-694-0960*

Email Address: *info@historicbethlehem.org*

Website: *www.historicbethlehem.org/*

Mission: *The Historic Bethlehem Partnership provides heritage education to school children and adults through programs and preservation of historic buildings, records and material documenting the history of early Bethlehem and the greater Lehigh Valley.*

81. HISTORIC CATASAUQUA PRESERVATION ASSOCIATION

616 Second Street, Catasauqua, Pennsylvania 18032

Contact: *Janice Lathrop*

Phone: *610-266-0255*

Mission: *The Historic Catasauqua Preservation Association preserves the buildings and industrial artifacts of Catasauqua.*

82. HISTORICAL SOCIETY OF BERKS COUNTY

940 Centre Avenue, Reading, Pennsylvania 19601

Phone: *610-375-4375 Fax: 610 375-4376*

Email Address: *society.library@verizon.net*

Publications: *"The Historical Review of Berks County" / Quarterly*

Website: *www.berksweb.com/histsoc*

Mission: *To collect, preserve, and foster an appreciation for the historically important physical culture of our country, and further, it is to promote in present-day citizens of all ages an interest and knowledge of past area events, people and cultural heritage in order to instill a sense of pride in local history which may act as a foundation for future successes*

83. HISTORICAL SOCIETY OF SCHUYLKILL COUNTY

14 North 3rd Street, PO Box 1181, Pottsville, Pennsylvania 17901

Phone: *570-622-7540*

Website: *www.rootsweb.com/~paschuyl/HSSC/index.html*

Mission: *Our purpose is to discover, procure, and preserve the records of the history of Schuylkill County and any materials which may illustrate that history.*

84. HUGH MOORE PARK

30 Centre Sq., Easton, Pennsylvania 18042

Contact: *Steven Humphrey*

Phone: *610-339-6619*

E-Mail Address: *ncm@canals.org*

Web Site: *canals.org/index.old*

Publications: *"The Locktender" / Quarterly*

91. LACKAWANNA HISTORICAL SOCIETY

232 Monroe Avenue, Scranton, Pennsylvania 18510

Phone: *570-344-3841*

Website: *http://204.186.88.7*

Mission: *The Society's mission is to collect, preserve, and interpret the artifacts, archives and bibliographic materials of the social, cultural and economic history of Lackawanna County and Northeastern Pennsylvania.*

98. LEHIGH COUNTY HISTORICAL SOCIETY

Old Courthouse, Hamilton and Fifth, P.O. Box 1548, Allentown, Pennsylvania 18105

Contact: *John J. Zolomij / Executive Director*

Phone: *(610) 435-1074 ext.19*

Publications: *Newsletter "Town Crier" and biennial journal "Proceedings"*

Website: *www.lehighcountyhistoricalsociety.org*

99. LEHIGH GAP HISTORICAL & PRESERVATION SOCIETY

P.O. Box 267, Palmerton, Pennsylvania 18071

Contact: *Cathy Long*

Phone: *610-377-0428*

113. LENNI LENAPE HISTORICAL SOCIETY

2825 Fish Hatchery Road, Allentown, Pennsylvania 18103

Contact: *Carla J. Messinger*

Phone: *610.797.2121*

Web Site: *web-savvy.com/river/Schuylkill/lenape_museum.html*

Mission: *The Lenni Lenape Historical Society is a non-profit educational organization dedicated to preserving, presenting, and perpetuating the history and cultural heritage of the Lenni Lenape (Delaware) of the original homeland, and other Native Peoples. -- Includes The Lenni Lenape Historical Society Museum of Indian Culture*

117. LOWER MACUNGIE TOWNSHIP HISTORICAL SOCIETY

Post Office Box 3722, Wescosville, Pennsylvania 18106

Contact: *Craig L.Bartholomew, President*

Phone: *610-967-3653*

E-Mail Address: *LMTHS@macungie.org*

Web Site: *www.macungie.org/LMTHS*

123. LUZERNE COUNTY HISTORICAL SOCIETY

49 South Franklin Street, Wilkes-Barre, Pennsylvania 18701

Contact: *Jesse Teitelbaum / Executive Director*

Phone: *570-823-6244 Fax: 570-823-9011*

Email Address: *executivedirector@luzernecountyhistory.com*

Website: *www.luzernecountyhistory.com/*

Publications: *"FORCAST"*

124. MACUNGIE HISTORICAL SOCIETY

P.O. Box 355, Macungie, Pennsylvania 18062

Phone: *610-965-0372 Fax: 610-966-0573*

Group Type: *Non-Profit*

Email Address: *MHS@macungie.org*

Website: *www.macungie.org*

Mission: *The support of an educational undertaking by promoting the discovery, collection, preservation, archive, display, interpretation, and publication of the history, historical records, culture, landmarks, artifacts, memorabilia, and data of, and relating to, the Borough of Macungie and its surrounding area.*

126. MAUCH CHUNK HISTORICAL SOCIETY OF CARBON COUNTY

P.O. Box 273, Jim Thorpe, Pennsylvania 18229

Contact: *Sheila O'Neal / President; Sandra Reese / Vice-President*

Phone: *570-325-4439*

E-Mail Address: *steve@perdie.com*

Publications: *Newsletter / Twice a year*

Membership Count: *400*

129. MONROE COUNTY HISTORICAL ASSOCIATION

Stroudsburg, Pennsylvania 18360

Phone: *570-421-7703*

Group Type: *Non-Profit*

Website: *www.pastconnect.com/mhs*

Publications: *"THE FANLIGHT" / Quarterly*

Mission: *The Monroe County Historical Association is a non-profit organization dedicated to the preservation and dissemination of Monroe County history*

132. MORAVIAN HISTORICAL SOCIETY

214 E. Center Street, Nazareth, Pennsylvania 18064

Contact: *Susan M. Dreydoppel-Executive Director*

Phone: *610-759-5070 Fax: 610-759-2461*

Email Address: *info@moravianhistoricalsociety.org*

Website: *www.moravianhistoricalsociety.org/*

Publications: *"Transactions of the Moravian Historical Society" / biennial journal and "The Moravian Historian" / newsletter*

134. NATIONAL CANAL MUSEUM

30 Centre Square,, Easton, Pennsylvania 18042

Contact: *Steven J. Humphrey / Executive Director*

Phone: *610-559-6613 Fax: 610-250-6686*

E-Mail Address: *ncm@canals.org*

Web Site: *www.canals.org*

Publications: *"The Locktender" / Quarterly Newletter*

Mission: *Come discover America's canal heritage at the National Canal Museum. Take a journey back in time to the early 1800's and experience what the world was like before railroads, highways and airplanes.*

135. NATIONAL MUSEUM OF INDUSTRIAL HISTORY

Office of the Executive Director, 530 E. Third Street, Bethlehem, Pennsylvania 18015-1390

Contact: *Robert C. Wilkins / Executive Director*

Phone: *610-694-2000 Fax: 610-694-6641*

E-Mail Address: *nmih@fast.net*

Web Site: *http:www.nmih.org*

Mission: *The National Museum of Industrial History is dedicated to presenting the story and accomplishments of American industry and promoting its future.*

144. NORTHAMPTON COUNTY HISTORICAL AND GENEALOGICAL SOCIETY

107 South Fourth Street, Easton, Pennsylvania 18042

Contact: *Colleen Cunningham Lavdar / Executive Director*

Phone: *610-253-1222 Fax: (610) 253-4701*

E-Mail Address: *director@northamptonctymuseum.org*

Website: *www.northamptonctymuseum.org/*

148. OLD ALLENTOWN PRESERVATION ASSOCIATION

147 North Tenth Street, Allentown, Pennsylvania 18102

Phone: *610-740-9919*

Email Address: *malsberger@enter.net*

Website: *www.oldallentown.org*

Publications: *"Old Town News" / Bi-Monthly*

Mission: *Since 1976 we have been dedicated to preserving the historic architecture of Old Allentown and building a sense of community in our neighborhood.*

193. SLATE BELT MUSEUM

P.O. Box 58, Rt. 611, Mount Bethel, Pennsylvania 18343

Phone: *570-897-6181*

Email Address: *wemery@epix.net*

Website: *www.geocities.com/Heartland/Ridge/7028/slatebeltmuseum.html*

Publications: *"Homefront" / Monthly*

228. WALNUTPORT CANAL ASSOCIATION

417 Lincoln Ave., Walnutport, Pennsylvania 18088

Contact: *Everett and Marilyn Kaul / Curator*

Phone: *610-767-5817*

E-Mail Address: *marylinkaul@enter.net*

232. WAYNE COUNTY HISTORICAL SOCIETY MUSEUM

810 Main Street, P.O. Box 446, Honesdale, Pennsylvania 18431

Contact: *Sally Talaga / Director*

Phone: *570-253-3240 Fax: 570-253-5204*

Email Address: *Director wchs@ptd.net, Librarian wchspa@ptd.net*

Website: *www.waynehistorical.org*

I. Other

11. AGSHEN, INC.

424 Center St. Room 302, Bethelehm, PA 18018

Contact: *Dan Poresky*

Phone: *610-691-5253*

E-Mail Address: *dan@agshen.org*

Web Site: *www.agshen.org*

Mission: *The vision of AGSHEN (pronounce Action) is a livable world for us and future generations. Our mission is to serve all who share this vision by providing them the infrastructure and institutions needed to create demand and deliver solutions for achieving environmental sustainability. A sustainable society is one that satisfies its own needs without diminishing the prospects for future generations.*

14. ALLENTOWN HIKING CLUB

206 S. 17th St., Allentown, Pennsylvania

Contact: *Janet Goloub / President*

E-Mail: *president@allentownhikingclub.org*

Website: *www.allentownhikingclub.org*

Publications: *Newsletter / Quarterly*

Mission: *The aspiration of this club is to escape the crowded city; to walk, hike and climb for enjoyment and exercise with nature loving companions; to maintain its section of the Appalachian Trail; and to stimulate public interests in every phase of nature and the outdoors through programs and lectures.*

Issues: *Pollution Prevention; Land Conservation; Local Land Use; Environmental Education; Wildlife Conservation Management; Outdoor Recreation; and River, Stream, or Watershed Protection.*

Region Served: *Lehigh County*

15. ALLIANCE FOR SUSTAINABLE COMMUNITIES-LEHIGH VALLEY

1966 Creek Road, Bethlehem, Pennsylvania 18015

Contact: *Martin Boksenbaum*

Phone: *610-838-7666 (Joris Rosse)*

E-Mail Address: *mwb@fast.net*

Group Type: *Public Interest; Non-Profit*

Publications: *E-Mail Publications and Alerts*

Mission: *The Alliance is dedicated to working for community sustainability. This will involve holistic approaches to the environment, social justice, health, participatory democracy, and local economies. We are com-mitted to active, collaborative approaches to achieving long-term positive outcomes.*

Issues: *Political and Environmental Advocacy; Water Pollution; Local Land Use; and River, Stream or Watershed Protection.*

23. ARROWHEAD LAKES

HC 88, Box 305, Pocono Lake, Pennsylvania 18347

24. AUDUBON SOCITY – BUCKS COUNTY CHAPTER

6324 Upper York Rd., New Hope, Pennsylvania 18938

Contact: *Bruce McNaught / Executive Director*

Phone: *215-297-5880Fax: 215-297-0835*

E-Mail Address: *mail@bcas.org*

Publications: *"The Harbinger" Newsletter / Quarterly*

Mission: *To conserve wildlife, promote awareness of environmental problems, educate the public about the interdependence of humans and their environment, and further the wise use of land and water.*

Issues: *Wetlands; Air Pollution; Pollution Prevention; Environmental Education; Recycling; Local Land Use; Land Conservation; Industrial Site Re-use; Forestry Issues; Outdoor Recreation; Wildlife Conservation Management; and River, Stream, or Watershed Protection.*

Membership Count: *2,300*

25. AUDUBON SOCIETY-GREATER WYOMING VALLEY

P.O. Box 535, Dallas, Pennsylvania 18612

Contact: *Robert C. Houck / President*

Phone: *570-825-BIRD*

Group Type: *Public Interest; Advocacy*

Publications: *"Valley Views" Newsletter / Bi-monthly*

Mission: *To promote the conservation and protection of wildlife, plants, soil and water in relation to human activity; initiate and carry out plans to protect these resources; and provide more opportunity to be aware of our environment.*

Issues: *Wetlands; Air Pollution; Water Pollution; Oil & Gas Issues; Pollution Prevention; Mining & Reclamation; Environmental Education; Recycling; Local Land Use; Municipal Waste; Hazardous Waste; Land Conservation; Industrial Site Reuse; Forestry Issues; State-Owned Land; Outdoor Recreation; Wildlife Conservation Management; and River, Stream, or Watershed Protection.*

Region Served: *Multi-county*

Membership Count: *500*

26. AUDUBON SOCIETY-LEHIGH VALLEY CHAPTER

P.O. Box 290, Emmaus, Pennsylvania 18049

Contact: *Frederic Brock / Treasurer*

Phone: *610-264-4544*

Group Type: *Public Interest; Advocacy*

Publications: *"Osprey" / Bi-monthly*

Mission: *To promote the conservation and protection of wildlife, plants, soil and water in relation to human activity; initiate and carry out plans to protect these resources; and provide more opportunity to be aware of our environment.*

Issues: *Wetlands; Environmental Education; Land Conservation; Outdoor Recreation; and Wildlife Conservation and Management.*

Region Served: *Multi-county*

Membership Count: *1300*

27. AUDUBON SOCIETY – NORTHEAST PENNSYLVANIA

P.O. Box 711, Honesdale, Pennsylvania 18431-0711

Contact: *Joe Strasser / President*

Phone: *570-253-9250 Fax: 570-226-9856*

Group Type: *Public Interest; Advocacy; Education; Conservation.*

E-Mail Address: *sawwhet@ptd.net*

Web Site: *www.audubon.org/chapter/pa/northeast*

Publications: *"Eco-Notes" / Bi-Monthly*

Mission: *To promote the conservation and protection of wildlife, plants, soil and water in relation to human activity; initiate and carry out plans to protect these resources; and provide more opportunity to be aware of our environment.*

Issues: *Wetlands; Air Pollution; Water Pollution; Pollution Prevention; Environmental Education; Local Land Use; Land Conservation; Forestry Issues; Wildlife Conservation and Management; and River, Stream or Watershed Protection.*

Region Served: *Multi-County*

Membership Count: *700*

28. AUDUBON SOCIETY – POCONO MOUNTAIN CHAPTER

P.O. Box 231, Bushkill, Pennsylvania 18324

Contact: *Chris Turn / President*

Phone: *570-588-6850 Fax:*

Group Type: *Public Interest; Advocacy*

E-Mail Address: *birder@esu.edu*

Publications: *"Pocono Mt. Audubon Newsletter" / Quarterly*

Mission: *To promote the conservation and protection of wildlife, plants, soil and water in relation to human activity; initiate and carry out plans to protect these resources; and provide more opportunity to be aware of our environment.*

Issues: *Wetlands; Water Pollution; Environmental Education; Wildlife Conservation and Management; and River, Stream or Watershed Protection.*

Region Served: *Multi-County*

Membership Count: *300+*

47. COALITION FOR ALTERNATIVE TRANSPORTATION

60 W. Broad St. Ste. 97, Bethlehem, Pennsylvania 18018

Contact: *Steve Schmitt / Director*

Phone: *610-954-5744 Fax: 610-974-2803*

Group Type: *Public Interest*

E-Mail Address: *cat@carfree.org*

Web Site: *www.carfree.org*

Publications: *Monthly Calendar*

Mission: *To promote and develop better transportation options and minimize the damaging effects of automobiles.*

Issues: *Air Pollution; Oil & Gas Issues; Pollution Prevention; Environmental Education; Local Land Use; Land Conservation; and Outdoor Recreation.*

Region Served: *Multi-County*

Membership Count: *1,500*

95. LAKE HARMONY

Box 227, 1437 East Lamplighter Lane, Gwynedd, Pennsylvania 19436

Contact: *Pat Hill*

96. LEAGUE OF WOMEN VOTERS OF PENNSYLVANIA

226 Forster Street, Harrisburg, PA 17102

Contact: *Elizabeth Milner*

Phone: *717-234-1576*

Citizen Information Center: *1-800-692-7281*

League Information: *800-JOIN-LWV*

E-mail: *lwvpa@pa.lwv.org*

Web Site: *pa.lwv.org*

Mission: *"The purpose of the League of Women Voters of the United States is to promote political responsibility through informed and active participation of citizens in government and to act on selected governmental issues."*

103. LEHIGH VALLEY CANOE CLUB

P.O. Box 20194, Lehigh Valley, Pennsylvania 18002

Phone: *610-559-9595*

Group Type: *Recreation*

E-Mail Address: *drempp@hotmail.com*

Web Site: *www.enter.net/~lvcc*

Publications: *"River Readings" / newsletter Six times per year*

Mission: *The purpose of the LVCC is to unite persons interested in paddle sport in the Lehigh Valley and adjacent watersheds to provide information, education and training to increase the safety, enjoyment and skills of its members. To this end the LVCC will provide.*

Issues: *Water Safety; Education; and River, Stream, or Watershed Protection.*

104. LEHIGH VALLEY COALITION FOR A SAFE ENVIRONMENT

P.O. Box 48, Nazareth, Pennsylvania 18064

Contact: *Joan Garret / Steering Committee Chair*

Phone: *610-746-0893 Fax: 610-746-2743*

Group Type: *Public Interest*

E-Mail Address: *JTGarr@email.msn.com*

Mission: *To stop the burning of hazardous waste in cement kilns.*

Issues: *Hazardous Waste*

Region Served: *Local Community*

107. LEHIGH VALLEY GREENS

810 Vernon St., Bethlehem, Pennsylvania 18015

Contact: *Guy Gray / Member*

Phone: *610-865-9050 Fax:*

Group Type: *Public Interest*

E-Mail Address: *vernonst@igc.apc.org*

Web Site:

Publications: *Newsletter / Quarterly*

Mission: *To promote environmental education and sustainability.*

Issues: *Environmental Education; Local Land Use; Land Conservation; Industrial Site Reuse; River, Stream or Watershed Protection; and Alternative Transportation.*

Region Served: *Multi-County*

Membership Count: *20*

116. LOCAL ENVIRONMENTAL AWARENESS DEVELOPMENT GROUP (LEAD)

P.O. Box 13033, Reading, Pennsylvania 19612-3033

Contact: *Nancy L. Tobias / President*

Phone: *610-929-5495 Fax:*

Group Type: *Public Interest*

Mission: *To protect and support the right for all creatures to have clean air, land and water.*

Issues: *Wetlands; Air Pollution; Water Pollution; Pollution Prevention; Environmental Education; and (LLW) Radioactive Waste.*

Region Served: *Single county*

163. PENNSYLVANIA COUNCIL OF PROFESSIONAL FORESTERS

311 2ND St., Pine Grove, Pennsylvania 17963

Contact: *Don Oaks / Secretary/Treasurer*

Phone: *570-345-6284 Fax: 570-345-5471*

Group Type: *Advocacy*

E-Mail Address: *pnforest@ptd.net*

Publications: *Newsletter*

Issues: *Wetlands; Environmental Education; Local Land Use; Land Conservation; Forestry Issues; State-Owned Land; Hunting or Fishing; Outdoor Recreation; Wildlife Conservation & Management; and River, Stream or Watershed Protection.*

Region Served: *State*

Membership Count: *50*

189. SIERRA CLUB-BERKS COUNTY GROUP

525 Andrea Pl., Yardley, Pennsylvania 19067

Contact: *Marcia Bachman / Secretary*

Phone: *610-562-2462 Fax:*

Group Type: *Public Interest; Advocacy*

Publications: *Newsletter / Quarterly*

Mission: *To explore, enjoy and protect the wild places of the earth; to practice and promote the responsible use of the earth's ecosystems and resources; to educate and enlist humanity to protect and restore the quality of the natural and human environments.*

Issues: *Wetlands; Air Pollution; Water Pollution; Pollution Prevention; Mining & Reclamation; Environmental Education; Recycling; Local Land Use; Municipal Waste; Hazardous Waste; Land Conservation; Industrial Site Re-use; (LLW) Radio Active Waste; Forestry Issues; State-Owned Land; and River, Stream, or Watershed Protection.*

Region Served: *Multi-county*

Membership Count: *597*

191. SIERRA CLUB-LEHIGH VALLEY GROUP

P.O. Box 1901, Allentown, Pennsylvania 18105

Contact: *David McGuire / Chair*

Phone: *610-997-3618 Fax:*

Group Type: *Public Interest; Advocacy*

Mission: *To explore, enjoy and protect the wild places of the earth; to practice and promote the responsible use of the earth's ecosystems; to educate and enlist humanity to protect and restore the quality of the natural and human environments.*

Publications: *Newsletter / Quarterly*

Issues: *Wetlands; Air Pollution; Water Pollution; Pollution Prevention; Mining & Reclamation; Environmental Education; Recycling; Local Land Use; Municipal Waste; Hazardous Waste; Land Conservation; Industrial Site Re-use; (LLW) Radioactive Waste; Forestry Issues; Forestry Issues; Outdoor Recreation; Wildlife Conservation and Management; and River, Stream or Watershed Protection.*

Region Served: *Multi-county*

192. SIERRA CLUB-NORTHEASTERN GROUP

P.O. Box 1311, Scranton, Pennsylvania 18501

Contact: *Jennifer Lavery*

Phone: *570-587-5223 Fax:*

Group Type: *Public Interest; Advocacy*

E-Mail Address: *nesierra@aol.com*

Web Site: *www.members.aol.com/nesierra*

Publications: *Newsletter / Bi-monthly*

Mission: *To explore, enjoy and protect wild places; to practice and promote the responsible use of the earth's ecosystems and resources; to educate and enlist humanity to protect and restore the quality of the environment.*

Issues: *Wetlands; Air Pollution; Water Pollution; Pollution Prevention ; Mining & Reclamation; Environmental Education; Recycling; Local Land Use; Municipal Waste; Hazardous Waste; Land Conservation; Industrial Site Re-use; (LLW) Radioactive Waste; Forestry Issues; State-Owned Land; Outdoor Recreation; Wildlife Conservation and Management; and River, Stream or Watershed Protection.*

Region Served: *Multi-county*

Membership Count: *900*

B. Management Resources and Tools

1. PROGRAMS

a. Cultural

PENNSYLVANIA HISTORICAL AND MUSEUM COMMISSION

The Pennsylvania Historical and Museum Commission (PHMC) is a resource of historical information concerning the watershed and has several preservation and education programs. PHMC provides technical support and grants to enhance historical museums and sites around the state, including the Pennsylvania History and Museum Grant Program, the Certified Local Government Grant Program, and the Keystone Historic Preservation Grant Program.

The Commission's Bureau for Historic Preservation administers all official state historic preservation programs and activities. These include maintaining the Commonwealth's cultural resource inventory, preparing a state preservation plan, nominating properties to the National Register of Historic Places, reviewing state and federal government undertakings for effects on cultural resources, assisting in certifying historic building rehabilitation projects seeking federal tax incentives, conducting archaeological investigations, overseeing the designation of historic districts under municipal ordinances, advising local governments on preservation issues, providing grants to local governments, historical and cultural institutions, and preservation organizations to restore historic buildings, to conduct cultural resource surveys, to write National Register nominations, and to assist with heritage educational programs and exhibits.

Pennsylvania municipalities have authority to protect historic properties under municipal ordinances. Information is available for municipalities that are seeking to establish preservation ordinances. The Bureau manages the Certified Local Government (CLG) grants that enable municipalities to expand their preservation activities. The Bureau conducts regular workshops for Certified Local Governments.

Extensive architectural and technical guidance is available for repair and maintenance of historic buildings. This includes the complete Preservation Briefs series published by the National Park Service as well as other printed material. Information is also available on the 20% federal rehabilitation tax credit (RTC) that is available for qualified historic buildings.

The PHMC has a comprehensive grants program to further the presentation and interpretation of Pennsylvania history by local, county, and regional historical and museum organizations, to preserve local historic records and documents, to prepare exhibits, to do research on local history, to support local historic preservation efforts, to restore or rehabilitate historic buildings owned by local governments or non-profit organizations, and to assist local governments that have municipal preservation ordinances.

PRESERVATION PENNSYLVANIA

Preservation Pennsylvania, through creative partnerships, targeted educational and advocacy programs, advisory assistance, and special projects, assists Pennsylvania communities to protect and utilize the historic resources they want to preserve for the future. Preservation Pennsylvania is a private non-profit organization dedicated to the protection of historically

and architecturally significant properties. In its capacity as the statewide historic preservation organization for Pennsylvania, Preservation Pennsylvania acts as a resource for and provides expertise to the many local and regional preservation organizations and agencies throughout the Commonwealth. Preservation Pennsylvania regularly responds to requests for information and assistance on a wide range of technical preservation issues.

b. Aquatic

Abandoned Mine Drainage Programs

Abandoned Mine Drainage has been identified as the principal source of impairment to the Lehigh River. Several government agencies exist to deal with the issues of mining and abandoned mine drainage in Pennsylvania and include the Office of Surface Mining, the Pennsylvania DEP Bureau of Mining and Reclamation, and the Pennsylvania DEP Bureau of Abandoned Mine Reclamation.

The Office of Surface Mining (OSM)

The Office of Surface Mining is the office of the Interior Department that is responsible for protecting the environment during coal mining and making sure the land is reclaimed afterward. OSM builds partnerships with the governments of the states where coal is mined. The Surface Mining Law gives primary responsibility for regulating surface coal mine reclamation to the states themselves, a responsibility that 24 coal states have chosen to exercise. On federal lands and Indian Reservations and in the coal states that have not established regulatory programs of their own (Tennessee and Washington), the Office of Surface Mining issues the coal mine permits, conducts the inspections, and handles the enforcement responsibilities.

The Bureau of Mining and Reclamation (BMR)

The Bureau of Mining and Reclamation administers an environmental regulatory program for all mining activities, including mine subsidence regulation, mine subsidence insurance, and coal refuse disposal; conducts a program to ensure safe underground bituminous mining and protect certain structures from subsidence; administers a mining license and permit program; administers a regulatory program for the use, storage, and handling of explosives. The program also provides for training, examination, and certification of applicants for blaster's licenses and administers a loan program for bonding of anthracite underground mines and for mine subsidence. The Bureau administers the EPA Watershed Assessment Grant Program, the Areas Unsuitable for Mining Program (UFM), the Small Operator's Assistance Program (SOAP), and the Remining Operator's Assistance Program (ROAP).

The Bureau of Abandoned Mine Reclamation (BAMR)

The Bureau of Abandoned Mine Reclamation administers and oversees the Abandoned Mine Reclamation Program in Pennsylvania. The bureau is responsible for resolving problems such as mine fires, mine subsidence, dangerous highwalls and other hazards which have resulted from past mining practices, and for abating or treating abandoned mine drainage from mines.

Three of the many programs that exist to address abandoned mine drainage and mine land reclamation issues include the Regional Watershed Support Initiative, the Clean Streams Initiative, and the Reclaim Pennsylvania project.

REGIONAL WATERSHED SUPPORT INITIATIVE

The goal of the Regional Watershed Support Initiative is to provide financial support for the formation and activities of watershed groups whose primary focus is abandoned mine drainage (AMD) abatement and abandoned mine land (AML) reclamation. An additional goal is to support the continuing AMD/AML coordination efforts of the Eastern and Western Pennsylvania Coalitions for Abandoned Mine Reclamation (EPCAMR and WPCAMR). The EPCAMR and WPCAMR will distribute grants to public and private volunteer groups primarily interested in starting new AMD/AML watershed associations, watershed authorities, or partnerships. Assistance will be targeted to groups that intend to form a new organization, partnership, association, authority or coalition, with the primary goal of assessing and remediating sources of watershed AMD and, by association, AML reclamation.

THE CLEAN STREAMS INITIATIVE

The Clean Streams Initiative is a broad-based citizen/industry/government program working to eliminate abandoned mine drainage from abandoned coal mines. Using a combination of private and governmental resources, the initiative facilitates and coordinates citizen groups, university researchers, the coal industry, corporations, the environmental community, and local, state, and federal government agencies that are involved in cleaning up streams polluted by mine drainage.

RECLAIM PENNSYLVANIA

Reclaim Pennsylvania is DEP's new initiative designed to maximize reclamation of the state's quarter million acres of abandoned mineral extraction lands. Pennsylvania is striving for complete reclamation of its abandoned mines and plugging of its orphaned wells. DEP developed concepts to make abandoned mine reclamation easier. These concepts, collectively called Reclaim Pennsylvania, include legislative, policy and management initiatives designed to enhance mine operator, volunteer, and DEP reclamation efforts. Reclaim Pennsylvania has the following four objectives: to encourage private and public participation in abandoned mine reclamation efforts; to improve reclamation efficiency through better communication between reclamation partners; to increase reclamation by reducing remining risks; and to maximize reclamation funding by expanding existing sources and exploring new sources.

WATERSHED MANAGEMENT RESOURCES

Section 303(d), Clean Water Act (CWA)

Section 303(d) of the Clean Water Act requires that each state identify those waters that do not currently support designated uses, and to establish a priority ranking of these waters by taking into account the severity of the pollution and the designated uses of such waters. For each waterbody on the list, the state is required to establish a total maximum daily load (TMDL) for the pollutant or pollutants of concern at a level necessary to implement the applicable water quality standards. Guidance issued in August 1997 by the Environmental Protection Agency (EPA) suggests that states also include a schedule for TMDL development.

Total Maximum Daily Load

The primary mission of the TMDL program is to protect public health and ensure healthy watersheds by assuring that waterbodies are meeting water quality standards. States and Territories identify impaired waterbodies, those not meeting water quality standards. Lists of these waterbodies are provided to the public and EPA every two years. The lists are priori-

ty-ranked based upon severity of the pollution and the uses to be made of the waterbodies. States then develop TMDLs for waterbodies on the list. TMDLs specify the reductions needed to meet water quality standards and allocate those reductions among the sources in the watershed. EPA reviews and approves the lists and the TMDLs. If EPA disapproves, the Agency must act in lieu of the state.

What is a TMDL?

- A TMDL or Total Maximum Daily Load is a calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards, and an allocation of that amount to the pollutant's sources.
- Water quality standards are set by states, territories, and tribes. They identify the uses for each waterbody, for example, drinking water supply, contact recreation (swimming), and aquatic life support (fishing), and the scientific criteria to support that use.
- A TMDL is the sum of the allowable loads of a single pollutant from all contributing point and non-point sources. The calculation must include a margin of safety to ensure that the waterbody can be used for the purposes the state has designated.
- The Clean Water Act, section 303, establishes the water quality standards and TMDL programs.
- Section 303(d) of the Clean Water Act authorizes the TMDL program; the current regulations can be found at 40 CFR 130.7. The recommendations of the Federal Advisory Committee are guiding the development of proposed changes.

PENNSYLVANIA DEPARTMENT OF ENVIRONMENTAL PROTECTION OFFICE OF WATER MANAGEMENT

The Office of Water Management plans, directs and coordinates departmental programs associated with the management and protection of the Commonwealth's water resources; administers and oversees departmental programs involving surface and groundwater quantity and quality planning, and soil and water conservation; coordinates policies, procedures and regulations which influence public water supply withdrawals and quality, sewage facilities planning, point source municipal and industrial discharges, encroachments upon waterways and wetlands, dam safety, earth disturbance activities and control of storm water and non-point source pollution; and coordinates the planning, design and construction of flood protection and stream improvement projects.

PENNSYLVANIA'S NON-POINT SOURCE (NPS) MANAGEMENT PROGRAM

The Pennsylvania Non-point Source (NPS) Management Program 1999 Update outlines the Commonwealth's plan to address non-point source pollution over the next four years and beyond. This update enhances Pennsylvania's Non-point Source Management Program approved by EPA in 1992 in compliance with Section 319(b) of the Federal Water Pollution Control Act (Clean Water Act) as amended by P.L. 100-4 on February 4, 1987. This plan also establishes the overall strategy Pennsylvania will use to implement the watershed protection aspects of Governor Ridge's Growing Greener program.

c. Land

MUNICIPAL PLANNING

Although municipal planning regulations, zoning, and comprehensive plans are not permanent and can/should be changed over the years to adapt to changing community needs and goals, these regulations are vital in shaping a region and the individual communities within a region.

The importance of careful land-use planning cannot be over emphasized. With the changes in the Municipal Planning Code (MPC) in the year 2000, which allow for regional planning across municipal boundaries, municipalities can plan together and make decisions which make more sense for their communities.

Agricultural Protection Zoning is one example of municipal planning that can effectively designate farming as the primary land use and discourage other land uses in those areas. Historic Preservation Zoning is another useful planning tool for encouraging the protection of historical features in a community.

AGRICULTURAL LAND PRESERVATION PROGRAM

A very effective method for farmland preservation is the county/state purchase of development rights program. In this program, farm owners are paid for their development rights, and the farm remains as available farmland.

This voluntary program has been very successful since its beginning in 1989. Farm owners must first join an agricultural security area in the municipality where the farm is located or a neighboring municipality's agricultural security area. A farm owner then fills out an application for the county program to sell the development rights of the farm. The farm is ranked against other applicants, and, if the farm ranks high enough, an independent appraisal is completed and an offer is made to the farm owner. The program's ranking system is designed to select the farms that have the most productive soils and are most threatened by development. The soil factor is nearly fifty percent of the score. Other factors include proximity to sewage and water lines, type of development nearby, amount of agricultural activity nearby, and the amount of protected farmland nearby. If the offer is accepted by the farm owner, the farm is forever protected from development, and will remain available for farming for future generations.

AGRICULTURAL SECURITY AREA (ASA)

An Agricultural Security Area (ASA), permitted under Pa. State Act 43, provides enrolled landowners protection from condemnation, enforcement of nuisance laws, and any other ordinances that may prohibit or limit viable farming practices. Owners wanting to participate in state and/or county agricultural easement programs must first participate in this program.

Landowners of viable agricultural land may submit a proposal to the municipality for inclusion in the agricultural security area, provided such landowner(s) own at least 10 acres of viable agricultural land to be in the area. The farmland may be contiguous or not, but there must be at least 10 acres of each parcel or an anticipated $2,000 gross income from each parcel. Following public notice, the proposed lands are reviewed based on the Land Evaluation and Site Assessment (LESA) system. If land passes the minimum acceptable standards, the land acquires this designation. Every seven years all lands are monitored. At any time, a landowner may submit, in writing, a desire to remove from this designation, and 180 days later, the parcel is removed. The ASA designation does not protect land from future development.

FOREST LEGACY PROGRAM

The Forest Legacy Program (FLP) is a new program for Pennsylvania. It is a federal program in partnership with states, which supports state efforts to protect environmentally sensitive forest lands. This voluntary program is designed to protect privately owned forests through the purchase of development rights, which prevent private forests from being converted to non-forest uses.

The goals of the program are:

1. To maintain traditional forest uses, including recreation and timber harvesting following Best Management Practices
2. To maintain productivity of forests for future generations
3. To prevent forest parcelization
4. To conserve significant tracts of contiguous forests
5. To conserve water resources and riparian zones
6. To conserve important habitats for plants, fish, and wildlife
7. To restore degraded forested ecosystems

The program works similarly to the agricultural land preservation program in that a landowner applies to the program, and the forest land is ranked for several factors including timber quality, the threat of development, and conservation values. A certified appraisal is completed, and, if the landowner accepts the offer and terms of the easement, the forest land is perpetually protected from non-forest uses.

The state or county is responsible for enforcement of the easement. The Forest Legacy Program is a cost-share program run by the U.S. Forest Service. The federal government pays up to 75% of the total program costs for each property. The in-kind match can be made by cash contributions, donated interests in land, or in-kind services.

2. Funding

a. Funding Cultural Components

Certified Local Government Grant Program

Pennsylvania Historical and Museum Commission (PHMC)

Funding under this program is limited to federally designated Certified Local Governments. Funding is available for the following: the categories of cultural resource surveys, national register nominations, technical and planning assistance, educational and interpretive programs, staffing and training, and pooling CLG grants and third party administration.

Community Conservation Partnerships Program

Pennsylvania Department of Conservation and Natural Resources (DCNR)

Heritage Parks Grants promote public-private partnerships to preserve and enhance natural, cultural, historic, and recreation resources to stimulate economic development through heritage tourism. Grants are available to municipalities, non-profit organizations, or federally designated commissions acting on behalf of the municipalities in a heritage park area. Grants are awarded for a variety of purposes including feasibility studies; development of management action plans for heritage park areas; specialized studies; implementation projects; and hiring of state heritage park managers. Grants require a 25-50 percent local match.

KEYSTONE HISTORIC PRESERVATION GRANT PROGRAM

Pennsylvania Historical and Museum Commission (PHMC)

Funding under this program is available to non-profit organizations and local governments for capital improvements on historic resources listed in or eligible for listing in the National Register of Historic Places. (Private property owners are not eligible for funding under this program and may wish to refer directly to PHMC Programs of Interest for information on investment tax credits.) Funding is available in the categories of preservation, restoration, and rehabilitation

PENNSYLVANIA HISTORY AND MUSEUM GRANT PROGRAM

Pennsylvania Historical and Museum Commission (PHMC)

Funding under this program is designated to support a wide variety of museum, history, archives and historic preservation projects, as well as non-profit organizations and local governments.

STATE COMMUNITY DEVELOPMENT BLOCK GRANT (CDBG) PROGRAM

U.S. Department of Housing and Urban Development (HUD)

The state CDBG Program provides states with annual direct grants, which they in turn award to smaller communities and rural areas for use in revitalizing neighborhoods, expanding affordable housing and economic opportunities, and/or improving community facilities and services.

Listed in Table 7-1 is a matrix of Cultural Funding Programs.

b. Funding Aquatic Components

ABANDONED MINE LAND PROGRAM – CLEAN STREAMS INITIATIVE

Office of Surface Mining

The Clean Streams Program is a broad-based citizen, industry and government program working to eliminate acid mine drainage from abandoned coal mines. Using a combination of private and governmental resources, the program facilitates and coordinates citizen groups, university researchers, the coal industry, corporations, the environmental community, and local, state, and federal government agencies that are involved in cleaning up streams polluted by acid drainage. Begun as an initiative in 1994, this successful program has funded 77 projects in 10 states as of 2002.

C-SAW

Resource Conservation & Development Councils (RC&D);
U.S. Department of Agriculture (USDA)

The Resource Conservation & Development Councils (RC&D) are a non-profit organization authorized by the United States Department of Agriculture (USDA) to provide administrative support to watershed groups across the state. The local Resource Conservation & Development Councils (RC&D) will provide instructions for filling out a C-SAW two-page request for assistance application.

The goal of the C-SAW program is not to offer direct assistance, but rather to provide training to build the capacity of groups to plan, conduct watershed assessments, and conduct

TABLE 7-1 CULTURAL FUNDING PROGRAMS MATRIX

Program	Agency	Description	Target Audience	Contact
Certified Local Government Grant Program	Pennsylvania Historical and Museum Commission (PHMC)	Offers multiple funding opportunities to a wide variety of nonprofit organizations and public agencies throughout the Commonwealth.	Federally designated Certified Local Governments	Certified Local Government Grant Manager Janice E. Stramara Bureau for Historic Preservation Commonwealth Keystone Building 400 North Street Harrisburg, Pennsylvania 17120 Phone: 717-783-2838 jstramara@state.pa.us
Community Conservation Partnerships Program	The Department of Conservation and Natural Resources (DCNR)	Promote public-private partnerships to preserve and enhance natural, cultural, historic and recreation resourcesto stimulate economic development through heritage tourism.	Local communities, non-profits and other organizations for recreation and conservation projects.	The Grants Project Management Division of DCNR RCSOB 6th Floor PO Box 8475 Harrisburg, PA 17105-8551 Phone: 717-783-4734
Keystone Historic Preservation Grant Program	Pennsylvania Historical and Museum Commission (PHMC)	Offers multiple funding opportunities to a wide variety of nonprofit organizations and public agencies throughout the Commonwealth.	Nonprofit organizations and local governments for capital improvements on historic resources	Keystone Historic Preservation Grant Administrator Bryan Van Sweden Bureau for Historic Preservation Commonwealth Keystone Building 400 North Street Harrisburg, Pennsylvania 17120 Phone: 717-772-5071 bvansweden@state.pa.us
Pennsylvania History and Museum Grant Program	Pennsylvania Historical and Museum Commission (PHMC)	Offers multiple funding opportunities to a wide variety of nonprofit organizations and public agencies throughout the Commonwealth.	Museum, history, archives and historic preservation projects, nonprofit organizations and local governments.	Program Director for PHMC Grant Programs Ira F. Smith III Bureau for Historic Preservation Commonwealth Keystone Building 400 North Street Harrisburg, Pennsylvania 17120 Phone: 717-783-9927
State Community Development Block Grant (CDBG) Program	U.S. Department of Housing and Urban Development (HUD)	Provides States with annual direct grants, which they in turn award to smaller communities and rural areas for use in revitalizing neighborhoods, expanding affordable housing and economic opportunities, and/or improving community facilities and services.	Local Governments and communities.	State and Small Cities Division Rm. 7184, 451 7th Street, SW, Washington, DC 20410 Phone: 202-708-1322.

post-implementation monitoring in the future. This is accomplished through program management assistance by providing:

- Specialists who can help identify solutions and assist groups in the development of monitoring programs, restoration projects, and protection plans.
- Training on conducting assessments and developing restoration projects and protection plans.
- Technical, scientific support in study design and implementation..

CHALLENGE 21 – FLOOD HAZARD MITIGATION AND RIVERINE RESTORATION

U.S. Army Corps of Engineers (USACE)

The Army Corps' flood hazard mitigation and riverine ecosystem restoration initiative focuses on sustainable, non-structural approaches. This program will, where appropriate, move families and businesses out of harm's way and work to return the floodplains of rivers and creeks to a condition where they can naturally moderate floods as well as provide other benefits to communities and the environment. Key federal partners include the Federal Emergency Management Agency, the Department of Agriculture, the Department of Interior, and the Environmental Protection Agency.

CLEAN WATER ACT – 319 PROGRAM

U.S. Environmental Protection Agency (EPA)

Through its 319 program, EPA provides grants to the states and tribes to implement non-point source projects and programs in accordance with Section 319 of the Clean Water Act (CWA). Non-point source pollution reduction projects can be used to protect source water areas and the general quality of water resources in a watershed. In Pennsylvania the 319 program is administered by the Pennsylvania Department of Environmental Protection.

COLDWATER CONSERVATION FUND

Trout Unlimited

Trout Unlimited's Coldwater Conservation Fund (CCF) supports scientific and economic research and analysis and science-based watershed restoration projects that further Trout Unlimited's mission. Each year, the Coldwater Conservation Fund (CCF) funds more than $1 million in biological and economic research and watershed-scale demonstration projects. The Coldwater Conservation Fund's independent Board of Directors approves a slate of projects each fall and helps raise the funds to support those projects.

COMMUNITY CONSERVATION PARTNERSHIPS PROGRAM

Pennsylvania Department of Conservation and Natural Resources (DCNR)

River Conservation Grants are available to municipalities, counties, municipal and intermunicipal authorities, and river support groups to conserve and enhance river resources. River support groups must be non-profits which are designated to act on behalf of interested municipalities. Planning grants are available to identify significant natural and cultural resources, threats, concerns and special opportunities and to develop river conservation plans. Implementation grants are available to carry out projects or activities defined in an approved river conservation plan. Grants require a 50 percent cash or in-kind match.

Conservation Reserve Program (CRP)

U.S. Department of Agriculture (USDA)
Natural Resource Conservation Service (NRCS)

The Conservation Reserve Program (CRP) provides technical and financial assistance to eligible farmers and ranchers to address soil, water, and related natural resource concerns on their lands in an environmentally beneficial and cost-effective manner. The program provides assistance to farmers and ranchers in complying with federal, state, and tribal environmental laws, and encourages environmental enhancement. The program is funded through the Commodity Credit Corporation (CCC). The Conservation Reserve Program is administered by the Farm Service Agency, with Natural Resource Conservation Service (NRCS) providing technical land eligibility determinations, Environmental Benefit Index Scoring, and conservation planning.

Fisheries Habitat Restoration Program

National Oceanic and Atmospheric Administration (NOAA)

The NOAA Habitat Restoration Program (Restoration Program) leads and coordinates NOAA's restoration activities to fulfill the NOAA habitat restoration mission in a coordinated and effective manner. This cooperative approach provided through the Restoration Program fosters data and information exchange among NOAA's restoration programs.

Growing Greener Program

Commonwealth of Pennsylvania

The Growing Greener Program is the largest single investment of state funds in Pennsylvania's history to address Pennsylvania's critical environmental concerns of the 21st century. The following four agencies are involved in helping communities "grow greener" under the Environmental Stewardship & Watershed Protection Act. The agencies provide specific funding for various projects and programs throughout Pennsylvania:

- Pennsylvania Department of Environmental Protection (DEP): watershed protection, mine reclamation, oil and gas well plugging, technical assistance, new and innovative technology grants
- Department of Conservation and Natural Resources (DCNR): open space and recreation grants
- Pennsylvania Infrastructure Investment Authority (PENNVEST): wastewater, drinking water, stormwater management grants
- Pennsylvania Department of Agriculture (PDA): county farmland preservation grants

National Corporate Wetlands Restoration Partnership (CWRP)

U.S. Army Corps of Engineers (USACE)

The National Corporate Wetlands Restoration Partnership (CWRP) is a public-private partnership between the federal government, state governments and private corporations to restore wetlands and other aquatic habitats. The CWRP's objective is to protect, enhance and restore wetlands and other aquatic habitats by partnering to leverage the collective resources, skills and processes of the private and public sectors. In the CWRP, corporations contribute funds to a participating private foundation or state trust fund. These funds will be matched by federal and state funds to undertake aquatic ecosystem restoration projects.

NATIONAL FISH AND WILDLIFE FOUNDATION (NFWF)

U.S. Fish and Wildlife Service (USFWS)

National Fish and Wildlife Foundation funds projects to conserve and restore fish, wildlife, and native plants through matching grant programs. The Foundation awards grants to projects that address priority actions promoting fish and wildlife conservation and the habitats on which they depend, work proactively to involve other conservation and community interests, leverage Foundation-provided funding, and evaluate project outcomes. Federal, state, and local governments, educational institutions, and non-profit organizations are welcome to apply for a grant throughout the year.

NATIONAL FISH PASSAGE PROGRAM

U.S. Fish and Wildlife Service (USFWS)

In 1999, the U.S. Fish and Wildlife Service initiated the National Fish Passage Program to work with others to address the problem of barriers to the migration of fish through streams and rivers. The National Fish Passage Program uses a voluntary, non-regulatory approach to remove and bypass barriers. The program addresses the problem of fish barriers on a national level, working with local communities and partner agencies to restore natural flows and fish migration. The program is administered by national and regional coordinators, and delivered by Fish and Wildlife Management Assistance Offices, with over 300 biologists located across the nation.

NORTH AMERICAN WETLANDS CONSERVATION ACT OF 1989

U.S. Fish and Wildlife Service (USFWS)

The North American Wetlands Conservation Act of 1989 provides matching grants to private or public organizations or to individuals who have developed partnerships to carry out wetlands conservation projects in the United States, Canada, and Mexico. A North American Wetlands Conservation Act standard grant proposal is a 4-year plan of action supported by a NAWCA grant and partner funds to conserve wetlands and wetlands-dependent fish and wildlife through acquisition (including easements and land title donations), restoration and/or enhancement, with a grant request between $51,000 and $1,000,000. Small grants (up to $50,000) are administered separately. Match must be non-Federal and at least equal the grant request (referred to as a 1:1 match). Match is eligible up to 2 years prior to the year the proposal is submitted and grant and match funds are eligible after the proposal is submitted and through the project period.

PARTNERS FOR FISH AND WILDLIFE PROGRAM

U.S. Fish and Wildlife Service (USFWS)

The Partners for Fish and Wildlife Program is the primary mechanism for delivering voluntary on-the-ground habitat improvement projects on private lands for the benefit of federal trust species. The program provides technical and financial assistance to landowners to help meet the habitat needs of federal trust species on private lands.

Pennsylvania Department of Environmental Protection (PADEP)

The Pennsylvania Department of Environmental Protection can make money available for watershed, drinking water, wastewater and stormwater projects through the following grants:

- Growing Greener Program
- Sewage Treatment Plant Operations Grant
- Small Systems Regionalization Grant
- Small Water Systems Consolidation Construction Grant Program
- Water Resources Education Network "Opportunity Grants"

Pre-Disaster Mitigation Program

Federal Emergency Management Agency (FEMA)

Funding for the program is provided through the National Pre-Disaster Mitigation Fund to assist states and local governments (to include Indian Tribal governments) in implementing cost-effective hazard mitigation activities that complement a comprehensive mitigation program. All applicants must be participating in the National Flood Insurance Program (NFIP) if they have been identified through the NFIP as having a Special Flood Hazard Area (a Flood Hazard Boundary Map (FHBM) or Flood Insurance Rate Map (FIRM) has been issued).

Rivers, Trails and Conservation Assistance Program (RTCA)

National Park Service (NPS)

Rivers & Trails works in communities with the goal of helping communities achieve on-the-ground conservation successes for their projects. The program's focus is on helping communities help themselves by providing expertise and experience. From urban promenades to trails along abandoned railroad rights-of-way to wildlife corridors, their assistance in greenway efforts is wide ranging. Similarly, their assistance in river conservation spans downtown riverfronts to regional water trails to stream restoration.

Rivers & Trails has conservation professionals in communities nationwide.

Section 1135 – Habitat Restoration for Fish and Wildlife Resources
U.S. Army Corps of Engineers (USACE)

The Corps of Engineers has the authority, provided under Section 1135 of the Water Resources Act of 1986, as amended, to make modifications in the structures and operations of water resources projects constructed by the Corps or funded jointly with other federal agencies to improve the quality of the environment. The primary goal of these projects is ecosystem restoration with an emphasis on projects benefiting fish and wildlife.

Section 206 – Floodplain Management Services

U.S. Army Corps of Engineers (USACE)

The Corps of Engineers' Floodplain Management Services Program (FPMS), also known as the Section 206 Program, is authorized by Section 206 of the Flood Control Act of 1960, as amended. Under this program, the Corps is authorized to provide a full range of technical services and planning guidance on floods and floodplain issues to municipalities or indiduals.

STATE REVOLVING FUND PROGRAMS: CLEAN WATER ACT AND SAFE DRINKING WATER ACT

U.S. Environmental Protection Agency (EPA)

The Safe Drinking Water Act, as amended in 1996, established the Drinking Water State Revolving Fund (DWSRF) to make funds available to drinking water suppliers to finance infrastructure improvements. The program also emphasizes providing funds to small and disadvantaged communities and to programs that encourage pollution prevention as a tool for ensuring safe drinking water.

WATERSHED ASSISTANCE GRANTS

U.S. Environmental Protection Agency (EPA)

EPA's Watershed Assistance Grants are founded on building cooperative agreements with one or more non-profit organization(s) or other eligible entities to support watershed partnerships and long-term effectiveness. Funding then supports organizational development and capacity building for watershed partnerships with a diverse membership.

WETLANDS RESERVE PROGRAM (WRP)

Natural Resource Conservation Service (NRCS)

The Wetlands Reserve Program is a voluntary program offering landowners the opportunity to protect, restore, and enhance wetlands on their property. The USDA Natural Resources Conservation Service (NRCS) provides technical and financial support to help landowners with their wetland restoration efforts. The NRCS goal is to achieve the greatest wetland functions and values, along with optimum wildlife habitat, on every acre enrolled in the program. This program offers landowners an opportunity to establish long-term conservation and wildlife practices and protection.

WILDLIFE HABITAT INCENTIVES PROGRAM (WHIP)

U.S. Department of Agriculture (USDA);
Natural Resource Conservation Service (NRCS)

The Wildlife Habitat Incentives Program (WHIP) is a voluntary program for people who want to develop and improve wildlife habitat primarily on private land. Through WHIP USDA's Natural Resources Conservation Service provides both technical assistance and up to 75 percent cost-share assistance to establish and improve fish and wildlife habitat. WHIP agreements between NRCS and the participant generally last five to ten years from the date the agreement is signed. WHIP has proven to be a highly effective and widely accepted program across the country. By targeting wildlife habitat projects on all lands and aquatic areas, WHIP provides assistance to conservation minded landowners who are unable to meet the specific eligibility requirements of other USDA conservation programs. Program administration of WHIP is provided under the Natural Resources Conservation Service.

Listed in Table 7-2 is a matrix of Aquatic Funding Programs.

TABLE 7-2 AQUATIC FUNDING PROGRAMS MATRIX

Program	Agency	Description	Target Audience	Contact
Abandoned Mine Land Program-Clean Streams Initiative	Office of Surface Mining	Charges fees to coal producers that are placed in a dedicated fund for abandoned mine closure and acid mine drainage clean up.	Broad-based citizen, industry, government	Bureau of Mining and Reclamation Grants Contact: Steve Jones RCSOB 5th Floor, P.O. Box 8476 Harrisburg, PA 17105 Phone: 717-787-7669 Fax: 717-783-4675 E-mail: sjones@state.pa.us
C-SAW	Resource Conservation & Development Councils (RC&D's), U.S. Department of Agriculture (USDA)	RC&D Councils are a non-profit organization authorized by the United States Department of Agriculture to provide administrative support to watershed groups across the state of Pennsylvania.	Watershed Groups, non-profit organizations	Suzanne Berkowitz, Program Assistant Pocono Northeast RC&D 1300 Old Plank Road Mayfield, Pennsylvania Phone: 570-282-8732 ext. 4, Fax: 570-281-5379 Email: pnercd@ptd.net
Challenge 21-Flood Hazard Mitigation and Riverine Restoration	U.S. Army Corps of Engineers (US ACE)	Helps relocate frequently flooded homes and restore riparian habitat.	Local Communities, wildlife restoration, conservation and restoration agencies.	Planning Division, Headquarters, U.S. Army Corps of Engineers: 20 Massachusetts Avenue, N.W. Washington, D.C. 20314-1000 Phone: 202-761-0115
Clean Water Act-319 Program	Environmental Protection Agency (EPA)	Through its 319 program, EPA provides formula grants to the states and tribes to implement non-point source projects and programs in accordance with section 319 of the Clean Water Act (CWA).	Local governments, community groups, non-profit conservation, watershed, greenway and trail organizations	U.S. Environmental Protection Agency Office of Wetlands, Oceans and Watersheds Nonpoint Source Control Branch (4503F) Ariel Rios Bldg., 1200 Pennsylvania Ave., NW, Washington, DC 20460 Phone: 202-260-7100
Coldwater Conservation Fund	Trout Unlimited	Supports scientific and economic research and analysis and science-based watershed restoration projects that further TU's mission.	Conservation organizations, research groups, watershed organizations.	Whit Fosburgh National Office, Trout Unlimited 1500 Wilson Blvd., #310 Arlington, VA 22209-2404 Phone: (800) 834-2419 Fax: 703-284-9400 wfosburgh@tu.org
Community Conservation Partnerships Program	Department of Conservation and Natural Resources (DCNR)	Grants are available to municipalities, counties, municipal and intermunicipal authorities, and river support groups to conserve and enhance river resources.	Local communities, non-profits and other organizations for recreation and conservation projects.	The Grants Project Management Division of DCNR RCSOB 6th Floor PO Box 8475 Harrisburg, PA 17105-8551 Phone: 717-783-4734
Conservation Reserve Program (CRP)	U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS)	Provides incentives for farmers and ranchers to implement conservation practices on their lands.	Farmers, ranchers, and conservation districts.	Malcolm Henning, National Program Manager Phone: 202-720-1872 Michele Gidcumb, CRP Soil Conservationist Phone: 202-720-5742

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TABLE 7-2 AQUATIC FUNDING PROGRAMS MATRIX (continued)

Program	Agency	Description	Target Audience	Contact
Fisheries Habitat Restoration Program	National Oceanic and Atmospheric Administration (NOAA)	Forges partnership to help communities restore fisheries habitat.	Restoration and conservation organizations, local and state agencies, industry, academia, private landowners and volunteer organizations.	NOAA's Program Planning and Integration 1315 East West Highway Silver Spring, MD 20910 Phone: 301-713-1622 ext. 1632 Fax: 301-713-0585
Growing Greener Program	Commonwealth of Pennsylvania	The total dollar commitment to the Growing Greener Program has been doubled from $645 million to $1.3 billion and extended through 2012.	Local governments, community groups, non-profit conservation, watershed, greenway and trail organizations	Growing Greener Grants Center 16th Floor, Rachel Carson State Office Building P.O. Box 2063 Harrisburg, PA 17105-2063 Phone: 717-705-5400
National Corporate Wetlands Restoration Partnership (CWRP)	U.S. Army Corps of Engineers (USACE)	The National Corporate Wetlands Restoration Partnership (CWRP) is a public-private partnership between the federal government, state governments and private corporations to restore wetlands and other aquatic habitats.	Participating private foundations or state trust funds to protect aquatic ecosystem restoration projects.	William Hubbard, US Army Corps of Engineers 696 Virginia Rd Concord MA 01742 Phone: 978-318-8238
National Fish and Wildlife Foundation (NFWF)	U.S. Fish and Wildlife Service (USFWS)	Conserves fish, wildlife, plants and the habitat upon which they depend through public-private partnerships and project grants.	Private, Non-profit organizations	Grants and Programs; Eastern Region Tom Kelsch, Director Phone: 202-857-0166 Fax: 202-857-0162 1120 Connecticut Avenue, NW, Suite 900 Washington, DC 20036
National Fish Passage Program	U.S. Fish and Wildlife Service (USFWS)	Provides opportunities for communities to restore natural river functions and native fish populations by removing or circumventing barriers to fish passage.	Local Communities, state, tribal, and federal agencies	Northeast Fish Passage Coordinator: David Perkins 300 Westgate Center Drive Hadley, MA 01035-9589 Phone: 413-253-8405 Fax: 413-253-8488 Web Site: fisheries.fws.gov/FWSMA/fishpassage
North American Wetland Conservation Grants Program	U.S. Fish and Wildlife Service (USFWS)	Provides matching grants to private or public organizations or to individuals to protect and restore wetland ecosystems throughout North America.	Private or public organizations or to individuals	Standard Grants proposals: David Buie E-Mail Address: david_buie@fws.gov Phone: 301-497-5870 Small Grants Program proposals: Keith Morehouse E-Mail Address: keith_morehouse@fws.gov Phone: 703-358-1888. General office number: 703-358-1784.

TABLE 7-2 AQUATIC FUNDING PROGRAMS MATRIX (continued)

Program	Agency	Description	Target Audience	Contact
Partners for Fish and Wildlife	U.S. Fish and Wildlife Service	Helps landowners plan and design habitat management/ restoration projects.	Private landowners, conservation organizations.	Assistant Director - Fisheries and Habitat Conservation Mamie Parker , Assistant Director (AF) U.S. Fish and Wildlife Service 1849 C Street, N.W. Washington, D.C. 20240 Phone: 202-208-6394 ext 3245
• Sewage Treatment Plant Operations Grant • Small Systems Regionalization Grant • Small Water Systems Consolidation Construction Grant Program • Water Resources Education Network "Opportunity Grants • Growing Greener Program	Pennsylvania Department of Environmental Protection (PA DEP)	The Pennsylvania Department of Environmental Protection can make money available for watershed, drinking water, wastewater and stormwater projects.	Non-Profit organizations, municipalities, watershed and local communities.	Northeastern Regional Field Office 2 Public Square Wilkes-Barre, PA 18711-0790 Mark Carmon / Community Relations Coordinator Phone: 570-826-2511 www.state.pa.us
Pre-Disaster Mitigation Program	Federal Emergency Management Agency (FEMA)	Helps communities reduce losses from floods and other events by restoring and protecting healthy, more natural ecosystems.	Municipalities, local governments	Mitigation Division Region III One Independence Mall, 6th floor 615 Chestnut St. Philadelphia, PA 19106-4404 Phone: 215-931-5608
Rivers, Trails, and Conservation Assistance Program (RTCA)	National Park Service (NPS)	Provides advice and counsel to communities on river protection initiatives.	Local Communities, Tribal groups, conservation organizations.	Rivers & Trails provides assistance to non-profit organizations, community groups, tribes or tribal governments, and local or State government agencies. This may include aquatic assistance for river conservation and watershed planning projects.
Section 1135-Habitat Restoration for Fish and Wildlife Resources	U.S. Army Corps of Engineers (US ACE)	Increases and restores habitat affected by dams and flood control projects.	State, regional, local governments or other non-Federal public agencies	Mr. Russ Rote, P.E. Chief, Flood Control and Flood Plain Management Section E-mail: Russ.L.Rote@saj02.usace.army.mil Phone: 904-232-2232

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TABLE 7-2 AQUATIC FUNDING PROGRAMS MATRIX (continued)

Program	Agency	Description	Target Audience	Contact
Section 206-Flood Plain Management Services	U.S. Army Corps of Engineers (US ACE)	Increases and restores habitat affected by dams and flood control projects.	State, regional, local governments or other non-Federal public agencies	Mr. Russ Rote, P.E. Chief, Flood Control and Flood Plain Management Section E-mail: Russ.L.Rote@saj02.usace.army.mil Phone: 904-232-2232
State Revolving Fund Programs-Clean Water Act and Safe Drinking Water Act	Environmental Protection Agency (EPA)	Funds projects that reduce non-point pollution, protect estuaries, prevent contamination of drinking source waters, and reduce polluted runoff by protecting natural area and other "green infrastructure."	Municipalities, local governments	U.S. Environmental Protection Agency Office of Wetlands, Oceans and Watersheds Nonpoint Source Control Branch (4606M) Ariel Rios Bldg., 1200 Pennsylvania Ave., NW, Washington, DC 20460 SDWA hotline: (800) 426-4791
Watershed Assistance Grants	Environmental Protection Agency (EPA)	Supports innovative efforts that build the capacity of community-based partnerships to conserve and restore watersheds.	Watershed partnerships, non-profit organizations	U.S. Environmental Protection Agency Office of Wetlands, Oceans and Watersheds (4501T) Ariel Rios Bldg., 1200 Pennsylvania Ave., NW, Washington, DC 20460 Phone: 202-566-1291 E-Mail Address: cole.james@epa.gov Web Site: www.epa.gov/owow/watershed/wacademy/fund.html
Wetlands Reserve Program (WRP)	Natural Resources Conservation Service (NRCS)	Provides incentives for landowners to protect, restore, and enhance wetlands and associated uplands on private lands.	Recreational organizations, rural communities, recreationist groups.	Leslie Deavers, 202-720-1067
Wildlife Habitat Incentives Program (WHIP)	Natural Resources Conservation Service (NRCS)	Provides financial incentives to develop habitat for fish and wildlife on private lands.	Conservation Districts, wildlife conservation groups, State wildlife agencies and non-profit and private organizations.	Martha Joseph, 202-720-7157

c. Funding Land Components

Agricultural Land Preservation Fund

U.S. Department of Agriculture (USDA);
Pennsylvania Bureau of Farmland Protection

State funding in Pennsylvania for open space preservation and protection comes from a variety of programs. The most successful such program is the Agricultural Land Preservation Fund, which is administered by the Bureau of Farmland Protection within the Department of Agriculture. Its purpose is to purchase development rights (agricultural conservation easements) on lands containing high-ranking soil classification, for the purpose of keeping the land open for agriculture. The program requires that each county that wishes to participate must create an Agricultural Land Preservation Board to administer the program. The county must also contribute some of its own funds, which are then matched with substantially more money by the state. The state money comes from a levy on the real-estate transfer tax, a levy on the cigarette tax, and, at times, from bond issues. The county money can come from tax revenue or bond issues. Pennsylvania is a national leader in the protection and preservation of agricultural lands.

Community Conservation Partnerships Program

The Department of Conservation and Natural Resources (DCNR)

The Department of Conservation and Natural Resources is another leading source of funds for land preservation. Money from its Keystone grants program (which receives money from Pennsylvania's Growing Greener initiative) has been used to purchase both land and conservation easements. DCNR makes purchases of land or easements on its own through the Bureau of Forestry and Bureau of State Parks, but it also grants funds to land trusts, conservancies, and municipalities to enable them to acquire land and easements. This is a competitive grant program in which applications are reviewed and ranked by DCNR, and then awards are made to successful applicants annually.

Comprehensive Recreation, Park and Open Space Plans

Pennsylvania Department of Conservation & Natural Resources (DCNR)

There are grants to develop a comprehensive long-range planning document that provides strategies to address a municipality's recreation, park and open space needs.

Conservation Reserve Program (CRP)

U.S. Department of Agriculture (USDA);
Natural Resource Conservation Service (NRCS)

The Conservation Reserve Program (CRP) provides technical and financial assistance to eligible farmers and ranchers to address soil, water, and related natural resource concerns on their lands in an environmentally beneficial and cost-effective manner. The program provides assistance to farmers and ranchers in complying with federal, state, and tribal environmental laws, and encourages environmental enhancement. The program is funded through the Commodity Credit Corporation (CCC). CRP is administered by the Farm Service Agency, with NRCS providing technical land eligibility determinations, Environmental Benefit Index Scoring, and conservation planning.

THE DEPARTMENT OF COMMUNITY AND ECONOMIC DEVELOPMENT (DCED)

The Department of Community and Economic Development can also make money available for land protection and preservation projects at the request of members of the Pennsylvania Legislature. The money can be granted to municipalities as well as land trusts, conservancies, or other non-profits. The mission of the Department of Community and Economic Development (DCED) is to foster opportunities for businesses and communities to succeed and thrive in a global economy, thereby enabling Pennsylvanians to achieve a superior quality of life.

ENVIRONMENTAL QUALITY INCENTIVES PROGRAM (EQIP)

U.S. Department of Agriculture (USDA);
Natural Resource Conservation Service (NRCS)

EQIP is a voluntary USDA/NRCS conservation program for producers to treat soil, water and related natural resource concerns. It provides technical and financial assistance to promote environmental quality in agricultural production. The Environmental Quality Incentives Program (EQIP) was reauthorized in the Farm Security and Rural Investment Act of 2002 (Farm Bill) to provide a voluntary conservation program for farmers and ranchers that promotes agricultural production and environmental quality as compatible national goals. Only agricultural producers, individuals or entities engaged in livestock or agricultural production may participate in EQIP program.

FARM AND RANCH LANDS PROTECTION PROGRAM

U.S. Department of Agriculture (USDA);
Natural Resource Conservation Service (NRCS)

The Farm and Ranch Land Protection Program (FRPP) provides matching funds to help purchase development rights to keep productive farm and ranchland in agricultural uses. Working through existing programs, USDA partners with state, tribal, or local governments and non-governmental organizations to acquire conservation easements or other interests in land from landowners. USDA provides up to 50 percent of the fair market easement value.

FOREST LEGACY PROGRAM (FLP)

U.S. Forest Service (USFS)

The Forest Legacy Program, relatively new (to Pennsylvania), is similar to the agricultural program. It uses money from federal sources, matched by state, county, or local sources to purchase development rights from owners of land containing timber resources. Landowners are not required to timber land preserved through the FLP, but timbering cannot be prohibited under these easements

GREEN FUTURE FUND

Northampton County; Lehigh County

The Green Future Fund was created to preserve green space in Lehigh and Northampton counties. The funds will be used to buy farmland easements, create new parks and maintain existing ones, used to create and enhance nature trails and greenways, and to protect waterways.

Land and Water Conservation Fund (LWCF)

Department of the Interior;
U.S. Forest Service (USFS)

The LWCF program provides matching grants to states and local governments for the acquisition and development of public outdoor recreation areas and facilities. The program is intended to create and maintain a nationwide legacy of high quality recreation areas and facilities and to stimulate non-federal investments in the protection and maintenance of recreation resources across the United States.

Monroe County Initiative Program

Monroe County Planning Commission

Provides funding for land conservation and protection of open space in Monroe County.

Pennsylvania "Growing Smarter" Initiative

Pennsylvania Department of Community and Economic Development (DCED)

The Department of Community and Economic Development can also make money available for land protection and preservation projects at the request of members of the Pennsylvania Legislature. The money can be granted to municipalities as well as land trusts, conservancies, or other non-profits.

Pre-Disaster Mitigation Program

Federal Emergency Management Agency (FEMA)

Funding for the program is provided through the National Pre-Disaster Mitigation Fund to assist states and local governments (to include Indian Tribal governments) in implementing cost-effective hazard mitigation activities that compliment a comprehensive mitigation program. All applicants must be participating in the National Flood Insurance Program (NFIP) if they have been identified through the NFIP as having a Special Flood Hazard Area (a Flood Hazard Boundary Map (FHBM) or Flood Insurance Rate Map (FIRM) has been issued).

Rivers, Trails and Conservation Assistance Program (RTCA)

National Park Service (NPS)

Rivers & Trails works in communities with the goal of helping communities achieve on-the-ground conservation successes for their projects. Our focus is on helping communities help themselves by providing expertise and experience from around the nation. From urban promenades to trails along abandoned railroad rights-of-way to wildlife corridors, our assistance in greenway efforts is wide ranging. Similarly, our assistance in river conservation spans downtown riverfronts to regional water trails to stream restoration. Rivers & Trails has conservation professionals in communities nationwide.

Small Communities Planning Assistance Program (SCPAP)

Pennsylvania Department of Community and Economic Development (DCED)

The Small Communities Planning Assistance Program provides up to 100 percent of the cost to prepare multi-municipal Comprehensive Plans and implementing ordinances. Program guidelines emphasize compliance with CDBG Program requirements.

STATE PLANNING ASSISTANCE PROGRAM (SPAG)

Governor's Center for Local Government Services

The State Planning Assistance Program provides 50-50 matching funds for visioning and comprehensive planning projects involving multi-municipal efforts. The World Class Communities Program (WCCP) also provides funds up to 50 percent for multi-municipal planning and visioning efforts.

TEA-21 INTERMODAL SURFACE TRANSPORTATION ENHANCEMENT ACT

The Pennsylvania Department of Transportation (PENNDOT)

The Pennsylvania Department of Transportation administers federal funds received through the (known as ISTEA, or currently, T-21). These funds can be used for purchase of land or easements through a competitive application process. Projects such as trails or other lands that enhance the public's ability to move from one place to another receive the most favorable consideration.

Listed in Table 7-3 is a matrix of Land Funding Programs.

TABLE 7-3 LAND FUNDING PROGRAMS

Program	Agency	Description	Target Audience	Contact
American Farmland Trust	Bureau of Farmland Preservation	The bureau oversees the Commonwealth's program to purchase agricultural easements and administers legislative programs designed to preserve farmland through the State Agricultural Preservation Board.	Farmers and ranchers.	Bureau of Farmland Preservation at Phone: 717-783-3167
Community Conservation Partnerships Program	The Department of Conservation and Natural Resources (DCNR)	Makes purchases of land or easements on its own through the Bureau of Forestry and of State Parks, but it also grants Bureau funds to land trusts, conservancies, and municipalities to enable them to acquire land and easements.	Local communities, non-profits and other organizations for recreation and conservation projects.	The Grants Project Management Division of DCNR Phone: 717-783-4734
Comprehensive Recreation, Park and Open Space Plans	The Department of Conservation and Natural Resources (DCNR)	Grants to develop a comprehensive long-range planning document that provides strategies to address a municipality's recreation, park and open space needs.	Local communities, non-profits and other organizations for recreation and conservation projects.	The Grants Project Management Division of DCNR Phone: 717-783-4734
Conservation Reserve Program (CRP)	U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS)	Provides incentives for farmers and ranchers to implement conservation practices on their lands.	Farmers, ranchers, and conservation districts.	Malcolm Henning, National Program Manager Phone: 202-720-1872 Michele Gidcumb, CRP Soil Conservationist Phone: 202-720-5742

TABLE 7-3 LAND FUNDING PROGRAMS MATRIX

Program	Agency	Description	Target Audience	Contact
Environmental Quality Incentives Program (EQIP)	U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS)	Helps farmers and ranchers develop resource conservation practices.	Farmers, ranchers, conservation organizations, conservation districts,	Anthony Esser, National EQIP Program Manager Phone: 202-720-1840 Edward Brzostek, Acting Program Manager Phone: 202-720-1834
Farm and Ranch Lands Protection Program	U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS)	Provides matching funds to help purchase development rights to keep productive farm and ranchland in agricultural uses.	Farmers and ranchers.	Denise C. Coleman National FRPP Manager Phone: 202-720-9476
Forest Legacy Program (FLP)	U.S. Forest Service (USFS)	Uses money from federal sources,matched by state, county, orlocal sources to purchase development rights (agricultural conservation easements) fromowners of land containing timber resources.	Private forest land owners	Deirdre Raimo, Program Coordinator USDA Forest Service P.O. Box 640, 271 Mast Road Durham, NH 03824 Phone: 603-868-7695 Fax: 603-868-7604 E-mail: draimo@fs.fed.us
Green Future Funds	Northampton County; Lehigh County	Created to preserve green space in Lehigh and Northampton Counties. The funds will be used to buy farmland easements, create new parks and maintain existing ones, used to create and enhance nature trails and greenways, and to protect waterways.	Farmers, conservation organizations, sportsman groups, inner city organizations, and builders associations.	Bob Korp Director of Planning County of Lehigh 17 South Seventh Street Allentown, PA 18101-2400 Phone: 610-782-3001
Land and Water Conservation Fund (LWCF)	Department of the Interior; U.S. Forest Service (USFS)	Acquires ecologically important federal/state land.	State and Local conservation and land easement organizations	Recreation and Conservation Dept. of Conservation and Natural Resources P.O. Box 8767 Harrisburg, PA 17105 Phone: 717-783-2659
Monroe County Initiative Program; Natural Area Land Trust Program; County Natural Areas/ Passive Recreation Lands	Monroe County Planning Commission	Conservation of Lands and Protection of open space in Monroe County.	County initiatives to protect lands	Monroe County Planning Commission Administrative Center 1 Quaker Plaza, Room 106 Stroudsburg, PA 18360-2169 David Albright, Open Space Coordinator Phone: 570-517-3149 Fax: 570-420-3564 E-Mail Address: dalbright@co.monroe.pa.us

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TABLE 7-3 LAND FUNDING PROGRAMS MATRIX (continued)

Program	Agency	Description	Target Audience	Contact
Pennsylvania "Growing Smarter" Initiative	Pennsylvania Department of Community and Economic Development (DCED)	To encourage sound land management practices, the Center offers a wide range of tools to support wise decisions about land use and encourage strong communities, economic development, a healthy environment and an improved quality of life.	Local governments and communities.	Governor's Center for Local Government Services Department of Community and Economic Development 4th Floor, Commonwealth Keystone Building Harrisburg, PA 17120-0225 (voice) 888-223-6837 E-Mail Address: feedback@landuseinpa.com
Pre-Disaster Mitigation Program	Federal Emergency Management Agency (FEMA)	Helps communities reduce losses from floods and other events by restoring and protecting healthy, more natural ecosystems.	Municipalities, local governments	Mitigation Division Region III One Independence Mall, 6th floor 615 Chestnut St. Philadelphia, PA 19106-4404 Phone: 215-931-5608
Rivers, Trails, and Conservation Assistance Program (RTCA)	National Park Service (NPS)	Provides assistance to non-profit organizations, community groups, tribes or tribal governments, and local or State government agencies. This may include landassistance for urban greening, and open space protection projects	Local Communities, Tribal groups, conservation organizations.	Rivers & Trails provides assistance to non-profit organizations, community groups, tribes or tribal governments, and local or State government agencies. This may include aquatic assistance for river conservation and watershed planning projects.
Small Communities Planning Assistance Program (SCPAP)	PA Department of Community and Economic Development (PA DCED)	Provides grants up to 100% of the costs to eligible municipalities to prepare comprehensive plans, development regulations and special strategies for development. Generally, 51% of the municipality's residents must be low or moderate income, according to the census or a survey. Limited to municipalities under 10,000 population	Local governments and communities.	Governor's Center for Local Government Services Department of Community and Economic Development 4th Floor, Commonwealth Keystone Building Harrisburg, PA 17120-0225 (voice) 888-223-6837 E-Mail Address: feedback@landuseinpa.com
State Planning Assistance Program (SPAG)	Governor's Center for Local Government Services	Provides 50-50 matching funds for visioning and comprehensive planning projects involving multi-municipal efforts. The World Class Communities Program (WCCP) also provides funds up to 50 percent for multi-municipal planning and visioning efforts.	Local governments and communities.	Governor's Center for Local Government Services State Office 4th Floor, Commonwealth Keystone Building 400 North Street Harrisburg, Pennsylvania 17120-0225 Kenneth Klothen / Executive Director Phone: 888-223-6837 E-Mail Address: ra-dcedclgs@state.pa.us

TABLE 7-3 LAND FUNDING PROGRAMS MATRIX (continued)

Program	Agency	Description	Target Audience	Contact
Tea-21 Intermodal Surface Transportation Enhancement Act	Pennsylvania Department of Transportation (PENNDOT)	Funds can be used for purchase of land or easements through a competitive application process. Projects such as trails or other lands that enhance the public's ability to move from one place to another receive the most favorable consideration.	Any federal or state agency, county or municipal government or non-profit organization	Pennsylvania Department of Transportation Center for Program Development and Management\ P.O. Box 3365 Harrisburg, PA 17105-3365 Attention: Dan Accurti

d. Funding Biological Components

COLDWATER CONSERVATION FUND

Trout Unlimited

Trout Unlimited's Coldwater Conservation Fund (CCF) supports scientific and economic research and analysis and science-based watershed restoration projects that further Trout Unlimited's mission. Each year, the Cold Conservation Fund (CCF) funds more than $1 million in biological and economic research and watershed-scale demonstration projects.

FISHERIES HABITAT RESTORATION PROGRAM

National Oceanic and Atmospheric Administration (NOAA)

The NOAA Habitat Restoration Program (Restoration Program) is a cross-line office program that leads and coordinates NOAA's restoration activities to fulfill the NOAA habitat restoration mission in a coordinated and effective manner. This cooperative approach provided through the Restoration Program fosters data and information exchange among NOAA's restoration programs.

NATIONAL FISH AND WILDLIFE FOUNDATION (NFWF)

U.S. Fish and Wildlife Service (USFWS)

National Fish and Wildlife Foundation funds projects to conserve and restore fish, wildlife, and native plants through matching grant programs. The Foundation awards matching grants to projects that address priority actions promoting fish and wildlife conservation and the habitats on which they depend, work proactively to involve other conservation and community interests, leverage Foundation-provided funding, and evaluate project outcomes. Federal, state, and local governments, educational institutions, and non-profit organizations are welcome to apply for a general matching grant throughout the year.

NATIONAL FISH PASSAGE PROGRAM

U.S. Fish and Wildlife Service (USFWS)

In 1999, the U.S. Fish and Wildlife Service initiated the National Fish Passage Program to work with others to address this problem. The National Fish Passage Program uses a voluntary, non-regulatory approach to remove and bypass barriers. The program addresses the problem of fish barriers on a national level, working with local communities and partner agencies to restore natural flows and fish migration. The program is administered by national and

regional coordinators, and delivered by Fish and Wildlife Management Offices, with their 300 biologists located across the Nation. Appropriations for the program support the coordinators, in-the-water fish passage projects, and the Fish Passage Decision Support System.

NEOTROPICAL MIGRATORY BIRD CONSERVATION ACT

U.S. Fish and Wildlife Service (USFWS)

Passed by the U.S. Congress in 2000, the Neotropical Migratory Bird Conservation Act establishes a matching grants program to fund projects that promote the conservation of these birds in the United States, Latin America, and the Caribbean. The Act's purposes are to perpetuate healthy populations of neotropical migratory birds. Any U.S., Latin American, or Caribbean individual, corporation, government agency, trust, association, or other private entity can apply for funding.

PARTNERS FOR FISH AND WILDLIFE PROGRAM

U.S. Fish and Wildlife Service (USFWS)

The Partners for Fish and Wildlife Program is the primary mechanism for delivering voluntary on-the-ground habitat improvement projects on private lands for the benefit of federal trust species. The program provides technical and financial assistance to landowners to help meet the habitat needs of federal trust species on private lands.

STATE WILDLIFE GRANTS (SWG) PROGRAM

Pennsylvania Game Commission (PGC);
Pennsylvania Fish and Boat Commission (PFBC)

Congress has funded the State Wildlife Grants (SWG) program, which provides federal funding to the Pennsylvania Game Commission (PGC) and Pennsylvania Fish & Boat Commission (PFBC) for managing and recovering species of greatest conservation concern. The PGC and PFBC solicit project proposals from organizations across the Commonwealth for consideration to receive funds under the SWG program. Projects of all sizes are considered, however funds in this program are only available on a reimbursement basis, so qualifying organizations must be able to support the project prior to reimbursements.

WILDLIFE HABITAT INCENTIVES PROGRAM (WHIP)

U.S. Department of Agriculture (USDA);
Natural Resource Conservation Service (NRCS)

The Wildlife Habitat Incentives Program (WHIP) is a voluntary program for people who want to develop and improve wildlife habitat primarily on private land. Through WHIP USDA's Natural Resources Conservation Service provides both technical assistance and up to 75 percent cost-share assistance to establish and improve fish and wildlife habitat. WHIP agreements between NRCS and the participant generally last five to ten years from the date the agreement is signed.

WHIP has proven to be a highly effective and widely accepted program across the country. By targeting wildlife habitat projects on all lands and aquatic areas, WHIP provides assistance to conservation minded landowners who are unable to meet the specific eligibility requirements of other USDA conservation programs. Program administration of WHIP is provided under the Natural Resources Conservation Service.

Listed in Table 7-4 is a matrix of Biological Funding Programs.

TABLE 7-4 BIOLOGICAL FUNDING PROGRAMS MATRIX

Program	Agency	Description	Target Audience	Contact
Coldwater Conservation Fund	Trout Unlimited	Supports scientific and economic research and analysis and science-based watershed restoration projects that further TU's mission.	Conservation organizations, research groups, watershed organizations.	Whit Fosburgh National Office, Trout Unlimited 1500 Wilson Blvd., #310 Arlington, VA 22209-2404 Phone: (800) 834-2419 Fax: 703-284-9400 wfosburgh@tu.org
Fisheries Habitat Restoration Program	National Oceanic and Atmospheric Administration (NOAA)	Forges partnership to help communities restore fisheries habitat.	Restoration and conservation organizations, local and state agencies, industry, academia, private landowners and volunteer organizations.	NOAA's Program Planning and Integration 1315 East West Highway Silver Spring, MD 20910 Phone: 301-713-1622 ext. 1632 Fax: 301-713-0585
National Fish and Wildlife Foundation (NFWF)	U.S. Fish and Wildlife Service (USFWS)	Conserves fish, wildlife, plants and the habitat upon which they depend through public-private partnerships and project grants.	Private, Non-profit organizations	Grants and Programs; Eastern Region Tom Kelsch, Director Phone: 202-857-0166 Fax: 202-857-0162 1120 Connecticut Avenue, NW, Suite 900 Washington, DC 20036
National Fish Passage Program	U.S. Fish and Wildlife Service (USFWS)	Provides opportunities for communities to restore natural river functions and native fish populations by removing or circumventing barriers to fish passage.	Local Communities, state, tribal, and federal agencies	Northeast Fish Passage Coordinator: David Perkins 300 Westgate Center Drive Hadley, MA 01035-9589 Phone: 413-253-8405 Fax: 413-253-8488 Web Site: fisheries.fws.gov/FWSMA/fishpassage
Neotropical Migratory Bird Conservation Act (Act)	U.S. Fish and Wildlife Service (USFWS)	Passed by the U.S. Congress in 2000, the Neotropical Migratory Bird Conservation Act (Act) establishes a matching grants program to fund projects that promote the conservation of these birds in the United States, Latin America, and the Caribbean.	Any U.S., Latin American, or Caribbean individual, corporation, government agency, trust, association, or other private entity can apply for funding.	Division of Bird Habitat Conservation Phone: 703-358-1784 E-Mail Address: neotropical@fws.gov

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TABLE 7-4 BIOLOGICAL FUNDING PROGRAMS MATRIX (continued)

Program	Agency	Description	Target Audience	Contact
Partners for Fish and Wildlife	U.S. Fish and Wildlife Service (USFWS)	Helps landowners plan and design habitat management/ restoration projects.	Private landowners, conservation organizations.	Assistant Director-Fisheries and Habitat Conservation Mamie Parker , Assistant Director (AF) U.S. Fish and Wildlife Service 1849 C Street, N.W. Washington, D.C. 20240 Phone: 202-208-6394 ext 3245
State Wildlife Grants (SWG) Program	Pennsylvania Game Commission (PGC); Pennsylvania Fish and Boat Commission (PFBC)	Congress has funded the State Wildlife Grants (SWG) program, which provides federal funding to the PA Game Commission (PGC) and PA Fish & Boat Commission (PFBC) for managing and recovering species of greatest conservation concern.	Sporting and conservation organizations	Patti Barber Game Commission's Bureau of Wildlife Management Phone: 717-787-5529
Wildlife Habitat Incentives Program (WHIP)	Natural Resources Conservation Service (NRCS)	Provides financial incentives to develop habitat for fish and wildlife on private lands.	Conservation Districts, wildlife conservation groups, State wildlife agencies and non-profit and private organizations.	Martha Joseph, 202-720-7157

e. Funding Recreational Components

COMMUNITY CONSERVATION PARTNERSHIPS PROGRAM

The Department of Conservation and Natural Resources (DCNR)

Community Grants are awarded to municipalities for recreation, park and conservation projects. These include the rehabilitation and development of parks and recreation facilities; acquisition of land for park and conservation purposes; and technical assistance for feasibility studies, trails studies, and site development planning. Pennsylvania Recreational Trails Program Grants provide funds to develop and maintain recreational trails and trail related facilities for motorized and nonmotorized recreational trail use. These are competitive grants in which applications are reviewed and ranked by DCNR, and then awards are made to successful applicants annually.

COMPREHENSIVE RECREATION, PARK AND OPEN SPACE PLANS

Pennsylvania Department of Conservation & Natural Resources (DCNR)

These are grants to develop a comprehensive long-range planning document that provides strategies to address a municipality's recreation, park and open space-needs.

LUZERNE COUNTY GREENSPACE ALLIANCE

Greater Wilkes-Barre Chamber of Business and Industry

The Luzerne County Greenspace Alliance provides matching grants to municipalities, non-profit and greenway organizations located within Luzerne County for planning and outdoor

recreation projects. Matching funds are available for public outdoor recreation projects including Rails-to-Trails, watershed management plans, trails, and greenways. It is a competitive program in which applications are reviewed and ranked by Greenspace Alliance, and then awards are made to successful applicants annually.

RIVERS, TRAILS AND CONSERVATION ASSISTANCE PROGRAM (RTCA)

National Park Service (NPS)

Rivers & Trails works in urban, rural, and suburban communities with the goal of helping communities achieve on-the-ground conservation successes for their projects. The program's focus is on helping communities help themselves by providing expertise and experience from around the nation. From urban promenades to trails along abandoned railroad rights-of-way to wildlife corridors, their assistance in greenway efforts is wide ranging. Similarly, their assistance in river conservation spans downtown riverfronts to regional water trails to stream restoration.

Rivers & Trails has conservation professionals in communities nationwide.

STATE COMMUNITY DEVELOPMENT BLOCK GRANT (CDBG) PROGRAM

U.S. Department of Housing and Urban Development (HUD)

The State CDBG Program provides states with annual direct grants, which they in turn award to smaller communities and rural areas for use in revitalizing neighborhoods, expanding affordable housing and economic opportunities, and/or improving community facilities and services.

Listed in Table 7-5 is a matrix of Recreational Funding Programs

TABLE 7-5 RECREATIONAL FUNDING PROGRAMS MATRIX

Program	Agency	Description	Target Audience	Contact
Community Conservation Partnerships Program	The Department of Conservation and Natural Resources (DCNR)	Community Grants are awarded to municipalities for recreation, park and conservation projects. These include the rehabilitation and development of parks and recreation facilities; acquisition of land for park and conservation purposes; and technical assistance for feasibility studies, trails studies, and site development planning.	Local communities, non-profits and other organizations for recreation and conservation projects.	The Grants Project Management Division of DCNR RCSOB 6th Floor PO Box 8475 Harrisburg, PA 17105-8551 Phone: 717-783-4734
Comprehensive Recreation, Park and Open Space Plans	The Department of Conservation and Natural Resources (DCNR)	Grants to develop a comprehensive long-range planning document that provides strategies to address a municipality's recreation, park and open space needs.	Local communities, non-profits and other organizations for recreation and conservation projects.	The Grants Project Management Division of DCNR RCSOB 6th Floor PO Box 8475 Harrisburg, PA 17105-8551 Phone: 717-783-4734

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TABLE 7-5 RECREATIONAL FUNDING PROGRAMS MATRIX (continued)

Program	Agency	Description	Target Audience	Contact
Luzerne County Greenspace Alliance	Greater Wilkes-Barre Chamber of Business and Industry	Provides matching grants to municipalities, non-profit and greenway organizations located within Luzerne County for planning of outdoor recreation projects.	Municipalities, Non-Profit Organizations, Rails-to-Trails	Thomas Ruskey 2 Public Square, P.O. Box 5340 Wilkes-Barre, PA 18710-5340 Phone: 570-823-2101 E-Mail Address: truskey@wilkes-barre.org
Rivers, Trails, and Conservation Assistance Program (RTCA)	National Park Service (NPS)	Provides assistance to non-profit organizations, community groups, tribes or tribal governments, and local or State government agencies. This may include recreational assistance for trails and greenway planning and rail-trail conversion projects.	Local Communities, Tribal groups, conservation organizations.	National Park Service Rivers Trails, and Conservation Assistance Program 1849 C Street, NW, Org. Code 2220 Washington, D.C. 20240 202-354-6900 E-Mail Address: Sam_Stokes@nps.gov Web Site: www.nps.gov/rivers
State Community Development Block Grant (CDBG) Program	U.S. Department of Housing and Urban Development (HUD)	Provides States with annual direct grants, which they in turn award to smaller communities and rural areas for use in revitalizing neighborhoods, expanding affordable housing and economic opportunities, and/or improving community facilities and services.	Local Governments and communities.	State and Small Cities Division Rm. 7184, 451 7th Street, SW, Washington, DC 20410, Phone: 202-708-1322.

Additional information on projects already funded through the states Growing Greener Grant Program in the Lehigh River watershed are shown in Appendix D – 2.

3. TOOLS

a. Aquatic

1. ABANDONED MINE DRAINAGE TREATMENT AND ELIMINATION TECHNOLOGY

Preventing acid drainage from surface mines requires the elimination of water movement through acid material. Separating and covering acid-forming materials with non-toxic soil, grading the surface to divert water away from the reclaimed areas and planting grasses and trees to stabilize the soil accomplish this. Water flowing from the restoration may also be treated to improve its quality before it enters nearby streams

Most acid drainage originates in abandoned underground coalmines and is carried by surface or groundwater into nearby streams. Filling or sealing the old shafts to eliminate acid production is expensive, and results are inconsistent. For this reason, water treatment has been the most practical solution to the problem (Michaud, 1994).

Methods of water treatment used to eliminate acid mine drainage from abandoned underground mines can be grouped into two types. The most common method is chemical treatment. Called "active" treatment because it requires constant maintenance, this method usually involves neutralizing acid-polluted water with hydrated lime or crushed limestone. This treat-

ment reduces acidity and significantly decreases iron and other metals. However, it is expensive to construct and operate and is considered a temporary measure because the acid drainage problem has not been permanently eliminated. The second treatment method is called biological, or "passive," control. This technology involves the construction of a treatment system that is more permanent and requires little or no maintenance. Passive control measures involve the use of anoxic drains, limestone rock channels, alkaline recharge of groundwater and diversion of drainage through man-made wetlands or other settling structures. Passive treatment systems are relatively inexpensive to construct and have been very successful on some small discharges of acid drainage (Michaud, 1994).

Prevention and Minimization of AMD Formation

For the formation of AMD, three components are required: sulfur-bearing material, water, and air. Certain bacteria also act to catalyze the oxidation of the pyrite. If any one of these components can be eliminated, AMD generation will not occur.

At active surface mining operations, the volume of surface runoff entering the site can be minimized by using perimeter diversion ditches, by relocating stream channels, and by grouting or lining streambeds to prevent water loss to the spoil. Sealing the spoil piles with an impermeable capping material such as fly ash, cemented fly ash, clay, or geopolymers can minimize infiltration of surface runoff and air. The optimization of the long-term effectiveness of these capping materials is presently being investigated by a number of research groups. Where conditions are suitable, pyretic spoil can also be effectively isolated from oxygen by placing it underwater in flooded pits, or by encapsulation with an impervious material (Michaud, 1996).

In underground operations, grouting of fractured overburden can be used to prevent the infiltration of surface water into the mine workings. Research is also being carried out to determine the effectiveness of injecting alkaline materials such as cemented fly ash into the underground workings. This could reduce the formation of AMD by coating the surface of the reactive pyrite. Because fly ash is a waste product from the power generation industry, it is inexpensiveæthis usage could provide a beneficial means of disposing of ash (Michaud, 1996).

Several methods are presently being investigated for their ability to inhibit AMD formation or to treat it in situ. When added to pyretic material, phosphate can form an extremely insoluble surface coating of ferric phosphate, thereby inhibiting the AMD formation reactions. Although very effective in the laboratory, the practicality, and economics of this method in the field have yet to be demonstrated (Michaud, 1996).

AMD generation can also be inhibited by the addition of bactericides or surfactants to the pyretic spoil. This technique is, however, expensive and not permanent. The addition of alkaline substances like limestone to the spoil material by mixing or layering can be used to neutralize acidity and to inhibit the acid-forming reactions. However, unless integrated with an ongoing spoiling operation, the cost of excessive material movement may be prohibitive. Alkaline solutions or slurries can also be injected into the spoil material, or the surface drainage diverted through ponds filled with alkaline material. This method can temporarily inhibit the acid-forming reaction and neutralize the AMD (Sobek, 1990).

Passive Treatment After AMD Formation

Constructed Wetlands: Passing AMD through wetlands (natural or constructed) can decrease the concentration of dissolved metals in the water, decrease acidity, and trap sediment. The basic mechanisms identified for the retention of metals include the

accumulation of metals in living plants and in the organic substrate, the exchange and organic complexion reactions with the substrate, and chemical and microbiological oxidation and reduction reactions that lead to precipitation.

There are aerobic and anaerobic constructed wetlands. Aerobic systems consist of wetlands of cattails or more diverse vegetation growing in a clay soil or mine spoil substrate. These conditions increase levels of oxygen in the substrate, and promote oxidation and precipitation of metals. Anaerobic wetlands are constructed with a thicker organic substrate composed of organic material such as hay, manure, peat moss, or mushroom compost. The main purpose of this design is to create an environment where oxygen content is restricted in order to promote the anaerobic sulfate reduction of metals (Watzlaf, 1995).

Anoxic Limestone Drains (ALD): The theory of Anoxic Limestone Drains (ALDs) is quite simple. Acid Mine Drainage is passed through a bed of limestone gravel that is buried to limit the input of oxygen. As the AMD dissolves the limestone, the pH rises and bicarbonate alkalinity is added to the water. This promotes metals precipitation in subsequent ponds or wetlands. Anoxic conditions within the limestone prevent iron oxidation and limestone armoring. However, the use of ALDs is not suitable under certain water chemistry conditions. Ferric iron and aluminum both precipitate within an ALD, decreasing performance by armoring limestone and plugging flow paths. It is also possible that a properly designed and constructed ALD will not generate sufficient alkalinity to completely neutralize acidic water due to limited limestone solubility. Water chemistry that appears similar based on evaluation of standard Acid Mine Drainage analytes may generate dissimilar alkalinity concentrations (Hedin, 1994)

Diversion Wells: A typical diversion well consists of a cylinder or vertical tank of metal or concrete filled with sand-sized limestone. This well may be erected in or beside a stream or may be sunk into the ground by a stream. A large pipe enters vertically down the center of the well and ends shortly above the bottom. Water is fed to the pipe from an upstream dam or deep mine portal. The water flows down the pipe, exits the pipe near the bottom of the well, then flows up through the limestone in the well, thereby fluidizing the bed of limestone in the well. The acid water dissolves the limestone for alkalinity generation, and metal flocs produced by hydrolysis and neutralization reactions are flushed through the system by water flow out the top of the well. The churning action of the fluidized limestone also aids in limestone dissolution and helps remove iron oxide coatings so that fresh limestone surfaces are always exposed. Metal flocs suspended in the water are precipitated in a downstream pond (Hedin, 1994).

Limestone Sand Treatment: Sand-sized limestone may also be directly dumped into AMD streams at various locations in watersheds. The sand is picked up by the stream flow and redistributed downstream, furnishing neutralization of acid as the stream moves the limestone through the streambed. The limestone in the streambed reacts with acid in the stream, causing neutralization. Coating of limestone particles with iron oxides can occur, but the agitation and scouring of limestone in the streambed keep fresh surfaces available for reaction (Robb, 1994).

Limestone Ponds: Limestone ponds are a new passive treatment idea in which a pond is constructed on the upwelling of an AMD seep or underground water discharge point. Limestone is placed in the bottom of the pond, and the water flows upward through the limestone. The pond is sized and designed to retain water for one or two days for limestone dissolution, and to keep the seep and limestone under water (Robb, 1994).

Open Limestone Channels: Open Limestone Channels (OLCs) introduce alkalinity to acid water by the use of open channels or ditches lined with limestone. AMD is introduced to the channel and is treated by limestone dissolution. OLCs neutralize acidity in AMD as long as open channels are constructed of sufficient length to maintain contact time between the limestone and acid water. Open Limestone Channels show promise for neutralizing AMD in watershed restoration projects and abandoned mine land reclamation projects where one-time installation costs are incurred, little or no maintenance is required, and systems do not have to meet specific water quality standards (Ziemkiewicz, 1994).

Successive Alkalinity Producing Systems: (SAPS) Successive Alkalinity Producing Systems combine the use of an Anoxic Limestone Drain and an organic substrate into one system. Oxygen concentrations in AMD are often a design limitation for ALDs. In situations where the dissolved oxygen concentrations are above 1 or 2 mg/L, the water can be introduced into a pond with the following design. Acid water is ponded over organic compost, which is underlain by limestone. Below the limestone is a series of drainage pipes that convey the water into an aerobic pond where metals are precipitated. The hydraulic head drives ponded water through the anaerobic organic compost, where oxygen stripping as well as iron and sulfate reduction can occur prior to water entry into the limestone. Water with high metal loads can be successively cycled through additional SAPS. Iron and aluminum clogging of limestone and pipes can be removed by flushing the system (Robb, 1994).

Bioremediation: Bioremediation of soil and water involves the use of microorganisms to convert contaminants to less harmful species in order to remediate contaminated sites. Microorganisms can aid or accelerate metal oxidation reactions and cause metal hydroxide precipitation. Other organisms can promote metal reduction and aid in the formation and precipitation of metal sulfides. Reduction processes can raise pH, generate alkalinity and remove metals from AMD solutions. In most cases, bioremediation of AMD has occurred in designed systems like anaerobic wetlands where oxidation and reduction reactions are augmented by special organic substrates and limestone (Robb, 1994).

Remining Remining is the process of returning to abandoned surface or underground mines for further coal removal. Where AMD occurs, remining reduces acid loads by decreasing infiltration rates, covering acid-producing materials and removing the remaining coal, which is the source of most pyrite. In 1992 the Surface Mine Conservation and Reclamation Act (SMCRA) was amended to provide incentives for the active coal industry to remine abandoned mine lands.

Actively remining previously abandoned surface or deep mines is the most efficient way to reclaim abandoned mine lands at no cost to taxpayers (Report 5000-BK-DEP2274, 1998). Mine operators who mine abandoned areas must then restore the land to current reclamation standards. The Department of Environmental Protection offers many incentives to mine operators who engage in remining.

Reclamation Abandoned mine reclamation refers to the process of cleaning up environmental pollutants and safety hazards associated with a site and returning the land to a productive condition.

In 1977 Congress introduced the federal Surface Mining Control and Reclamation Act (SMCRA). As a result, coal-producing states were required to update their mining regulations if they wished to retain primary responsibility (primacy) for regulating their sur-

face mining industry. SMCRA mandated that all active coal operators must return the lands they mine back to their original contour and post bonds to guarantee the work will be done within a specific amount of time after active mining ceases. Should an operator fail to undertake reclamation, the state would then use the financial guarantee to pay a contractor to do it. In addition, the act established the Abandoned Mine Reclamation Fund by imposing a fee on active mine operators based on the tonnage of coal removed. The trust fund, administered by the Office of Surface Mining and Enforcement (OSM), is used to reclaim mine lands abandoned prior to 1977. An amendment to SMCRA also allows states to put aside grant money specifically for treating mine drainage.

Since the early 1980s, under the Reclamation-In-Lieu of Civil Penalties Program, DEP has routinely allowed operators to perform reclamation instead of paying civil penalties assessed for active permit violations. The reclamation performed is always more valuable than the actual assessed civil penalty and the activity cannot address the operation's legal responsibility (Report 5000-BK-DEP2274, 1998). DEP's District Mining offices have used this program to facilitate many types of abandoned mine reclamation, including abandoned surface mine reclamation, deep mine sealing and reclamation, mine drainage remediation projects and control of surface subsidence due to abandoned deep mine operations.

Bond Forfeiture Bond forfeiture is the final enforcement action against an operator who is unwilling or unable to complete the reclamation of a site. When a forfeiture occurs, the government assumes the responsibility of reclaiming the abandoned mine. Additionally, operators who fail to reclaim their mines can never receive another mining permit -- not only in Pennsylvania, but also in the United States.

Water Management Diverting surface water from the spoil above the site to decrease the amount of water entering the mined area is highly recommended in acid-producing areas (Skousen, 1992). Channeling surface waters or mine waters to control volume, direction and contact time can be used to minimize the effects of acid mine drainage on receiving streams. The diversion of water from mining areas and from acid-producing materials is an abatement technique used in both surface and underground mines. Surface diversion of runoff involves the construction of drainage ditches to move surface water quickly off the site before infiltration or to limit its movement into disturbed areas. The diversion is accomplished either by ditching on the uphill side of the surface mines or by providing new channels or impervious channels for existing surface streams to convey water across the disturbed area (Skousen, 1992). Because the discharge of the Jeddo Tunnel is so large (40,000 gpm), surface water diversion methods are highly recommended and are essentially the only viable AMD abatement techniques for the watershed.

2. MANAGING AGRICULTURAL NON-POINT SOURCE POLLUTION

Agricultural activities that cause NPS pollution include confined animal facilities, grazing, plowing, pesticide spraying, irrigation, fertilizing, planting and harvesting. The major agricultural NPS pollutants that result from these activities are sediment, nutrients, pathogens, pesticides and salts. Agricultural activities also can damage habitat and stream channels. Agricultural impacts on surface water and groundwater can be minimized by properly managing activities that can cause NPS pollution.

Managing Sedimentation Sedimentation occurs when wind or water runoff carries soil

particles from an area, such as a farm field or construction sites, and transports them to a water body, such as a stream or lake. Excessive sedimentation clouds the water, which reduces the amount of sunlight reaching aquatic plants; covers fish spawning areas and food supplies; and clogs the gills of fish. In addition, other pollutants like phosphorus, pathogens and heavy metals are often attached to the soil particles and wind up in water bodies with the sediment. Farmers and ranchers can reduce erosion and sedimentation by applying management measures to control the volume and flow rate of runoff water, keep the soil in place and reduce soil transport.

Managing Nutrients Nutrients such as phosphorus, nitrogen and potassium in the form of fertilizers, manure, sludge, irrigation water, legumes and crop residues are applied to enhance production. When they are applied in excess of plant needs, nutrients can wash into aquatic ecosystems where they can cause excessive plant growth, which creates a foul smell and taste in drinking water and kills fish. Farmers can implement nutrient management plans that help maintain high yields and save money on the use of fertilizers while reducing NPS pollution.

Managing Confined Animal Facilities By confining animals to areas or lots, farmers can efficiently feed and maintain livestock. However, these confined areas become major sources of animal waste. Runoff from poorly managed facilities can carry pathogens (bacteria and viruses), nutrients and oxygen-demanding substances that cause major water quality problems. Ground water can also be contaminated by seepage. Discharges can be limited by storing and managing facility wastewater runoff with an appropriate waste management system.

Managing Irrigation Irrigation water is applied to supplement natural precipitation or to protect crops against freezing or wilting. Inefficient irrigation can cause water quality problems. Excessive irrigation can concentrate pesticides, nutrients, disease-carrying microorganisms and salts--all of which impact water quality--in the top layer of soil. Farmers can reduce NPS pollution from irrigation by improving water use efficiency. Actual crop needs can be measured with a variety of equipment.

Managing Pesticides Pesticides, herbicides and fungicides are used to kill pests and control the growth of weeds and fungus. These chemicals can enter and contaminate water through direct application, runoff, wind transport and atmospheric deposition. They can kill fish and wildlife, poison food sources and destroy the habitat that animals use for protective cover. To reduce NPS contamination from pesticides, people can apply Integrated Pest Management (IPM) techniques based on the specific soils, climate, pest history and crop for a particular field. IPM helps limit pesticide use and manages necessary applications to minimize pesticide movement from the field.

Managing Livestock Grazing Overgrazing exposes soils, increases erosion, encourages invasion by undesirable plants, destroys fish habitat, and reduces the infiltration of sediment necessary for building streambanks, wet meadows and floodplains. To reduce the impacts of grazing on water quality, farmers can adjust grazing intensity, keep livestock out of sensitive areas, provide alternative sources of water and shade, and re-vegetate rangeland and pastureland.

3. AGRICULTURAL BEST MANAGEMENT PRACTICES

Methods of cleaning up land runoff fall into two categories: keeping nutrients from entering the water or putting fewer nutrients on the land initially. Known as best management practices (BMPs), the techniques range from farming with less fertilizer to planting seed directly

into existing vegetation, a practice that avoids plowing and disrupting the soil and also reduces runoff. Other BMPs involve storing manure in concrete or steel pits, altering farm slopes to retard runoff, fencing cattle from streams so they do not pollute the water and cause streambank erosion, and planting winter cover crops to take up excess fertilizer left in the soil after the main harvest.

Some BMPs show great promise for controlling nutrients and sediment contributed by agriculture. Research and field tests at the University of Maryland's Wye Experiment Station, for example, show potential for controlling nitrogen by sowing fields in winter cover crops like rye and wheat. On many soils, the largest pulses of nitrogen leaving fields are not in the spring when fertilizer is applied, but in winter, as the leftover residues of crops decay or manure is spread when no plants are growing to take it up. Cover crops can absorb the bulk of this runoff. Plowed back into the spring, they can substitute for part of a farmer's purchase of commercial fertilizer (Horton, 1991).

There are a large number of best management practices that can be used by farmers to mitigate the effects of non-point source pollution in the Jordan Creek watershed.

Agri-chemical Handling Facility (AHF) The AHF is a permanent structure with an impervious surface to provide an environmentally safe area for handling of on-farm agri-chemicals, such as pesticides and fertilizers that are used in spraying operations of cropland. This practice provides for the containment and isolation of spillage from on-farm agri-chemical mixing, loading, unloading and rinsing operations in order to minimize pollution of the soil, water, air plant or plant or animal resources.

Barnyard Runoff Control The collection and reduction of runoff water and agricultural wastes from barnyards, feedlots and other outdoor livestock concentration areas for storage or treatment to improve water quality.

Contour Buffer Strips Contour buffer strips are strips of perennial vegetation alternated with wider cultivated strips, farmed on the contour. These strips of permanent vegetation slow runoff and trap sediment. This practice is most effective when used with other conservation practices such as conservation tillage and crop rotation.

Contour Farming Contour farming is preparing the soil, planting, cultivating and harvesting crops around a hill nearly on the level, rather than up and down the hill. Crop rows on the contour form hundreds of small dams to slow runoff.

Contour Stripcropping Contour stripcropping is a system of growing crops in approximately even width strips or bands on the contour to reduce soil erosion. The crops are arranged so that a strip of meadow or close growing crop is alternated with a strip of rowcrop, or alternating strips of high and low residue-producing crops.

Cover Crops A cover crop is a crop of close-growing grasses, legumes or small grains grown to control soil erosion during periods when the major crops do not furnish enough cover. Cover crops are often seeded in the fall to protect the soil until the next spring's planting of major crops, and may add organic matter to the soil and trap excess plant nutrients.

Crop Rotation Crop rotation is growing various crops on the same piece of land—often changing the crops year by year. This practice may include alternating row crop production from a high residue-producing crop such as corn to a low residue-producing crop like soybeans. Crop rotations work best with other conservation practices such as conservation tillage, strip cropping, contouring and grassed waterways.

Critical Area Planting Planting vegetation on highly erodible or critically eroding areas in order to stabilize the soil, reduce damage from sediment and runoff to downstream areas and improve wildlife habitat and visual resources.

Diversion A diversion channel is a channel and ridge similar to a terrace that diverts excess runoff from an area for use or safe disposal in another area. A diversion might be used to divert water from a feedlot, cropland, an active gully or farm buildings.

Field Borders A field border is a band or strip of perennial vegetation, usually grass or legumes, next to cropland on the outside of a field. Field borders reduce erosion on end rows and also function as turn areas for farm machinery.

Filter Strips Filter strips are strips of vegetation a minimum of 15 to 25 feet wide that remove sediment, organic matter and other pollutants from runoff. They can be used on cropland next to streams, ponds and lakes or other areas to reduce sediment loads that could reach waterways.

Forest Stand Improvement Apply to stands of forest trees where quality can be improved through thinning, pruning, and releasing describable seedlings and young trees.

Grassed Waterways Grassed waterways are areas planted with grass where water usually concentrates as it runs off a field. Grass in the waterway slows the water and guides it off the field, significantly reducing gully erosion.

Heavy Use Protection Protecting heavily used areas by establishing vegetative cover, by surfacing with suitable materials, or by installing needed structures. The purpose of this practice is to stabilize urban, recreation or agricultural facility areas frequently and intensely used by people, animals or vehicles.

Mortality Composting Facility A facility for the composting of the normal daily mortalities from a poultry or livestock operation. This facility is designed to biologically treat animal carcasses by composting and to protect the environment by stabilizing nutrients, destroying pathogens and producing low odor, humus-like material that is useful as a fertilizer substitute and soil amendment.

Nutrient Management Nutrient management involves applying the correct amount and form of plant nutrients for optimum yield and minimum impact on water quality. Practicing strong nutrient management reduces input costs and protects water quality by preventing over-application of commercial fertilizers and/or animal manure.

Pesticide Management Pest management involves having an expert "scout" crops and recommending that farmers apply pesticides only when concentrations surpass a certain threshold. While sometimes this means spraying more than usual, it often saves considerably on pesticide application.

Pasture/Grazing Management A planned grazing system is two or more grazing units rotated, or alternately rested, and grazed in a planned sequence. This practice improves grazing efficiency. Rotational grazing systems conserve water resources, enhance wildlife habitat and reduce soil erosion while improving water quality.

Roof Runoff Management A facility for collecting, controlling and disposing of runoff water from roofs. This practice prevents roof runoff water from flowing across animal concentration waste areas, roads and alleys and to reduce pollution and erosion, improve water quality, prevent flooding, improve drainage and protect the environment.

Residue Management Residue farming leaves a planned level of the past year's crop residue on the soil surface after planting. Often referred to as conservation tillage, this cropping system leaves at least 30% groundcover after planting. Methods of leaving more residue include using high residue-producing crops, waiting until spring for tillage operations, reducing the number of tillage passes, planting cover crops, driving more slowly on tillage operations and applying no-till techniques.

Spring Development Improving springs and seeps by excavating, cleaning, capping or providing collection and storage facilities. The purpose of this practice is mainly to improve the distribution and/or quality of water, or to increase the quantity of water for livestock or wildlife and also to obtain water for irrigation if water is available in a suitable quantity and quality.

Streambank Fencing/Protection Stream protection involves protecting a stream by excluding livestock and establishing buffer zones or vegetation to filter runoff. Fencing prevents cattle from trampling banks, destroying vegetation and stirring up sediment in the streambed. A buffer zone of vegetation along the streambank filters runoff and may also absorb excess nutrients and chemicals.

Stripcropping Growing crops in approximately even width strips or bands. The crops are arranged so that a strip of meadow or close growing crop is alternated with a strip of row crop, or alternating strips of higher and low. Apply to cropland subject to erosion or soil movement that constitutes a pollution hazard.

Structure for Water Control A structure in an irrigation, drainage or other water management system that conveys water, controls the direction or rate of flow or maintains a desired water surface elevation. The purpose of this structure is to control the stage, discharge, distribution, delivery or direction of the flow of water in open channels or water use areas. Also used for water quality control and to protect fish and wildlife and other natural resources.

Subsurface Drainage A conduit such as a tile, pipe, or tubing installed beneath the ground surface to collect and/or convey drainage water. This practice improves the soil environment for vegetative growth by regulating the water table and groundwater flow.

Terraces Terraces reduce the rate of runoff and allow soil particles to settle out. The resulting cleaner water is then carried off the field in a non-erosive manner. Terraces are most effective when used in combination with other practices such as crop residue management, contour farming, crop rotations and field borders. Terracing reduces sediment pollution of lakes and streams.

Tree Plantings Planting trees to establish a stand of trees can be an effective conservation measure in open areas or sparse woodlands where soils are adapted to hardwood forests. Establishing forests—or retaining them where they exist between farms and waterways—appears to do a remarkable job of improving polluted runoff, including the elusive subsurface flows of nitrogen in groundwater (www.epa.gov).

Trough A trough or tank, with needed devices for water control and wastewater disposal, installed to provide drinking water for livestock. This practice allows for the desired protection of vegetative cover through proper distribution of grazing or through better grassland management.

Underground Outlet A conduit is installed beneath the surface of the ground to collect surface water and convey it to a suitable outlet. This practice disposes of excess water

from terraces, diversions, subsurface drains, surface drains, spillways from dams or roof downspouts without causing damage by erosion or flooding.

Waste Stacking Pad A stabilized area for the temporary storage and handling of solid manure or other stackable agricultural wastes.

Water and Sediment Control Basins Water and sediment control basins are short earthen dams built across the slope and minor drainage ways. Basins trap sediment, reduce gully erosion, and reform the land surface.

4. ELEMENTS OF A SUCCESSFUL AGRICULTURAL NPS POLLUTION CONTROL PROGRAM

The Rural Clean Water Program (RCWP) is a major source of practical information on how to conduct a successful NPS control project. An RCWP evaluation, conducted during 1991 and 1992 by the National Water Quality Evaluation Project (NWQEP) at North Carolina State University, compiled elements that are considered to be essential to the success of an agricultural NPS pollution control program (Coffey, 1992). The participation of landowners, the accurate definition of the most critical areas and the implementation of nutrient management techniques are the three elements of a model project identified in the study.

Landowner Participation: It has been demonstrated that the better landowners understood the project purposes, the more willing they were to participate. One recurring theme was that repeated landowner contact was necessary to obtain high rates of participation. Information/education programs that involved the larger rural community as well as the actual users of the water resources tended to be more successful. The project that obtained the highest level (essentially 100%) of landowner participation did so by getting the local dairy cooperative to levy a penalty on the price paid for milk to dairy farmers who scored below a given level on a conservation/management rating scale.

Defining Critical Areas: Treating critical areas is the best NPS control strategy at the watershed level. Criteria used to identify the critical areas contributing most to water resource impairments generally include erosion rate, proximity to watercourses and animal unit concentration. Several project experiences suggest that particular attention must be given to certain management practices, including tillage operations and nutrient and pesticide management. The ability to identify critical areas and management practices successfully also increases the cost effectiveness of the entire project and the overall success in improving water quality in the impaired resource (Coffey, 1992).

The critical area approach is important for two reasons. First, for budgeting purposes, it is far more cost effective to focus treatment on the most intense sources. Second, ranking areas for treatment should allow the opportunity to produce the greatest water quality changes in the shortest possible timeframe. Experiences from the RCWP support these general conclusions, reaffirming the belief that targeting is the key to NPS control (Coffey, 1992).

Nutrient Management: In projects where animal unit densities are high relative to crop nutrient needs, and/or where soil and topographic characteristics are conducive to rapid nutrient flushing, an efficient nutrient management program appears to be a prerequisite to improved water quality (Coffey, 1992).

Changes in nutrient management directed at improving water quality often involve recommendations that differ from traditional farming practices. Traditionally, the use of commercial fertilizers in conjunction with animal wastes is often viewed as insurance.

The experience of the RCWP, however, shows that educating producers while providing soil and manure testing services, assessments of crop nutrient needs, specific recommendations for application rates and guidance on optimal timing, can significantly reduce excess nutrient applications. A mass balance approach to agricultural nutrient management is very important when the objective is water quality (Coffey, 1992). This includes calculating farm-level nutrient budgets in terms of waste, legume fixation, nutrient cycling within the production system and nutrient outputs.

5. WELLHEAD PROTECTION

Wellhead protection involves the reduction of threats to the quality of groundwater used for drinking water. Boundaries known as wellhead protection zones are areas of open, unthreatened land that help to maintain good quality groundwater supplies. The zones can be separated into three different areas. A radius of no greater than 400 feet and no less than 100 feet defines the Wellhead Protection Area 1, Wellhead Zone (WHZ). The area considered in this zone for each wellhead is determined using a volumetric flow equation. The second Wellhead Protection Area is defined as the Zone of Diversion (ZOD). The area is defined as the area from which the design-pumping rate for the well draws water. The Zone of Contribution (ZOC) is the third Wellhead Protection Area and is defined as the area that provides water to sustain the supply of the protected well. The definitions of each zone may vary slightly between municipalities.

Upper Mount Bethel Township in Northampton County implemented an ordinance on the issue of wellhead protection. Some of the restrictions include prohibiting stormwater retention basins in the area, mapping of the zones, and an extensive list of restricted conditions for various land-use activities and facilities. Other municipalities have installed monitoring wells in order to provide an early warning signal for pollutants in the drinking water supply.

6. SOURCE WATER ASSESSMENT AND PROTECTION PROGRAM

The 1996 Safe Drinking Water Act reauthorization requires states to develop a Source Water Assessment and Protection (SWAP) Program. The SWAP program assesses the drinking water sources serving public water systems for their susceptibility to pollution. This information will be used as a basis for building voluntary, community-based barriers to drinking water contamination. The states are required to assess all sources (including ground and surface water sources) serving public water systems within two years of program approval, with the possibility of an 18 month extension. In Pennsylvania, this represents about 14,000 permanent drinking water sources that will need to be assessed by June 2003.

As part of the assessment program, Pennsylvania is required to:

1. Delineate the boundaries of the areas providing source waters for all public water systems; and
2. Identify (to the extent practicable) the origins of regulated and certain unregulated contaminants in the delineated area to determine the susceptibility of public water systems to such contaminants.

These assessments are of the raw water quality, not the finished water compliance. Pennsylvania must use all reasonably available hydrogeologic information, water flow, recharge, and discharge, and any other information deemed necessary to accurately delineate the source water assessment areas.

Source water assessments will provide communities and water suppliers with information that they will need to make informed decisions on how to best protect their drinking water supplies. Source water protection grants are available from DEP for municipalities and water suppliers to develop local source water protection programs. DEP provides technical support and loans to communities to assist them in developing protection plans. The League of Women Voters, through the Water Resource Education Network, provides training and mini-grants for local coalition building to promote local education and dialogue on the issues of source water protection.

b. Land

Conservation Easements

A conservation easement is a legal agreement between a landowner and a conservation organization or government entity that restricts the uses that can occur on the land, and thus permanently protects the property. In the past, conservation organizations have been the principal conservation easement service providers. More recently, local municipalities have initiated their own conservation easement programs.

In either case, there are certain steps to be carried out when a conservation easement is used to protect property. Usually the land is surveyed to identify the boundaries and acreage. An appraisal is completed, and the value of the development rights or what the landowner is "giving up" is determined. In some cases, the landowner is paid for allowing the restrictions to be put on the land. Even if the development rights are purchased, conservation easements are still a less expensive method to use to protect land than buying the property outright. The value of the development rights can be more than 50% of the total fair market value. More commonly, the landowner donates the value of the development rights to either the conservation organization or government entity. The landowner can realize some tax benefits with this donation.

Most conservation easements prohibit residential or commercial development, and are designed to protect the conservation values of the property. In some cases, the conservation easement does permit some future development, with limitations. Conservation easements are useful tools for preservation, since the landowner retains ownership, maintains the property, and pays the property taxes, but the land is protected.

Transfer of Development Rights

Transfer of Development Rights (TDRs) is a zoning tool that allows conservation and development to occur simultaneously in a municipality. This is a voluntary process. With a TDR program, development is directed into a certain area (receiving area) and other areas are reserved for open space or agriculture (sending area). The development rights from properties in the sending area are sold or transferred to lands in the receiving area, where services exist and development is preferred. To date, TDRs have been a very effective land protection tool in Maryland but used in only a few municipalities in Pennsylvania.

Agricultural and Forestland Tax Incentives

This program was enabled by state legislation Act 319, commonly called "Clean and Green." Under this program, local assessment offices are directed to assess farmland and forestlands at their agricultural or forest value instead of fair market or development value. This is a voluntary program, in which landowners must apply to enroll at the county assessment office. When enrolled, property owners agree to keep the land in agriculture or forest and are penalized

financially if they break this agreement. Although it is not permanent protection, Clean and Green has been very effective in protecting land, with over five million acres enrolled in 48 counties statewide.

IMPACT FEES

Municipalities can assess developers for portions of the transportation capital improvement costs related to their developments by passing ordinances requiring that impact fees be paid by the developer to the municipality. These fees generate revenue for funding the costs of transportation capital improvements necessitated by and attributed to the new development. Pennsylvania's Traffic Impact Fee Law, more commonly known as Act 209, or Article V-A of the Municipalities Planning Code (MPC) governs the use of such fees. Act 209 contains detailed provisions that a municipality must follow when establishing impact fees. Impact fees lower a municipality's infrastructure installation costs. These fees ensure that the cost for needed capital improvements associated with roadway improvements is applied to new development in a manner that allocates the cost for improvements proportionally among new property owners.

To assess impact fees on new development, the Act requires municipalities to fairly apportion the costs of infrastructure in formulating a program. The municipality's costs of infrastructure planning studies may also be included as part of the impact fees. Impact fees are limited to 50 percent of the cost of improvements on state roads. The impact fees are refunded if construction of the improvement does not begin within the prescribed time, and improvements are limited to a service area of seven square miles. Adjacent municipalities may cooperate to develop coordinated impact fee programs and Transportation Capital Improvements Programs (TCIPs).

RECREATION AND OPEN SPACE FEES

A Municipality can also require developers to pay a fee when plans for a new residential or commercial development are submitted for approval. These monies are reserved in an open space/recreation fund for the community to use to improve park facilities or acquire park or open space lands. The municipality must have an official open space/recreation plan in order to require such fees.

ZONING OVERLAYS

The overlay district concept implies that more than one zoning district regulates development for a specific area within a municipality, because of some unique characteristic of that area. Often used as a layer over more than one zoning district, a zoning overlay can also cross municipal boundaries if applied at a multi-municipal or county level by the participating municipalities. While the underlying zoning district(s) designates basic zoning regulations, such as permitted uses and conditional uses, the overlay district may establish more restrictive development regulations, such as setbacks, design guidelines, signage, buffers, environmentally sensitive requirements, etc. The overlay district regulations will generally prevail over those of the underlying zoning district(s). Integral to land use planning, overlay districts manage concerns related to such issues as open space protection, recreation development, environment resource protection, historic and cultural preservation, wellhead protection, view shed protection, aesthetics and infrastructure planning in the area. In the context of infrastructure planning, overlay districts provide buffers for adjacent land uses while allowing continued traffic movement around the overlay district. They provide sufficient setbacks to facilitate potential widening of right-of-way and/or access ramps, without disrupting surrounding uses, and they maintain circulation movement through the overlay district while accommodating additional development.

DEVELOPMENT DISTRICTS

Municipalities can plan future land use for their community by designating development districts. A development district has two intended purposes: first is to encourage compact development, which permits efficient, cost-effective provision of infrastructure and public services. Second, by directing growth away from agricultural lands and natural resource areas these areas are protected. Use of this tool should be part of, or based on, a comprehensive plan. By designating development districts municipalities can plan for growth in areas that have public services and direct growth away from natural resource areas that are not appropriate for development.

GROWTH AREAS

A growth area is a geographic delineation, or boundary line, within which a municipality plans for higher density development is encouraged and the needed infrastructure (roads, water, sewer, schools and parks) exists or is planned. Outside of this area, land is planned to remain in predominantly rural (rural and agricultural and natural features areas) uses. Growth areas are not a tool to stop development; rather, they are used to geographically indicate where more development is appropriate and public investment in development is most appropriate.

Growth areas attempt to focus municipal resources to ensure that as the market creates the demand for development, the infrastructure will be available. It encourages growth in areas where it is appropriate and discourages development where it is not wanted. It encourages revitalization and reinvestment in growth areas.

The urban growth area should be drawn to include enough land for the development needs of the next 20 years. This includes needed land for residential, institutional, commercial and industrial development, and for public open space and recreational facilities, and sufficient additional land to provide for flexibility in the real estate market. The growth area should be indicated on the Official Map of the municipality and /or participating municipalities. The use of growth areas as a planning tool is relatively new to Pennsylvania, and there is no specific authorization for the use of growth areas in Pennsylvania law. The growth areas approach can be most effective if used as part of a regional planning process.

OFFICIAL MAP

An official map is both a map and a land-use ordinance. It identifies public lands and allows a municipality to identify and reserve private land for future public use. It legally establishes the location of existing and proposed streets, waterways, parks and other facilities within a municipality.

Under the MPC, an official map is a land-use ordinance and is adopted like any other land-use ordinance. An official map may focus on streets or parkland, but usually also includes a variety of public facilities or lands. The official map can cover an entire municipality or can focus on growth areas.

The official map illustrates the location of private lands that a municipality plans for public uses and describes a fixed time that land is to be reserved. If the owner of the land files written notice of an intention to develop, the reservation of private property identified on the map for future public uses lapses one year. If the municipality still wants to see the land be converted to public use, the municipality must acquire the land to preclude its development.

The official map illustrates a community's long-range goals for roads, public facilities and open space. Zoning, subdivision and land-use ordinances should incorporate references to the official map to ensure that the official map will be taken into consideration by developers. The offi-

cial map reserves important lands without immediate purchase, and can be amended as needed. Improvements identified on the map also provide positive support for grant applications by illustrating a historical commitment to specific projects. The governing body must adopt the official map by municipal ordinance, following public notice and a public hearing, and see that once adopted, the document is recorded at the County Recorder of Deeds.

Environmental Resource Inventory

An Environmental Resource Inventory (ERI) is a report that documents the existing natural, cultural, historical and other features in a municipality. Typically, the Inventory contains descriptions of these features and maps showing the locations. It can be used to identify the community's special resources by mapping their exact locations, and also suggest areas that should be protected from development. The Inventory can be useful in many aspects of community planning and development plan review, in addition to the designing of trails and greenways, and open space areas in a community.

Map of Potential Conservation Lands

A Map of Potential Conservation Lands is the foundation for conservation area preservation. The map identifies a network of open space and greenways throughout a municipality for conservation. It does not delineate parcels for land acquisition but rather makes a municipality and landowners aware of natural systems in a particular site and its connection to a larger green network. Parcel boundaries do not confine natural systems, so this map outlines and connects these systems based on their natural boundaries. The Potential Conservation Lands Map should coincide with the municipality's official map and show the pattern of resources relative to undeveloped land. Designated areas may be already developed or contain physical improvements, such as homes, buildings, pavement, etc. The plan does not suggest nor imply that these improvements be removed but rather to advise future development. A few connecting parcels, not identified under a particular natural feature, may be noted as providing critical linkages and illustrate lands most vulnerable to development.

The base map locates woodlands, open fields, moderate slopes and historic/cultural features, tax parcel boundaries, roads, streams, and watershed boundaries. Three layers overlay this base. The first layer identifies lands protected and lands for potential acquisition. The second layer two shows unbuildable lands limited by natural features such as steep slopes, wetlands, floodplains, and hydric soils. Finally, the third layer identifies lands, either wooded or of prime agricultural soils, and cultural and historic features worthy of conservation or preservation.

The initial step in preparing a map of conservation lands requires identification of existing protected lands in a municipality. Municipality, county, and privately owned lands which are secured open space should be identified. These lands include municipality parks and open space, county owned lands, and private lands with conservation. The primary conservation lands map locates natural systems, which currently restrict development. These areas include steep slopes, wetlands, floodplains, and flood prone soils. The Secondary Conservation Lands Plan identifies natural systems and future possible lands for open space preservation. These lands are identified according to soils, flood prone areas (undevelopable land), riparian buffers, view sheds, and future municipality park and recreation acquisition. In addition, lands currently enrolled in the Agricultural Securities Act, as well as privately owned park and recreation areas, are included on the plan. These agricultural lands currently provide open space, and potentially could be secured through future easement agreements. Other resources identified include

buildable woodlands, significant farmland, cultural landscapes, scenic view sheds, and other features based on soils, woodland cover, topography, floodplain, wetlands, and watersheds.

Business Improvement Districts and Business District Authorities

As development continues to move outside of the urban core, formerly strong urban centers often see significant deterioration. Despite the effects of this growth, downtowns remain cultural, historical, educational, architectural and entertainment centers. Facilities related to these uses are among the few unique assets and competitive advantages of cities. In recent years, a number of land use implemented practices are revitalizing our communities. These practices cover a wide range of topics, from historic preservation to development partnerships, and from grant and loan programs to place-based community and economic development initiatives. The practices involve federal, state, county and local agencies and resources, plus the involvement of the public. Making our communities safe from crime, improving the quality of schools and creating employment opportunities are the prerequisites for rebuilding downtowns. Pennsylvania's communities are the foundation of our Commonwealth and their social and economic viability is critical to the overall health of Pennsylvania.

Business Improvement Districts (BIDs), also known as Business District Authorities (BDAs) in Pennsylvania, are legal entities created for the implementation of business improvement activities in defined business districts. This practice is authorized under the Municipality Authority Act of 1945, the Business District Authority Act (Act 41) of 1980, and Pennsylvania Statute Title 53 (Municipalities Generally), Part V (Public Improvements, Utilities and Services), Chapter 54 (Business Improvement Districts). District property owners usually organize BIDs or BDAs. Based on the ability to levy assessments on property within the district, they typically consist of commercial uses. Common initial activities of BIDs usually cover "clean and safe," meaning the focus is on cleaning up the district and improving safety. Other typical activities of a BID include: strategic planning, maintenance, security, consumer marketing, business recruitment and retention, parking and transportation management, facade programs, social services and capital improvements.

Environmental Advisory Councils

Environmental Advisory Councils (EAC) are voluntary citizen advisory committees, which serve as additional, useful, planning resources for local governments regarding land-use issues. Appointed by the governing body of each municipality, EAC consists of three to seven members. EACs typically focus on environmental issues such as clean air, clean water, etc. but have also acted as a review board for development plans and have addressed such things as the location, design, and construction of trails, access points to streams and rivers, and suggestions for the location or relocation of heavy industry. EACs frequently publish informational newsletters for the residents in their municipality, and complete Environmental Resource Inventories (ERI) for the municipality to serve as a tool for planning development and protecting natural and historical resources.

Part VIII

RECOMMENDATIONS

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Addendum A 445

Watersheds are natural boundaries that bind water resources together. They usually do not conform to municipal or state lines. Natural and cultural resource problems must be solved within an ecological system—the watershed; and they must be solved locally by people with an interest in the health of their environment. Locally managed and monitored watershed improvement projects are integral in preserving, protecting, and enhancing the resources of the Lehigh River watershed.

The recommendations that follow have been based upon the current findings from literature reviews, field and laboratory studies, and suggestions and concerns broached by municipal leaders, conservation groups, and other interested organizations and individuals. Due to the wide variety, broad scope, and large scale of several potential projects and suggested recommendations, it should be recognized that this is a long-term plan for remediation and ongoing management of the watershed.

This section is organized into several parts. The eight goals for the watershed are listed below and include goals for each major component covered in this watershed plan (i.e., cultural, aquatic, land, biological, and recreational components) followed by goals for: increasing municipal understanding and involvement in watershed stewardship; increasing environmental awareness, knowledge, skills, and stewardship commitment; and a goal for monitoring and updating watershed resource information on a continuing basis.

Each goal is then expanded into several objectives. Recommendations are listed under each of those objectives. These recommendations are listed beginning with general recommendations followed by recommendations that are more specific for the watershed. It should be noted that there is some overlap of recommendations under each goal. For instance, riparian buffer protection and enhancement is listed under the goals for water quality, land protection, and biology since it is important to each of those watershed components.

Specific projects that were identified by Wildlands Conservancy staff or recommended by municipalities, watershed associations, or individuals are listed in the (Addendum A Specific Recommendations) at the end of the recommendations section. Due to the time and scope of work of the project, it is impossible to list all of the potential specific projects in the watershed. In the case that a specific project is not listed, the general recommendation, listed in the first part of the recommendation section would cover the activities taking place.

The major goals for the Lehigh River watershed are:

A. GOAL: PROTECT AND PRESERVE CULTURAL AND HISTORICAL RESOURCES

B. GOAL: IMPROVE WATER QUALITY IN THE LEHIGH RIVER WATERSHED

C. GOAL: PROTECT SIGNIFICANT AND VALUABLE LAND COMPONENTS

D. GOAL: PROTECT BIOLOGICAL RESOURCES

E. GOAL: INCREASE AND ENHANCE WATERSHED RECREATIONAL OPPORTUNITIES

F. GOAL: PROMOTE MUNICIPAL WATERSHED STEWARDSHIP

G. GOAL: PROMOTE ENVIRONMENTAL AWARENESS, KNOWLEDGE, SKILLS, SUPPORT, AND STEWARDSHIP COMMITMENT

H. GOAL: MONITOR AND UPDATE WATERSHED RESOURCE INFORMATION ON A CONTINUING BASIS

A. GOAL: Protect and Preserve Cultural and Historical Resources

The historic resources of the Lehigh River watershed are unique and valuable. Preservation must therefore become an integral part of public and private decision making. Many of the recommendations listed in this section are from the Pennsylvania Historic Preservation Plan completed by the Pennsylvania Historical and Museum Commission.

I. OBJECTIVE: IDENTIFY AND PRESERVE REGIONALLY AND NATIONALLY SIGNIFICANT HISTORICAL SITES AND LANDSCAPES WITHIN AND/OR CONNECTED TO THE LEHIGH RIVER WATERSHED.

a. Recommendation: Support watershed heritage tourism and program development.

b. Recommendation: Work with and help establish historical societies throughout the watershed (Specific examples included in Addendum A).

c. Recommendation: Conduct a systematic survey of the watershed and surrounding area to identify and list potential national historic registry sites and structures.

d. Recommendation: Work with historical societies and the Pennsylvania Historical and Museum Commission to create and maintain a collection of historical documents, photographs, paintings, etc., of the Lehigh River and its watershed (Specific examples included in Addendum A).

e. Recommendation: Support heritage resource publications that focus on the important role that the Lehigh River has had in the development of the Lehigh River watershed, Pennsylvania, and the nation.

f. Recommendation: Provide assistance to the Bureau for Historic Preservation to offer ongoing training workshops on getting properties listed on the National Register of Historic Places and applying for state grants and administering local historic districts.

g. Recommendation: Preserve and restore historic structures and districts important on a local, county, state, and/or federal level. (Specific examples included in Addendum A).

II. OBJECTIVE: EDUCATE RESIDENTS ABOUT THE WATERSHED CULTURAL AND HISTORICAL HERITAGE AND VALUE.

a. Recommendation: Support the expansion of Pennsylvania history, historic preservation, and archaeology in school curriculums.

b. Recommendation: Maximize the public benefit of historic preservation and archaeological projects by building public education activities into every project.

c. Recommendation: Provide more educational materials and events directed at state and local officials and public and private sector professionals involved in law, planning, real

estate, and land development. Make presentations at annual conferences and events they attend, inviting them to workshops designed specifically for them and providing briefings and technical assistance materials on request.

d. Recommendation: Work with partners to launch a new workshop series for teachers focusing on Pennsylvania history and heritage-related topics.

e. Recommendation: Work with middle schools, high schools, and community colleges to interest students in historic preservation. Specific ideas to be explored include internships, preservation-related job fairs, and expansion of Pennsylvania History Day programs in collaboration with the Pennsylvania Council for social studies and Penn State University.

f. Recommendation: Expand the historical marker program and work with the Pennsylvania Department of Transportation to promote history exhibits at highway welcome centers.

III. OBJECTIVE: BUILD BETTER COMMUNITIES THROUGH HISTORIC PROTECTION AND PRESERVATION.

a. Recommendation: Strengthen and expand historic preservation planning at the local and regional levels.

b. Recommendation: Continue to support studies on the economic impacts of historic preservation and distribute the findings into local communities.

c. Recommendation: Expand the use of historic preservation as an economic development strategy.

d. Recommendation: Develop model historic-preservation ordinances, design guidelines, and prepare case studies to support preservation and sound land-use planning.

e. Recommendation: Work with a wide range of state and local partners to develop heritage tourism potential in communities across the watershed.

f. Recommendation: Strengthen local and regional planning legislation at the state level and take steps to clarify and simplify the historic designation process at the local level.

g. Recommendation: Support getting more historical and archaeological resources inventoried, protected, and incorporated into local comprehensive plans and zoning ordinances.

h. Recommendation: Maximize use of existing programs such as Keystone Opportunity Zones and Community Development Block Grants to revitalize historic communities. Work in close collaboration with state and local governments, businesses, and community development corporations to encourage communities to apply for designation and funding under these programs.

i. Recommendation: Promote flexible building code interpretation and streamlining of local approval processes to facilitate rehabilitation of historic properties.

j. Recommendation: Develop user-friendly technical assistance materials. This will include establishing a clearinghouse of information on preservation-related grants, incentives, techniques, regulations, contractors, and consultants.

k. Recommendation: Develop a technical assistance outreach program. This will include outreach efforts directed at historic-property owners, non-profit organizations, and local governments.

l. Recommendation: Put state and local historical resource data on a Geographic Information System (GIS) available via the Internet. This will provide important information for individuals, local governments, and the development community during planning and development decisions.

B. GOAL: Improve Water Quality in the Lehigh River Watershed

Good quality water resources in the watershed are essential for recreation, industrial use, and human consumption. Natural conditions, historical and existing land-use practices, and other anthropogenic effects affect water quality in the Lehigh River watershed. This section lists recommendations for water quality and stream improvement and conservation in the watershed for the Lehigh River and its tributaries, groundwater, and lakes.

I. OBJECTIVE: REMEDIATE ABANDONED MINE DRAINAGE (AMD) IMPACTS IN THE LEHIGH RIVER AND ITS TRIBUTARIES

a. Recommendation: Reduce abandoned mine drainage impacts in the Lehigh River watershed by utilizing proven and innovative technologies.

b. Recommendation: Promote re-mining and reclamation of abandoned mine lands causing AMD.

c. Recommendation: Reclaim abandoned mine lands.

d. Recommendation: Increase public understanding and awareness about the mine drainage impacts to the Lehigh River.

e. Recommendation: Identify the locations of additional AMD sources affecting Nesquehoning Creek and the Lehigh River.

f. Recommendation: Install an aerobic wetland to treat the Lausanne Tunnel Mine Discharge.

g. Recommendation: Install a Successive Alkalinity Producing System (SAPS) to treat the Owl Hole discharge and determine where surface water is entering the mine pool that is drained by the Owl Hole discharge.

h. Recommendation: Reduce the Quakake Tunnel discharge by examining the Jeansville mine basin into which it drains and identify, prioritize, and remediate surface infiltration points within the area draining to the Quakake Tunnel.

i. Recommendation: Conduct further research and field reconnaissance to determine the possible existence of additional mine drainage sources in the Black Creek basin and conduct water quality monitoring on each of the four Black Creek tributaries (Beaver, Hazle, Quakake, and Wetzel creeks) to further define where AMD is entering the Black Creek.

j. Recommendation: Treat the Sandy Run discharge with a SAPS. Infiltration points draining to the tunnel should be identified, and appropriate measures taken to control the water on the surface.

k. Recommendation: Treat the Hazle Brook overflow with a step wetland (or vertical flow wetland) treatment system, and fill the water-filled pit directly north of the discharge.

l. Recommendation: Treat the Buck Mountain #1 Tunnel with an open limestone channel.

m. Recommendation: Treat Buck Mountain #2 discharge by constructing an oxic limestone drain.

n. Recommendation: Perform long-term maintenance and monitoring at the Lausanne Tunnel AMD project.

II. OBJECTIVE: PROMOTE STREAM, FLOODPLAIN, WETLAND, AND RIPARIAN-BUFFER RESTORATION AND ESTABLISHMENT FOR WATER-QUALITY IMPROVEMENT

a. Recommendation: Restore degraded stream reaches throughout the watershed.

b. Recommendation: Encourage voluntary planting of native species of streamside vegetation.

c. Recommendation: Work with local citizens, volunteer groups, and landowners to establish, monitor, and maintain wetlands and riparian buffers.

d. Recommendation: Use public lands to demonstrate the implementation of Best Management Practices (BMPs).

e. Recommendation: Provide educational programs and opportunities for municipal officials and landowners to learn about the benefits of floodplains, wetlands, and riparian buffers and how they improve water quality.

f. Recommendation: Incorporate wetlands into development plans as scenic or passive recreational spaces.

g. Recommendation: Establish riparian buffers along streams within the Lehigh River watershed (Specific examples included in Addendum A).

h. Recommendation: Provide technical assistance in the form of information, funding sources, and demonstrations to municipal officials and landowners for dealing with riparian issues and riparian restorations (Specific examples included in Addendum A).

i. Recommendation: Promote the use of conservation easements to permanently protect stream and riparian corridors and reduce streambank erosion.

j. Recommendation: Implement stream and riparian buffer restoration- and enhancement-related recommendations listed within existing watershed conservation management plans, assessments, and restoration plans including:

- Little Lehigh Creek Stream Corridor Conservation Project Stream Status Report (Wildlands Conservancy 1994);
- Monocacy Creek Watershed Conservation Management Plan (Wildlands Conservancy 1998);
- Jordan Creek Watershed Conservation Management Plan (Wildlands Conservancy 2000);
- Lehigh River Abandoned Mine Drainage Assessment and Abatement Plan (Wildlands Conservancy 2000)
- Little Lehigh Creek Watershed Stream Assessments (Biohabitats, 2003);
- Monocacy Creek Erosion Restoration Plan (Lehigh Valley Planning Commission, 2003);
- Leibert Creek Watershed Assessment (Emmaus Borough and Barry Isett & Associates in-progress);

- Lynn/Albany Township Watershed Assessment Project (Spotts Stevens and McCoy and Lehigh County Conservation District, in-progress).

k. Recommendation: Promote the implementation of fluvial geomorphic-based restoration approaches such as the Natural Stream Channel Design, where appropriate, to achieve channel and streambank stability, restore sediment transport, reduce erosion and sedimentation, and improve water quality and aquatic habitats.

l. Recommendation: Complete fluvial geomorphic assessments and develop stream restoration plans for streams (Specific examples included in ADDENDUM A).

m. Recommendation: Remove low-head run-of-the-river dams in the Lehigh River watershed, where feasible and appropriate, to reduce thermal pollution, improve water quality, restore fish passage, and improve aquatic habitat (Specific examples included in Addendum A).

n. Recommendation: Remove rock dams and establish a riparian buffer on streams (Specific examples included in Addendum A).

o. Recommendation: Construct stable access point(s) and place educational signage along the Lehigh River at the Canal Street Park in Northampton Borough, Northampton County.

p. Recommendation: Address channel alteration and establish a riparian buffer along Coplay Creek at Twin Lakes Golf Course, North Whitehall Township, Lehigh County.

q. Recommendation: Specify limits on development and encroachment within mapped floodplains (land-use density, intensity, elevations, location), including areas of shallow flooding.

r. Recommendation: Reduce and manage floatable debris (garbage) stored in the floodplain.

s. Recommendation: Retain and preserve floodplains for open space and recreation.

t. Recommendation: Update and expand the assessment of floodplain resources to include smaller streams, percentage of hydric soils, and frequency and duration of flooding.

III. OBJECTIVE: REDUCE URBAN AND SUBURBAN NON-POINT SOURCE POLLUTION

a. Recommendation: Use public rights-of-way as an opportunity for stormwater runoff controls such as wet ponds or vegetated swales. Examples include: land under bridges and overpasses, the median strips of roads and highways, and the exit ramp rights-of-way off major roads.

b. Recommendation: Encourage municipalities to use all road salt, pesticides, herbicides, and fertilizers sparingly and according to manufacturers' directions.

c. Recommendation: Avoid direct discharge of soap and oily grit into the stormwater system by washing cars on the lawn instead of the driveway.

d. Recommendation: Fix oil leaks in vehicles to avoid the excess oil becoming a part of non-point source pollution.

e. Recommendation: Educate homeowners about the benefits of using all pesticides, herbicides, and fertilizers sparingly and according to manufacturers' directions.

f. Recommendation: Dispose of all household chemicals safely and at community waste-disposal facilities.

g. Recommendation: Implement and support existing county hazardous-waste programs.

h. Recommendation: Dispose of all pet waste appropriately and avoid letting waste and associated bacteria wash into the stormwater system.

i. Recommendation: Promote the use of lawn alternatives such as wildflower meadows and native grasses in place of manicured lawns in municipal, institutional, commercial, and residential landscapes.

j. Recommendation: Promote the use of environmentally friendly lawn practices such as installing drought-resistant lawn, mulching lawnmowers, and push lawnmowers.

k. Recommendation: Promote subdivision ordinances that require riparian areas to be kept un-mowed and planted with native plant species in a corridor with a minimum width of about 100 feet along streams

l. Recommendation: Support the dirt and gravel road program to stabilize ditches, ditch drain outlets, roads, and road banks for the reduction of sediment pollution to waterways.

m. Recommendation: Establish new and support existing community shade-tree commissions.

n. Recommendation: Use commercial, institutional, and governmental parking lots as opportunities for runoff controls such as vegetated 'rain gardens,' swales, channels, and basins.

IV. OBJECTIVE: INSTITUTE AND IMPROVE STORMWATER MANAGEMENT PRACTICES

a. Recommendation: Develop Act 167 Plans for sub-watersheds of the Lehigh River that currently do not have them, and update existing plans, as needed.

b. Recommendation: Promote and implement storm runoff volume and rate controls as described in the approved Act 167 Stormwater Management Plans in the watershed.

c. Recommendation: Implement the recommendations listed in the appendix of the Lehigh Valley Planning Commission's Act 167 Stormwater Management Plans and other approved plans throughout the watershed.

d. Recommendation: Incorporate NPDES Phase II standards for stormwater quality into new Act 167 Plans.

e. Recommendation: Evaluate Best Management Practices (BMPs) to determine if they are effective, require modification or updating, and make necessary changes to improve effectiveness of BMPs.

f. Recommendation: Implement BMPs for controlling stormwater quantity and quality.

g. Recommendation: Avoid direct discharges from storm drains to the river and tributaries.

h. Recommendation: Install storm-drain curb markers, available through Pennsylvania's Growing Greener "Only Rain in the Drain" program, as a visual reminder to keep trash, motor oil, soap suds, fertilizer, and other pollutants from getting into the storm-drain system.

i. Recommendation: Convert stormwater runoff to sheet flow over a porous medium or channeled to an infiltration structure, such as a sedimentation pond or trench that directs runoff into the ground rather than directly into the river and tributaries.

j. Recommendation: Support and encourage municipalities to construct, repair, manage, and maintain dirt and gravel roads.

k. Recommendation: Encourage counties and municipalities to cooperate in their stormwater management regulations and efforts.

l. Recommendation: On sites where standard BMPs are not feasible, use innovative BMPs that are designed to function by gravity flow between components. Some of these include:

- Sand filtration systems;
- Underground sand filters consisting of multiple chambers;
- Surface sand filters such as double-trench systems; and
- Peat/sand filtration systems.

m. Recommendation: Implement the BMPs associated with Muncipalities Stormwater (MS4) requirements in all regulated communities. Some of these practices include:

- Replace existing open-throated city inlets;
- Maintain and inspect detention basins;
- Implement regular street sweeping and leaf removal;
- Clean stormwater inlets and catchment basins;
- Monitor and control pollutants from permitted sites;
- Clean-up snow dumpsites; and
- Review BMPs on an annual basis.

n. Recommendation: Identify and minimize combined sewer overflows.

o. Recommendation: Culverts and bridges should be sized and located to convey both low flow and storm events. Structures must also be properly maintained and inspected to prevent obstruction, scour, and erosion.

p. Recommendation: Identify and minimize erosion caused by stormwater.

V. OBJECTIVE: REDUCE AGRICULTURAL NON-POINT SOURCE POLLUTION

a. Recommendation: Encourage streambank fencing and riparian planting in agricultural areas.

b. Recommendation: Continue to develop and support existing partnerships and coordinate watershed planning efforts between organizations to implement and promote the use of agricultural BMPs.

c. Recommendation: Educate landowners about the environmental, economic, recreational, and aesthetic benefits associated with agricultural BMPs.

d. Recommendation: Encourage landowners to work with appropriate agencies to develop and adhere to Nutrient Management Plans.

e. Recommendation: Educate landowners about the various federal and state conservation programs that can provide funding and technical assistance in planning, designing, permitting, implementing, and maintaining agricultural BMPs.

f. Recommendation: Implement and promote the use of agricultural BMPs such as stream

fencing, agricultural crossings, and riparian buffers to reduce non-point source pollution, improve water quality, and improve aquatic and terrestrial habitats on agricultural lands along tributaries of the Lehigh River (Specific examples included in Addendum A).

g. Recommendation: Continue to develop and support existing partnerships and coordinate planning efforts between members of the agricultural community, watershed organizations, and federal, state, and local conservation agencies.

h. Recommendation: Promote the use of conservation easements to permanently protect stream and riparian corridors, and to reduce streambank erosion.

i. Recommendation: Install stream fencing, establish a riparian buffer, and remove low-head dam on a private horse farm along Saucon Creek located on Creek Road in Northampton County.

VI. Objective: Promote the proper operation and maintenance of septic systems and sewage treatment plants

a. Recommendation: Properly maintain and operate sewage treatment facilities within the Lehigh River watershed.

b. Recommendation: Reduce rainwater infiltration into the sewage treatment system lines.

c. Recommendation: Assess current sewage collection systems in order to reduce leakage and infiltration.

d. Recommendation: Conduct workshops for on-lot septic system owners about proper maintenance and cleaning procedures.

e. Recommendation: Promote and adopt municipal ordinances designed to insure the proper maintenance and operation of on-lot septic systems

f. Recommendation: Work with wastewater treatment plants to ensure proper operation and maintenance.

VII. Objective: Manage Water Resource at Francis E. Walter Reservoir

a. Recommendation: Bring together parties interested in the water storage and use of Francis E. Walter Reservoir to discuss current and future discharge rates and scenarios.

b. Recommendation: Manage the Francis E. Walter Reservoir to provide the maximum environmental, water-quality, recreational, and economic benefits to the watershed community.

c. Recommendation: Conduct public forums and meetings to discuss the issues surrounding the Francis E. Walter Reservoir.

d. Recommendation: Bring together all interested parties, fishing community, private boaters, whitewater rafting companies, environmental professionals, water suppliers, and the general public to reach consensus on the uses of the Francis E. Walter Reservoir.

e. Recommendation: Conduct the needed studies to determine optimal flow rates from the Francis E. Walter Reservoir to protect the environment and provide maximum additional recreational opportunities.

f. Recommendation: Comprehensively evaluate the data available from all sources to determine the water-quality, environmental, recreational and economic opportunities and benefits of additional releases from Francis E. Walter Reservoir.

g. Recommendation: Conduct a flow-needs assessment of the Lehigh River.

h. Recommendation: Construct a road across the top of the dam in order to provide additional flexibility in storage capacity at the Francis E. Walter Reservoir.

i. Recommendation: Assess the precipitation of iron oxide and elevated hydrogen sulfide levels in the discharge of Francis E. Walter Reservoir if the pool level is held at a higher level than normal for drought relief and downstream flow augmentation (Reynolds 2000).

j. Recommendation: Work with the U.S. Army Corps of Engineers and other appropriate state and federal agencies to provide a forecast of potential future flows.

k. Recommendation: Natural flows should be paralleled as closely as feasible (Reynolds 2000).

l. Recommendation: The 1994 agreement, which stipulates that releases should not be reduced below 144 cfs during storage events for whitewater releases, should be adhered to (Reynolds 2000).

m. Recommendation: Document the effects of additional water releases from the Francis E. Walter Reservoir and Beltzville Reservoirs.

n. Recommendation: Continue to operate the Francis E. Walter Reservoir to meet the flood control objectives of the reservoir to protect life and property downstream.

o. Recommendation: Pursue congressional re-authorization of the uses of the Francis E. Walter Reservoir.

VIII. OBJECTIVE: PROMOTE WATER CONSERVATION

a. Recommendation: Complete comprehensive water-budget studies for all sub-watersheds.

b. Recommendation: Combine existing source-water and groundwater studies to generate watershed-based water budgets that consider the cumulative impacts of water withdrawal and recharge.

c. Recommendation: Provide education and support educational events designed to educate students and residents about water conservation.

C. GOAL: Protect Significant and Valuable Land Components

The five main land-use types in the watershed are forest, agriculture, urban, wetlands, and barren lands. Past and current patterns of land use have caused significant impacts to the Lehigh River watershed. This section lists recommendations for land protection in the watershed.

Information regarding the methodology developed by Wildlands Conservancy for land protection prioritization is shown in Appendix B – 1.

I. OBJECTIVE: PRESERVE NATURAL AREAS INVENTORY SITES (NAIS) AND HIGH PRIORITY AREAS

a. Recommendation: Utilize innovative strategies and funding sources to acquire, manage, and protect open space.

b. Recommendation: Educate the watershed community in the benefits of "smart-growth" and conservation strategies.

c. Recommendation: Protect priority lands as designated by county and local open-space plans throughout the watershed.

d. Recommendation: Protect or acquire unprotected NAI sites in all counties throughout the watershed.

e. Recommendation: Update NAI studies in the watershed and complete the NAI study and field verifications for Carbon County.

f. Recommendation: Protect high-priority areas including, but not limited to:

- Exceptional Value (EV) streams;
- All stream headwaters and riparian corridors;
- Wetland areas;
- Aquashicola and Pohopoco Creek valleys – Carbon and Monroe counties;
- Headwaters of Lehigh River-Lehigh Township, Wayne County;
- Riparian buffers on Lehigh River-Borough of White Haven, Luzerne County;
- Riparian zone along Trout Creek- Salisbury Township, Lehigh County;
- Bear Creek acquisition/protection project-Bear Creek Township, Luzerne County;
- Sub-watersheds of Mountain and Swabia creeks and headwaters of Mountain Creek-Borough of Macungie, Lehigh County;
- Headwaters of Jordan Creek – Lehigh County;
- Headwaters of the Little Lehigh Creek – Lehigh and Berks counties;
- In-holdings between Lehigh Gorge State Park and Hickory Run State Park;
- In-holdings in State Gamelands #91 and #135;
- In-holdings in Bethlehem Water Authority / Wild Creek Reservoir;
- Lands connecting The Nature Conservancy lands, Bethlehem Water Authority, and State Gamelands #127;
- Lehigh River corridor from State Gamelands #141 / Lehigh Gorge to the Blue Mountain;
- Lehigh River between State Gamelands #40 and #135;
- Lands between Lehigh River and State Gamelands #40;
- Lands that connect Jordan Creek headwaters with State Gamelands #205;
- Lands that connect State Gamelands #217 with preserved farms and surrounding farm-lands (Trexler Hollow, Lowhill Township);
- Lands that connect the Appalachian Trail with Cherry Valley, Monroe County;
- Preserve land holdings in Long Pond, working with The Nature Conservancy;
- Unprotected lands designated as Scenic River lands by Pennsylvania Department of Conservation & Natural Resources;
- Lands along the main stem of the Lehigh River;
- In-holdings along the Little Lehigh Parkway, city of Allentown; and
- Lands adjacent to the Robert Rodale Reserve and the South Mountain Preserve, South Mountain.

(High-priority areas determined by using the ranking methodology included in Appendix B-2.)

II. OBJECTIVE: CREATE AND PROTECT GREENWAYS AREAS

a. Recommendation: Identify and protect potential and existing greenways from development in the Lehigh River watershed.

b. Recommendation: Incorporate greenways and connections to greenways into development plans as scenic and/or passive recreational space.

c. Recommendation: Utilize rail, transportation, and utility corridors to develop a network of greenways.

d. Recommendation: Educate community residents and municipal officials on the benefits greenways provide, and how to plan for them.

e. Recommendation: Share information and data to coordinate greenway development and preservation in eastern Pennsylvania.

f. Recommendation: Develop new greenways to connect to existing greenways (Specific examples included in Addendum A).

III. OBJECTIVE: PROTECT FORESTS

a. Recommendation: Protect large areas of contiguous forestlands.

b. Recommendation: Promote the development of Department of Interor's Forest Stewardship Program to forest landowners.

c. Recommendation: Protect mountainous areas (Specific examples included in ADDENDUM A).

IV. OBJECTIVE: PRESERVE FARMLAND AREAS

a. Recommendation: Protect agricultural lands designated by county agricultural-land preservation programs including:

- Lands with classes I – IV soils in areas possessing preserved farms;
- Buffer lands within preserved farms areas;
- Other productive farmlands; and
- Farms adjacent to protected farms.

b. Recommendation: Encourage and support county agricultural-preservation programs.

c. Recommendation: Promote new and support existing agriculture security areas.

d. Recommendation: Educate farmers, community residents, and municipal officials on the benefits of protecting farmlands.

e. Recommendation: Share information and data to coordinate agricultural preservation in Pennsylvania.

f. Recommendation: Encourage and provide technical and financial support for farmers to diversify and develop entrepreneurial ventures.

V. OBJECTIVE: PROTECT EXISTING RIPARIAN AREAS AND WETLANDS

a. Recommendation: Protect wetlands and streamside riparian areas throughout the watershed.

b. Recommendation: Protect buffer lands bordering streams throughout the watershed, especially lands bordering Exceptional Value (EV) streams (Cross Keys Run, Frame Cabin Run, Shafer Run, Stony Creek, Deep Run, First Hollow Run, White Bear Creek, and Wild Creek) and headwater tributaries.

c. Recommendation: Acquire and protect existing water-authority lands from development.

d. Recommendation: Educate community residents and municipal officials on the benefits of wetlands.

e. Recommendation: Implement municipal wetland and riparian buffer ordinances that protect water resources.

f. Recommendation: Incorporate wetlands and riparian corridors into development plans as scenic and/or passive recreational space to ensure that the natural functions of the wetland are undisturbed.

g. Recommendation: Encourage municipalities to develop an official wetland map to be used to foster open discussions with developers over wetland delineations such as, but not limited to:

h. Recommendation: Permanently protect wetlands with conservation easements, especially if developers are required to create wetlands as part of a permitting process.

VI. OBJECTIVE: PROTECT OTHER LAND RESOURCES

a. Recommendation: Encourage and support programs for recycling metal, batteries, compost, glass, paper, plastics, refrigerant, tires, and used oil.

b. Recommendation: Protect lands adjacent to Pennsylvania State Gamelands, especially where these will link gamelands to other protected lands such as state forests and state parks.

c. Recommendation: Utilize innovative strategies and funding sources to acquire, manage, and protect open space.

d. Recommendation: Protect open land adjacent to other protected lands.

e. Recommendation: Protect lands adjacent to the Appalachian Trail, the D & L Trail, and other established trails.

f. Recommendation: Acquire and protect lands along the Lehigh River that are outside of the Lehigh Gorge State Park boundary and south of the Francis E. Walter Dam.

g. Recommendation: Protect open space, as is feasible, adjacent to schools, colleges, retirement centers, hospitals, and other public and private institutions (Specific examples included in Addendum A).

h. Recommendation: Design and implement gateway gardens, utilizing Best Management Practices and native plant species, to create gateways into communities (Specific examples included in Addendum A).

VII. OBJECTIVE: MANAGE PRESERVED AND PROTECTED LAND

a. Recommendation: Provide landowners with information on land protection techniques, wise forestry practices, and Best Management Practices (BMP) for forestlands.

b. Recommendation: Educate landowners and municipal officials about land stewardship, development of management plans, and the facilitation of these management plans.

c. Recommendation: Provide BMP assessments for lands already protected by public or private means.

d. Recommendation: Conduct environmental resource inventories for privately owned forestlands, where appropriate.

e. Recommendation: Develop and adopt sound forest management plans that protect environmentally sensitive wooded areas.

VIII. OBJECTIVE: PROMOTE THE RE-USE AND REVITALIZATION OF BROWNFIELDS AND GRAYFIELDS

a. Recommendation: Support the re-use and revitalization of abandoned or under-utilized industrial sites, or brownfields.

b. Recommendation: Promote the reclamation and re-use of abandoned mine lands, or grayfields.

c. Recommendation: Support organizations involved in the re-use of brownfields like the Lehigh Valley Land Recycling Initiative (LVLRI).

d. Recommendation: Address and/or support specific brownfield projects (Specific examples included in Addendum A).

e. Recommendation: Support and encourage the vision for the National Museum of Industrial History, being developed in concert with the Smithsonian Institution, on the former Bethlehem Steel site in the city of Bethlehem, Northampton County.

f. Recommendation: Support and encourage the vision for the development of The Bethlehem Works Project on the former Bethlehem Steel site in the city of Bethlehem, Northampton County.

g. Recommendation: Encourage and support communities to utilize funding available through Main Street Program as well as Keystone Opportunity Zones.

h. Recommendation: Determine best course of action for the Lafarge Quarry in Allen Township, Northampton County.

i. Recommendation: Redevelop existing commercial and industrial urban properties to support the economic health of urban areas.

j. Recommendation: Encourage in-fill housing in smaller boroughs and villages, towns and cities, especially in Allentown, Bethlehem, and Easton.

D. GOAL: Protect Biological Resources

The biological resources in the watershed are essential to the health of the natural environment, and to sustaining the benefits human beings derive from nature. This section lists recommendations for addressing the threats to, and advancing conservation of, the watershed's biological resources. Many of the recommendations listed here are from Pennsylvania Department of Conservation & Natural Resources' report entitled Pennsylvania's Wildlife and Wild Places, 2003.

I. OBJECTIVE: PROTECT BIODIVERSITY AND WILDLIFE HABITAT

a. Recommendation: Restore and improve degraded or impaired habitats.

b. Recommendation: Restore wetlands and riparian buffers.

c. Recommendation: Keep deer populations at levels that permit forest regeneration and restore habitat for small mammals, songbirds, forest amphibians, and woodland wildflowers.

d. Recommendation: Provide ecological restoration opportunities for the public, assist with a wide variety of projects such as tree planting, removal of invasive plant species, planting native species, and bank stabilization in both urban and rural areas. Restoration efforts should focus on degraded waters or habitats that have significant economic or ecological value.

e. Recommendation: Provide resources, equipment, and expertise for local and county municipalities to develop and implement management for preserved woodlands, natural areas, riparian zones, and recreational areas.

f. Recommendation: Understand and control the spread of the hemlock wooly adelgid.

g. Recommendation: Develop and implement management plans for publicly owned woodlands.

h. Recommendation: Acquire and/or protect wetland habitat suited for endangered bog turtles, and other threatened and endangered species.

i. Recommendation: Promote wildlife habitat-friendly conservation practices for home-owners and businesses.

j. Recommendation: Identify, establish, and protect Important Bird Areas (IBAs) and Important Mammal Areas (IMAs).

k. Recommendation: Reclaim surface-mine lands with grassland to provide habitat for grassland birds.

l. Recommendation: Control invasive species to promote the health of native plant and animal communities.

m. Recommendation: Provide educational materials to municipalities about invasive and native plant species, and support municipalities in the process of removing invasive plants along the Lehigh River.

n. Recommendation: Provide community education and outreach programs related to wildlife and wildlife habitat.

o. Recommendation: Control invasive and exotic plant species throughout the watershed, specifically at, but not limited to:

- Along roadways, under power lines, in greenways, and adjacent to trails and railroad tracks;
- The Appalachian Trail;
- Federal, state and local parks;
- The Hellertown Swamp;
- All Natural Areas Inventory sites;
- Pool Wildlife Sanctuary;
- All Riparian corridors;
- South Mountain;
- All Pennsylvania State Gamelands;
- Trexler-Lehigh County Game Preserve.

II. OBJECTIVE: CONDUCT AND SUPPORT SPECIES INVENTORIES AND RESEARCH PROGRAMS

a. Recommendation: Support statewide efforts to inventory the status of biodiversity in Pennsylvania.

b. Recommendation: Inventory the watershed to locate and identify the presence of any threatened or endangered species of flora and fauna.

E. GOAL: Increase and Enhance Watershed Recreational Opportunities

Recreation plays an important role in the lives of the residents of the Lehigh River watershed. The protection, enhancement, and creation of recreational resources within the watershed will have significant positive impacts on many aspects of the community. This section lists recommendations on increasing and enhancing the recreational resources in the watershed.

I. OBJECTIVE: CREATE, IMPROVE, AND EXPAND WATERSHED RECREATIONAL FACILITIES.

a. Recommendation: Support and encourage the construction and/or restoration of parks, recreational greenways, and trails.

b. Recommendation: Support, encourage, and facilitate frequent trail maintenance.

c. Recommendation: Conduct studies of existing streamside parks in the watershed in order to guide future environmental improvements in these parks.

d. Recommendation: Maintain publicly owned land in the watershed, in a natural environmentally beneficial state, wherever practical.

e. Recommendation: Work with state, county, and local recreational agencies to form a watershed recreation task group to coordinate planning for development and operation of recreational facilities within the watershed.

f. Recommendation: Re-establish or improve riparian corridors in watershed recreational areas.

g. Recommendation: Examine the feasibility of linking recreational areas along the Lehigh River and its tributaries with riparian corridors through easement or acquisition.

h. Recommendation: Expand current Pennsylvania State Gamelands and improve access to gamelands throughout the watershed.

i. Recommendation: Develop all-terrain vehicle (ATV) recreational alternatives on appropriate lands within the Lehigh River watershed. Use mine-impacted lands where feasible. (Specific examples included in Addendum A).

j. Recommendation: Support, encourage and facilitate the master planning of parks, recreational greenways, and trail designs.

II. OBJECTIVE: IMPLEMENT AND ENHANCE TRAILS AND RAILS-TO-TRAILS PROJECTS.

a. Recommendation: Enhance the experience of using greenways by providing informa-

tion about ecology, natural history, and conservation through the installation of educational signs posted along greenway trails and appropriate riparian corridors.

b. Recommendation: Work with state, county, and local agencies and landowners in creating volunteer trail-maintenance programs to help maintain trails and greenways.

c. Recommendation: Conduct a feasibility study to: assess the extent of abandoned rail lines and public right-of-way lands; the possibilities of linking the lines; the costs associated with acquiring the necessary lands or easements; and converting and maintaining them as usable trails.

d. Recommendation: Examine the economic benefits of trails and rails-to-trails projects.

e. Recommendation: Connect recreational facilities, parks, stream corridors, schools, and communities using trails or greenways.

f. Recommendation: Establish and support rails-to-trails and trail projects in the Lehigh River watershed (Specific examples included in Addendum A).

g. Recommendation: Connect the Nor-Bath Trail in East Allen Township, Northampton County, to the D&L Trail.

h. Recommendation: Acquire missing segments of the D&L trail along the Lehigh River and Lehigh Canal.

i. Recommendation: Establish connections from Hazleton to the D&L Trail.

j. Recommendation: Establish spur trails off the D&L Trail.

k. Recommendation: Enhance existing trails and rails-to-trails projects (Specific examples included in ADDENDUM A).

III. OBJECTIVE: SUPPORT RIVER-BASED RECREATION

a. Recommendation: Provide and improve access to the Lehigh River and its tributaries for recreational activities.

b. Recommendation: Create, maintain, and improve the Lehigh River Water Trail, including signage.

c. Recommendation: Support the Urban Wilderness Challenge and other events designed to promote river recreation and awareness.

d. Recommendation: Create and support programs designed to promote river recreation.

e. Recommendation: Open additional stream miles to public recreation.

f. Recommendation: Enhance existing fishing opportunities and areas.

g. Recommendation: Promote the establishment of special regulation areas where appropriate to protect naturally reproducing fish populations.

h. Recommendation: Support organizations whose mission is it to promote the recreational use of the river and its tributaries.

IV. OBJECTIVE: CLEAN UP THE STREAM CORRIDORS, PARKS, GREENWAYS, AND TRAILS WITHIN THE WATERSHED.

a. Recommendation: Sponsor public river corridor, park, greenway, and trail clean-up days, which also provide opportunities for education.

b. Recommendation: Develop strong public-education programs encouraging residents to use the waterways and land responsibly, and to feel a sense of ownership and to help prevent littering. Post "no littering or dumping" signs on recreation lands throughout the watershed and promote the "carry in-carry out" ethic, where appropriate

c. Recommendation: Support organizations dedicated to the clean-up of watershed recreational areas and trails.

d. Recommendation: Annual or semi-annual clean-ups should occur throughout the Lehigh River watershed (Specific examples included in Addendum A).

F. GOAL: Promote Municipal Watershed Stewardship

Planning and municipal involvement is extremely important to the health of the watershed. This section lists recommendations for increased municipal understanding and involvement in watershed stewardship.

I. OBJECTIVE: IMPLEMENT AND IMPROVE MUNICIPAL ORDINANCES

a. Recommendation: Use zoning ordinances to control the type of development or redevelopment allowed within community boundaries.

b. Recommendation: Promote regulations which require proper operation and maintenance practices for on-site septic systems.

c. Recommendation: Encourage municipalities to adopt environmentally friendly ordinances including, but not limited to:

- Sewage-management ordinances and programs for areas with high potential for malfunctioning on-lot systems;
- Sinkhole ordinances;
- Riparian buffer ordinances;
- Floodplain ordinances (100 – 500 year)

d. Recommendation: Adopt environmentally beneficial ordinances in municipalities dealing with environmental-ordinance issues (Specific examples included in Addendum A).

e. Recommendation: Support wellhead-protection ordinances and programs in municipalities, especially those without public sewers (Specific examples included in Addendum A).

f. Recommendation: Develop and update floodplain management ordinances and zoning to provide standards for the use and development of land in floodplain areas.

II. OBJECTIVE: IMPLEMENT AND IMPROVE MUNICIPAL PLANS

a. Recommendation: Encourage regional planning among municipalities.

b. Recommendation: Develop and/or update regional comprehensive and open-space plans, zoning ordinances, and sub-division and land-development ordinances (SALDO) to promote the development of greenways and trails, and to preserve lands and open space across municipal boundaries.

c. Recommendation: Update municipal Official Sewage Facilities plans (Act 537 plans). Make the Act 537 plans consistent with comprehensive plans and zoning ordinances to provide infrastructure needed in areas planned or zoned for growth.

d. Recommendation: Update, develop, and implement park, recreation, open space, and environmental plans.

e. Recommendation: Inventory and document the environmental condition of municipal natural resources and open space.

f. Recommendation: Incorporate all related land and water issues into municipal park, recreation, open space, and environmental plans.

g. Recommendation: Provide educational workshops and programs for municipal officials concerning environmentally beneficial zoning, regional planning, and ordinances.

h. Recommendation: Create municipal newsletters and websites to inform and educate municipal residents about environmental issues.

i. Recommendation: Update/develop local and regional municipal comprehensive plans that are 10 or more years old such as, but not limited to:

BERKS COUNTY

Townships: Longswamp
Boroughs: Topton

CARBON COUNTY

Townships: East Penn, Franklin, Lehigh, Mahoning, Penn Forest, Towamensing
Boroughs: East Side, Jim Thorpe, Lower Summit Hill, Nesquehoning, Palmerton, Parryville, Weatherly, and Weissport

LACKAWANNA COUNTY

Townships: Clifton, Covington, Spring Brook, and Thornhurst

LEHIGH COUNTY

Townships: Heidelberg, Lower Macungie, Lower Milford, Lynn, Salisbury, South Whitehall, Upper Macungie, Upper Milford, Upper Saucon, Washington, Weisenberg, Whitehall, and city of Allentown
Boroughs: Alburtis, Coopersburg, Coplay, Emmaus, Fountain Hill, Macungie, and Slatington

LUZERNE COUNTY

Townships: Bear Creek, Buck, Butler, Dennison, Foster, Hazle, and Jenkins
Boroughs: Freeland, White Haven, and Hazleton City

MONROE COUNTY

Townships: Chestnuthill, Coolbaugh, Eldred, Polk, and Tunkhannock

NORTHAMPTON COUNTY

Townships: Allen, Bushkill, East Allen, Lower Nazareth, Lower Saucon, Moore, Palmer, and Upper Nazareth
Boroughs: Bath, Chapman Quarries, Freemansburg, Glendon, Hellertown, North Catasauqua, Northampton, Walnutport, West Easton, and Wilson

SCHUYLKILL COUNTY

Townships: East Brunswick, Kline, Rush, and West Penn
Boroughs: McAdoo and Tamaqua

j. Recommendation: Update/develop zoning, ordinances, and SALDOs which are 10 or more years old such as, but not limited to:

ZONING

BERKS COUNTY

Boroughs: Topton

BUCKS COUNTY

Townships: Springfield

CARBON COUNTY

Boroughs: East Side, Lansford, Nesquehoning, Parryville, and Weissport

LACKAWANNA COUNTY

Townships: Clifton

LEHIGH COUNTY

Townships: Heidelberg, Lynn , North Whitehall, Salisbury, South Whitehall, UpperMacungie, Upper Milford, Upper Saucon, Washington, and Weisenberg

Boroughs: Alburtis, Coopersburg, Coplay, Emmaus, Fountain Hill, Macungie, and Slatington

LUZERNE COUNTY

Townships: Buck, Butler, Dennison, Foster, Hazle, and Pittston

Boroughs: Freeland, White Haven, and Hazleton City

MONROE COUNTY

Townships: Eldred and Polk

NORTHAMPTON COUNTY

Townships: East Allen, Lehigh, Lower Nazarth, Lower Saucon, Moore, Palmer, Upper Nazareth, Williams, and city of Easton

Boroughs: Bath, Chapman Quarries, Freemansburg, Glendon, Hellertown, Walnutport, West Easton, and Wilson

SCHUYLKILL COUNTY

Townships: East Brunswick and Kline

Boroughs: McAdoo

WAYNE

Townships: Lehigh

SALDO

BERKS COUNTY

Townships: Maxatawny

CARBON COUNTY

Townships: Franklin and Lower Towamensing

Boroughs: Bowmanstown, Lansford, Lehighton, Palmerton, Parryville, and Weissport

LACKAWANNA COUNTY

Townships: Clifton and Thornhurst

LEHIGH COUNTY

Townships: Hanover, Heidelberg, Lowhill, Lynn, South Whitehall, Upper Macungie, Upper Milford, Upper Saucon, Washington, Weisenberg, Whitehall, and city of Allentown

Boroughs: Alburtis, Catasauqua, Coopersburg, Coplay, Emmaus, Fountain Hill, Macungie, and Slatington

LUZERNE COUNTY

Townships: Bear Creek, Buck, Butler, Dennison, Foster, Hazle, Pittston, and Hazleton City
Boroughs: Freeland and White Haven

MONROE COUNTY

Townships: Chestnuthill, Eldred, Polk, and Tobyhanna

NORTHAMPTON COUNTY

Townships: Allen, Bethlehem, East Allen, Hanover, Lehigh, Lower Nazareth, Moore, Palmer, Upper Nazareth, city of Bethlehem, and city of Easton
Boroughs: Chapman Quarries, Freemansburg, Glendon, Hellertown, Northampton, West Easton, Walnutport, Wilson

SCHUYLKILL COUNTY

Townships: Kline, Rush, and West Penn
Boroughs: McAdoo and Tamaqua

G. GOAL: Promote Environmental Awareness, Knowledge, Skills, Support, and Stewardship Committment

Education about and awareness of Lehigh River watershed resources is important in developing a sense of watershed stewardship, which is important to the protection, preservation, and enhancement of watershed resources. This section lists recommendations for increasing environmental awareness, knowledge, skills, support, and stewardship commitment.

I. OBJECTIVE: PROVIDE ENVIRONMENTAL, HERITAGE, AND CULTURAL EDUCATION OPPORTUNITIES FOR THE GENERAL PUBLIC, LOCAL GOVERNMENT, AND BUSINESS LEADERS.

a. Recommendation: Educate the public with a basic knowledge of: 1) the natural laws which govern the environment of the watershed; 2) the skills needed to solve its environmental problems; and 3) recognition of each individual's responsibility to find solutions to the environmental problems of the watershed.

b. Recommendation: Encourage the development of a stewardship ethic that leads to the conservation of the watershed's natural, historical, and cultural heritage, and to the correction and prevention of environmental degradation in the watershed.

c. Recommendation: Promote the creation of watershed organizations on tributaries of the Lehigh River (Specific examples included in Addendum A).

d. Recommendation: Support the efforts of watershed organizations and other environmental groups.

e. Recommendation: Educate stakeholders in benefits of "smart growth" and conservation strategies.

f. Recommendation: Establish a Lehigh River watershed land preservation consortium to inventory and improve the communication and effectiveness of proactive conservation efforts, among watershed associations, conservation groups, and state, county, and local governments and resource offices throughout the watershed.

g. Recommendation: Provide educational programming that will familiarize all members of the watershed community with Best Management Practices for homeowners and farmers to protect streams.

h. Recommendation: Develop a "Lehigh River Walk" three-dimensional working model of the Lehigh River and its canal depicting the history of the industrial, cultural and natural history of the watershed in Bethlehem, Pennsylvania at the site of BethWorks.

i. Recommendation: Document the entire length of the Lehigh River and its tributaries using video, photos, and written descriptions of significant sites for use in planning and educational efforts.

j. Recommendation: Develop books, brochures, guides, videos, tours, etc. to be used to promote public awareness of the natural, recreational, and heritage resources of the Lehigh River watershed, and of the efforts underway for the implementation of this plan.

k. Recommendation: Develop and post educational signs at critical sites along waterways at key locations such as stream crossings and recreational sites to increase public awareness of threats to the Lehigh River watershed.

l. Recommendation: Post signs at every major river and stream crossing identifying the name of the water body.

m. Recommendation: Post watershed boundary signs along major traffic corridors near watershed boundaries.

n. Recommendation: Educate landowners about land preservation options.

o. Recommendation: Improve communication between the agricultural and land-owning community and the appropriate agencies to find the sources of funding for acquisition and preservation of these valuable resources.

p. Recommendation: Provide information about farmland preservation available to watershed landowners.

q. Recommendation: Educate local municipal and county governments and landowners about sprawl and about methods to control it.

r. Recommendation: Educate the general public, landowners, and especially municipal officials about the actual cost of residential developments verses the actual cost of open space or farmland for a municipality.

s. Recommendation: Promote the formation of environmental advisory councils (EACs) in each of the watershed municipalities (Specific examples included in Addendum A).

II. OBJECTIVE: PROVIDE EDUCATIONAL OPPORTUNITIES FOR ALL STUDENTS IN THE LEHIGH RIVER WATERSHED.

a. Recommendation: Create and expand watershed educational programs that provide field trip opportunities to school-age students.

b. Recommendation: Continue and expand experiential educational programs within the watershed – like Wildlands Conservancy's Bike & Boat, Navigators, and River Rat programs – that expose students to the culture and environments of the Lehigh River watershed.

c. Recommendation: Continue and expand the Northampton County Junior Conservation School and other school-related programs designed to expose students to the outdoors.

d. Recommendation: Support the Pennsylvania Envirothon.

e. Recommendation: Support student involvement in watershed groups.

f. Recommendation: Continue the Lehigh River Sojourn and other programs designed to promote river awareness.

g. Recommendation: Create original productions like 'My Name is Jeremiah' dealing with the Lehigh River watershed and its resources.

h. Recommendation: Maintain and expand a 'Walk on the Watershed Map' of the Lehigh River watershed, and conduct in-school programs.

i. Recommendation: Develop and distribute educational Lehigh River watershed book covers to school districts within the Lehigh River watershed.

j. Recommendation: Develop educational programs that are aligned with the Pennsylvania Academic Standards.

k. Recommendation: Incorporate watershed themes into school districts' education programming (Northampton Middle School is a model).

l. Recommendation: Cooperate and provide assistance to student groups and school districts conducting monitoring projects in the Lehigh River watershed.

m. Recommendation: Maintain and make available to the public the Harry C. Trexler Lehigh River Watershed Exhibit Center at Pool Wildlife Sanctuary in Emmaus.

n. Recommendation: Hold and support an annual Pennsylvania Youth Summit.

III. OBJECTIVE: PROVIDE EDUCATIONAL OPPORTUNITIES FOR EDUCATORS WITHIN THE LEHIGH RIVER WATERSHED.

a. Recommendation: Provide continuing education classes on the resources of the Lehigh River watershed.

b. Recommendation: Develop and hold field trips and educational tours of the Lehigh River watershed.

c. Recommendation: Provide training on the Pennsylvania Academic Standards using the Lehigh River watershed.

d. Recommendation: Provide technical support for teachers and school districts using the Lehigh River watershed as a resource.

e. Recommendation: Develop a committee of Lehigh River watershed educators to continue, create, and expand educational opportunities and ideas for students of the Lehigh River watershed.

IV. OBJECTIVE: SUPPORT ORGANIZATIONS AND ACTIVITIES, WHICH PROTECT WATERSHED RESOURCES

a. Recommendation: Contact local, county, state, and federal government officials to encourage them to financially support all programs which enhance, protect, and restore environmental resources.

b. Recommendation: Promote the use of federal tax credits and state and federal grants to revitalize historic communities by providing information and assistance regarding applying for funds.

c. Recommendation: Provide funding for educating potential farmers at colleges, universities, and trade schools.

d. Recommendation: Support financially organizations and activities, which protect environmental resources.

V. OBJECTIVE: HOLD PUBLIC MEETINGS AND FORUMS

a. Recommendation: Hold an annual Lehigh River watershed partnership forum.

b. Recommendation: Develop articles and editorials in local newspapers, as well as television and radio features, to keep the general public well informed about issues and activities in the Lehigh River watershed.

c. Recommendation: Develop and conduct periodic seminars on environmental topics affecting the Lehigh River watershed.

d. Recommendation: Work with the Penn State Cooperative Extension, County Conservation Districts, and NRCS to promote education about Best Management Practices to farmers.

H. GOAL: Monitor and Update Watershed Resource Information on a Continuing Basis

Maintaining and updating records on the condition of the watershed is essential for recognizing and assessing threats that may disrupt the balance of the ecosystem. Monitoring watershed resources can also be used to demonstrate the effectiveness of restoration and preservation projects. This section lists recommendations for the continued monitoring and updating of watershed resource information.

I. OBJECTIVE: CONDUCT WATER QUALITY SAMPLING AND ANALYSIS.

a. Recommendation: Coordinate water-quality monitoring efforts within the watershed.

b. Recommendation: Develop and maintain continuous water-quality monitoring on the Lehigh River.

c. Recommendation: Conduct water sampling and analysis of the Lehigh River tributaries on a regular basis to:

- Identify problem areas on which to focus remediation;
- Monitor and document changes in overall health of the watershed while providing background information for future studies and projects; and
- Note adjustments that should be made in management practices.

d. Recommendation: Conduct stream walks annually to monitor physical changes within the watershed such as sedimentation, streambank stabilization, and vegetative cover.

e. Recommendation: Standardize sampling protocols and reporting procedures throughout the watershed.

f. Recommendation: Promote and enhance communication between groups monitoring the Lehigh River and its tributaries.

g. Recommendation: Continue and support the sampling programs of Tobyhanna/Tunkhannock Creek Watershed Association.

h. Recommendation: Monitor the effects of abandoned mine drainage remediation projects.

i. Recommendation: Create real-time water-quality monitoring on the Lehigh River at the Northampton Borough Municipal Authority and other appropriate locations.

j. Recommendation: Conduct comprehensive sediment studies for Lehigh River tributaries.

k. Recommendation: Complete visual stream assessments, such as U.S. Environmental Protection Agency's "Rapid Bio-assessment Protocols" or U.S. Department of Agriculture's "Stream Visual Assessment Protocols" for Lehigh River tributaries.

l. Recommendation: Complete fluvial geomorphic stream assessments, stream classifications, and restoration plans for Lehigh River tributaries.

II. OBJECTIVE: CONDUCT BIOLOGICAL MONITORING.

d. Recommendation: Maintain records of the condition of the stream-corridor habitat and the vegetative, aquatic, and wildlife species present within that corridor.

e. Recommendation: Conduct research on the flora and fauna of the Lehigh River watershed, i.e., mammal, bird, fish, macro-invertebrate, native and exotic trees/shrubs, and wildflower inventories.

f. Recommendation: Conduct periodic macro-invertebrate sampling.

g. Recommendation: Encourage the implementation of monitoring standards for volunteer-stewardship, youth-education, and stream-watch programs to survey or maintain stream corridor vegetation, stream quality, and biological habitat.

h. Recommendation: Provide resources, equipment, and expertise for area school districts, colleges, and watershed groups interested in conducting water-quality and water-quantity monitoring on the Lehigh River and its tributaries.

III. OBJECTIVE: DEVELOP, UPDATE, AND MAINTAIN WATERSHED RESOURCE INFORMATION

d. Recommendation: Develop and update a watershed-wide database that will include water, land, cultural, and biological resource information.

e. Recommendation: Make the database and interactive GIS information available on the web.

f. Recommendation: Utilize and support Lehigh University as a clearinghouse for Lehigh River watershed information.

g. Recommendation: On a regular basis, visually inspect the watershed to identify and examine areas of concern, and to identify potential opportunities to protect its natural, cultural, historic, and recreational resources.

h. Recommendation: Establish and maintain regular features in the media throughout the watershed about the resource.

i. Recommendation: Develop watershed conservation or watershed restoration plans for key sub-watersheds of the Lehigh River (Specific examples included in Addendum A).

j. Recommendation: Complete an update of this Lehigh River Watershed Conservation Management Plan every five years.

k. Recommendation: Complete a State of the Lehigh River Report every five years, at a minimum.

Addendum A

SPECIFIC RECOMMENDATIONS

Recommendation: Work with and help establish historical societies throughout the watershed. Specific examples included Lynn Township, Lehigh County.

Recommendation: Work with historical societies and the Pennsylvania Historical and Museum Commission to create and maintain a collection of historical documents, photographs, paintings, etc., of the Lehigh River and its watershed. Specific examples include Lower Saucon Township, Northampton County.

Recommendation: Preserve and restore historic structures and districts important on a local, county, state, and/or federal level. Specific examples include:

- The central business district in the city of Easton;
- Log house and farm houses and barns in Lower Macungie Township, Lehigh County;
- The Old Mill Bridge, Meadows Bridge and Heller Homestead in Lower Saucon Township, Northampton County;
- Canal boat artifacts in the Borough of Northampton, Northampton County;
- Historic homes in the Borough of Macungie, Lehigh County;
- The Helfrich Springs Grist Mill and Grim Homestead in Whitehall Township, Lehigh County;
- The old post office and old grist mill in the Borough of White Haven, Luzerne County;
- The Kreidersville covered bridge in Allen Township, Northampton County.

Recommendation: Establish riparian buffers along streams within the Lehigh River watershed. Specific examples include:

- Unnamed tributary to the Monocacy Creek, located west of Rt. 987 in Moore and East Allen townships, Northampton County;
- Little Lehigh Creek along Spring Creek Road in Lower Macungie Township, Lehigh County;
- Saucon Creek located immediately downstream of Chestnut Hill Road/Bridge crossing in Upper Saucon Township, Lehigh County;
- Hokendauqua Creek at Kreidersville Covered Bridge Park in Allen Township, Northampton County;
- Leibert Creek and its tributaries in Emmaus Borough and Upper Milford Township, Lehigh County.

Recommendation: Provide technical assistance in the form of information, funding sources, and demonstrations to municipal officials and landowners for dealing with riparian issues and riparian restorations. Specific examples include:

- Kidder Township, Carbon County – Restoration and flood controls are needed in the Hickory Run Stream and the Mud Run Creek;
- Borough of Macungie, Lehigh County – Mountain Creek and Swabia Creek;
- Whitehall Township, Lehigh County – Riparian buffer areas need improvement at Coplay Creek, Jordan Creek, and the Lehigh River;
- Eldred Township, Monroe County -- Riparian buffer needs improvement in the Buckwha Creek area.

Recommendation: Complete fluvial geomorphic assessments and develop stream restoration plans for streams. Specific examples include:

- Jordan Creek at Covered Bridge Park in South Whitehall Township, Lehigh County;
- Jordan Creek at Jordan Park in Allentown, Lehigh County;
- Catasauqua Creek at Willow Brook Golf Course, Catasauqua Borough, Northampton County;
- Saucon Creek at Saucon Valley Country Club, Upper and Lower Saucon townships, Lehigh and Northampton counties;
- Saucon Creek at Saucon Park, Bethlehem Township, Northampton County;
- Little Lehigh Creek at Wildlands Conservancy/Pool Wildlife Sanctuary, Lower Macungie Township, Lehigh County;
- Mahoning Creek, Lehighton Borough, Carbon County.

Recommendation: Remove low-head run-of-the-river dams in the Lehigh River watershed, where feasible and appropriate, to reduce thermal pollution, improve water quality, restore fish passage, and improve aquatic habitat. Specific examples include:

- Lehigh River below Bowmanstown, Carbon County;
- Hokendauqua Creek at Petersville Rod and Gun Club in Moore Township, Northampton County;
- Monocacy Creek in the city of Bethlehem, south of Route 22;
- Catasauqua Creek at the Willow Brook Golf Course, Catasauqua Borough, Northampton County;
- Little Lehigh Creek at Wildlands Conservancy/Pool Wildlife Sanctuary, Lower Macungie Township, Lehigh County;
- Leibert Creek, Furnace Dam, Upper Milford Township;
- Unnamed tributary to the East Branch of the Monocacy Creek in Lower Nazareth Township, Northampton County.

Recommendation: Remove rock dams and establish a riparian buffer on streams. Specific examples include:

- Saucon Park, Bethlehem Township, Northampton County; and
- Lizard Creek at Andreas Sporting Club on Rt. 895 in Andreas, West Penn Township, Schuylkill County.

Recommendation: Implement and promote the use of agricultural BMPs such as stream fencing, agricultural crossings, and riparian buffers to reduce non-point source pollution, improve water quality, and improve aquatic and terrestrial habitats on agricultural lands along tributaries of the Lehigh River. Specific examples include:

- Dry Run Creek in Allen Township, Northampton County;
- Little Lehigh Creek in Longswamp Township, Berks County;
- Switzer Creek at the intersection of Bausch and Miller Roads in Lynn Township, Lehigh County;
- Saucon Creek, Northampton County.

Recommendation: Develop new greenways to connect to existing greenways. Specific examples include:

- Lands that connect Little Lehigh Creek headwaters with preserved farms and surrounding farmlands;

- Lands that connect the Robert Rodale Reserve and the South Mountain Preserve (both on South Mountain) with Walking Purchase Park in Salisbury Township;
- Longswamp Township, Berks County – develop a regional recreational greenway plan;
- Borough of White Haven, Luzerne County – develop greenway/trail connection to Hazleton from Lehigh Gorge;
- Bushkill Township, Northampton County – develop a township-wide greenway plan which connects with greenways in adjacent municipalities in the watershed;
- City of Bethlehem, Northampton County – develop linear greenway park along the old Southern rail line;
- Upper Milford Township – develop a greenways plan to serve as a blueprint of green infrastructure in which stormwater management, natural landscaping, and ecological restoration and management are integrated into land development projects and to protect the Little Lehigh, Indian, and Swabia Creek riparian zones;
- Washington Township, Lehigh County – implement the Slate Heritage Trail Master Plan;
- Washington Township, Lehigh County – develop spur rail-trail off of Slate Heritage Trail

Recommendation: Protect mountainous areas. Specific examples include:

- South Mountain (Emmaus) – acquire land to add to the South Mountain Preserve and develop a management plan for the preserve;
- Kittatinny Ridge/Blue Mountain (throughout watershed) – protect open space and natural areas from development;
- Jonas Mountain – protect natural areas and wildlife habitat of Jonas Mountain, Polk Township, Monroe County.

Recommendation: Encourage municipalities to develop an official wetland map to be used to facilitate open discussions with developers over wetland delineations. Specific examples include:

- Longswamp Township, Berks County;
- Kidder Township, Carbon County;
- Lynn Township, Lehigh County;
- Upper Milford Township, Lehigh County.

Recommendation: Protect open space, as is feasible, adjacent to schools, colleges, retirement centers, hospitals, and other public and private institutions. Specific examples include:

- Lower Macungie and Upper Milford townships, Lehigh County-protect 24-acre and 51-acre tracts as open space adjacent to East Penn School District.

Recommendation: Design and implement gateway gardens, utilizing Best Management Practices and native plant species, to create gateways into communities. Specific examples include:

- Nesquehoning Township, Carbon County;
- Lake Harmony and Kidder townships, Carbon County;
- Trexlertown and Upper Macungie townships, Lehigh County.

Recommendation: Address and/or support specific brownfield projects. Specific examples include:

- Lebanon Chemical and City Incinerator sites, Lehigh County;
- City of Bethlehem, former Bethlehem Steel properties, Northampton County;
- Palmer Twp., former Bethlehem Corp. site, Northampton County;
- Palmerton Borough, Horsehead Industry Corp., Carbon County;

- Banks Township, strip mines, Carbon County;
- Borough of White Haven, old printing factory, Luzerne County;
- Lehigh Landing (former A&B Meat Packing Plant), City of Allentown.

Recommendation: Develop all-terrain vehicle (ATV) recreational alternatives on appropriate lands within the Lehigh River watershed. Use mine-impacted lands where feasible. Specific examples include Borough of White Haven, Luzerne County.

Recommendation: Establish and support rails-to-trails and trail projects in the Lehigh River watershed. Specific examples include:

- Bodnarczuk Tract, Hokendauqua Creek, Allen Township, Northampton County;
- Thornhurst Township, Lackawanna County – develop township-owned land for public access to the Lehigh River and active and passive recreational areas;
- Borough of Macungie, Lehigh County – connecting parks in borough and connecting to Lock Ridge Park in Alburtis, Lower Macungie Township and Borough of Alburtis;
- Upper Milford Township, Lehigh County – study township and develop trail plan;
- Salisbury Township, Lehigh County; protect land along Trout Creek, and develop a trail system;
- Allen Township, Northampton County – develop the existing towpath along the Lehigh Canal;
- Borough of White Haven, Luzerne County – new trail development plan on the rail-trail north of White Haven;
- Thornhurst Township, Lackawanna County – public access to the Lehigh River, active and passive recreational areas;
- Borough of White Haven, Luzerne County – assessment of regional recreational scope
- Longswamp Township, Berks County – develop a recreational trail through the Macungie Mountain Ridge woodland;
- Upper Saucon Township, Lehigh County – rails-to-trails project;
- City of Allentown, Lehigh County – Little Lehigh Parkway.

Recommendation: Enhance existing trails and rails-to-trails projects. Specific examples include:

- D & L Trail along the Lehigh River;
- Ironton Rail –Trail, Whitehall and North Whitehall townships and the Borough of Coplay, Lehigh County;
- Buckwha Creek Trail – completion of trail and parking lot design and construction Lower Towamensing Township, Carbon County;
- Nor-Bath Trail, East Allen Township, Northampton County;
- Switchback Trail, Carbon County;
- The Appalachian Trail, Carbon, Lehigh, Monroe, and Northampton counties;
- Northern Lehigh Slate Trail.

Recommendation: Annual or semi-annual clean-ups should occur throughout the Lehigh River watershed. Specific examples include:

- Main stem of the Lehigh River from Allentown to Easton;
- The D & L Trail;
- The main stem of the Jordan Creek in the city of Allentown;
- Thornhurst Township, Lackawanna County – Lehigh River and adjacent lands;

- Various slate and limestone quarries throughout Lehigh and Northampton counties;
- The Appalachian Trail.

Recommendation: Support wellhead-protection ordinances and programs in municipalities, especially those without public sewers. Specific examples include Covington Township, Lackawanna County and Eldred Township, Monroe County.

Recommendation: Adopt environmentally beneficial ordinances in municipalities dealing with environmental-ordinance issues. Specific examples include:

- Palmer Township, Northampton County – support and provide information on conservation district ordinances;
- Lower Milford Township, Lehigh County – adopt natural features preservation zoning;
- Lynn Township, Lehigh County – update conservation district ordinances.

Recommendation: Promote the creation of watershed organizations on tributaries of the Lehigh River. Specific examples include:

- Black Creek;
- Cedar Creek;
- Coplay Creek;
- Jordan Creek;
- Lizzard Creek;
- Mahoning Creek;
- Nesquehoning Creek;
- Saucon Creek;
- Sandy Run.

Recommendation: Promote the formation of environmental advisory councils (EACs) in each of the watershed municipalities. Specific examples include:

- Longswamp Township, Berks County – develop an EAC to address water issues;
- Kidder Township, Carbon County – institute an EAC to address trail, stormwater management, water control, and development issues.

Recommendation: Develop watershed conservation or watershed restoration plans for key sub-watersheds of the Lehigh River. Specific examples include:

- Aquashicola Creek;
- Black Creek;
- Cedar Creek;
- Coplay Creek;
- Hokendauqua;
- Lizard Creek;
- Nesquehoning Creek;
- Pohopoco Creek;
- Saucon Creek;
- Sandy Run;
- Tobyhanna/Tunkhannock Creeks

References

RECOMMENDATIONS

Reynolds, Lou and Leroy Young. Investigation of the Effect of White Water Boating Releases from the F.E. Walter Reservoir on Benthic Macro-Invertebrate Communities in the Lehigh River. PA Fish and Boat Commission, 2000.

Part IX

APPENDIX

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Appendix A–1.

FRANCIS E. WALTER RESERVOIR AND THE ARMY CORPS OF ENGINEERS' DAM OPERATION

The Francis E. Walter Reservoir, originally known as Bear Creek Reservoir, is located near the convergence of Bear Creek and the Lehigh River in Luzerne and Carbon Counties in northeastern Pennsylvania. It is a man-made impoundment created by the U.S. Army Corps of Engineers in 1961 by damming the Lehigh River at the confluence with Bear Creek. The 3,000-foot long, 234-foot high earth-fill dam creates a 90-acre pool at the normal 1,300-foot National Geodetic Vertical Datum (N.G.V.D.) and controls a drainage area of 288 square miles. The reservoir is approximately 86 miles north of Philadelphia, 20 miles southeast of Wilkes Barre, 39 miles south of Scranton and 23 miles north of Allentown. The project area is part of the Pocono Mountain complex.

The Francis E. Walter Reservoir, along with local flood protection projects at Allentown, Pennsylvania and Bethlehem, Pennsylvania was authorized in House Document No. 587, 79th Congress, 2nd Session for Lehigh River flood control protection. The reservoir project was also authorized for recreation as part of Public Law 100-676, Section 6, dated November 17, 1988.

As outlined in the October 1994 Francis E. Walter Reservoir, Lehigh River, Pennsylvania Water Control Manual (Revised), the Francis E. Walter Reservoir Project is an integral part of the Lehigh River Flood Control Program. The project is regulated by the Philadelphia District in conjunction with the Beltzville Lake project in Carbon County for optimum flood control benefits on the Lehigh River. The primary purpose of the project is flood control. Francis E. Walter, in addition to aiding in flood control along the Lehigh River, is operated for recreation and drought emergency water supply for salinity repulsion in the Delaware River Estuary.

The Hydrology-Hydraulics Branch, Philadelphia District, U.S. Army Corps of Engineers gives instructions for the storage and discharge of water from the F.E. Walter Reservoir project. Under normal regulation, the flood control system is operated in such a manner that the flow passed through the dam equals inflow into the reservoir while maintaining the normal pool elevation of 1,300.0 feet N.G.V.D. A conservation release of 50 cfs makes up the current minimum release criterion on the Lehigh River below the project. During flood periods, the flood control system is operated with the gates closed to the minimum required flood control outflow (100 cfs) only long enough to obtain the maximum reduction of damaging flood stages downstream. Releases from the Francis E. Walter project are governed by actual and/or predicted flood stages at critical downstream control points, by predicted inflow volume into the lake and by regulation of the Beltzville Lake project.

All releases of water are made through the project's flood control release system. The operational rule curve for the project, as described in the Schedule of Regulation, has a normal year-round pool elevation of 1,300.0 feet N.G.V.D. During temporary storage for drought emergencies, the summer pool is 1,392.0 feet N.G.V.D. (1 April through 1 December) while the winter pool is 1,370.0 feet N.G.V.D. (1 December through 1 April). The pool elevations and release flows may fluctuate slightly due to constant changes in hydrologic conditions in the watershed, whitewater releases and Delaware River Basin Commission (DRBC) requested emergency drought releases. The Schedule of Regulation covers flood control regulation of the Francis E. Walter Reservoir and Beltzville Lake project under the following conditions: Schedule Plan B, all

controlling downstream gauges below critical stage with the pool elevation above normal pool elevation; Schedule Plan C, any one controlling downstream gauge above critical stage with the pool elevation at any elevation below spillway crest; and Schedule Plan D, the pool elevation at or above spillway crest elevation. Schedule Plan A covers normal, non-flooding conditions.

The DRBC utilizes the temporary drought emergency storage of up to 11.3 billion gallons at Francis E. Walter Reservoir to augment the flow objective of the Delaware River at Trenton, New Jersey according to the Delaware River Basin Commission's drought operating plan. The Plan is basin wide and evolved after public hearings, agency inputs, and consultations. Historically, conservation drought warning and drought storage releases to the Lehigh River would be 43 cfs as described in the Delaware River Basin Water Code (December 1996). This flow represents the Q7-10 flow at the United States Geological Survey gauging station (Station ID 01447800) on the Lehigh River downstream of the F.E. Walter Reservoir. As defined in the Pennsylvania Chapter 93 Regulations, this 7-day, 10-year low flow is the actual or estimated lowest seven consecutive-day average flow that occurs once in ten years for a stream with unregulated flow, or the estimated minimum flow for a stream with regulated flow. In the past, the Corps has conducted emergency drought storage and release operations in accordance with the DRBC coordinated plan. Agency coordination conducted for the drought of 2002 concluded that the recommended minimum release during drought filling periods should be 156 cfs.

The Francis E. Walter Reservoir and Recreation

Whitewater rafting is a popular recreational industry on the Lehigh River below Francis E. Walter Reservoir. Downstream recreation in the form of whitewater releases are sanctioned under Public Law 100-676, Section 6, dated November 1988 and has existed historically at the Francis E. Walter Reservoir Project. Five events are scheduled annually for whitewater releases. For those events, water is stored up to elevation 1,309.0 ft. N.G.V.D. (minimum elevation of access road located on the upstream embankment of the project). There are two-day release events scheduled for the second and fourth weekends of June and one-day release events scheduled for the 3rd Saturday of September and the 1st and 3rd Saturdays of October.

Storage for each scheduled event begins on the Monday two weeks prior to the event. The regulation of the reservoir during whitewater storage calls for a minimum release of 144 cfs during the storage period until the pool reaches elevation 1,309.0 ft. N.G.V.D., or until the time of the event. If inflows fall below 144 cfs during the storage period, releases are cut back to the inflow value. If the pool reaches elevation 1,309.0 ft. N.G.V.D. in advance of the scheduled event, outflows are regulated to equal inflows while maintaining the pool elevation at 1,309.0 ft. N.G.V.D. If the pool does not reach elevation 1,309.0 ft. N.G.V.D. prior to the scheduled event, cooperating agencies and commercial whitewater outfitters will coordinate and decide if a lesser release value will be made or if the event will be cancelled. Scheduled releases for all events, if water is available, are a minimum of 500 cfs and a maximum of 750 cfs. During basin wide Delaware River basin drought warning and drought declarations by the Delaware River Basin Commission, cancellation of the events are carefully evaluated.

Although fish and wildlife conservation is not the reservoir's primary objective, consideration is given to downstream aquatic resources during storage events for whitewater releases, and efforts are made to reduce the impacts associated with releases. Criteria have been developed to avoid abrupt gate raising and closing changes during above normal releases for flood control regulation. In addition, efforts are made to minimize adverse shock effects on downstream fisheries due to releases.

The Fish and Wildlife Coordination Act of 1958 (PL 85-624), which amended the Act of March 10, 1934, provides that fish and wildlife conservation shall receive equal consideration with other project purposes and be coordinated with other features of water resource development programs. A fundamental fishery management tool is maintaining a stabilized pool elevation, which encompasses shoreline fish habitat during the spring spawning and nursery cycles. Successful management of pool elevation stability must take into account natural weather events and the need for pool adjustments that are frequently necessary during the spring season. Water control management needs take precedence over fishery accommodation but the attempt is made to adjust procedures for fishery purposes whenever possible. The Philadelphia District routinely coordinates with state resource agencies and local interests concerning operations during whitewater releases and fish stockings.

The Francis E. Walter project has no selective withdrawal capability. An inoperable bypass system does exist. The three-flood control gates release water near the reservoir bottom. Thermal selectivity withdrawals are not possible at this time. As a result, the water in the lower water column and its associated water quality is released first. The water quality in the lake is greatly influenced by inflow to the lake, especially the period from April through October. This would include volume, sediment load, and water quality in general. The drainage basin above the dam is predominantly forested with little development. However, development is occurring and has increased the potential for environmental degradation.

On August 11, 1999, the Lehigh River Stocking Association (LRSA) and the Raymond Proffitt Foundation (RPF) filed a lawsuit in federal court against the U.S. Army Corps of Engineers alleging mismanagement of water resources on the Lehigh River. In a November 20, 2001 ruling, Judge Brody dismissed the lawsuit against the U.S. Army Corps of Engineers.

Recommendations regarding the use and operation of the Francis E. Walter Reservoir were made as part of the Lehigh River Watershed Conservation Management Plan. It is hoped that these recommendations will provide a blueprint for future actions and activities relative to the management of the water resources of the Lehigh River. The recommendations are listed in Section VIII.

Appendix A-2.

National Pollutant Discharge Elimination System (NPDES) of the Lehigh River watershed

Source: U.S. Environmental Protection Agency, 2003.

ID Number	Name	County	*Data Source	Description	Discharge Type	Receiving Stream	NPDES #	Ownership	Activity	Permit
PAD980690739	Agway Petroleum Corp - Macungie	Lehigh	PCS	Petroleum Bulk Stations and Terminals	Industrial Wastewater	Swabia Creek	PA0070084	Private	Active	State
			BRS	Fuel Oil Dealers						
PAD003001195	Air Products & Chemicals	Lehigh	PCS	Electric and Gas Welding and Soldering Equipment	Industrial Wastewater	Trout Creek	PAR112201	Private	Active	State
PAD987353679	Air Products & Chemicals INC	Lehigh	PCS	Industrial Gases	Industrial Wastewater	Iron Run	PA0011185	Private	Active	State
			NCDB	Cellulosic Manmade Fibers						
PAD002390797	Allen Organ Co	Lehigh	PCS	Musical Instruments	Industrial Wastewater	Swabia Creek	PA0012203	Private	Active	State
PAD000411363	Allentown City	Lehigh	PCS	Sewerage Systems	Sewage, Public	Lehigh Riv/ Little Lehigh CK/Other C	PA0063665	Public	Active	State
			AIRS/ AFS	Air and Water Resource and Solid Waste Management						
PAD987385267	Allied Utility Services INC	Lehigh	PCS	Sewerage Systems	Sewage, Public	Coplay Creek	PA0052426	Private	Active	State
PAD002399285	American Nickeloid Co.	Northampton	PCS	Electroplating	Industrial Wastewater	Lehigh River	PA0011762	Private	Active	State
			PA-Efacts	Sheet Metal Work						
PAD073652422	Ametek West Chester Plastics D	Carbon	TRIS	Custom Compounding of Purchased Plastics Resins	Industrial Wastewater	Nesquehoning Creek	PA0060747	Private	Active	State

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NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) OF THE LEHIGH RIVER WATERSHED *(continued)*

ID Number	Name	County	*Data Source	Description	Discharge Type	Receiving Stream	NPDES #	Ownership	Activity	Permit
			AIRS/AFS	Plastics Materials						
			PCS	Custom Compounding of Purchased Plastics Resins						
			NCDB							
PA0001646215	Arrowhead Sewer Company	Lackawanna	PCS	Sewerage Systems	Sewage, Public	Lehigh River	PA0001646215	Private	Active	State
PAD043394683	Ashland Chemical Company	Northampton	PA-Efacts	Chemicals and Chemical Preparations	Industrial Wastewater	Lehigh River	PAD043394683	Private	Active	EPA
			PCS	Industrial Inorganic Chemicals						
PAD000428441	Atlas Minerals Chemical Company	Berks	TRIS	Plastics Materials	Industrial Wastewater	Toad Creek	PA0012998	Private	Active	EPA
			TRIS	Paints						
			TRIS	Adhesives and Sealants						
			AIRS/AFS	Brick						
			PCS	Asphalt Felts and Coatings						
PAD987382496	Bath Boro Auth	Northampton	PCS	Sewerage Systems	Sewage, Public	Monocacy Creek	PA0020206	Public	Active	State
PA0001116300	Beaver Meadows Mun Auth	Carbon	PCS	Sewerage Systems	Sewage, Public	Beaver Creek	PA0021199	Public	Active	State
PAD987384583	Becker	Northampton	PCS	Operators of Residential Mobile Home Sites		Bertsch Creek	PA0052591	Private	Active	State
PA0001644962	Beers	Carbon	PCS	Sewerage Systems	Sewage, Non-Public	Aquashicola Creek	PA0062472	Private	Active	

National Pollutant Discharge Elimination System (NPDES) of the Lehigh River watershed *(continued)*

ID Number	Name	County	*Data Source	Description	Discharge Type	Receiving Stream	NPDES #	Ownership	Activity	Permit
PAD987268521	Bethlehem Authority- Waste Water	Lehigh	PCS	Sewerage Systems	Industrial Wastewater	Lehigh River	PA0026042	Public	Active	State
PA0001412667	Bethlehem City	Northampton	PCS	Water Supply		Indian Creek	PA0026218	Public	Active	State
PA0001587914	Bethlehem Steel Corp	Northampton	PCS	Steel Works		Lehigh River	PA0011177	Private	Active	State
			TRIS	Secondary Smelting and Refining of Nonferrous Metals						
PAD001339092	Bethlehem Steel Corp	Northampton	PCS	Metals Service Centers and Offices		Monocacy Creek	PA0040614	Private	Active	
PA0002258531	Big Boulder Corp	Carbon	PCS	Sewerage Systems		Tunkhannock Creek	PA0061182	Private	Active	State
PA0002258051	Blue Mountain Ski Area	Carbon	PCS	Amusement and Recreation Services	Sewage, Non-Public	Buckwha Creek	PA0063428	Private	Active	State
PA0001646736	Blue Ridge Real Estate	Carbon	PCS	Museums and Art Galleries		Porter Run	PA0034118	Private	Active	State
PAD003000197	Boc Gases	Northampton	PCS	Industrial Gases		Dry S Wale Trib to Lehigh Canal	PA0012092	Private	Active	State
8003462	Bohning	Northampton				East Branch Saucon Creek	PA0063886	Private	Active	State
PA0001644863	Bowmanstown Boro	Carbon	PCS	Sewerage Systems	Sewage, Public	Lehigh River	PA0062910	Public	Active	State
PAD987383346	Bookmont Health Care Center I	Monroe	PCS	Administration of Public Health Programs	Sewage, Non-Public	Pohopoco Creek	PA0062260	Private	Active	State
PAD060508397	Buckeye Pipeline Co	Lehigh	PCS	Refined Petroleum Pipelines	Industrial Wastewater	Swabia Creek	PA0055174		Active	State
			AIRS/AFS	Crude Petroleum Pipelines						

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NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) OF THE LEHIGH RIVER WATERSHED *(continued)*

ID Number	Name	County	*Data Source	Description	Discharge Type	Receiving Stream	NPDES #	Ownership	Activity	Permit
7566838	Burroughs Fuels Inc-Exxon Ones	Carbon				Mud Run	PA0063835	Private	Active	State
PA0000517847	Carbon Dack Assoc. LLC	Carbon	PCS	Sewerage Systems		Mahoning Creek	PA0061247	Private	Active	State
PAD987361689	Cas	Carbon	PCS	Sewerage Systems		Lehigh River	PA0070220	Private	Active	State
PAD035059013	Catasauqua Boro	Lehigh	PCS	Sewerage Systems	Sewage, Public	Lehigh River	PA0021580	Public	Active	State
			Docket	Public Finance						
9934958	Cempro Inc	Lehigh	PCS	Concrete Products		Monocacy Creek	PAS212207	Private	Active	State
7348940	Central Carbon Municipal Auth	Carbon	PCS	Sewerage Systems		Lehigh River	PA0063711	Public	Active	State
PAD041364373	Champion Spark Plus Company	Carbon	TRIS	Electric Lamp Bulbs and Tubes		Hazle Creek	PA0062626	Private	Active	State
			TRIS	Aircraft Parts And Auxiliary Equipment						
			PCS	Electronic Coils						
7168132	Chrin Brothers Landfill	Northampton	PCS	Refuse Systems	Industrial Wastewater	Storm Sewer Lehigh River	PAR502202	Private	Active	State
PAD057357485	Columbia Petroleum Corp.	Lehigh	PCS	Petroleum Bulk Stations and Terminals		Swabia Creek	PA0055361	Private	Active	State
PAD094230653	Comm Of PA - Dept of Public WE	Luzerne	PCS	Elementary And Secondary Schools		Linesville Creek	PA0036439	State	Active	State
			NCDB							
			NCDB							

National Pollutant Discharge Elimination System (NPDES) of the Lehigh River watershed *(continued)*

ID Number	Name	County	*Data Source	Description	Discharge Type	Receiving Stream	NPDES #	Ownership	Activity	Permit
PA0001644368	Conrad Michael & Linda	Berks	PCS	Sewerage Systems						
			PA-Efacts	Operators of Dwellings Other Than Apartment Buildings	Sewage, Non-Public	Swabia Creek	PA0086550	Private	Active	State
PAD115137416	Consolidated Cigar Corp.	Schuylkill	PCS	Cigars		Wet Weather Channel To Catawissa Ck	PA0039861	Private	Active	State
PAD987361821	Coolbaugh Twp	Monroe	PCS	Sewerage Systems		Tobyhanna Creek	PA0062294	Public	Active	State
PA0000632638	Crafco	Lehigh	PCS	Asphalt Paving Mixtures and Blocks		Lehigh River	PAR702205	Private	Active	State
PA0001645696	DCNR-Bur of State Parks -Beltzv	Carbon	PCS	Museums and Art Galleries	Sewage, Non-Public	Pohopoco Creek	PA0032107	State	Active	State
PA0001646710	DCNR-Hickory Run State Park	Luzerne	PCS	Museums and Art Galleries	Sewage, Non-Public	Hickory Run	PA0032999	State	Active	State
PA5213820892	Dept of Army/ Tobyhanna Army Depot	Monroe	PA-Efacts	Electrical Machinery		Hummler Run	PA0010987	Federal	Active	State
			PA-Efacts	Electric Services						
			PA-Efacts	National Security						
			TRIS	Sheet Metal Work						
			TRIS	Electroplating						
			TRIS	Fabricated Metal Products						
			PCS	General Government						
			BRS	Nonferrous Foundries						
			BRS	Communications Equipment						

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NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) OF THE LEHIGH RIVER WATERSHED *(continued)*

ID Number	*Name*	*County*	**Data Source*	*Description*	*Discharge Type*	*Receiving Stream*	*NPDES #*	*Ownership*	*Activity*	*Permit*
9861364	Eastern Industries Inc	Northampton	PCS	Asphalt Paving Mixtures and Blocks		Monocacy Creek	PAS702203	Private	Active	State
PA0001644707	Ecolaire Inc	Northampton	PCS	Fabricated Plate Work (Boiler Shops)	Industrial Wastewater	Lehigh River	PA0051551	Private	Active	State
9356708	Essroc Cement Corp	Lehigh	PCS	Cement		Ranger Lake to Coplay Creek	PA0063983	Private	Active	State
PA0001645076	Fairland Sewer Co Inc	Lehigh	PCS	Sewerage Systems		Fells Creek	PA0063282	Private	Active	State
PAD987384732	Farm & Home Oil Co.	Lehigh	PCS	Petroleum Bulk Stations and Terminals		Swabia Creek	PA0062782	Private	Active	State
PAD043277466	Farm and Home Oil Co.	Bucks	PCS	Fuel Oil Dealers	Industrial Wastewater	Swabia Creek	PA0053813	Private	Active	State
PA0001646744	Foster Twp	Luzerne	PCS	Sewerage Systems		Lehigh River	PA0061689	Public	Active	State
PA0002257913	Four Seasons Village	Carbon	PCS	Sewerage Systems	Sewage, Non-Public	Mahoning Creek	PA0060879	Private	Active	State
10207030	Frank Casilio & Sons Inc	Northampton	PCS	Ready-Mixed Concrete		Lehigh River	PAR212223	Private	Active	State
PA0000550145	Freeland Boro Mun Auth	Luzerne	PCS	Sewerage Systems		Wet Weather Channel to Pond Creek	PA0024716	Public	Active	State
PAD002518090	Friskies Petcare Co / Alpo Petfood	Lehigh	PCS	Dog and Cat Food		Jordan Creek	PA0014681	Private	Active	State
PAD000431437	Geo Specialty Chemicals - Trim	Lehigh	PA-Efacts	Paints	Industrial Wastewater	Jordan Creek	PA0070505	Private	Active	State
			PCS	Industrial Organic Chemicals						

National Pollutant Discharge Elimination System (NPDES) of the Lehigh River watershed *(continued)*

ID Number	Name	County	*Data Source	Description	Discharge Type	Receiving Stream	NPDES #	Ownership	Activity	Permit
PA0001115716	Glencrest Realty Company	Lehigh	PCS	Mobile Home Dealers	Sewage, Non-Public	Coplay Creek	PA0034070	Private	Active	State
PA0000548818	Hazleton City Auth-Water Dept.	Luzerne			Industrial Wastewater	Dreck Creek Reservoir - Dam F	PA0063011	Public	Active	State
PA0001644442	Hickory Hills MHC	Northampton	PCS	Operators of Residential Mobile Home Sites	Sewage, Non-Public	East Branch Monocacy Creek	PA0032328	Private	Active	State
PA0001645845	Hickory Sewer Corp.	Luzerne	PCS	Sewerage Systems		Pond Creek	PA0061875	Private	Active	State
PA0001644871	Holota. Steven	Northampton	PCS	Sewerage Systems		Indian Creek	PA0051608	Private	Active	State
PA0001645555	Hometown Li'L Wolf LLC	Lehigh	PCS	Mobile Home Dealers		Coplay Creek	PA0034746	Private	Active	State
PAD002392991	Ingersoll - Rand Company	Lehigh	PA-Efacts	Hand and Edge Tools		Lehigh River	PAR112205	Private	Active	State
			PA-Efacts	Internal Combustion Engines						
			PA-Efacts	Mining Machinery and Equipment						
			PCS	Pumps and Pumping Equipment						
			PA-Efacts	Fluid Power Pumps and Motors						
			PA-Efacts	Industrial Supplies						
PA0002258671	International Resort Properties	Carbon	PCS	Hotels and Motels		Black Creek	PA0032972	Private	Active	EPA
7348970	J & J Enterprises - Close Properties	Carbon				Tunkhannock Creek	PA0063789	Private	Active	State

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NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) OF THE LEHIGH RIVER WATERSHED *(continued)*

ID Number	*Name*	*County*	**Data Source*	*Description*	*Discharge Type*	*Receiving Stream*	*NPDES #*	*Ownership*	*Activity*	*Permit*
PA0001645670	Jim Thorpe Boro	Carbon	PCS	Water Supply	Sewage, Public	Mauch Chunk Creek	PA0062421	Public	Active	State
PAD051883668	Jim Thorpe Boro	Carbon	PCS	Sewerage Systems	Sewage, Public	Lehigh River	PA0021873	Public	Active	State
PAD987398781	Just Born	Northampton	PCS	Candy and Other Confectionary Products		Storm Sewer to Lehigh River	PA0062791	Private	Active	State
PAD094224771	Kama Corp	Luzerne	PCS	Unsupported Plastics Film and Sheet		Hazle Creek	PAR232209	Private	Active	State
			TRIS	Plastics Products						
			AIRS/AFS	Plastics Materials						
PAD002389559	Keystone Cement Company	Northampton	PCS	Cement	Industrial Wastewater	Monocacy Creek	PA0011517	Private	Active	State
			Docket	Local Trucking Without Storage						
PA0000567503	Keystone MHP	Lehigh	PCS	Operators of Residential Mobile Home Sites	Sewage, Non-Public	Lehigh River	PA0044270	Private	Active	State
PA0001644525	Kidspeace Corp	Lehigh				Jordan Creek	PA0062880	Private	Active	State
PAD987386562	Lakeview Estates International	Wayne	PCS	Private Households	Sewage, Non-Public	Lake Watauqua Outfall	PA0062367	Private	Active	State
PAD002393460	Larfarge Corp	Lehigh	PCS	Cement	Industrial Wastewater	Lehigh River	PA0012505	Private	Active	
PA0000519785	Laroche Industries	Carbon	PCS	Chemicals and Allied Products	Industrial Wastewater	Aquashicola Creek	PA0062138	Private	Active	
8019512	Lasko Metal Products Inc	Chester	PCS	Electric Housewares and Fans		Goose Creek	PAR110014	Private	Active	State
PA0000520486	Laudenslager Roy	Lehigh	PCS	Sewerage Systems	Sewage, Non-Public	Jordan Creek	PA0062511	Private	Active	State
PA0000560862	Lehigh CO Auth / Green Hills Wat	Lehigh	PCS	Refuse Systems		Little Cedar Creek	PA0051811	Private	Active	State

National Pollutant Discharge Elimination System (NPDES) of the Lehigh River watershed *(continued)*

ID Number	Name	County	*Data Source	Description	Discharge Type	Receiving Stream	NPDES #	Ownership	Activity	Permit
PA0001115617	Lehigh County Auth - Heidelber	Lehigh	PCS	Sewerage Systems	Sewage, Non-Public	Mill Creek	PA0036102	Public	Active	State
PA0001645050	Lehigh County Community College	Lehigh	PCS	Sewerage Systems	Sewage, Non-Public	Jordan Creek	PA0051799	Public / Private	Active	State
PAD987361854	Lehigh County Game Preserve	Lehigh	PCS	Sewerage Systems	Sewage, Non-Public	Jordan Creek	PA0055131	State	Active	State
7348872	Lehigh Twp Mun Auth	Northampton	PCS	Sewerage Systems	Sewage, Public	Indian Creek	PA0063231	Public	Active	State
7348882	Lehigh Twp Mun Auth	Northampton	PCS	Sewerage Systems	Sewage, Public	Bertsch Creek	PA0063240	Public	Active	State
PA0001482116	Lehigh University	Northampton	PCS	Colleges		Saucon Creek	PA0044423	Private	Active	State
PAD987335866	Lehighton Boro	Carbon	PCS	Sewerage Systems		Mahoning Creek	PA0020494	Public	Active	State
PAD002399186	Lehighton Electronics Inc	Carbon	PCS	Relays and Industrial Controls	Industrial Wastewater	Mahoning Creek	PA0044920	Private	Active	State
			BRS	Printed Circuit Boards						
PA0001106798	Lehighton Land Co - Otto's Cam	Carbon	PCS	Recreational Vehicle Parks and Campsites		Pohopoco Creek	PA0061948	Private	Active	State
8746380	Lehighton Water Auth	Carbon	PCS	Water Supply	Sewage, Public	Long Run	PA0063860	Public	Active	State
PA0002258150	Lehighton Water Auth	Carbon	PCS	Water Supply		Long Run	PA0062936	Public	Active	State
PAD002389252	Lucent Technologies	Lehigh	PA-Efacts	Telephone and Telegraph Apparatus	Industrial Wastewater	Spring Run - Trib To Lehigh River	PA0011134	Private	Active	State
			PCS	Semiconductors and Related Devices						
			PA-Efacts	Electronic Components						
			NCDB							

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NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) OF THE LEHIGH RIVER WATERSHED *(continued)*

ID Number	Name	County	*Data Source	Description	Discharge Type	Receiving Stream	NPDES #	Ownership	Activity	Permit
PA0001115856	Mahoning Valley Nursing & Reha	Carbon	PCS	Intermediate Care Facilities	Sewage, Non-Public	Stewart Creek	PA0070491	Private	Active	State
9053150	Micropack Corp	Carbon				Aquashicola Creek	PA0063941	Private	Active	State
PA0001646892	Montrose Mun Auth	Susquehanna	PCS	Sewerage Systems	Sewage, Public	Pettis Creek	PA0060801	Public	Active	State
PA0000466185	Nesquehoning Boro Council	Carbon	PCS	Public Order and Safety	Sewage, Public	Nesquehoning Creek	PA0062243	Public	Active	State
7349528	Northampton Area School Dist	Northampton	PCS	Sewerage Systems	Sewage, Public	Trib of Hokendaqua Creek	PA0051675	Public / Private	Active	State
PAD987345493	Northampton Boro	Northampton	PCS	Sewerage Systems		Hokendaqua Creek	PA0031127	Public	Active	State
PA0002257996 Boro Mun Auth	Northampton	Lehigh	PCS	Water Supply	Sewage, Public	Spring Creek	PA0063568	Public / Private	Active	State
PA0002181121	Northampton Pulp LLC	Northampton	PCS	Pulp Mills		Lehigh River	PA0063266	Private	Active	State
PA0000567016	Northeastern Lehigh School Dis	Berks	PCS	Elementary And Secondary Schools		Trib to Lyon Creek	PA0040932	Public / Private	Active	State
PA0001645092	Owen Lois	Northampton	PCS	Sewerage Systems	Sewage, Non-Public	Bertsch Creek	PA0051594	Private	Active	State
9285742	PA Perlite Corp	Northampton	PCS	Minerals and Earths		Monocacy Creek	PAS212206	Private	Active	State
PA0000548289	Palmerton Boro	Carbon	PCS	Sewerage Systems	Sewage, Public	Aquashicola Creek	PA0023051	Public	Active	State
PA0001115724	Parkland School Dist	Lehigh	PCS	Sewerage Systems	Sewage, Non-Public	Jordan Creek	PA0052132	Public / Private	Active	State
PAD095366456	Parkland School Dist - Kernsvi	Lehigh	PCS	Elementary And Secondary Schools	Sewage, Non-Public	Jordan Creek	PA0070246	Public / Private	Active	State
PA0002258036	Pencor Services	Monroe			Sewage, Non-Public	Pohopoco Creek	PA0062502	Private	Active	State
PA0002258689	Penn Lake Park Boro Sew Auth	Luzerne				Wright Creek	PA0063614	Public	Active	State

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) OF THE LEHIGH RIVER WATERSHED *(continued)*

ID Number	Name	County	*Data Source	Description	Discharge Type	Receiving Stream	NPDES #	Ownership	Activity	Permit
PA0000516674	Phamachem Corporation	Northampton	TRIS	Medicinal Chemicals and Botanical Products						
			TRIS	Pharmaceutical Preparations						
			PCS	Sewerage Systems	Industrial Wastewater	Lehigh Canal	PA0051691	Private	Active	
PA0002258283	Pinecrest Development Corp	Monroe	PCS	Sewerage Systems		Beaver Creek	PA0061719	Private	Active	State
PAD000780023	Pipeline Petroleum Inc	Lehigh	PCS	Petroleum and Petroleum Products Wholesalers		Little Lehigh Creek	PA0041009	Private	Active	State
			AIRS/AFS	Petroleum Bulk Stations and Terminals						
PAD987363462	Pocono International Raceway	Monroe	PCS	Hotels and Motels		Tobyhanna Creek	PA0035351	Private	Active	State
PA0000519561	Pocono Mountain Industries Inc	Monroe	PCS	Sewerage Systems		Red Run	PA0060895	Private	Active	State
PA0001648633	Pocono Mountain Lodge	Carbon	PCS	Operators of Apartment and Buildings		Black Creek	PA0070475	Private	Active	State
PAD056602923	Prior Coated Metals	Lehigh	PA-Efacts	Electroplating		Trout Creek	PAR202216	Private	Active	State
			PCS	Coating						
PA0001115799	Property Management Inc -Maple	Luzerne	PCS	Operators of Residential Mobile Home Sites		Pond Creek	PA0040487	Private	Active	
PA0002258010	Reliant Energy New Jersey Hold	Lehigh	PCS	Petroleum Bulk Stations and Terminals		Lehigh River	PA0036811	Private	Active	State

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NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) OF THE LEHIGH RIVER WATERSHED *(continued)*

ID Number	Name	County	*Data Source	Description	Discharge Type	Receiving Stream	NPDES #	Ownership	Activity	Permit
PAD053061578	Rhodia Inc	Northampton	PA-Efacts	Industrial Gases		Monocacy Creek	PA0028495	Private	Active	State
			PA-Efacts	Industrial Inorganic Chemicals						
			PA-Efacts	Industrial Organic Chemicals						
			PCS	Cyclic Organic Crudes and Intermediates						
			NCDB							
8031774	Ritter Dean & Marybeth	Lehigh				Jordan Creek	PAG042202	Private	Active	State
7607792	Saunders James & Judy	Schuylkill				Lizard Creek	PA0063827	Private	Active	State
PA0001645704	Schleicher Duane	Carbon				Lizard Creek	PA0063487	Private	Active	State
PAD987385747	Slatington Boro Auth	Lehigh	PCS	Sewerage Systems	Sewage, Public	Lehigh River	PA0020176	Public	Active	State
PA0001644756	Sobotka Chales III & Carla	Northampton	PCS	Private Households		East Branch of Saucon Creek	PA0063088	Private	Active	State
PA0001644459	SPG Inc - Whispering Hollow No	Northampton	PCS	Operators of Residential Mobile Home Sites		Hokendaqua Creek	PA0070301	Private	Active	State
PA0000519991	Stillwater Sewer Corp.	Monroe	PCS	Sewerage Systems	Sewage, Non-Public	Stillwater Lake	PA0061107	Private	Active	State
PA0000518761	Stoney Creek Hotel	Carbon	PCS	Sewerage Systems	Sewage, Non-Public	Stoney Creek	PA0063037	Private	Active	State
PA0001644848	Stout Henry	Lehigh	PCS	Sewerage Systems	Sewage, Non-Public	Jordan Creek	PA0062766	Private	Active	State
7348802	Sun Company Inc (R&M)	Carbon	PCS	Sewerage Systems	Industrial Wastewater	Stoney Creek	PA0061905	Private	Active	State
PAD041552829	Tarkett	Lehigh	PCS	Linoleum	Industrial Wastewater	Lehigh River	PA0013234	Private	Active	State

National Pollutant Discharge Elimination System (NPDES) of the Lehigh River watershed *(continued)*

ID Number	Name	County	*Data Source	Description	Discharge Type	Receiving Stream	NPDES #	Ownership	Activity	Permit
PAD987286711	Thornhurst Cntry Club Estates	Luzerne	PCS	Savings Institutions	Sewage, Non-Public	Pond Creek	PA0060411	Private	Active	State
PA0001645852	Tobyhanna Twp	Monroe			Sewage, Public	Tobbyhanna Creek	PA0063533	Private	Active	State
PAD043405281	Topton Boro	Berks	PCS	Sewerage Systems	Sewage, Public	Toad Creek	PA0020711	Public	Active	State
PA0001645571	Travel Ports Of America Inc	Lehigh				Cedar Creek	PA0063495	Private	Active	State
PAD987345576	Upper Saucon Twp Mun Auth	Lehigh	PCS	Sewerage Systems	Sewage, Public	Saucon Creek	PA0053147	Public	Active	State
PAD987386687	Valley Gorge MHP	Luzerne	PCS	Mobile Homes	Sewage, Non-Public	Wildcat Run	PA0062251	Private	Active	State
PAD033897752	Wayne Highlands School Dist	Wayne	PCS	Elementary And Secondary Schools		Equinunk Creek	PA0060861	Public / Private	Active	State
			Docket	Administration of Educational Programs						
PA0002258176	Weatherly Boro	Carbon	PA-Efacts	Water Supply	Sewage, Public	Black Creek	PA0021555	Public	Active	State
			PCS	Sewerage Systems						
PA0000566836	Whispering Hollow South MHP	Northampton	PCS	Mobile Home Dealers	Sewage, Non-Public	Hokendaqua Creek	PA0033740	Private	Active	State
PA0001646694	White Haven Mun Auth	Luzerne	PCS	Sewerage Systems	Sewage, Public	Lehigh River	PA0020435	Public	Active	State
PA0002404788	Whitney Stephen	Delaware				Ridley Creek	PA0057380	Private	Active	State
9053160	Willis Elaine	Monroe				Deep Run	PA0063959	Private	Active	State
PA0001756527	Wynnewood Sewer Corp	Lehigh	PCS	Operators of Residential Mobile Home Sites		Lehigh River	PA0036081	Private	Active	State
PA0002257970	Youngs Webster	Lehigh				Saucon Creek	PA0053163	Private	Active	State

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NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) OF THE LEHIGH RIVER WATERSHED *(continued)*

ID Number	*Name*	*County*	**Data Source*	*Description*	*Discharge Type*	*Receiving Stream*	*NPDES #*	*Ownership*	*Activity*	*Permit*
PAD002395887	Zinc Corp of America - Palmert	Carbon	PA-Efacts	Inorganic Pigments	Industrial Wastewater	Aquashicola Creek and Lehigh River	PA0012751	Private	Active	State
			PA-Efacts	Primary Smelting and Refining of Nonferrous Metals						
			PA-Efacts	Secondary Smelting and Refining of Nonferrous Metals						
			PA-Efacts	Business Services						
			TRIS	Primary Metal Products						
			BRS	Nonclassifiable Establishments						
			Docket	Refuse Systems						

Notes:

PCS - Water Discharge Permits, EPA

PA-Efacts - Pennsylvania Environment, Facility, Application, Compliance Tracking System

BRS - Biennial Reporting System

TRIS - Toxic Chemical Release Inventory System

Docket - Enforcement Docket System

AIRS/AFS Aerometric Information Retrieval System/AIRS Facility Subsystem

NCDB National Compliance Data Base

Appendix A-3.

TRIS FACILITIES WITHIN THE LEHIGH RIVER WATERSHED

(Source: EPA environfacts, March 2001)

Source: U.S. Environmental Protection Agency

Facility ID	*Facility Name*	*Facility Address*
PAD987324951	A-TREAT BOTTLING CO.	2001 Union Blvd. Allentown, PA 18103
PA0000114868	ACME CRYOGENICS INC.	2801 Mitchell Ave. Allentown, PA 18103
PAD987367216	ADVANCED ENVIRONMENTAL RECYCLING CO. L.L.C.	2591 Mitchell Ave. Allentown, PA 18103
PAD021446935	AIR PRODS. & CHEMICALS INC., GARDNER CRYOGENICS FA	2136 City Line Rd. Bethlehem, PA 18002
PAD982569998	ALSTOM ENERGY SYS.	1550 Lehigh Dr. Easton, PA 18042
PAD079162848	AMERICAN NATL. CAN CO.	100 National Dr. Fogelsville, PA 18051
PAD002399285	AMERICAN NICKELOID CO.	129 Cherry St. Walnutport, PA 18088
PAD073652422	AMETEK WESTCHESTER PLASTICS	Green Acres Industrial Park Nesquehoning, PA 18240
PAD987329893	AMPAL INC.	2125 Little Gap Rd. Palmerton, PA 18071
PAD002392827	APOLLO METALS LTD.	1001 14th Ave. Bethlehem, PA 18018
PAD987328416	ASHLAND ACT	450 Allentown Dr., Allentown Business Park Allentown, PA 18103
PAD043394683	ASHLAND SPECIALTY CHEMICAL CO.	400 Island Park Rd. Easton, PA 18042
PAD000428441	ATLAS MINERALS & CHEMICALS, INC.	1227 Valley Rd. Mertztown, PA 19539
PAD982679169	B. BRAUN MEDICAL INC. MFG. DIV.	901 Marcon Blvd. Allentown, PA 18103
PAD982679169	B. BRAUN MEDICAL INC. MFG. DIV.	901 Marcon Blvd. Allentown, PA 18103
PAD987325156	BEATRICE CHEESE INC.	1002 Macarthur Rd. Whitehall, PA 18052
PAD987325164	BELL & HOWELL PHILLIPSBURG CO.	795 Roble Rd. Allentown, PA 18103
PAD002390961	BETHLEHEM APPARATUS CO. INC.	890 Front St. Hellertown, PA 18055
PAD002397495	BETHLEHEM CORP.	25th & Lennox St. Easton, PA 18045

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TRIS FACILITIES WITHIN THE LEHIGH RIVER WATERSHED *(continued)*

Facility ID	*Facility Name*	*Facility Address*
PA0001587914	BETHLEHEM STEEL CORP., STRUCTUAL PRODS. DIV.	501 E. 3rd St. Bethlehem, PA 18016
PA0002377851	BETHLEHEM STEEL STRUCTURAL, PRODS. CORP. METALS OP	1805 E. Fourth St. Bethlehem, PA 18016
PAD000621110	BETHLEHEM STRUCTURAL PRODS. CORP. COKE OPS.	2400 Coke Works Rd. Bethlehem, PA 18016
PAD001729615	BLUE RIDGE PRESSURE CASTINGS INC.	10th & Bridge Sts. Lehighton, PA 18235
PAD003000197	BOC GASES	1011 E. Market St. Bethlehem, PA 18017
PAD987333689	BONNEY FORGE CORP.	Cedar & Meadow Sts. Allentown, PA 18105
PAD003400256	BRIDESBURG FNDY. CO.	Front & Grape Sts. Whitehall, PA 18052
PAD982679169	BURRON MEDICAL INC.	901 Marcon Blvd. Allentown, PA 18103
PAD982679169	BURRON MEDICAL INC.	901 Marcon Blvd. Allentown, PA 18103
PA0000549477	CALORIC CORP.	403 N. Main St. Topton, PA 19562
9059630	CARLOS R. LEFFLER INC. MACUNGIE TERMINAL	5088 Shippers Ln. Macungie, PA 18062
PAD047353172	CARPENTER INSULATION CO., INSULATION DIV.	57 Olin Way Fogelsville, PA 18051
PAD047353172	CARPENTER INSULATION CO., INSULATION DIV.	Snowdrift Rd. Fogelsville, PA 18051
9934958	CEMPRO	298 Keystone Dr. Bethlehem, PA 18017
PAD987351343	CENTEC ROLL CORP.	1287 Applebutter Rd. Bethlehem, PA 18015
PAD041364373	CHAMPION AVIATION	75 W. Main St. Weatherly, PA 18255
PAD041364373	CHAMPION AVIATION	75 W. Main St. Weatherly, PA 18255
PAD987325362	COCA-COLA BOTTLING CO. OF LEHIGH VALLEY	2150 Industrial Dr. Bethlehem, PA 18017
PA0001917863	COCA-COLA USA FOUNTAIN	7551 Schantz Rd. Allentown, PA 18106
PAD987325412	CONAGRA FLOUR MILLING CO.	321 E. Breadfruit Dr. Treichlers, PA 18086
PAD115137416	CONSOLIDATED CIGAR CORP.	Mcadoo & Tresckow Rds. Mc Adoo, PA 18237
PAD987284593	COPLAY CEMENT CO.	S. Church St. Whitehall, PA 18052

TRIS FACILITIES WITHIN THE LEHIGH RIVER WATERSHED *(continued)*

Facility ID	*Facility Name*	*Facility Address*
PAD002390383	DENT MFG. INC.	226 W. 27 St. Northampton, PA 18067
PAD987367976	DOANE PET CARE CO.	6821 Ruppsville Rd. Allentown, PA 18106
PAD047353172	E. R. CARPENTER CO. INC.	57 Olin Way Fogelsville, PA 18051
PAD047353172	E. R. CARPENTER CO. INC.	Snowdrift Rd. Fogelsville, PA 18051
PAD002368066	ELECTRO-SPACE FABRICATORS INC.	300 W. High St. Topton, PA 19562
7620140	ELEMENTIS CATALYSTS INC.	1 W. Allen St. Unit 11 Allentown, PA 18102
PAD002391548	ELEMENTIS PIGMENTS INC.	1525 Wood Ave. Easton, PA 18042
PAD987320736	ENCOR COATINGS INC.	Rte. 248 Bath, PA 18014
6748902	EVERSON ELECTRIC CO.	2000 City Line Rd. Bethlehem, PA 18017
PAD981044381	EVERSON ELECTRIC CO.	860 N. Kiowa St. Allentown, PA 18103
PAD002398659	EXIDE CORP.	2001 Lehigh St. Allentown, PA 18103
PAD130764012	FOAM DESIGN INC.	934 Marcon Blvd. Allentown, PA 18103
PAD098736077	FOAMEX L.P.	50 Hilton St. Easton, PA 18042
PAD002518090	FRISKIES PETCARE CO. INC.	2050 Pope Rd. Allentown, PA 18104
PA0001901958	G & T INDS. OF PA INC. ALLENTOWN DIV.	W. Park Business Center, 7566 Morris Ct. Ste. 320 Allentown, PA 18106
PAD065645038	GARLAND COMMERCIAL IND.	185 E. South St. Freeland, PA 18224
PAD000431437	GEO SPECIALTY CHEMICALS TRIMET PRODS. GROUP	2409 N. Cedar Crest Blvd. Allentown, PA 18104
PAD002395887	HORSEHEAD RESOURCE DEVELOPMENT CO. INC.	Delaware Ave. Palmerton, PA 18071
PAD002395887	HORSEHEAD RESOURCE DEVELOPMENT CO. INC.	Delaware Ave. Palmerton, PA 18071
PA0000610352	HOUGHTON INTL. INC.	6681 Snowdrift Rd. Fogelsville, PA 18051
9059532	IMS WAYLITE INC.	1155 Business Center Dr. Horsham, PA 19044

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TRIS FACILITIES WITHIN THE LEHIGH RIVER WATERSHED *(continued)*

Facility ID	*Facility Name*	*Facility Address*
PAD080880040	IMS WAYLITE INC.	Rd. 5 Easton Rd. Bethlehem, PA 18015
PAD002392991	INGERSOLL-DRESSER PUMP CO.	1 Pump Pl. Allentown, PA 18105
PAD002395325	ITT ELECTRON TECH. DIV.	3100 Charlotte Ave. Easton, PA 18042
PAD987342979	J. R. PETERS INC.	6656 Grant Way Allentown, PA 18106
PAD094224771	KAMA CORP.	600 Dietrich Ave. Hazleton, PA 18201
PAD002389559	KEYSTONE CEMENT CO.	Rte. 329 Bath, PA 18014
PAD098735244	KME	1 Industrial Complex Nesquehoning, PA 18240
PAD981040710	KNOLL GROUP	1 Daniels Dr. Fogelsville, PA 18051
PA0000258988	KRAFT FOODS INC.	7352 Industrial Blvd. Allentown, PA 18106
PAD002393460	LAFARGE CORP. WHITEHALL PLANT	5160 Main St. Whitehall, PA 18052
PAD987325255	LAROCHE INDS. INC.	4th St. & Delaware Ave. E. Plant Zinc Corp Of Amer Palmerton, PA 18071
PAD982364226	LEBANON CHEMICAL CORP.	19th & Lawrence Allentown, PA 18104
PAD987325883	LEHIGH CULTURED MARBLE INC.	111 Lehigh St. Macungie, PA 18062
PA0000008631	LEHIGH HEAVY FORGE CORP.	1275 Daly Ave. Bethlehem, PA 18015
PAD987318193	LEHIGH VALLEY DAIRIES INC.	1000 N. Seventh St. Allentown, PA 18001
PAD002388528	LIFETIME DOORS INC.	Kesslersville Rd. Easton, PA 18042
PAD042845636	LIQUID CARBONIC	3720 Laurel Run Rd. Laflin, PA 18702
PAD002389252	LUCENT TECHS. INC.	555 Union Blvd. Allentown, PA 18103
PA0002180891	M. A. HANNA COLOR	2513 Highland Ave. Bethlehem, PA 18020
PAD042321117	MACK TRUCKS INC.	South 12th St. Allentown, PA 18103
PAD060493582	MACK TRUCKS INC.	7000 Alburtis Rd. Macungie, PA 18062
PA0000898726	MANCOR PA. INC.	160 Olin Way Allentown, PA 18106

TRIS FACILITIES WITHIN THE LEHIGH RIVER WATERSHED *(continued)*

Facility ID	*Facility Name*	*Facility Address*
PAD045133600	MANNESMANN REXROTH CORP.	2315 City Line Rd. Lehigh Valley, PA 18017
PA0002453702	MFS INC.	Rr #5 Box 5151 Easton Rd. Bethlehem, PA 18015
PA0000965533	MINRAD INC.	3950 Schelden Circle Bethlehem, PA 18017
PAD060511086	MOBIL OIL ALLENTOWN TERMINAL	1134 N. Quebec St. Allentown, PA 18103
PA0002453751	NATIONAL MAGNETICS GROUP INC.	1210 Win Dr. Bethlehem, PA 18017
PAD982566341	OPTOELECTRONICS CENTER	9999 Hamilton Blvd. Breinigsville, PA 18031
PAD056605959	PABST BREWING CO.	7880 Stroh Dr. Fogelsville, PA 18051
10162018	PACKAGING CORP. OF AMERICA	Cetronia Rd. Trexlertown, PA 18087
PA0000898734	PANTHER CREEK ENERGY FACILITY	4 Dennison Rd. Nesquehoning, PA 18240
PA0002453835	PENN FOAM CORP.	2625 Mitchell Ave. Allentown, PA 18103
PA0000898700	PENNSYLVANIA METALLURGICAL INC.	315 Columbia St. Bethlehem, PA 18015
PAD002395226	PFIZER PIGMENTS INC.	Rd. 4 Box 11 P Slatington, PA 18080
PAD987282647	PFIZER PIGMENTS INC.	640 N 13 St. Easton, PA 18042
PA0001385574	PG&E NATL. ENERGY GROUP NORTHAMPTON GENERATING PLA	1 Horwith Dr. Northampton, PA 18067
PA0000516674	PHARMACHEM CORP.	719 Stefko Blvd. Bethlehem, PA 18018
PAD002394765	PHOENIX FORGING CO. INC.	800 Front St. Catasauqua, PA 18032
9934968	PHOENIX HOTFORM	7550 Walker Way Allentown, PA 18106
PAD987345790	PHOENIX TUBE CO. INC.	1185 Win Dr. Bethlehem, PA 18017
PAD003001229	PILLSBURY CO.	2132 Downyflake Ln. Allentown, PA 18103
PA0000898718	POLYMER DYNAMICS INC.	2200 S. 12th St. Allentown, PA 18105
PA0002453785	POLYTEK DEVELOPMENT CORP.	55 Hilton St. Easton, PA 18042
PAD075995803	PP&L -MONTOUR STEAM ELECTRIC STATION	18 Mcmichael Rd. Danville, PA 17821

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TRIS FACILITIES WITHIN THE LEHIGH RIVER WATERSHED *(continued)*

Facility ID	*Facility Name*	*Facility Address*
PAD987339447	PRAXAIR DISTRIBUTION INC.	145 Shimersville Rd. Bethlehem, PA 18015
PAD045136884	PRINCE MFG. CO.	700 Lehigh St. Bowmanstown, PA 18030
PAD056602923	PRIOR COATED METALS	2233 26th St. S.W. Allentown, PA 18103
PA0002298529	PURITAN PRODS. INC.	635-711 Mill St. Allentown, PA 18103
PA0002434512	PURITAN PRODS. INC.	2290 Ave. A Bethlehem, PA 18017
PAD980552020	SAFETY-KLEEN SYS. (200701)	5540 Memorial Rd. Allentown, PA 18104
PAD987325511	SPECIALTY BRANDS, DURKEE-FRENCH PLANT	1001 8th Ave. Bethlehem, PA 18018
PAD002517274	SPIRAX SARCO INC.	1951 Glenwood St. S.W. Allentown, PA 18103
PAD001681352	STANLEY STORAGE SYSTEM	11 Grammes Rd. Allentown, PA 18105
PAD002389195	SYNTHETIC THREAD CO. INC.	825 12th Ave. Bethlehem, PA 18018
PAD041552829	TARKETT INC.	1139 Lehigh Ave. Whitehall, PA 18052
PA0000112326	TECHNICAL OIL PRODS. INC.	1 Adamson St. Easton, PA 18042
PAD001732718	TOWER PRODS. INC.	2703 Freemansburg Ave. Easton, PA 18045
PAD060494416	TRI-CITY MARBLE INC. 130130	4724 Springside Ct. Allentown, PA 18104
PAD002517381	TYLER PIPE CO.	101 N. Church St. Macungie, PA 18062
PA5213820892	U.S. ARMY, TOBYHANNA ARMY DEPOT	11 Hap Arnold Blvd. Tobyhanna, PA 18466
PAD987367836	VICTAULIC CO. OF AMERICA - ALBURTIS FACILITY	8023 Quarry Rd. Alburtis, PA 18011
PAD981041718	VICTOR-BALATA BELTING CO.	1118 S. 25th St. Easton, PA 18042
PAD041364373	WAGNER LIGHTING	75 W. Main St. Weatherly, PA 18255
PAD041364373	WAGNER LIGHTING	75 W. Main St. Weatherly, PA 18255
PAD002390219	WEATHERLY CASTING & MACHINE CO	300 Commerce St. Weatherly, PA 18255
PAD002395887	ZINC CORP. OF AMERICA	Delaware Ave. Palmerton, PA 18071
PAD002395887	ZINC CORP. OF AMERICA	Delaware Ave. Palmerton, PA 18071

Appendix A-4

PREVIOUS SURFACE WATER QUALITY STUDIES

A. Study 1: Lehigh River Biological Investigation, DRBC, PA Fish Commission, and PA Dept. of Health, 1965-1966

The objective of the Lehigh River water quality and biological investigation was to determine the relationship between water quality of the Lehigh River and its biological productivity as they relate to the present and future potential of the resident and anadromous (fish swimming upstream from the sea to spawn) fishery resources of the Delaware River basin. The field studies were conducted during the summers of 1965 and 1966 by the Delaware River Basin Commission, the Pennsylvania Fish Commission, and the Pennsylvania Department of Health. The samples included fish, aquatic vascular plants, macro-invertebrates, instream bioassays, and the standard physical and chemical properties of water.

The Lehigh River water quality survey was conducted during the summer months of 1965 and 1966; after the 1965 program was completed; eight additional sampling stations were established to permit additional studies in defined problem areas.

1. MINERAL AND PHYSICAL CHARACTERISTICS

(a) Temperature

The water temperature in the headwaters of the Lehigh River at Stoddartsville (L.R. 84.8 mile) and White Haven (L.R. 71.89 mile) during August and September 1965 was below 70°F. Downstream the temperature increased slowly reaching a mean of approximately 76-77°F from Walnutport (L.R. 33.3 mile) to the upstream area of Bethlehem (L. R. 12.2 mile). Sharp rises in temperature were recorded at the Freemansburg Bridge, Pennsylvania Route #412 (L. R. 9.3 mile). The mean temperature at this point was 85°F with a maximum reading of 92oF on August 18, 1965. The temperature decreased downstream to mean values of 83F at the 25th Street Bridge in Easton (L.R. 2.28 mile) and 80°F at the Third Street Bridge in Easton (L.R. 0.28 mile). The Delaware River had mean temperatures of 82°F at Easton water intake (D.R. 185.14 mile) and 79°F at Riegelsville Bridge (D.R. 169.3 mile). However, the samples collected at Easton were taken at the intake structure of the Easton filtration plant along the shoreline and may not be representative of temperature conditions at the center of the river. Single same-day grab samples taken at the center of the river above and below the Lehigh River both had temperature of 78°F.

(b) Alkalinity-acidity-pH

The alkalinity of the Lehigh River and the waters above White Haven was low. In this area, alkalinity concentrations averaged 12 mg/L. The pH ranged from 6.4 to 7.1. Beginning with the confluence of Sandy Run, four streams that contain acid mine drainage entered an 18-mile section of the Lehigh River. The acid tributaries are shown in Table A-1.

TABLE A-1. 1965 pH IN THE AMD TRIBUTARIES

AMD Tributary	*Average pH*
Sandy Run	3.7
Buck Mountain Creek	3.8
Black Creek	4.6
Nesquehoning Creek	4.5

The pH of these streams ranged from 3.7 to 4.6. They contained acidity concentrations that ranged from 56 to 116 mg/L. The acid tributaries caused a sharp decrease in the pH and alkalinity of the Lehigh River. The alkalinity of the Lehigh River was reduced in the reach and totally

depleted blow the confluence of Sandy Run (L.R. 67.8 mile) and at Lehighton (L.R. 43.14 mile). There was an immediate lowering of the pH of the Lehigh River at the point of confluence of each tributary followed by gradual recovery. Below Lehighton, tributaries with alkaline waters (Pohopoco Creek, L.R. 41.1 mile; Lizard Creek, L.R. 39.5 mile; and Aquashicola Creek L.R. 36.3 mile) enter the river and neutralization of the acid was found to occur at Walnutport (L.R. 33.3 mile) during survey flow conditions. The influence of streams from the limestone and dolomite areas of the basin raised the alkalinity from about 20 mg/L to over 70 mg/L in the Allentown to Easton area.

(c) Total dissolved solids

The lowest concentrations of total dissolved solids were found at the Stoddartsville (L.R. 85.4 mile) and the White Haven (L.R. 71.89 mile) stations. The concentrations at these points ranged from 40 to 80 mg/L. The total solids were found to increase as the river passes through the acid mine drainage area. The four tributaries containing acid mine drainage had total solids concentrations ranging from 200 to over 600 mg/L. At Lehighton (L.R. 43.14 mile), downstream of the mine drainage area, the total solids concentration ranged from 100 to 130 mg/L. Concentrations continued to rise downstream to the Allentown area. The concentration of total solids averaged 136 mg/L at the Central Railroad of New Jersey Bridge, Allentown (L.R. 18.26 mile). Large increases in total solids were found between Allentown, Hamilton Street Bridge (L.R. 17.0 mile) and the Freemansburg Bridge (L. R. 9.3 mile) due to the influence of limestone streams (Little Lehigh Creek, L.R. 16.7 mile; Monocacy Creek, L.R. 11.5 mile; and Saucon Creek, L.R. 9.1 mile) and a large increase of treated sewage and industrial waste discharges were found as well. Mean total dissolved solids concentrations are shown in Table A-2.

TABLE A–2. MEAN TOTAL DISSOLVED SOLIDS. (JULY AND AUGUST 1965)

Station	River Mile	TDS (mg/L)
Allentown	18.26	136
Bethlehem	12.15	218
Bethlehem	9.3	242
Easton	2.28	245
Easton	0.28	252

The total solids concentration in the Delaware above the Lehigh River averaged 90 mg/L at the Easton intake (D.R. 185.4 mile); below the Lehigh, the total solids had a mean concentration of 144 mg/L at Riegelsville (D.R. 174.8 mile).

(d) Dissolved oxygen (DO) and biochemical oxygen demand (BOD)

Dissolved oxygen concentrations were found to be near or above saturation for all stations from the headwaters area to the Central Railroad of New Jersey Bridge in Bethlehem (L.R. 12.15 mile). Dissolved oxygen concentrations ranged in this area from a low of 6.8 to a high of 11.6 mg/L, with the mean of about 9 mg/L. Biochemical oxygen demand was low, generally about 1 to 2 mg/L, from the headwaters to just above the City of Allentown (L.R. 18.26 mile). In the reach from Allentown to the mouth of the Lehigh River, the DO decreased sharply and the BOD increased. Mean values are presented in Table A-3.

TABLE A–3. MEAN DISSOLVED OXYGEN AND BIOCHEMICAL OXYGEN DEMAND. (JULY AND AUGUST 1965)

Station	River Mile	DO, mg/L	BOD, mg/L
Allentown	18.26	9.5	1.8
Bethlehem	12.15	8.7	3
Bethlehem	9.3	5.9	3.5
Easton	2.28	6.1	4.9
Easton	0.28	3.6	5.7

The dissolved oxygen sag occurred in two stages. An initial dissolved oxygen deficit of 22 % from saturation was found immediately below the City of Bethlehem (L.R. 9.3 mile). Dissolved oxygen levels were then fairly constant for about

seven miles. The second deficit, which was a very steep drop of 33 % from saturation, occurred in the two-mile stretch (L.R. 2.28 mile to L.R. 0.28 mile) at the mouth of the river. The total DO deficit from Bethlehem (L.R. 12.15 mile) to the mouth was 54 % from saturation where DO values averaged 3.6 mg/L.

Sludge deposits were observed over most of the bottom area at the mouth of the river. Chemical analyses showed the following composition of sludge in relation to heavy metals and the nitrogen group: total nitrogen, 4.6 mg/L; free ammonia, 0.55 mg/L; copper, 0.19 mg/L; chromium, 0.0 mg/L; iron, 1.82 mg/L; manganese, 500.0 mg/L; lead, 0.73 mg/L. The sludge had an oxygen uptake rate of 14.8 mg/L of oxygen per square foot per hour. It was estimated that in the reach the sludge had an oxygen demand of 1,982 pounds per day. This would lower the DO content of the Lehigh by about 1.0 mg/L.

In the Delaware River, the DO decreased 3.5 mg/L from a mean of 9.9 mg/L above the mouth of the Lehigh River at the Easton intake to a mean of 6.4 mg/L at Riegelsville. However, the upper station was supersaturated with DO during most sampling runs. The change in DO at the lower station when measured from saturation decreased 1.6 mg/L. The BOD increased in this reach from a mean of 2.0 mg/L above the mouth of the Lehigh River to 3.1 mg/L at Riegelsville.

(e) Phosphate

Phosphate levels in the Lehigh River from Allentown (L.R. 18.11 mile) to the mouth ranged from 0.19 mg/L to 4.33 mg/L. The mean phosphate level in this area was 1.5 mg/L. In the Delaware River phosphate levels ranged from 0.2 mg/L above the mouth of the Lehigh to 0.5 mg/L below the Lehigh River.

2. Biological Characteristics

(a) Macro-invertebrates

Thirty-five macro-invertebrate types (Genera) of benthic riffle fauna, consisting of 50,000 specimens, were collected by sampling techniques during this survey and usually identified taxonomically to Genera and, in some cases, to species.

The benthic macro-invertebrate distribution in the Lehigh River between 1965 and 1966 is shown in Table A-4. The most numerous species present at practically every station on the Delaware and Lehigh Rivers was *Hydropsyche sp.* (caddisfly). Caddisflies present in lesser numbers, found mostly in the Delaware River, were of the genera Molanna sp., Leuotricha sp., Oxyethera sp., Mystacides sp., and Leptocella sp.

Other types present in both rivers were *Turbellaira* (planaira), *Nematoda* (roundworm), *Tubifex sp.* (Tubifex worm), *Hirudinea* (leech), *Hydrophantes sp.* (water mite), *Peltoperla sp.* (stonefly), *Ephemerella sp.* (mayfly), *Stenonema sp.* (mayfly), *Paragyractis sp,* (aquatic caterpillars), *Simuliidae* (flies), *Tendipediiae* (midges), *Ferrissa sp.* (limpet), *Physa sp.* (snails), *Sphaerium sp.* (clams) and *Unionacea* (mussels).

The most numerous species per station was 32 at Belvidere (D.R. 201.7 mile), 27 at Martins Creek (D.R. 193.6 mile) on the Delaware River and 10 species at Thornhurst (L.R. 93.8 mile) and White Haven (L.R. 67.9 mile) on the Lehigh River.

The least number of species per station on the Delaware River was 12 at Raubsville and on the Lehigh River was zero at Penn Haven Junction and Jim Thorpe. No species of macro-invertebrates were found in Sandy Run, Buck Mountain Creek, Black Creek, and Nesquehoning Creek,

TABLE A-4. BENTHIC MACRO-INVERTEBRATE DISTRIBUTION IN THE LEHIGH BETWEEN 1965-1966

Location	River Mile	# of Samples	# of Species	Organisms per ft2,	Biomass kg/hectare
Easton	0.1	10	9	89	44
Glendon	3.3	10	10	115	50
Redington	6.6	10	7	15	6
Freemansburg	8.8	10	12	17	6
Bethlehem	11	6	5	6	
Bethlehem	12	10	8	18	14
Allentown	14.4	10	11	6	_
Allentown	17	10	7	14	7
Allentown	18	12	8	81	71
Catasauqua	21	12	4	160	129
Northampton	22.4	12	4	30	15
Treichlers	28.7	10	7	4	_
Walnutport	33.7	10	4	1	_
Lehigh Gap	35.2	6	5	7	_
Palmerton	36.1	4	2	2	_
Bowmanstown	39.1	6	4	4	_
Jim Thorpe	47	4	0	0	0
PennHaven Junction	56	4	2	1	1
Rock Port	62.8	4	4	5	1
Tannery	67.8	4	8	109	129
White Haven	73.4	4	7	36	66
Acahela Boy Scout Camp	83.4	4	8	53	69
Thornhurst	93.8	2	10	183	138

all tributaries containing acid mine drainage.

The biomass ranged from zero in the acid mine streams and some sections of the Lehigh River to 1.1015 kg per hectare on the Delaware River between Milford (D.R. 169.9 mile) and Lambertville (D. R. 148.1 mile), New Jersey. The mean biomass per station was 258 kg per hectare on the Delaware River and 27 on the Lehigh River.

(b) Fish

A total of 18,000 individual specimens constituting 43 species were collected at the 13 sampling stations on the Lehigh and Delaware Rivers.

Lehigh River—The eight fish sampling stations between Glendon (L.R. 3.2 mile) and Tannery (L. R. 70.1 mile) produced a total of 31 species, 7 less than the stations sampled on the Delaware River, ranging from a low of zero at Penn Haven Junction to highs of 20, 15, and 18 species at Allentown, Tannery, and the Acahela Boy Scout Camp, respectively.

The most common species of those sampled on the Lehigh River that occurred at almost every station were *Notropus cornutus* (Common Shiner), *Rhinchthys cataractae* (Longnose Dace), *Semoltilus corporalis* (Fallfish), and *Catostomus commersoni* (White Sucker).

Fish occurring rarely of those identified were *Salmo Gairdneri* (Rainbow Trout), *Salmo trutta* (Brown Trout), *Esox americana* (Redfin Pickerel), *Cyprinuus carpio* (Carp), *Notropus amoenus* (Comely Shiner), *Notropus procne* (Swallowtail Shiner), *Semotilus atromaculatus* (Creek Chub), *Anguilla rostrata* (American Eel), *Lepomis macrochirus* (Bluegill) and *Micropterus dolomieu* (Smallmouth Bass).

The biomass ranged from zero at Penn Haven Junction to highs of 173, 168, and 174 kilograms per hectare at Allentown, Tannery, and the Acahela Boy Scout Camp, respectively. The mean biomass for the eight stations on the Lehigh River was 68 kg per hectare.

The most numerous of any one species sampled in the order of rank were *Notropis hudsonius* (Spottail Shiner) 3,577, *Notropis cornutus* (common Shiner) 2,948, and *Rhinchthys cataractae* (Longnose Dace) 910.

(c) Aquatic vascular plants

A total of 20 species were identified on both the Lehigh and Delaware rivers. One additional specimen was collected and considered a hybrid of the genera Potamogeton sp. Table A-5 shows the submergent floating vascular plants in the Lehigh River in 1965.

Lehigh River—Aquatic plants were generally scarce in the Lehigh River and, by comparison, extremely abundant in the Delaware River with the exception of the Acahela Boy Scout Camp (L.R. 83.5 mile) and Freemansburg (L.R. 8.8 mile). At the Acahela Boy Scout Camp, six species were identified, but no one species occurred in very great abundance. The only species found tolerating the acid mine waters between White Haven and Northampton was *Sparganium americanum* (Burweed). While this plant is not usually a submergent plant, it was found growing in this manner. Three species were identified at Freemansburg with *Myriophyllum spicatum* (Water-milfoil) and *Potamogeton pectinatus* (Pondweed) extremely abundant. The river at Freemansburg, for approximately a distance of a mile, and from shore to shore, was completely overgrown with these two aquatic plants.

(d) Instream bioassay

Lehigh River—The instream bioassay tests indicated that the greatest stress to fish and daphnia occurred in the highly industrialized area of Allentown (L.R. 17.0 mile), Bethlehem (L.R. 12.0 mile), and Easton (L.R. 0.1 mile).

TABLE A-5. SUBMERGENT FLOATING VASCULAR PLANTS IN THE LEHIGH RIVER IN 1965.

Scientific Name	Common Name
Sparganiaoeae	Bur-reed
Sparganium americanum	Nuttall bur-reed
Zosteraceae	Pondweed
Potamogeton pectinatus	Fennel pondweed
Potamogeton foliosus	Leafy pondweed
Potamogeton epihydrus	Ribbonleaf pondweed
Hydrocharitaoeae	Waterweed
Eloda canadensis	Common waterweed
Elodea nuttallii	Western waterweed
Cyperaceae	Sedge
Eleocharis acicularis	Needle spike rush
Lemnaceae	Duckweed
Lemna minor	Minor duckweed
Pontederiaceae	Mud plantain
Heteranthera dubia	Water star grass
Nymphaeceae	Water-lily
Nuphar microphyllum	Yellow pond lilly
Ranunculaceae	Buttercup
Ranunculus triohophyllus	3-leaved water crowfoot
Pondostemaceae	Riverweed
Callitrichaceae	Water startwort
Callitriche heterophylla	Different-leaved water-starwort
Haloragaceae	Water-milifoil
Myriophyllum spicatum	Eurasian water milfoil
Utricularia vulgaris	Bladderwort

Conclusions

The primary objective of the Lehigh River biological investigation was to determine the relationship between water quality of the Lehigh River and its biological productivity as it relates to the present and future potential of the anadromous and resident fishery of the Delaware River basin. The total number of taxa found in the Lehigh River in 1965 is shown in Table A-6. It is concluded that:

- ***Present anadromous fishery***—The Lehigh River was not suitable for anadromous fishery for the following reasons:
  1. The present water quality resulting from the acid mine drainage from four tributary streams between Sandy Run (L.R. 67.8 mile) and Northampton (L.R. 22.5 mile) would cause excessive environmental stress as indicated by the present scarcity of a natural fish population.
  2. The water quality from Allentown (L.R. 17.0 miles) to Easton (L.R. 0.1 mile) was of such poor quality from inadequately treated domestic and industrial wastes that, even

though it does support a fish population, additional environmental stress would be encountered by the migrating adults and their fry.

3. The difficulties involved in getting the anadromous fish over, through, or around existing wooden dams.

- ***Future potential of anadromous fishery***—The Lehigh River could support an anadromous fishery provided that:

1. The acid mine drainage problem was corrected.
2. The water quality from Allentown (L.R. 17.0 mile) to Easton (L.R. 0.1 mile) was improved by providing and maintaining adequate treatment or control of all sources of wastewater discharge.
3. Provision was made for passage over, through, or around the low-level dams
4. A population of anadromous fish could be established that would spawn in the Lehigh River, migrate to the sea, and return later to the Lehigh River to spawn again.

- ***Present resident fishery***—The Lehigh River resident fishery varies widely along the river.

1. In the headwaters, Thornhurst (L.R. 93.8 mile-105.4 mile) to just below White Haven (L.R. 67.8 mile), there is a well balanced resident fish population, including game fish.
2. In the acid mine degradation area between Sandy Run (L.R. 67.8 mile and Northampton (L.R. 22.5 mile) the resident fish population has been virtually eliminated.
3. Between Northampton (L.R. 22.5 mile) and Allentown (L.R. 17.8 mile) the Lehigh River supports an abundant, but not well-balanced, resident fish population with few game fish.
4. In the industrial and domestic waste degradation area between Allentown (L.R. 17.0 mile) and Easton (L.R. 0.1 mile), the resident fish population has been greatly depleted.

- ***Future resident fishery***—A well balanced Lehigh resident fishery could be established provided that:

1. The acid mine drainage problem is corrected.
2. The water quality from Allentown (L.R. 17.0 mile) to Easton (L.R. 0.1 mile) is improved by providing and maintaining adequate treatment or control of all sources of wastewater discharge.

- ***Plant growth***—The present water quality of the Lehigh River may be one of the causes of the plant growth observed in the Delaware River between Raubsville (D. R. 178.5 mile and

TABLE A–6. TOTAL NUMBER OF TAXA FOUND IN THE LEHIGH RIVER IN 1965.

Station	*River Mile*	*Plants*	*Fish*	*Macro-invertebrates*
Easton	0.1	0		7
Glendon	3.3	3	3	4
Redington	6.6	3	12	1
Freemansburg	8.8	4		6
Bethlehem	12.0	0		3
Allentown	14.8	0		4
Allentown	16.8	0		2
Allentown	18.0		20	
Treichlers	27.3	2	6	1
Walnutport	33.3	2		1
Palmerton	36.1	2		3
Palmerton	39.1		6	
Jim Thorpe	47.0	1		0
Penn Haven Junction	54.1		0	
Penn Haven Junction	56.0	0		2
Rock Port	62.8	0		4
Tannery	67.3	0		9
Tannery	67.7	2		7
Tannery	69.6		15	
White Haven	73.4	2		7
Acahela Boy Scout Camp	83.4	6	18	8
Thornhurst	93.8	2		10
Total species		17	31	28

Trenton (D.R.133.9 mile). This plant growth area may have effects on the Delaware River basin fishery resources.

b. Study 2: A Biological and Chemical Survey of the Lower Lehigh River, Summer 1981, Lehigh University, March 1982

The Lehigh River was sampled biweekly for three months in the summer of 1981 for dissolved oxygen, pH, total alkalinity, ammonia nitrogen, nitrate nitrogen, orthophosphate, conductivity, and trihalomethanes. Total coliform and fecal coliform bacteria were also sampled biweekly. Benthic macroinvertebrates were sampled monthly and fish were sampled once.

The results of the study indicated that coliform bacteria, ammonia nitrogen, and orthophosphate were higher than desirable for game fish and water recreation. The benthic macroinvertebrate diversity was indicative of moderate pollution from Hokendauqua to Bethlehem and suggested severe pollution at Freemansburg.

Comparisons between the 1981 study and previous studies showed some improvement in both water chemistry and biota, including the presence of some game fish.

c. Study 3: "Priority Water Body Survey Report, Lehigh River and Tributaries, and Little Lehigh Creek and Tributaries" DER, Bureau of Water Quality Management, April 1989

The Lehigh River basin, from Francis E. Walter Dam to the mouth at Easton, was selected as a priority water body for toxic modeling because of documented aquatic life problems, contaminated fish tissue, presence of priority pollutants in discharges, documented exceedance of in-stream criteria for metals, and the potential presence of interacting multiple discharges. During the fall of 1987 the Lehigh basin was surveyed from White Haven to a point downstream from Lehighton, as were three tributaries to the Little Lehigh Creek: Toad Creek, Iron Run, and Spring Creek. Also in 1987, a spill bank runoff survey was performed on Aquashicola Creek above the New Jersey Zinc Company. The remainder of the basin was surveyed in the fall of 1988. This report combines all of the chemical and physical data from the 1987 and 1988 surveys for detailed water quality modeling.

Primarily, the Lehigh River Priority Water Body Survey was intended to provide chemical and flow data for estimating in-stream decay rates of toxic priority pollutants to calibrate and verify Total Maximum Daily Load models applied to the Lehigh and its tributaries.

FINDINGS:

Results from the 1987 survey show that the poorly limestone buffered main stem of the Lehigh River, from below White Haven to a point downstream from Lehighton, is negatively impacted by abandoned mine drainage from tributaries draining abandoned coal fields. Portions of Sandy Run, Buck Mountain Creek, Black Creek, and Nesquehoning Creek contribute to the low pH and high zinc concentrations in the main stem. These tributaries are devoid of any biotic communities and have several chemical parameters in excess of in-stream criteria. Three tributaries with substantial flow and good water quality enter the river near Lehighton. These tributaries—Mahoning Creek, Lizard Creek, and Pohopoco Creek—provide dilution, which increases the main stem pH to an acceptable level, although zinc and cadmium remain a problem.

In 1988, results showed that Aquashicola Creek contributes substantial quantities of zinc and

cadmium to the main stem of the Lehigh River, in addition to the loading of lead. Copper, aluminum and lead are from various downstream discharges along the middle reach, and iron is from a discharge by Bethlehem Steel near the mouth of the creek. Other parameters, including certain organics, may be of concern but do not violate in-stream criteria.

In the Little Lehigh Creek sub-basin, problems were noted in Toad Creek during the 1987 survey. The stream bottom is smothered by silt throughout most of its length from erosional runoff. Caloric Corporation discharges result in elevated in-stream concentrations of many chemical parameters, with sulfate, total dissolved solids, and phenols exceeding water quality criteria. Iron Run and Spring Creek were found to be excellent wild trout streams, but are in close proximity to a developing urban area that makes them susceptible to future point and non-point source impacts.

The 1988 Little Lehigh survey indicated that lead and copper concentrations are very high near the mouth, although in-stream criteria are not exceeded due to high hardness levels. Trace amounts of volatile organics were also detected in the Little Lehigh basin.

Combined 1987 and 1988 results for Aquashicola Creek clearly show that discharges and runoff from the New Jersey Zinc Company contribute substantial amounts of zinc and cadmium, with copper and lead also being problems to a lesser degree. The Palmerton Sewage Treatment Plant (STP) does not appear to compound these problems.

Hokendauqua Creek appears to have good water quality until it reaches a point below the Northampton STP, where concentrations of several metals are increased and the overall quality of the stream is degraded by sewage and urban encroachment.

d. Study 4: Effects of Heavy Metal Contamination on Aquatic Fauna near the Palmerton, Pennsylvania Smelters. Pennsylvania Cooperative Fish and Wildlife Research Unit, School of Forest Resources, Pennsylvania State University, August 1989

INTRODUCTION:

Heavy metals occur naturally in aquatic systems because of weathering rock and soils. In unpolluted or unaffected waters, the concentration of heavy metals is usually low. A high concentration of heavy metals in aquatic systems is usually associated with industrial processes, such as battery manufacturing, automobile exhaust, or, in the case of this study, smelting operations.

In Palmerton in 1898, the New Jersey Zinc Company built two smelting plants that stayed in production until 1980. These plants emitted exhaust from their smokestacks, which contained very high concentrations of heavy metals. These heavy metals then settled in the surrounding areas of Palmerton. In addition, the plants disposed of their solid wastes along the south bank of the Aquashicola Creek, a tributary of the Lehigh River. This deposited waste is what is causing the high concentration of heavy metals found downstream in the Aquashicola waters.

In this study of the heavy metals produced by the smelting plant, testing was done on four metals, cadmium, copper, lead, and zinc. All four of these heavy metals are on the United States Environmental Protection Agency list of priority pollutants. (Chapman et al., 1982) High concentrations of these four heavy metals can cause an effect on fish and insect community structures. For example a chronic toxicity test showed that copper adversely affected fish growth rates and reproduction. (Sephar et al., 1981)

OBJECTIVE:

The research done in this study had two objectives, (1) to determine the effects of heavy metal contamination on aquatic fauna, and (2) to evaluate the extent of heavy metal pollution near Palmerton, Pennsylvania.

STUDY AREA:

- There were three study areas chosen to test:
- Four sites on headwater streams
- Four sites on Aquashicola and Buckwha Creeks
- Three sites on the Lehigh River

METHODS:

Both biological parameters and chemical parameters were used in testing the study areas. The biological parameters used were fish and insect community structure, fish densities, fish growth, and fish reproduction. The chemical parameters used were water temperature, alkalinity, dissolved oxygen, pH, and heavy metal concentrations.

RESULTS:

The fish tested at the three different study areas were white suckers, brook trout, brown trout, rock bass, and American eels. At the first study area, which was the headwater streams, the heavy metal pollution from the smelter plants did not seem to have an effect on the fish community structure, trout densities, trout reproduction, or fish growth rates. The Lehigh River site produced the same results. However, downstream from the plant on the Aquashicola Creek, the high concentration of heavy metals was determined to have reduced the diversity of fish.

The insect community tested in the three test areas showed the same results as the fish community. The test areas on the headwater streams and on the Lehigh River did not show a great effect on the insect community due to the high concentration of heavy metals. As with the fish community, the insect community directly downstream from the zinc smelter plants did show a reduction when compared to the insect communities located upstream from the plants. It seems that a trend was developing that the further the test site was away from the zinc plants the less concentration of heavy metals were found in the insect community. All other chemical and biological parameters tested for seemed to be normal, with few exceptions.

The second objective of this research was to evaluate the extent of heavy metal pollution near Palmerton, Pennsylvania. The result was that the aerial extent of contamination was found to have no real significant trend in the fish samples collected close to Palmerton.

"It is probable that the aerial extent of contamination survey did not extend far enough from the Palmerton area to detect an appreciable reduction in the heavy metal pollution associated with the smelters" (Effects of Heavy Metal Contamination on Aquatic Fauna in the Vicinity of the Palmerton, Pennsylvania Smelters, August 1989).

e. Study 5: An Evaluation of Recreational White-Water Releases from Francis E. Walter Dam, Lehigh River, Luzerne, and Carbon Counties, Pennsylvania. Prepared for Whitewater Challengers, Inc by Ichthyological Associates, Inc. August 1990

This investigation was completed to determine whether the white-water releases flush the fish populations downstream, strand fish in dewatered habitats as water levels recede, and cause physical degradation of fish habitat. The study was conducted from June 22 through July 31, 1990, on a 30-mile stretch of the Lehigh River from the Francis E. Walter Dam to Jim Thorpe, Pennsylvania.

FIELD ASSESSMENT:

The assessment was made on three different days. The first of the three site visits was conducted the day before the first white-water release of that year. This day was chosen in order to assess the points where a problem with the aquatic life could occur. On this day special interest was paid to the area of the Lehigh River closest to the dam, because this area was the most likely to be affected by the white-water release. In addition, chemical parameters were taken on this first day at different locations to determine if the releases affected water quality along the Lehigh River: dissolved oxygen, water temperature, pH, alkalinity, and turbidity.

The second of three site visits occurred on the day of the white-water release. The objectives of this day were (1) to observe if flushing or displacement of fish and other aquatic organisms was occurring, (2) to observe how the fish's habitat was changing due to the white-water release, and (3) to evaluate the stranding of fish and other organisms once the release was discontinued and the water was allowed to recede to its normal level. Once again, water quality measurements were taken at all the sites to see if white-water release was affecting the water quality.

The third and final site visit was conducted in order to observe the river at "low flow" conditions. Observations were made at all the sites to see if any fish stranding had occurred, and to see if any habitat changes had occurred due to the white-water release. On this day the water quality measurements were not taken, and only observations were made.

RESULTS:

River substrate was observed to contain mostly cobble and boulders, and little sand or silt. This substrate was found to be stable and not conducive to shifting or rapid erosion. In addition, the water quality measurements taken were found to not change appreciably before and after the release. The only thing found was that the water had a low pH that makes it acidic, and less than ideal to support fish life. "There was no evidence showing water quality is significantly degraded as a result of white-water releases, but rather that the increase in flow may help to dilute acidic inflows such as that observed from Sandy Run" (Ichthyological Associates, 1990).

It was found that the white-water discharge does not flood the banks of the Lehigh River because the banks are too steep. Rather, the steep banks push the extra water through the same channel at a faster rate. "The fluctuations in discharge of the Lehigh River that are associated with white-water releases are well within the range of fluctuations that naturally occur in the river, and in many cases are well below the level of fluctuation typically observed during the times of year when white-water releases are scheduled." (Ichthyological Associates, 1990) The white-water release also causes no erosion of the banks of the Lehigh River to occur. The team of researchers also found that barely any stranding of fish, especially adult fish, occurs. They

were only able to find a few stranded tadpoles on the banks about three miles away from the dam. The substrate of the banks, made mostly of cobble and boulders, makes it highly unlikely that stranding will occur. As water levels fall, the fish are able to swim through the crevices of the cobble and boulders, so no stranding occurs. "Given the high gradient of the stream and the natural volatility of its discharge, the types of fish and other organisms living in the stream must be well adapted to the wide variety of flow conditions found in the river and are able to adjust to changing discharges without undue stress." (Ichthyological Associates, 1990)

f. Study 6: Lehigh River Fishkill, Pennsylvania Department of Environmental Protection, April, and May 1995

On April 24, 1995, Pennsylvania DEP responded to a report of a fishkill in the Lehigh River between Aquashicola Creek and Walnutport. The reported kill consisted of trout that had been stocked by the Lehigh River Stocking Association on April 22. According to reports, the newly stocked trout were being caught by anglers until mid to late afternoon when the fish quit biting and were seen moving listlessly toward shore. Dead trout appeared shortly thereafter. When DEP responded no dead fish were observed in the Palmerton/Walnutport area of the river. On May 7, the next scheduled stocking date, a similar event occurred. One final stocking of trout was conducted in early June. At that time, the trout were temperature-acclimated prior to stocking, and no reports of lethargic or dead fish were received.

Between the period of April 24 and May 18, 1995, physiochemical and biological sampling was conducted by Pennsylvania DEP on the river and at all of the NPDES permitted point source discharges to the river.

CONCLUSIONS:

Downstream from Nesquehoning Creek to the sampling location at Bowmanstown, the macrobenthic quality was similar and showed a substantial decline in taxonomic richness and pollution sensitivity as compared to the Glen Onoko Park sampling station, with the greatest loss occurring in scraper mayfly taxa and shredder stonefly taxa. No measured cause for the decline was found. Beginning at Palmerton and continuing to Northampton Borough, the macrobenthic quality became and remained extremely poor in taxonomic richness and pollution sensitivity. The only measured chemical parameter that exceeded the limit recommended for the protection of aquatic life at all sample locations was total zinc. Data from a station at Walnutport collected from 1985 to 1995 also documented periodic high aluminum values and pHs of less than 6.0. "At this point, it appears that continuing and/or periodic metals associated toxic conditions together with solids deposition, substrate cementing, scouring, and possibly solids associated metals toxicity are responsible for the macrobenthic paucity. (Lehigh River Fishkill Report, 1995)"According to DEP there did not appear to be any permitted facilities that were responsible for the extent of the macro-invertebrate degradation.

The Lehigh River between Palmerton and Northampton was similar to other rivers in the region where mining has predominated in the watershed to the extent that large areas of the watershed have exposed un-vegetated mining refuse as a source of solids and metals laden runoff in addition to AMD outfalls with high metals concentrations and low pHs. Macrobenthic quality is very poor to poor, but the fish quality is at least good. This phenomena may relate to a benthic limited effect from the solids loading and associated toxicity or to a greater sensitivity of the macrobenthos to metals and/or pH toxicity (Lehigh River Fishkill Report, 1995).

At Walnutport where a large number of stocked trout had reportedly died, nine fish taxa were collected including several size and presumably age classes of pollution sensitive species. The overwhelming conclusion from the fish data was that warm water species of fish were maintaining self-reproducing populations at Walnutport and at Northampton. Pennsylvania DEP concluded that the continued presence of such a fish population together with the presence of large numbers of 20-25 mm white sucker larva make it unlikely that acutely toxic conditions caused the kill of stocked trout. The total zinc concentrations from Palmerton to Northampton were above the acutely toxic to aquatic life concentrations.

Another explanation for the fishkill better fits the pattern of die-off and data interpretation. "There was the distinct possibility that the temperature was directly responsible for the fishkill" (Lehigh River Fishkill Report, 1995).

RECOMMENDATIONS:

Since no permitted facilities were found to be responsible for the fishkill, no corrective or penalizing action was taken.

"The long-term solution to improve water quality in the Lehigh River between Jim Thorpe and Northampton lies in controlling the effects of AMD both point and non-point, and similarly with controlling the effects caused by the area affected by the zinc plant. Both of these efforts are large scale and beyond our (Pennsylvania DEP) immediate regulatory scope." (Lehigh River Fishkill Report, 1995).

g. Study 7: "Upper Lehigh River 'Exceptional Value' Feasibility Report, Wildlands Conservancy, 1995

This report details the phase I initial study to determine the feasibility of obtaining "Exceptional Value" (EV) status on the upper Lehigh River. The second phase would involve the full EV petition, including field and database research, formulation of a report, and submission to the state.

The two types of special protection waters are High Quality (HQ) and Exceptional Value (EV). Water quality requirements are the same for both special protection categories; however, the difference between HQ and EV is that the waters designated as having EV status are waters containing outstanding, unique, or uncommon traits (Special Protection Waters Implementation Handbook. DEP #1455-11/92). EV waters are defined, in part, as "a stream or a watershed which constitutes an outstanding national, state, regional or local resource, such as waters of a national, state or county park or forest, or waters which are used as a source of unfiltered potable water supply, or waters which have been characterized by the fish commission as "Wilderness Trout Streams," and other waters of substantial recreational or ecological significance" (25 Pennsylvania Code #93.3).

In order to have the upper Lehigh River considered for EV status, two basic requirements must be met. First, it must attain all applicable water uses contained in the "Water Quality Standards" (25 Pennsylvania Code #93.3). Second, its water quality must generally be better than the established water quality criteria contained in the Water Quality Standards, or its water quality must be in a natural state. Some of the criteria that must be met in order for waters to be classified as special-protection waters are listed in Table A-7.

In determining whether waters are eligible for special protection, the Pennsylvania DEP will compare existing water quality with the water quality standards listed in 25 Pennsylvania Code #93.3. These standards must generally be met for the waters to be considered for special protection.

DESCRIPTION OF STUDY AREA:

The study area is defined as the upper Lehigh River, which is located north of the Francis E. Walter Reservoir. This stretch of the Lehigh River is approximately 18 miles long and drains an area of approximately 288 square miles. It flows from its headwaters in parts of Monroe, Luzerne, Lackawanna, and Wayne counties, to the FEW Dam just south of Stoddartsville. This section of the Lehigh River is designated as a special-protection stream. The river's current classification is a High Quality-Cold Water Fishery (HQ-CWF).

TABLE A–7. WATER QUALITY STANDARDS FOR SPECIAL PROTECTION WATERS

Parameter	Description
Aluminum	Concentration may not exceed 0.1 mg/L
Alkalinity	Minimum 20 mg/L as CaCo3, except where natural conditions are less, 100-200 mg/L is considered an ideal buffer level
Total Iron	Concentration may not exceed 1.5 mg/L
Dissolved Iron	Concentration may not exceed 0.3 mg/L
Dissolved Oxygen	Minimum daily average must exceed 6 mg/L
pH	pH must range between 6 and 9
Sulfate	Concentration may not exceed 250 mg/L
Temperature	No temperature above 19oC and no fast fluctuations

Other points of interest about the study area include the Lehigh Marshes, a nearly 4,000-acre tract of land that has been permanently preserved and which is part of approximately 25,000 acres of state game lands. The most important of these is state game lands 127, with its northern border located adjacent to the Lehigh River. This 2.4-mile section of the river is perhaps one of the most heavily fished waterways in the entire Commonwealth.

CHEMICAL WATER QUALITY DATA:

The U.S. EPA's STO-RET system, a database of sampling sites and their associated data, yielded information from one sampling point, located in Stoddartsville. The Stoddartsville gauging station is located directly northeast of the FEW Dam and has been collecting water quality data since 1962. The data from the last two years (1994-95) represents present water quality conditions of the upper Lehigh River. The water sampled at the Stoddartsville gauging station is considered representative of the water quality of the entire upper Lehigh River. The background water quality data from the Stoddartsville gauging station revealed that:

The concentration of aluminum in the upper Lehigh River exceeded the specific water quality criteria of 0.1 mg/L seven times on separate dates between 1994 and 1995. The concentration of alkalinity in the upper Lehigh River was below the specific water quality criteria of 20 mg/L for every sample between 1994 and 1995. In every sample analyzed between 1994 and 1995, the concentration of dissolved oxygen in the upper Lehigh River was below the level in which accelerated plant growth may occur. The concentration of iron in the upper Lehigh River did not exceed the specific water quality criteria of 10 mg/L on any sampling date in the last two years. In addition, nitrate concentrations did not exceed the 1mg/L level, which indicates that nutrient loading is not a problem in the upper Lehigh River.

BIOLOGICAL WATER QUALITY DATA:

A report of the Pennsylvania DEP stated that the benthic macro-invertebrate community near Gouldsboro indicated excellent water quality. During this study twenty-seven different taxa were present, some being pollution sensitive. The balanced trophic diversity of the community was further evidence of prolonged good water quality.

TABLE A–8. PRELIMINARY WATER QUALITY RESULTS

Parameter	Location 1	Location 2	Location 3	Location 4
Temperature	1°C	0°C	1°C	1°C
pH	7.8	7.9	8.1	7.7
Phosphate	>.05 mg/L	>.05 mg/L	>.05 mg/L	>.05 mg/L
Nitrate	>.05 mg/L	>.05 mg/L	>.05 mg/L	>.05 mg/L
Dissolved O_2	11 mg/L	9 mg/L	11 mg/L	12 mg/L

PRELIMINARY FIELD RESEARCH:

Preliminary field research was conducted on the upper Lehigh River to determine the water quality conditions. Water samples were analyzed for nitrate, phosphate, dissolved oxygen, pH, and temperature (Table A-8). All of the field samples meet Pennsylvania DEP's criteria for special-protection waters.

SUMMARY AND RECOMMENDATIONS:

The upper Lehigh River, from its headwaters to the FEW Dam, is designated a special-protection stream. The river's present classification is a HQ-CWF. The difference between HQ and EV is that the waters designated as having EV status are those containing outstanding, unique, or uncommon traits. The factors that will affect the re-designation of the upper Lehigh River include water quality, the presence of disturbance, and the existence of areas that have substantial recreational or ecological significance.

This study determined that water from the upper Lehigh River occasionally exceeds state water quality requirements for special-protection waters. The parameters that occasionally exceed the water quality standards are pH, temperature, aluminum, alkalinity, and dissolved oxygen. While these results will not automatically disqualify a re-designation to EV status, they are cause for further investigation.

h. Study 8: Parkland Scholl District and Lehigh University Hydrolab Probe Data Collection

The Parkland School District in cooperation with several local project partners began monitoring the Lehigh River at the Northampton Borough Municipal Authority water intake in 1996. Several basic water quality parameters were analyzed with samples being analyzed every hour. A second Hydrolab probe location was also established on the lower Lehigh River by Lehigh University. Both sets of data are available on Lehigh University's web site.

i. Study 9: Water Quality Review: 1995-2000 Pennsylvania DEP and USGS-NAWQA Data

SPECIFIC CONDUCTANCE:

NAWQA (National Water Quality Assessment Program) studies of three sites along the Lehigh River revealed an average value of 192.58 at Jordan Creek, 110.5 at Lehighton, and 316.42 at Glendon; and for all three sites, an average of 243 mmho/cm. Values ranged from 101 mmhos/cm in Lehighton to 467 mmhos/cm at the Glendon site during the years of 1998 and 1999.

Pennsylvania DEP studied four sites along the Lehigh between the years of 1995 and 2000. Specific conductance values ranged from 427 mmhos/cm at the Glendon site to 38 mmhos/cm at DEP's Route 115 site (Stoddartsville). The average of the values was 156 mmho/cm.

DISSOLVED OXYGEN:

The average value obtained during 1998 and 1999 NAWQA studies for the Jordan Creek site

was 12.47 mg/L, 10.4 mg/L at Lehighton, and 11.81 mg/L at Glendon. The lowest level was 9.3 mg/L at the Glendon site, and 15.2 mg/L at Jordan Creek was the highest.

The average dissolved oxygen value recorded by the Pennsylvania DEP for the Route 115 site is 9.82 mg/L; at Slatington, this value is 10.73 mg/L; at Treichlers this value is 11.11 mg/L; and at Glendon the average value is 10.75 mg/L. The average value over the five-year study at the four locations is 10.6 mg/L.

pH:

The average pH value obtained from the NAWQA study for the Jordan Creek site was 7.81; at Lehighton, it was 7.45; and at Glendon, it was 7.64. The highest and lowest values were both measured at the Jordan Creek site.

The Pennsylvania DEP average pH value at Route 115 is 6.22; at Slatington, it is 6.56; at Treichlers, it is 6.39; and at Glendon, it is 7.08. The average pH value for all four sites in this study is 6.6.

Water Temperature:

The average temperature for the Jordan Creek site in the NAWQA study is 13.10 °C. The average value at Lehighton is 17.05, and at Glendon, it is 12.33. Two of the sites studied exceeded the classification levels for a high quality, cold-water fishery: the Jordan Creek and Glendon, Pennsylvania. The Jordan Creek temperature reached up to 26°C, and the high for Glendon was 23.8°C. The water temperature remained below 19°C at the Lehighton site, reaching its highest temperature at 18.6°C.

For the Pennsylvania DEP study, at Route 115 the average water temperature value is 8.61; at Slatington, it is 10.96; at Treichlers, it is 11.21; and at Glendon, it is 12.57. All four sites reached temperatures above the HQ-CWF classification level. Glendon temperature peaked at 24.2°C, and the high for Slatington is 22.1°C. The highest water temperature recorded in the study is from the Treichlers site with a temperature of 25°C. The Route 115 site reached its highest temperature of 21°C twice during the duration of the study.

Dissolved Bicarbonate/Alkalinity:

In the 1998-1999 NAWQA study, the lowest levels of dissolved bicarbonate were found in the Lehighton area of the Lehigh River. The highest levels, with the largest range of values as well, were found at the Glendon site. Levels at this site ranged from 27 to 129 mg/L. The average value at the Jordan Creek site is 40.1 mg/L; at Lehighton, it is 6 mg/L; and at Glendon, it is 69.1 mg/L.

The Pennsylvania DEP data for alkalinity is reported in units of mg/L $CaCO_3$. The average alkalinity value at Route 115 is 7.74; at Slatington, it is 13.15; at Treichlers, it is 12.90; and at Glendon, it is 54.99. The levels for the Slatington, Treichlers, and Route 115 sites remained almost completely under 20 mg/L $CaCO_3$. The Glendon site levels fluctuated greatly, but only fell below 20 mg/L twice during the study period.

Nitrogen:

The NAWQA study measured three types of nitrogen content: nitrogen ammonia (NH_3), nitrite (NO_2), and total dissolved nitrogen (NO_2 plus NO_3). Levels of nitrogen ammonia in the Lehighton and Jordan Creek areas remained below 0.05 mg/L throughout 1998 and 1999 studies; the average value for Jordan Creek was 0.029 mg/L and was 0.02 mg/L for Lehighton. Glendon levels were between 0.02 and 0.22 mg/L and appeared to be decreasing over the

study time; the average value is 0.118 mg/L. Nitrite levels between 0.01 and 0.06 mg/L were measured in the three study sites by NAWQA. Glendon has the highest levels in general, and the lowest level maintained at 0.01 mg/L is at the Lehighton site. The average nitrate level for the Jordan Creek is 0.013 mg/L; for Lehighton, it is 0.01 mg/L; and for Glendon, it is 0.031 mg/L. The total dissolved nitrogen (nitrite and nitrate) level for the Jordan Creek was an average value of 2.64 mg/L; for Lehighton, it was 0.175 mg/L; and for Glendon, it was 2.35 mg/L. The Jordan Creek area fluctuated the most with levels as low as 0.65 and as high as 4.6 mg/L.

The Pennsylvania DEP study measured nitrite (NO2), nitrate (NO3), and ammonia (NH3). The nitrite levels for the Glendon site varied greatly from 0.008 to 0.06 mg/L, while the Slatington levels were between 0.004 to 0.02 mg/L. The Treichlers and Route 115 sites maintained fairly steady levels of approximately 0.004 mg/L over the five years of the study. The average nitrite level for the Route 115 site is 0.004 mg/L; for Slatington, it is 0.011 mg/L; for Treichlers, it is 0.00424 mg/L; and for Glendon, it is 0.022755 mg/L. For nitrate, the range in values is 0.05 to 2.96 mg/L at the Glendon site. Both the Treichlers and Slatington sites' values remained between 0.48 and 1.18 mg/L throughout the study. The Route 115 site had an average value of 0.16 mg/L NO3; the average nitrate value at Slatington was 0.541 mg/L; at Treichlers, it was 0.605 mg/L; and at Glendon, it was 1.89 mg/L. Ammonia levels were also recorded for the four sites. The levels varied greatly from 0.02 to 0.35 mg/L, with the highest level recorded at the Slatington site. Glendon and Slatington had the highest values overall. The average at Route 115 was 0.02 mg/L; at Slatington, it was 0.15 mg/L; at Treichlers, it was 0.030 mg/L; and at Glendon, it was 0.078 mg/L.

PHOSPHOROUS:

The average level of phosphorous obtained from the NAWQA study at Jordan Creek was 0.063 mg/L; at Lehighton, it was 0.01 mg/L; and at Glendon, it was 0.26 mg/L.

The Pennsylvania DEP data's average is approximately half that recorded by NAWQA at 0.08 mg/L. The Glendon site has the overall highest levels, while the other three sites have levels that remained for the most part below 0.12 mg/L. The average phosphorous value at the Route 115 site is 0.020 mg/L; at Slatington, it is 0.074 mg/L; at Treichlers, it is 0.026 mg/L; and at Glendon, it is 0.17 mg/L.

ORTHOPHOSPHATE:

The orthophosphate ion (PO43-) is the form of phosphorous is often measured in water quality studies, because it is the form found in many fertilizers. High orthophosphate levels are therefore a good indication that eutrophication is a threat to that body of water.

The average level of orthophosphate obtained from the NAWQA study at Jordan Creek was 0.018 mg/L; at Lehighton, it was 0.01 mg/L; and at Glendon, it was 0.21 mg/L. The highest levels by far are those recorded for the Glendon site. Lehighton and Jordan Creek both had relatively low levels below 0.04 mg/L.

DISSOLVED CARBON:

The Glendon and Jordan Creek sites have very similar levels of total dissolved carbon between 1.4 and 6.5 mg/L in the NAWQA study. Lehighton has the lowest levels, and the average value is 1.2 mg/L. The average value for Jordan Creek is 2.44 mg/L and for Glendon is 2.63 mg/L.

CALCIUM:

The average calcium level from the NAWQA study for Jordan Creek is 19.75 mg/L. The Lehighton levels were much lower with the highest level for that site being 7.2 mg/L, and the average value is 6.3 mg/L. At the Glendon site, the average calcium value is 22.58 mg/L.

MAGNESIUM:

The average magnesium value for the NAWQA study at Jordan Creek is 5.48 mg/L. The Lehighton levels are the lowest, with an average of 2.65 mg/L; and the Glendon site has the highest level of 15 mg/L, with an average of 9 mg/L.

SODIUM:

The study conducted by NAWQA recorded an average of 6.75 mg/L Na at Jordan Creek. Lehighton had similar levels, with an average of 7.35 mg/L. Glendon has the greatest values, and the average value is 18.49 mg/L.

POTASSIUM:

Soil leaching by runoff greatly increases levels of potassium in natural waters. Levels are highest in waters having high dissolved-solids concentrations.

The average potassium value for the NAWQA studies at Jordan Creek is 1.49 mg/L; at Lehighton, it is 0.65 mg/L; and at Glendon, it is 2.58 mg/L.

CHLORIDE:

The average chloride value for the NAWQA study at Jordan Creek is 13.6 mg/L and for Lehighton, it is 13.5 mg/L. Glendon has the highest levels, with the maximum level being 43 mg/L and the average value being 26.94 mg/L.

SULFATE:

The average of 25 mg/L SO4 for NAWQA sites is well within the drinking level standard. The values ranged between 15 to 47 mg/L during the 1998-1999 study. At the Jordan Creek site, an average value of 20.67 was recorded, at Lehighton, the average is 17.5, and at Glendon, the value is 30.58.

The average sulfate value for Route 115 collected by the Pennsylvania DEP is 6.91 mg/L; for Slatington, it is 18.42 mg/L; for Treichlers, it is 18.38 mg/L; and for Glendon, it is 31.13 mg/L. The Route 115 site has the lowest overall sulfate values. The highest measurement is 65 mg/L and was recorded at the Glendon site.

FLUORIDE:

Throughout the two years of the NAWQA study, the level of fluoride remained the same. The value is 0.1 mg/L F-. The average value at the Jordan Creek site, at the Lehighton site, and at the Glendon site, it is 0.1 mg/L.

SILICA:

The average for the NAWQA data is 4.9 mg/L. Silica levels for all three sites remained between 1.9 and 7.3 mg/L. The average level at the Jordan Creek site is 5.02, at Lehighton is 3.45, and at Glendon is 5 mg/L.

BORON:

The average boron level for the NAWQA study sites is 21.4 mg/L. The lowest level is 7.3 mg/L in Jordan Creek and the highest is 54.3 mg/L at the Glendon site. The average level at Jordan Creek is 13.51, at Lehighton, it is 12.15, and at Glendon, it is 30.83 mg/L.

IRON:

The average iron level from the NAWQA studies is 23.4 mg/L. The average value at the Jordan Creek site is 19.83, at Lehighton is 10.5, and at Glendon is 29.17. Lehighton has the lowest level at 10 mg/L while both the Glendon and Jordan Creek levels fluctuated throughout the study. The highest level is 61 mg/L at the Glendon site.

For the Pennsylvania DEP data, the average iron value at Route 115 was 17.3 mg/L; at Slatington, it was 25.4 mg/L; at Treichlers, it was 20.1 mg/L; and at Glendon, it was 25.2 mg/L.

ZINC:

The average zinc level for the Pennsylvania DEP study data at Route 115 is 10.19 mg/l; at Slatington, it is 124.33 mg/l; at Treichlers, it is 155.78 mg/l; and at Glendon, it is 71.65 mg/l.

LEAD:

The average lead level for the Pennsylvania DEP study at Route 115 is 1.07 µg/L; at Slatington, it is 1.21 µg/L; at Treichlers, it is 1.18 µg/L; and at Glendon, it is 1.51 µg/L.

ALUMINUM:

The average aluminum level for the Pennsylvania DEP study at Route 115 is 9.6 g/L; at Slatington, it is 2.9 mg/L; at Treichlers, it is 2.3 mg/L; and at Glendon, it is 24.8 mg/L.

j. Study 10: Pennsylvania DEP Benthic Macro-invertebrate and Habitat Analysis, 1995-2000

From 1995 to 2000, Pennsylvania DEP water pollution biologists collected 230 benthic macro-invertebrate samples in the Lehigh River and its tributaries. Macro-invertebrates were identified and ranked based on abundance as rare, common, abundant, very abundant, and prolific. Wildlands Conservancy analyzed this data by applying a modified version of the Hilsenhoff Family Biotic Index (FBI).

Family Biotic Index (FBI) is an initial tool for the assessment of benthic macro-invertebrate communities and their tolerance of organic pollution ("natural" non-point source pollution such as fertilizers and waste) and can be used to prioritize sites for more intensive evaluation. Tolerance values range from zero to 10 for families and increase as water quality decreases. The index was developed to summarize the various tolerances of the benthic arthropod community with a single value. The FBI equation used in this assessment is as follows:

$$\mathbf{FBI} = \frac{\sum(\mathbf{x_i} \times \mathbf{t_i})}{\mathbf{N}}$$

Where: $\mathbf{x_i}$ = number of individuals within a taxon

$\mathbf{t_i}$ = tolerance value of a taxon

$\mathbf{N}$ = total number of organisms in the sample

TABLE A-9. FAMILY BIOTIC INDICES FOR THE LEHIGH RIVER

Site	FBI	Water Quality	Organic Pollution	Location
1	2.24	Excellent	Organic pollution unlikely	Headwaters
2	2.11	Excellent	Organic pollution unlikely	Tobyhanna confluence
3	2.10	Excellent	Organic pollution unlikely	Above Sandy Run
4	1.36	Excellent	Organic pollution unlikely	Above Buck Mountain
5	3.05	Excellent	Organic pollution unlikely	Between Aquashicola and Bertsch
6	4.81	Good	Some organic pollution probable	Hokendauqua confluence
7	5.49	Fair	Fairly substantial pollution likely	Monocacy confluence
8	2.62	Excellent	Organic pollution unlikely	Below Saucon Creek
9	2.89	Excellent	Organic pollution unlikely	Above Delaware confluence

TABLE A - 10. FAMILY BIOTIC INDICES FOR TRIBUTARIES

Site	FBI	Water Quality	Organic Pollution	Tributary
T1	2.39	Excellent	Organic pollution unlikely	Tobyhanna Creek
T2	1.32	Excellent	Organic pollution unlikely	Hayes Creek
T3	2.45	Excellent	Organic pollution unlikely	Sandy Run
T4	2.34	Excellent	Organic pollution unlikely	Mud Run
T5	4.16	Very Good	Possible slight organic pollution	Mahoning Creek
T6	3.13	Excellent	Organic pollution unlikely	Bertsch Creek
T7	4.28	Good	Some organic pollution probable	Hokendauqua Creek
T8	6.46	Fairly Poor	Substantial pollution likely	Jordan Creek
T9	3.89	Very Good	Possible slight organic pollution	Little Lehigh Creek
T10	4.78	Good	Some organic pollution probable	Monocacy Creek
T11	4.22	Very Good	Possible slight organic pollution	Saucon Creek
T12	3.11	Excellent	Organic pollution unlikely	Pohopoco Creek
T13	3.55	Excellent	Organic pollution unlikely	Aquashicola Creek

Representative macroinvertebrate sample sites along the main stem of the river were chosen for analysis along with samples taken on tributaries closest to their confluence with the Lehigh River. Sites that indicate organic pollution problems include the Hokendauqua Creek, the Monocacy Creek, and the Jordan Creek (Table A-9 and A-10).

At each of the 230 sampling locations throughout the watershed, Pennsylvania DEP biologists also conducted habitat assessments of the in stream and surrounding habitat characteristics (Figures A-1 through A-7). Habitat variables evaluated include impervious cover, epifaunal substrate, embeddedness, velocity/depth regime, channelization, sediment deposition, frequency of riffles, vegetative protection, and riparian zone width.

Major habitat parameters of concern in the watershed are a lack of substantial riparian vegetation and sediment deposition. At least 15% of the waterways exhibit moderate to heavy deposits of fine sediment and have between 50 and 80% of their bottoms affected by sedimentation. At least 32% of the Lehigh waterways have poor to marginal riparian buffers. The percentage of tributaries with optimal riparian cover changes from 73% in the upper watershed to only 17% in the lower watershed, and bank vegetation changes from 93% of the upper tributaries considered optimal to 49% of the lower tributaries. Impervious land cover surrounding streams also decreases significantly from south to north.

FIGURE A–1. HABITAT CONDITIONS IN THE UPPER LEHIGH RIVER.

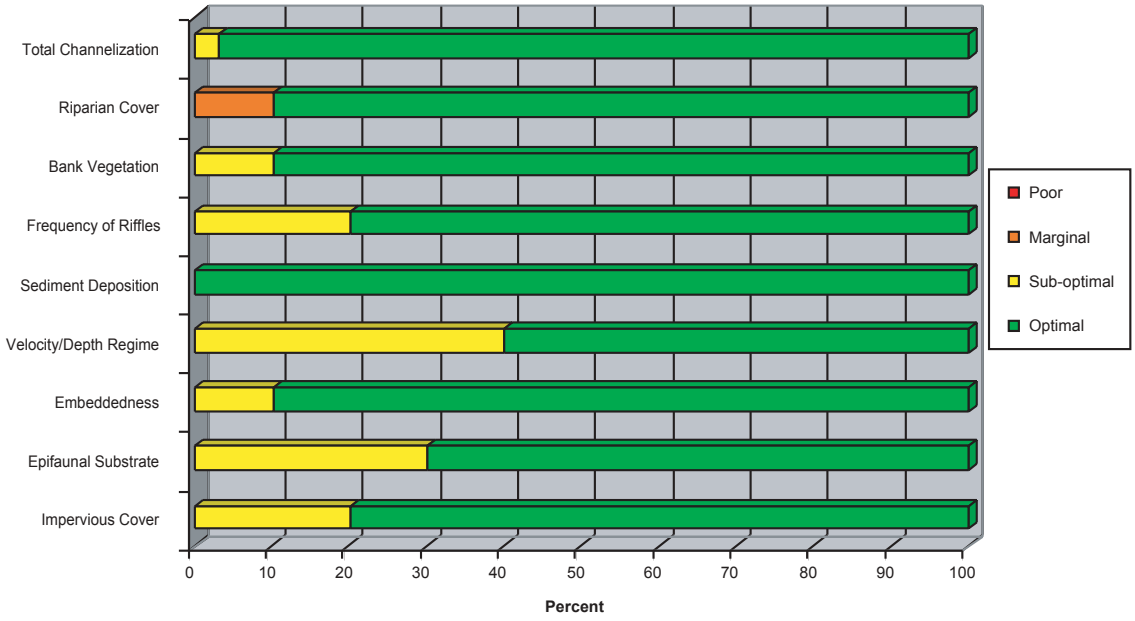


FIGURE A–2. HABITAT CONDITIONS IN THE MIDDLE LEHIGH RIVER

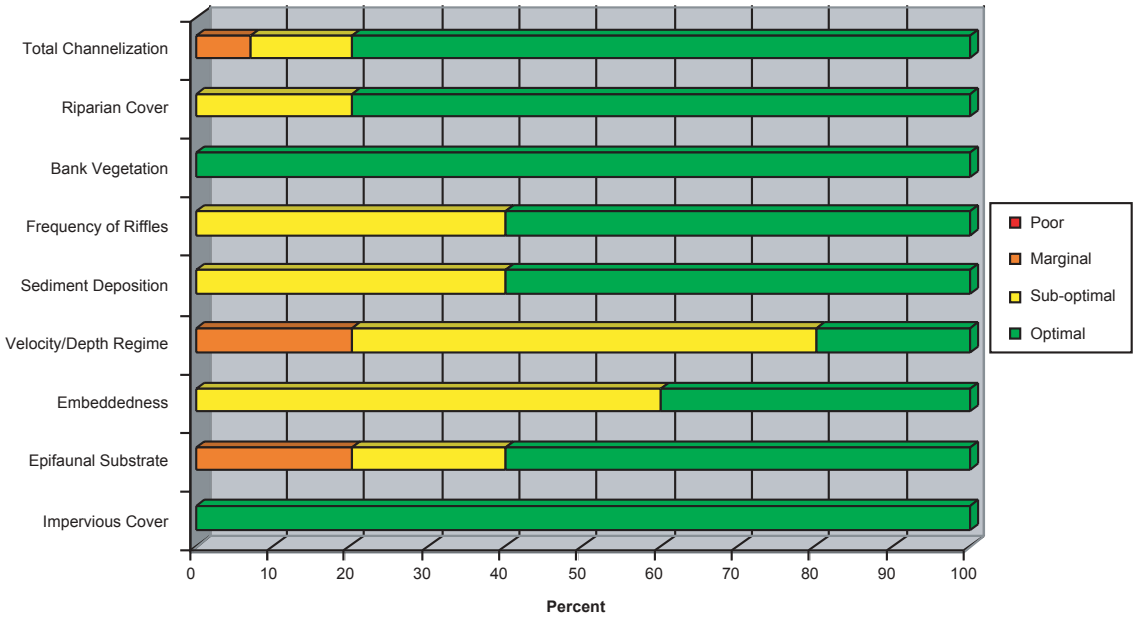


FIGURE A–3. HABITAT CONDITIONS IN THE LOWER LEHIGH RIVER

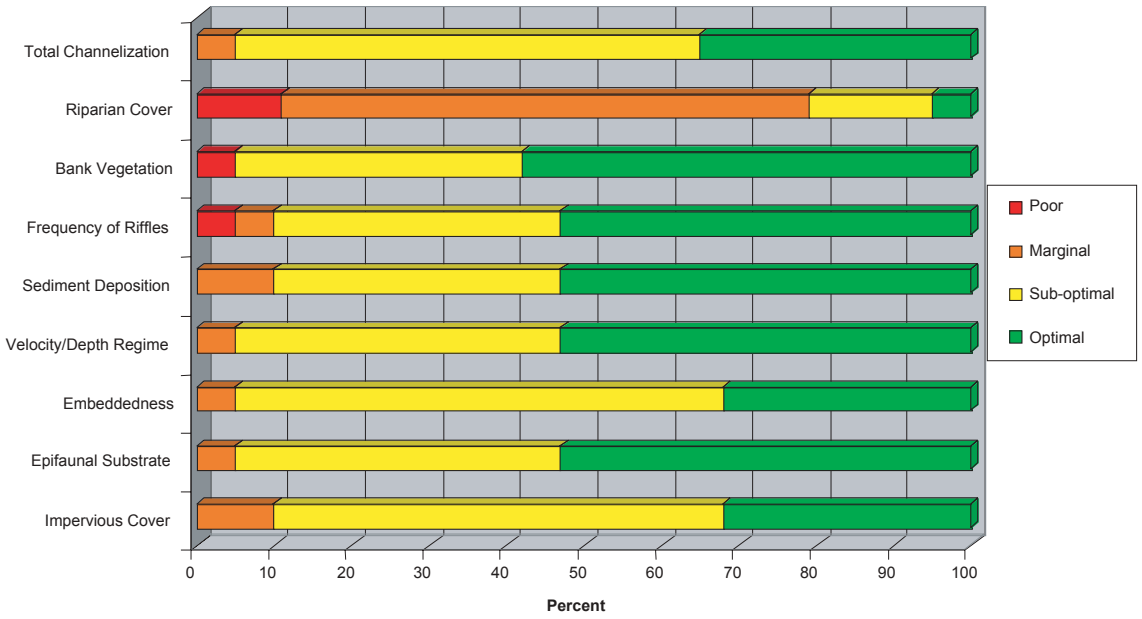


FIGURE A–4. HABITAT CONDITIONS IN THE LEHIGH RIVER WATERSHED

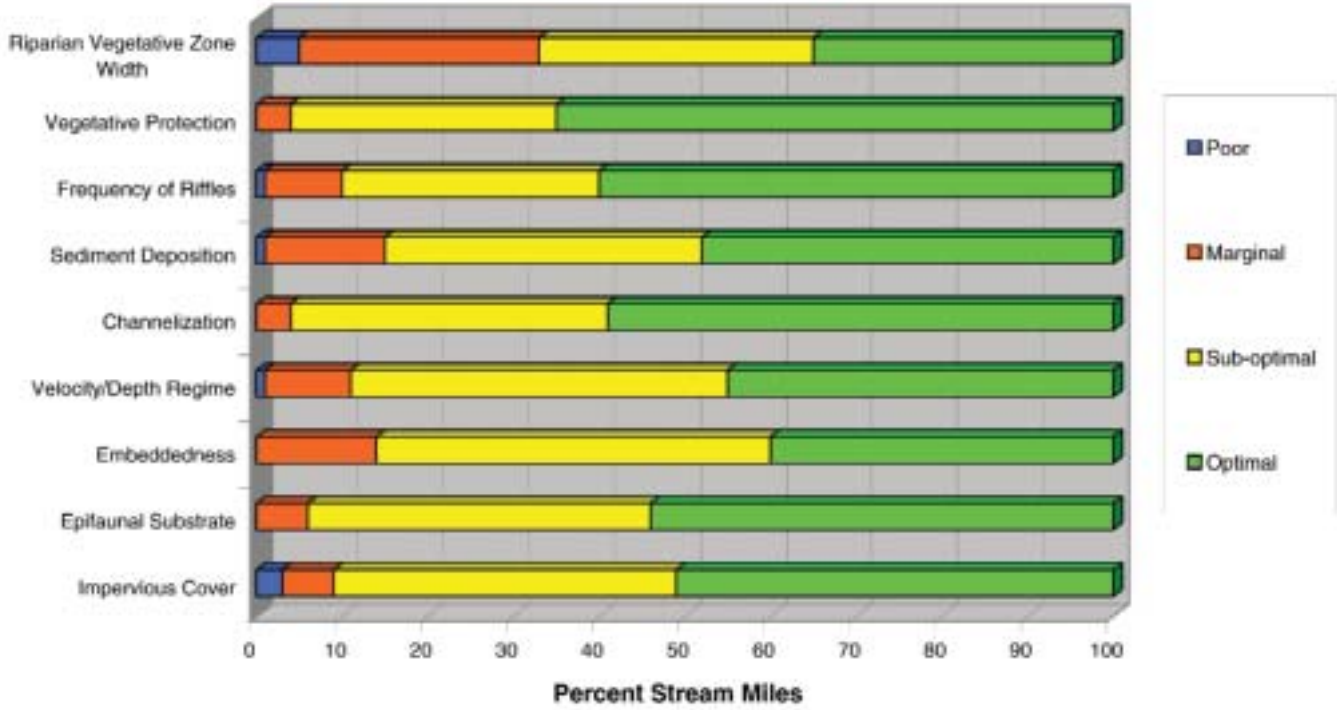


FIGURE A–5. HABITAT CONDITIONS IN THE UPPER TRIBUTARIES

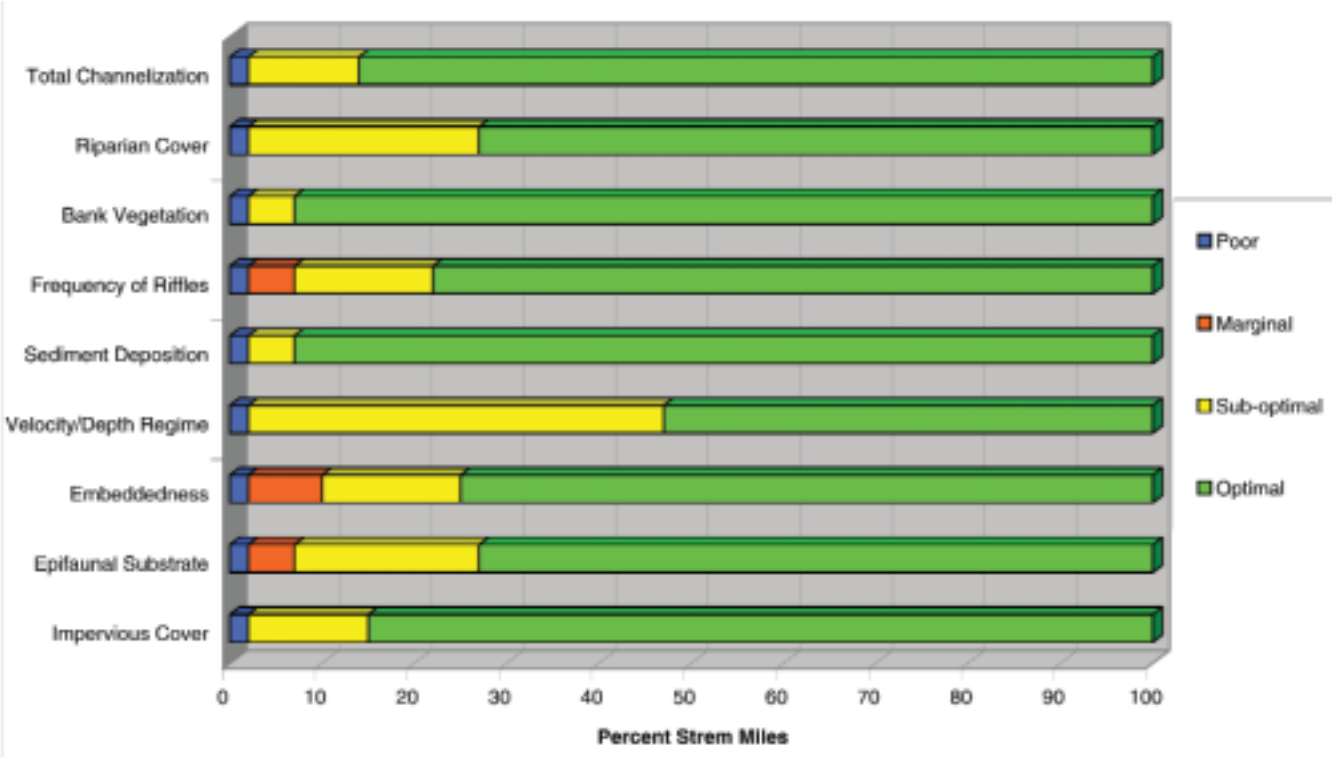


FIGURE A–6. HABITAT CONDITIONS IN THE MIDDLE TRIBUTARIES

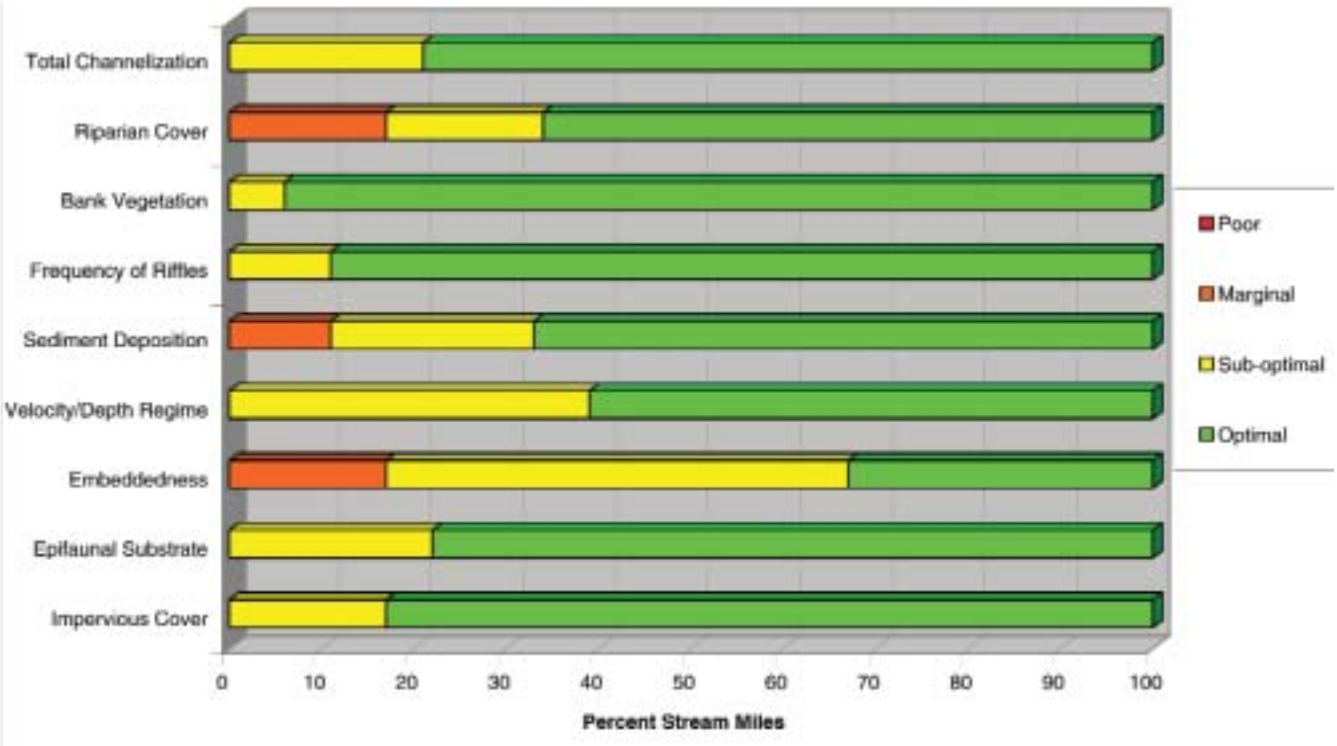
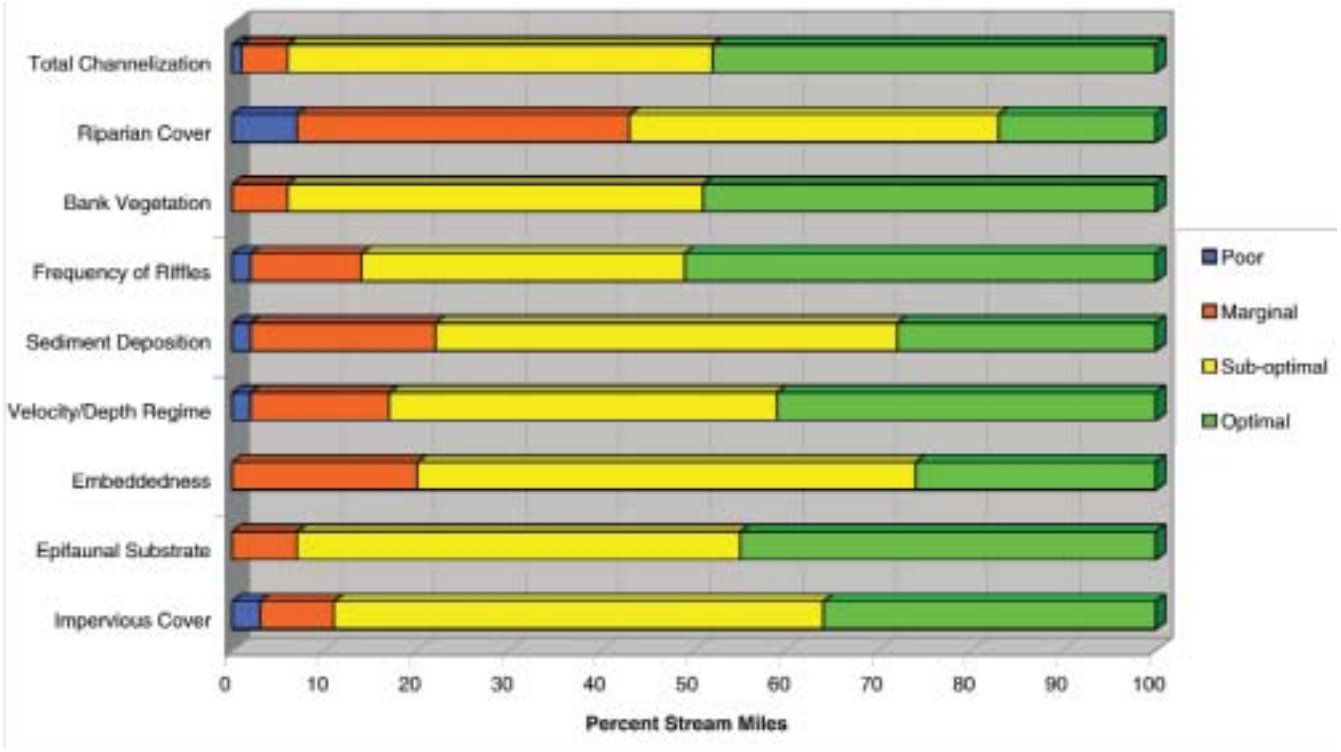


FIGURE A–7. HABITAT CONDITIONS IN THE LOWER TRIBUTARIES



k. Study 11: F.E. Walter White Water Releases, Effects on Macroinvertebrates, PA Fish and Boat Commission, December 2000

The Pennsylvania Fish and Boat Commission (PFBC) analyzed the effect of white water releases on the macroinvertebrate community downstream of the F.E. Water Dam (FEW) in 1998 and 1999.

In general, macroinvertebrate fauna changes in response to impoundments (Williams and Feltmate, 1992). Changes in invertebrate assemblage downstream of hydroelectric power generating dams have been documented (Camargo and Garcia de Jalon, 1995, Malmqvist and Englund, 1996). Hydropower induced changes in flow resulted in decreases in number of taxonomic groups, total biomass, and total density, but these changes decreased with time after the dam was constructed (Camargo and Garcia de Jalon, 1995).

PFBC found that it could not be determine from the results of the study that white water releases were resulting in any deleterious effects to the macroinvertebrate assemblage downstream of FEW. There may be some chronic depression of the macroinvertebrate community from the dam downstream to Pine Run near the Pennsylvania Turnpike bridge, though these effects were not consistently observed. The more general effects of dams on stream biota would be the likely cause of these observations, and not the white water release events.

l. Study 12: Lehigh River 2001 Water Quality Monitoring, DRBC and PADEP

INTRODUCTION:

The Delaware River Basin Commission (DRBC) and the Pennsylvania Department of Environmental Protection (PADEP) have been working toward determining flow needs and

TABLE A-11. MONITORING LOCATIONS THROUGHOUT 2001

Station	PADEP Water Use Category	Mainstream or Tributary	Location Description
LH1	HQ-CWF	Main	Upstream of FEW Dam at confluence of Tobyhanna Creek
LH2	HQ-CWF	Main	1,000 feet downstream of FEW
LH3	HQ-CWF	Main	At Tannery Bridge
LH4	HQ-CWF	Tributary	Hayes Creek
LH5	HQ-CWF	Tributary	Sandy Run
LH6	HQ-CWF	Tributary	Buck Mountain Creek
LH7	HQ-CWF	Tributary	Black Creek
LH8	HQ-CWF	Main	Glen Onoko
LH9	HQ-CWF	Tributary	Nesquehoning Creek
LH10	HQ-CWF	Main	Near Lehighton water intake
LH11	CWF	Tributary	Downstream of Lehighton sewage treatment outfall
LH12	CWF	Tributary	Pohopoco Creek leading from Beltzville Reservoir
LH13	TSF	Tributary	Lizard Creek
LH14	TSF, MF	Tributary	Aquashicola Creek
LH15	TSF	Main	Walnutport Gauge
LH16	CWF	Tributary	Bertsch Creek
LH17	TSF	Main	Northampton treatment plant intake

related water quality issues on the Lehigh River. The Flow Management Technical Advisory Committee was developed to address this issue. The committee consists of staff from the PADEP, Pennsylvania Fish and Boat Commission (PFBC), U.S. Army Corps of Engineers (USACE), Wildlands Conservancy (WC), and the DRBC.

A monitoring program was developed to obtain the existing water quality conditions of the Lehigh River in the spring of 2001. This data was collected to follow up existing water quality data over the past five years. A year of extensive data was collected from May to November 2001. Staff from the PFBC, PADEP, Wildlands Conservancy, USACE, and volunteer sources collected and analyzed the approximately 600 samples. This data will be used to develop a water quality flow model to determine the impacts of water quality and related water use issues on the entire length of the Lehigh River.

METHODS

Seventeen stations were monitored for 24 weeks in 2001 (see Table A-11). Seven stations were located on the main stem of the Lehigh River and ten were on tributaries. The sites ranged in location from just upstream of Francis E. Walter Reservoir to the Northampton Borough Municipal Water Authority intake. In addition, the USACE water quality reservoir sampling programs at the F.E. Walter and Beltzville Reservoirs were modified to meet study objectives. This included additional sampling stations, parameters, and numbers of samples. The study was a cost shared effort between the USACE and DRBC under Section 22 of the water Resources Development Act.

In-situ instruments, which measured temperature, pH, dissolved oxygen, chlorophyll, turbidity, and conductivity every hour, were installed at four of the main stem stations. Various other

meters were used at the other sites, and water grab sampling was conducted weekly. Water samples for total metals were conducted at eight stations once during the months of May, June, August, and September. The samples were analyzed for aluminum, cadmium, iron, manganese, and zinc. Rate curves and flow rates were monitored at Hayes Creek, Sandy Run, Buck Mountain, Black Creek, Nesquehoning Creek, Mahoning Creek, Lizard Creek, Aquashicola Creek, and Bertsch Creek.

Local weather conditions were recorded at two of the stations throughout the twenty-four week period. Air temperature, relative humidity, solar radiation, wind speed, and direction were monitored at the Walter and Beltzville Reservoir discharge towers.

RESULTS

(1.) Flows

Stream flow in the Lehigh River Watershed in 2001 is shown in Figure A-8. Average flows in the nine tributary stations ranged from 3.6 cfs at Bertsch Creek to 49.1 cfs at Aquashicola Creek. Bertsch Creek had the lowest average (3.6), minimum (1.0), and maximum (10.3) flows during the study period.

(2) Temperatures

Temperature probes were located at all river and tributary stations to continuously document changes in water temperature for the entire study period. Daily mean water temperatures were recorded at all seventeen stations. Figures A-9, A-11, and A-10 show the in-situ temperature for the headwaters to Sandy Run, Sandy Run to Pohopoco Creek, and Lehighton to Easton, respectively. The Pennsylvania DEP has seasonal specific temperature criteria for various classifications of fishery waters. The Temp1 criteria that is required for High Quality Cold Water Fisheries correlates to the time of year. For June this level is approximately 18°C and it increases to 19°C for the months of July and August. The September criteria is again 18°C, but then switches mid-month to16°C. In October, it switches from 12°C to 10°C and, by November, the value is as low as 8°C. The criteria for a Trout Stocking Fishery or a Cold Water Fishery are referred to as Temp3. The June values are 22°C and increase to 23°C in July. The criteria for

FIGURE A-8 LEHIGH RIVER WATERSHED FLOWS, 2001

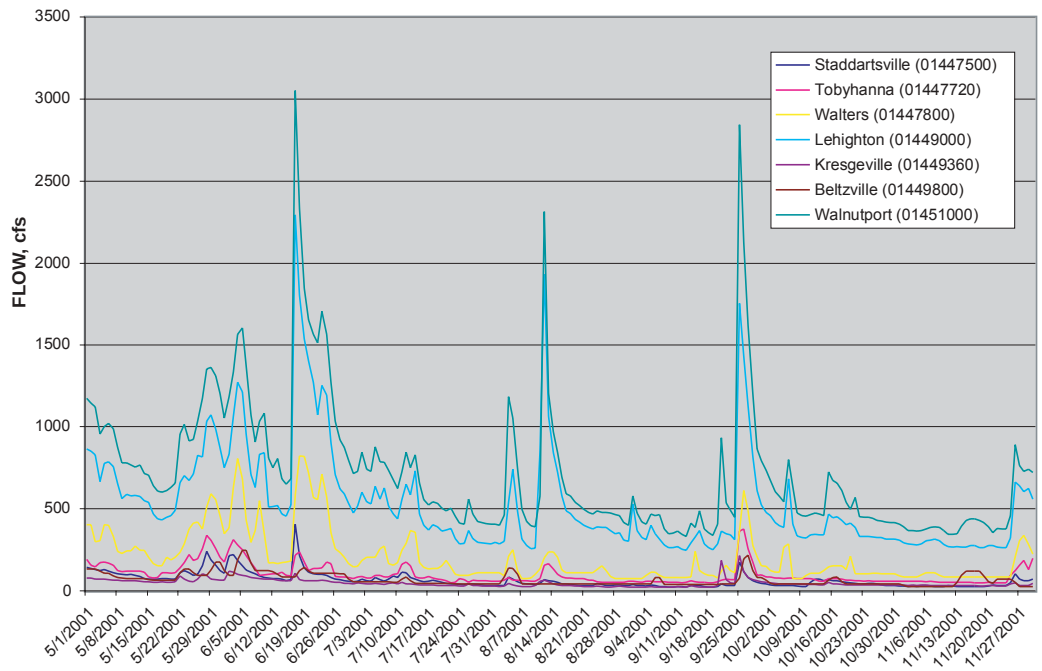


FIGURE A-9. IN-SITU TEMPERATURE FOR HEADWATERS TO SANDY RUN

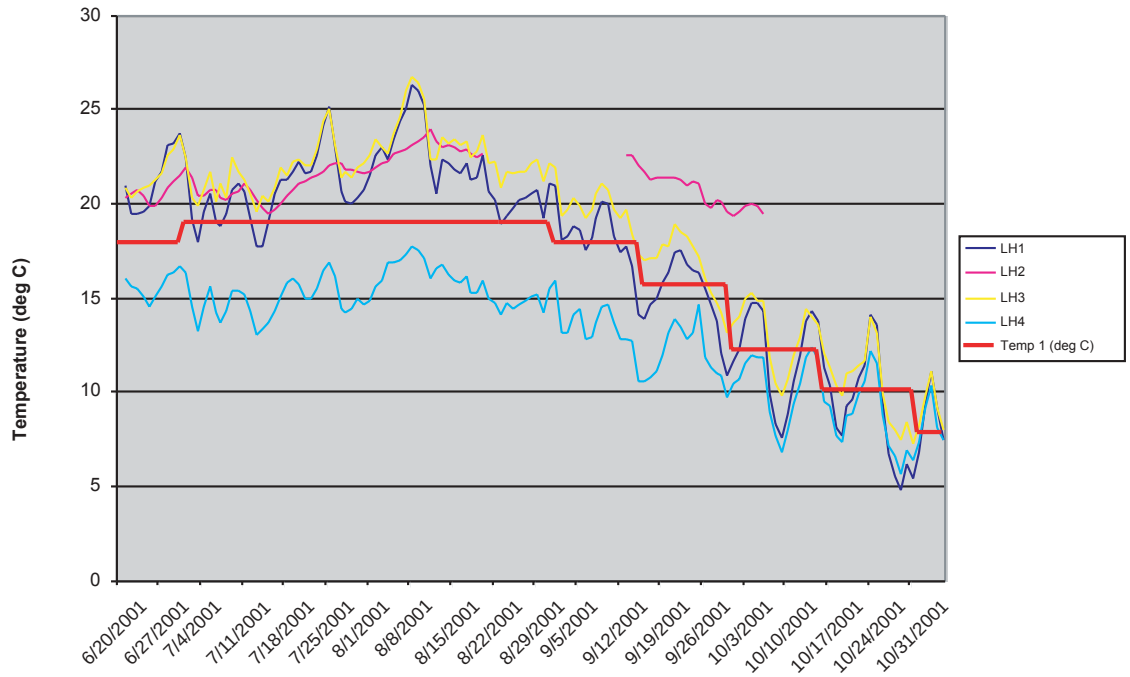


FIGURE A-10. IN-SITU TEMPERATURE FOR SANDY RUN TO POHOPOCO CREEK

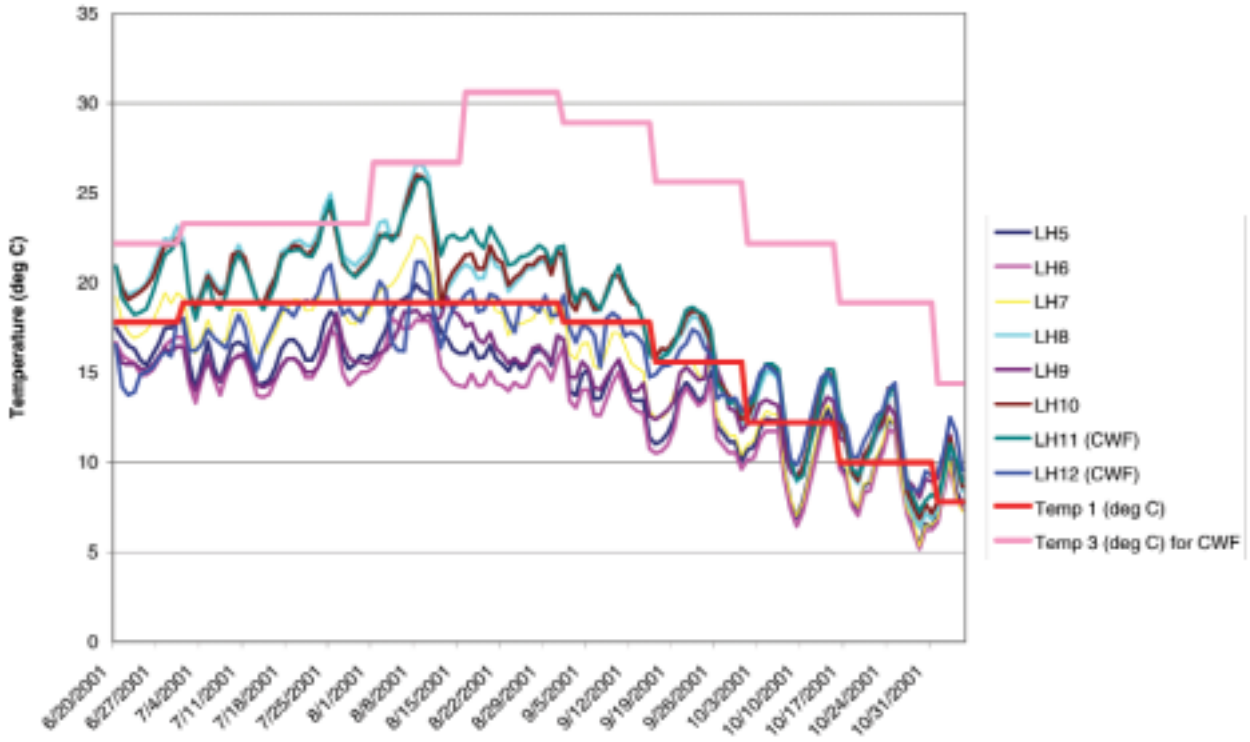
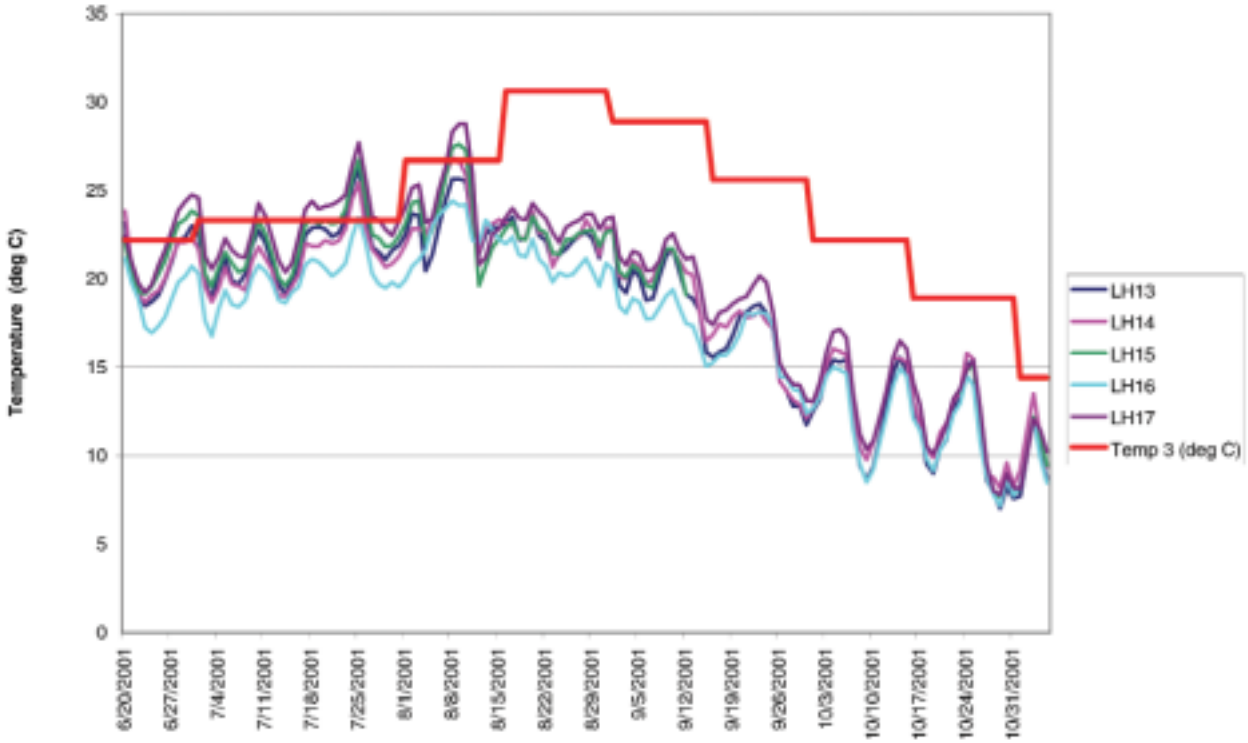


FIGURE A-11. IN-SITU TEMPERATURE FOR LEHIGHTON TO EASTON



August are the highest for the entire year with 27°C switching to 31°C mid-month. September values range from 28°C to 26°C mid-month. The October criterion is 22°C to 18°C, and that for November is 14°C.

Most of the tributaries and mainstream stations from LH11 to LH17 met the PADEP Temp3 requirements for either Trout Stocking Fishery or a Cold Water Fishery. High temperatures were found at the Glen Onoko (LH8), Lehighton (LH10), and Bertsch Creek (LH16) stations where the readings fluctuated from above to below the Cold Water Fishery criteria. The LH1, LH2, and LH3 stations did not comply with temperature requirements for a Cold Water Fishery for most of the monitoring period. Temperature readings were well below the Cold Water Fishery levels at the Hayes Creek (LH4) and Sandy Run (LH5) locations. Tributary station LH7 (Black Creek) was occasionally over the CWF temperature criteria in June and July, but generally below criteria after mid-August 2001. In contrast, water temperatures at tributary stations LH6 (Buck Mountain) and LH9 (Nesquehoning Creek) were well below the CWF criteria for most of the monitoring period.

(3) Dissolved Oxygen

Dissolved oxygen concentrations were monitored at four sites in the main stem of the Lehigh River during the twenty-four week period. Figures A-12, A-13, and A-14 show the dissolved oxygen levels for the headwaters to Sandy Run, Sandy Run to Pohopoco Creek, and Lehighton to Easton, respectively. Levels below the recommended 7.0 mg/L HQ-CWF dissolved oxygen criteria were observed in approximately 25% of the observations recorded at LH1. Low concentrations occurred during the end of June and into July of 2001. By fall 2001, the levels were well above the criteria, and in some cases reached supersaturated conditions. Levels for LH2 station were rarely below 7.0 mg/L, and concentrations at the LH10 station were never below the criteria, even in the warmer months. Out of 2,298 dissolved oxygen measurements in 2001 at station LH17, only two records were slightly below the 5.0 mg/L Trout Stock Fishery minimum and

FIGURE A–12. DISSOLVED OXYGEN LEVELS FOR HEADWATERS TO SANDY RUN

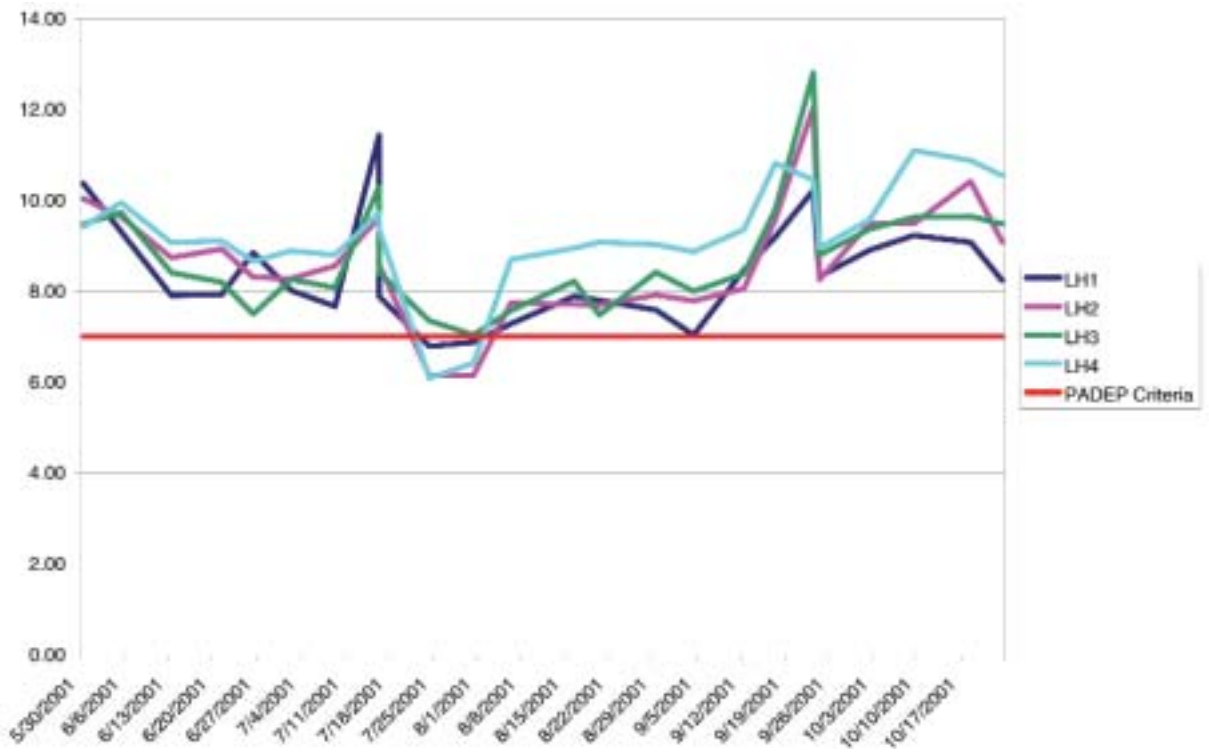


FIGURE A–13. DISSOLVED OXYGEN LEVELS FOR SANDY RUN TO POHOPOCO CREEK

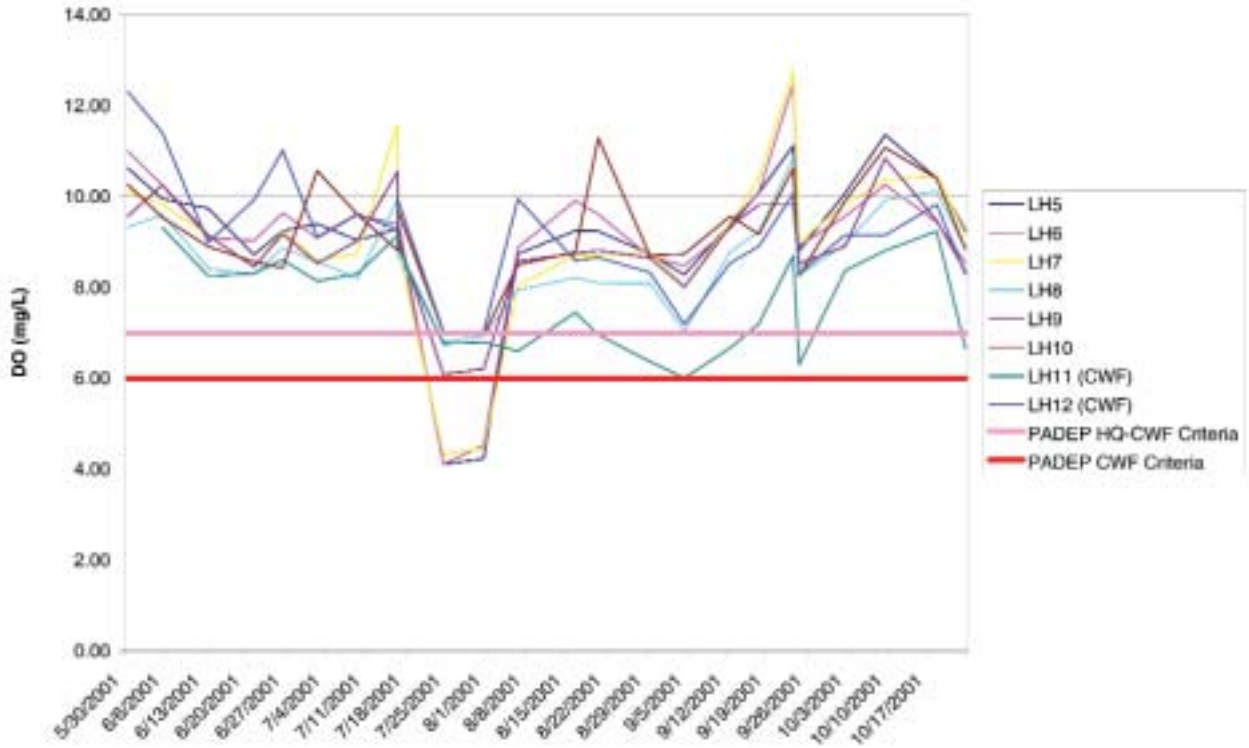
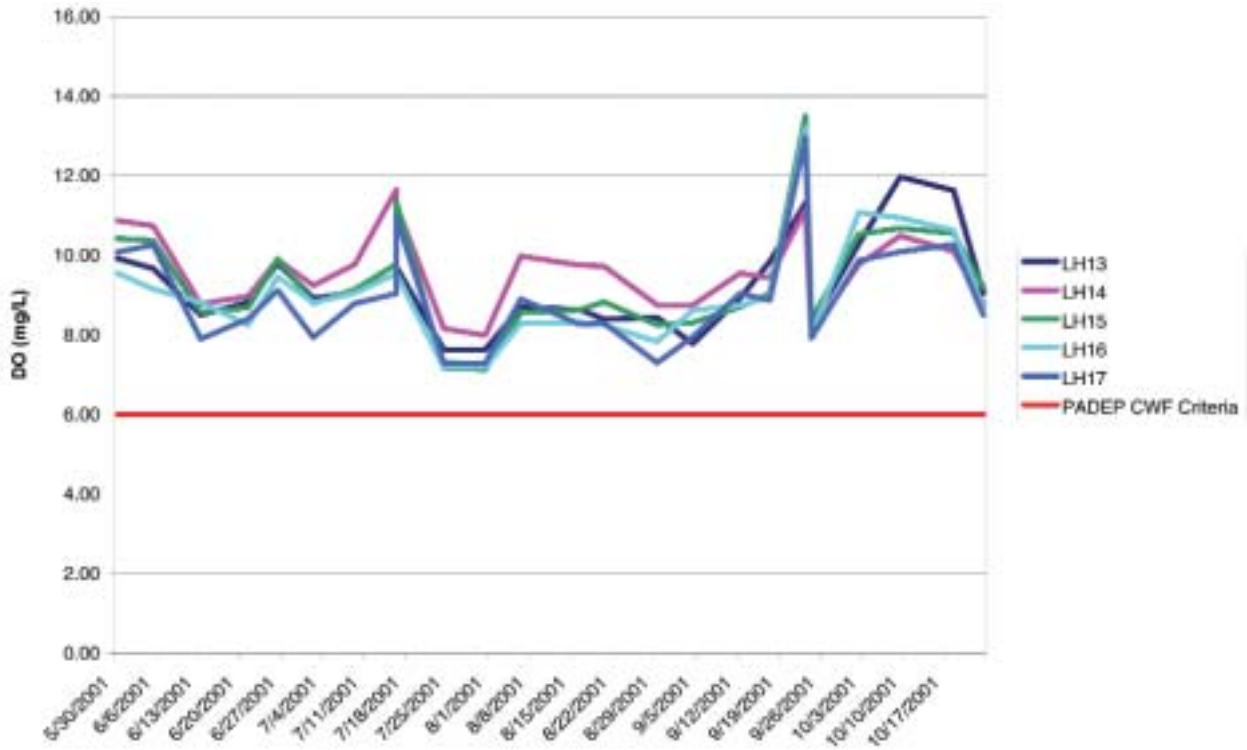


FIGURE A–14. DISSOLVED OXYGEN LEVELS FOR LEHIGHTON TO EASTON



daily averages were well above the 6.0 mg/L requirement.

(4) pH Levels

The pH levels of the four stations monitored remained within the 6 to 9 pH range required by the Pennsylvania DEP. In August 2001, approximately 25 readings below 6 were recorded at the station downstream of Walter Dam, 11 were below at the LH10 station, and one low reading was recorded at station LH1, upstream of Walter Dam. No pH levels below 6 were recorded at the Northampton LH17 station throughout the duration of the study.

(5) Nutrient Levels

Various nutrient levels were tested for at all 17 stations during the study. These measurements included ammonia nitrogen, nitrite, nitrate, phosphorous, and Biochemical Oxygen Demand (BOD). Figures A-15 through A-18 show the average phosphate and phosphorus, average ammonia, nitrate, and nitrite, average alkalinity, and average total inorganic and organic carbon concentrations, respectively. Other measurements included alkalinity, silica, and total inorganic and organic carbon.

Parameters remained within common levels at all stations except the LH11 station located in Mahoning Creek, just downstream of the Lehighton sewage treatment facility. Phosphorous levels at 16 of the stations remained below 0.1 mg/L. Total organic and inorganic carbon levels, as well as BOD levels, were below the test detection limits for most sites. Alkalinity and silica levels were consistently lower upstream than downstream, and these levels were fairly regular at the LH11 site as well.

The ammonia nitrogen, nitrite, and nitrate concentrations were all within regular freshwater levels except at the Mahoning Creek station. The ammonia at this station averaged 5.5 mg/L, well

FIGURE A -15. AVERAGE PHOSPHATE AND PHOSPHOROUS

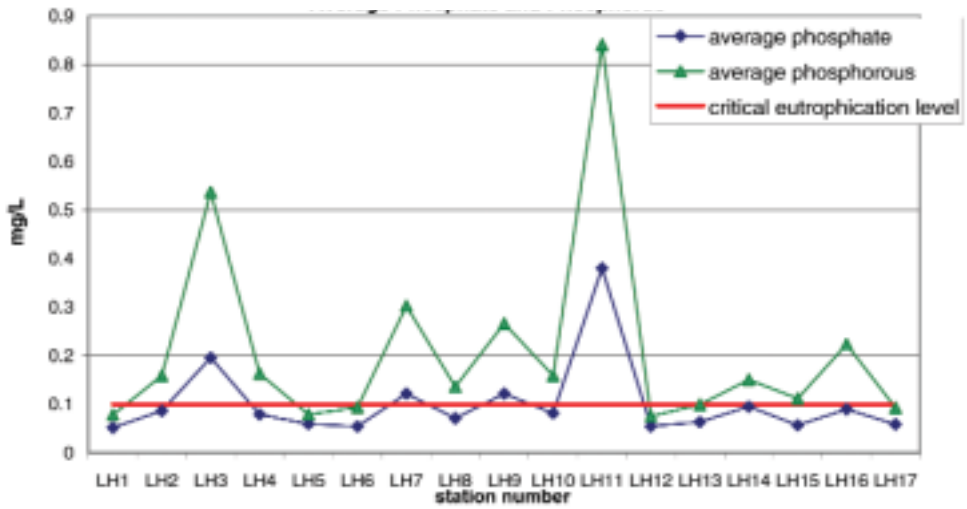


FIGURE A–16. AVERAGE AMMONIA, NITRATE AND NITRITE

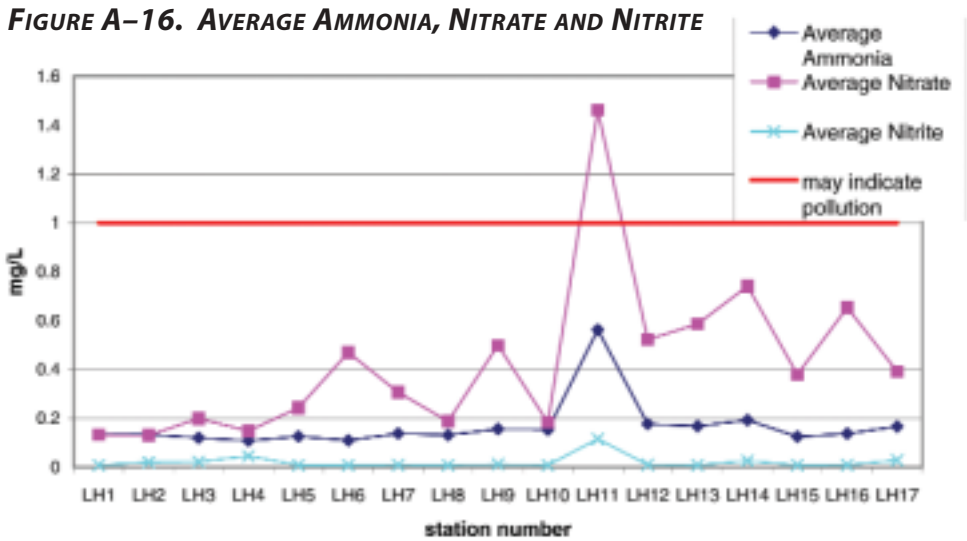
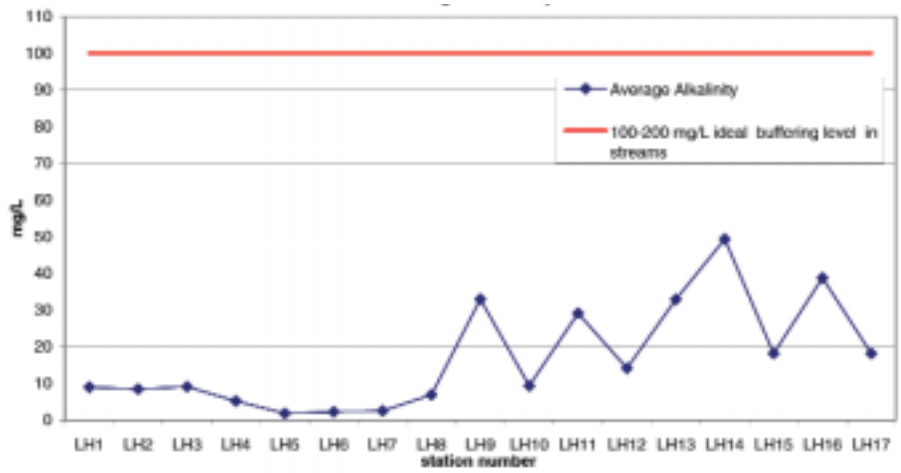


FIGURE A–17. AVERAGE ALKALINITY



above the average of 0.1 to 0.2 mg/L at the other 16 stations. The 1.4 mg/L nitrate readings at station LH11 were almost three times the average levels at the other stations. The average nitrite levels were less than 0.02 mg/L except for the average of 0.11 mg/L at the Mahoning Creek location. Phosphorous levels at this station were 0.38 mg/L, and the BOD levels approached 5.0 mg/L.

(6) Chlorophyll Concentrations

Chlorophyll levels were low throughout the study period, averaging around 1.5 mg/L. None of the seventeen stations varied much from this average, including the LH11 site on the Mahoning Creek. There was no seasonal trend in the levels, perhaps indicative of the riverine nature of the Lehigh River resulting in short residence time for the chlorophyll producing phytoplankton.

(7) Metals Concentration

Water samples were analyzed for levels of five total metals: aluminum, cadmium, iron, manganese, and zinc. Figures A-19, A-20, and A-21 show the aluminum, iron, and zinc present in the Lehigh River in 2001, respectively. The concentra-

tions of cadmium, iron, and manganese were consistently found within governmental standards at all of the sites tested. The aluminum and zinc levels varied between stations. Dissolved aluminum levels (measured in June 2001) exceeded criteria at stations LH6 and LH7. Values of total aluminum exceeded the Delaware River Basin Commission (DRBC) standard of 0.087 mg/L. Total zinc levels for all of the stations averaged 0.05 mg/L. Four measurements exceeded DRBC criteria. These levels were recorded in June at the Buck Mountain Creek (both June and August), Black Creek, and Aquashicola Creek stations (LH6, LH7, and LH14 respectively). Dissolved zinc levels at the Aquashicola Creek station were measured as 0.629 mg/L, which is five times higher than the DRBC standard of 0.082 mg/L.

FIGURE A–18. AVERAGE TOTAL INORGANIC AND ORGANIC CARBON

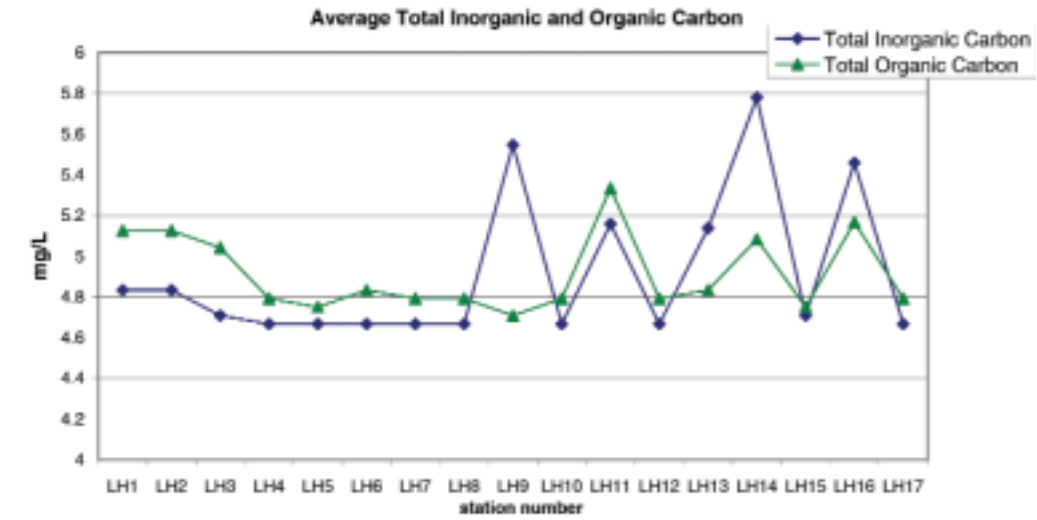


FIGURE A–19. ALUMINUM IN THE LEHIGH RIVER, 2001

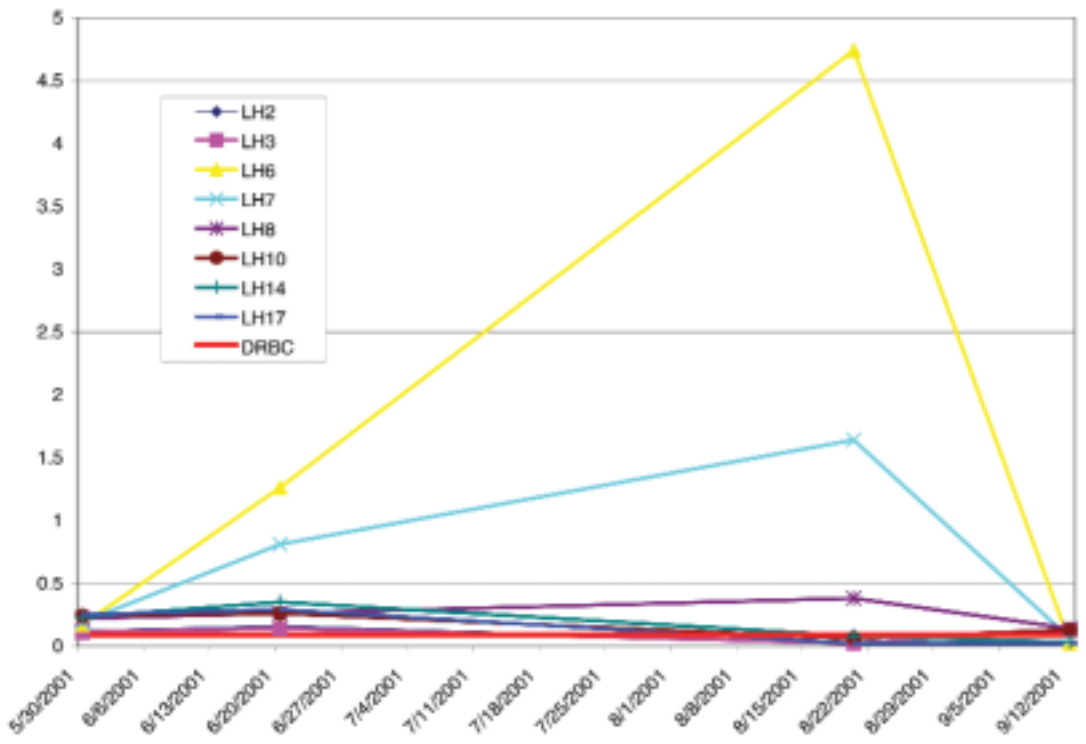


FIGURE A–20. IRON IN THE LEHIGH RIVER, 2001

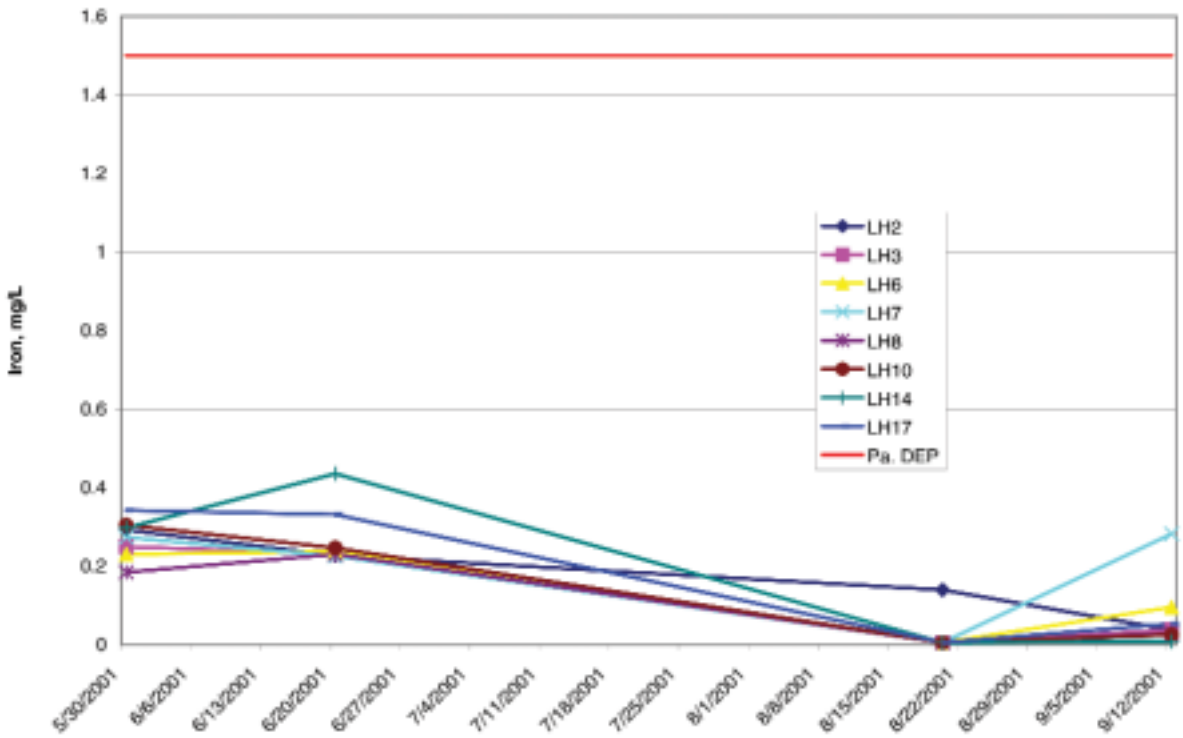
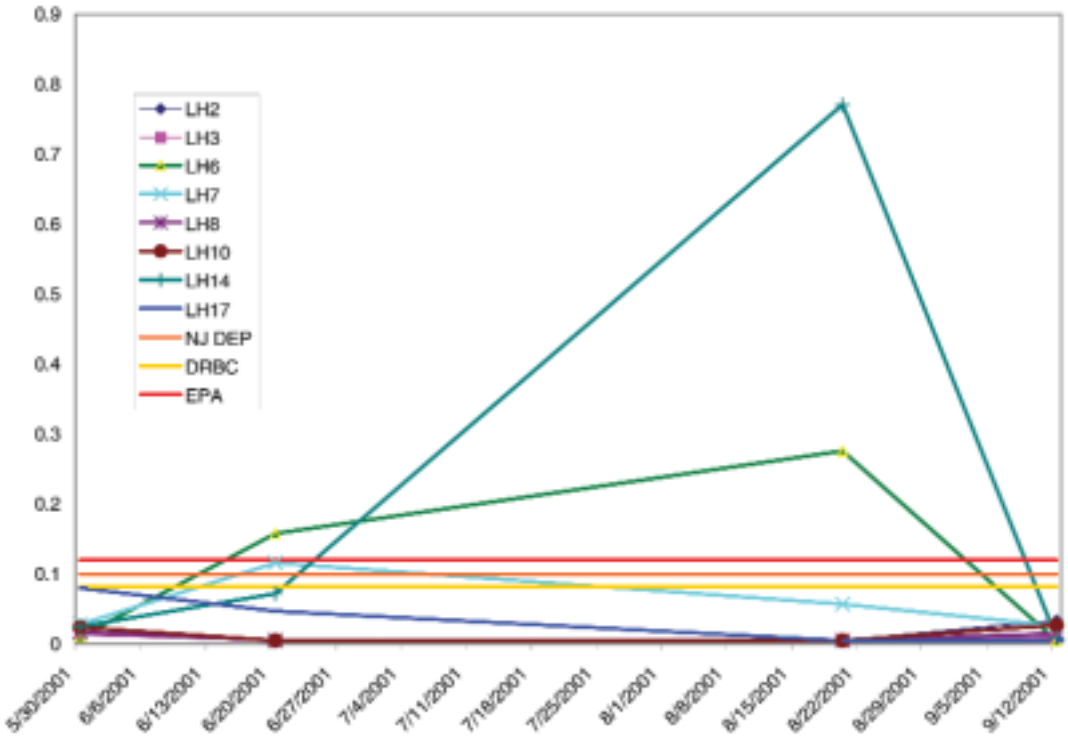


FIGURE A–21. ZINC IN THE LEHIGH RIVER, 2001



SUMMARY AND CONCLUSION

The data collected in 2001 suggest that water quality was generally within the PADEP and DRBC recommended levels with some exceptions. Temperature conditions upstream and immediately downstream of Walter Dam were too high to support a Cold Water Fishery according to PADEP guidelines. While most of the tributary water temperatures were within recommended levels, main stem stations just below the Lehigh Gorge State Park were above HQ-CWF requirements. Ambient water temperature in the lower portion of the Lehigh (between Mahoning Creek and Northampton) typically met the temperature requirement of the TSF critical use. Dissolved oxygen monitoring by the in-situ meters revealed that, apart from a few minor exceptions, oxygen levels were within acceptable ranges, even in the stream reach directly below Walter Dam. Overall pH levels remained between the required 6 to 9 range, except for a few short-term low pH events. Nutrient levels were not excessive, and with the exception of aluminum in May and June 2001, few water quality violations for metals were observed during the monitoring period. Chlorophyll levels monitored by weekly grab samples indicated that concentrations were consistently low (1.5 mg/L) throughout the entire monitoring period, suggesting that very little if any seasonal changes in water column phytoplankton biomass occurred in 2001.

I. Study 13: Lehigh River Benthic Macroinvertebrate Sampling, PA Fish and Boat Commission, US Army Corp of Engineers, 2002

The Pennsylvania Fish and Boat Commission (PFBC) and US Army Corp of Engineers (USACE) conducted a study to document the response of the benthic macroinvertebrate community to significant precipitation of iron oxide and elevated H2S levels in the discharge of FEW that resulted after pool levels were increased in 2002. The FEW normal non-flood elevation is 1300 ft (NGVD). As a result of a DRBC declared drought emergency in 2002, DRBC requested the USACE to store 12 billion gallons for drought relief. This resulted in a pool level of 1392 ft NGVD. At the time of the study, the pool level was 1377 ft NGVD, or 15 ft lower than the maximum elevation attained in 2002. The study indicated that the top of a well-defined thermocline was located at about 1370 ft NGVD and that the water was essentially anoxic below that point.

The benthic invertebrate samples collected in 2002 at two sites in the Lehigh River located between the mouth of Pine Run and FEW indicated a general decline in community structure downstream of the dam compared to an upstream site located just downstream of the confluence of Tobyhanna Creek. This is consistent with the findings from sampling efforts conducted in 1998 and 1999 at these same sites (Reynolds and Young, 2000). However, in 2002, the changes were generally more dramatic at the downstream sites than in previous years. The metrics used consistently demonstrated that the site nearest the dam had the poorest benthic macroinvertebrate community and the site upstream of the dam had the best. The most likely reason for the results that were observed in 2002 is the degraded water quality and precipitation of iron that occurred that year after the pool level was raised.

Others studying the effects if the precipitation of iron on benthic macroinvertebrate communities have made similar observations (McKnight and Feder, 1984; Gerhardt and Westermann, 1995; and Koryak et al., 1972, as cited by Ashby 2002). The site nearest the dam was most severely affected by this phenomenon, and some recovery had occurred at the confluence of Pine Run.

Appendix B–1.

LAND PRIORITIZATION METHODOLOGY

To develop land prioritization maps indicating areas of the watershed recommended for protection, the USGS National Land Cover Data (version 5-27-99) and county natural areas inventory (CNAI) data, surface water hydrology, protected lands, and other GIS coverages were utilized. Tax parcel data (when available) was transposed on GIS coverages to eliminate developed parcels that have already disturbed habitat. Tax parcel data will continue to be used to narrow the focus in these larger priority areas to protect specific stream corridors, large forested areas, greenways, and CNAI sites. All stream corridors will continue to be considered for protection. Using the GIS data, stream corridors will continue to be delineated as having either forest, agricultural, or no riparian buffer. Lands containing stream corridors which lack quality riparian vegetative cover will continue to be identified as areas requiring riparian restoration and best management practices (BMPs). Potential greenway corridors and conservation connections will continue to be identified within the watershed. Agricultural lands to be protected will continue to be selected according to their clustering potential with other protected lands and farms and their possession of stream corridors.

In addition to the goal of protecting as these priority lands from development, lands that are already protected by public or private means will be targeted for a BMP assessment. This is essential because protecting land alone does not ensure that the ecological values of the area are being protected, especially were public access is allowed. A proactive program to promote the use of BMPs on these lands will be initiated and ongoing.

Goals of Land Protection

- Protect and maintain an adequate supply of high quality water
- Protect areas of rare or endangered species, high biodiversity and habitat values
- Protect areas of contiguous forest
- Protect agricultural lands
- Protect recreational areas and greenways

Land Protection Project Selection Guide

This ranking system reflects our preservation priorities:

- open lands adjacent to other protected lands
- lands possessing water resources, especially Exceptional Value (EV) and High Quality Cold Water Fisheries (HQCWF), wetlands, and streamside riparian areas
- natural areas inventory sites
- forested lands, mountain ridges and steep slopes
- farmlands
- greenway linkages
- important bird areas

Overall, the following will be considered when proactively targeting lands for preservation:

- natural resource value
- threat of development
- potential cost and funding availability
- feasibility and landowner interest

Action steps will be taken to protect as much of the priority lands as possible utilizing a variety of effective preservation options:

- acquisition by state or local municipalities
- acquisition by non-profit organizations
- conservation easements
- management agreements
- natural resource protection ordinances
- cluster and overlay zoning

Wildlands Conservancy's current top priority lands for protection are illustrated in the following maps:

Map 10 - 1. Exceptional Value (EV) Stream Basins

Map 10 - 2. Unprotected EV Stream Basins

Map 10 - 3. Unprotected Wetlands

Map 10 - 4. Unprotected Natural Areas Inventory Sites

Map 10 - 5. Unprotected Agricultural Basins

Map 10 - 6. Unprotected Forest Lands

Appendix C-1.

RECREATION AREAS WITHIN THE LEHIGH RIVER WATERSHED

Source: Lehigh University and PASDA

Name	*Township*	*Description*	*Acreage*
CARBON COUNTY			
Abbott A.A. Basketball & Tennis Courts	Borough of Lansford	Neighborhood Park	0.7 acres
Aquashicola Playground	Lower Towamensing	Neighborhood Park	8.0 acres
Baer Memorial Park	Lehighton Borough	Public School Recreation Area	10.0 acres
Beltzville State Park	Towamensing Township	State Park	2023.4 acres
Bill Black Park	Summit Hill Borough	Community Park/Center	0.3 acres
Borough Hall	Palmerton Borough	Community Park/Center	0.4 acres
Borough of Bowmanstown Baseball Field	Bowmanstown Borough	Community Park/Center	1.5 acres
Borough Park	Palmerton Borough	Community Park/Center	9.0 acres
Bowmanstown Borough Hall Playground	Bowmanstown Borough	Neighborhood Park	0.5 acres
Bwmnstwn Boro Watershed/Archery Club	Bowmanstown Borough	Wildlife Refuge	3.0 acres
Elm Street Park	Summit Hill Borough	Neighborhood Park	0.5 acres
Eurana Park	Weatherly Borough	Community Park/Center	30.0 acres
Franklin Heights Memorial Park	Franklin Township	Neighborhood Park	7.2 acres
Ginter Park	Summit Hill Borough	Community Park/Center	2.0 acres
Heilman Dam	Lehighton Borough		60.0 acres
Hickovy Run State Park	Kidder Township	State Park	15482.9 acres
Jacob Weiss Park	Lehighton Borough	Community Park/Center	1.5 acres
Jim Thorpe Jr. High	Jim Thorpe Borough	Public School Recreation Area	1.0 acres
Junedale Playground	Banks Township	Community Park/Center	0.4 acres
Karen Park	Weissport Borough	Open Space	3.2 acres
L.B. Morris Elementary School	Jim Thorpe Borough	Public School Recreation Area	22.0 acres
Lake Marie Recreational Grounds	Beaver Meadows Borough	Community Park/Center	8.0 acres
Lehigh Gorge Park	Jim Thorpe Borough	State Park	5000.0 acres
Lehighton Area Highs School	Lehighton Borough	Public School Recreation Area	6.0 acres
Lehighton Area Middle School	Lehighton Borough	Public School Recreation Area	6.0 acres
Lehighton Area School District Stadium	Lehighton Borough	Public School Recreation Area	10.0 acres
Lehighton Recreation Commission	Lehighton Borough	Community Park/Center	6.0 acres
Lower Jacob Weiss Park	Lehighton Borough	Community Park/Center	1.0 acres
Ludlow Park	Summit Hill Borough	Community Park/Center	1.0 acres
Mahoning Twp. Park	Mahoning Township	Community Park/Center	2.2 acres
Maple Street	Banks Township	Neighborhood Park	0.5 acres
Mauch Chunk Lake Park	Jim Thorpe Borough	County Park	0.6 acres
Memorial Park	Banks Township	Community Park/Center	5.2 acres
Palmerton Area High School	Lower Towamensing Township	Public School Recreation Area	20.0 acres

RECREATION AREAS WITHIN THE LEHIGH RIVER WATERSHED *(continued)*

Name	*Township*	*Description*	*Acreage*
CARBON COUNTY *(continued)*			
Palmerton Memorial Park	Palmerton Borough	Community Park/Center	65.0 acres
Panther Valley Elementary School	Nesquehoning Borough	Public School Recreation Area	87.0 acres
Panther Valley High School	Summit Hill Borough	Public School Recreation Area	9.5 acres
Phifer Ice Dam Park	FranklinTownship	Community Park/Center	9.0 acres
Seventh Street Athletic Field	Palmerton Borough	Community Park/Center	2.0 acres
Six and Coal BallField	Lehighton Borough	Community Park/Center	1.0 acres
Skyline Park	Lehighton Borough	Community Park/Center	0.5 acres
State Game Lands No. 129	Kidder Township	State Game Lands	2780.3 acres
State Game Lands No. 141	Nesquehoning Borough	State Game Lands	17047.9 acres
State Game Lands No. 168	Lower Towamensing Township	State Game Lands	45.0 acres
State Game Lands No. 217	East Penn Township	State Game Lands	611.6 acres
State Game Lands No. 40	Kidder Township	State Game Lands	6118.5 acres
State Game Lands No. 41	Kidder Township	State Game Lands	2627.4 acres
Stephen S. Palmer Elementary School	Palmerton Borough	Public School Recreation Area	1.0 acres
The Community Grove	Lehighton Borough	Community Park/Center	4.0 acres
Third Street Ball Field	Palmerton Borough	Neighborhood Park	1.5 acres
Towamensing Elementary School	Towamensing Township	Public School Recreation Area	14.0 acres
Tresckow Playground	Banks Township	Community Park/Center	0.6 acres
Veterans Memorial Field	Banks Township	Community Park/Center	5.0 acres
Weatherly Middle School	Weatherly Borough	Public School Recreation Area	48.0 acres
Weiser State Forest, District #18	Penn Forest Township	State Forest	999.0 acres
Weissport Borough	Weissport Borough	Neighborhood Park	4.0 acres
West End Recreation Association	Palmerton Borough	Neighborhood Park	4.1 acre
BERKS COUNTY			
District - Topton Elementary School	Topton Borough	Public School Recreation Area	11.2 acres
Hereford Elementary School	Hereford Township	Public School Recreation Area	22.0 acres
Hereford Estate Recreation Park	Hereford Township	Community Park/Center	2.0 acres
Hereford Township Fishing Park	Hereford Township	Community Park/Center	3.6 acres
Hereford Township Municipal Park	Hereford Township	Community Park/Center	2.2 acres
High / Middle School	Topton Borough	Public School Recreation Area	31.8 acres
Longswamp Elementary School	Longswamp Township	Public School Recreation Area	13.4 acres
Longswamp Township Recreation Park	Longswamp Township	Community Park/Center	8.0 acres
Topton Community Park	Topton Borough	Community Park/Center	10.2 acres

continued on next page

RECREATION AREAS WITHIN THE LEHIGH RIVER WATERSHED *(continued)*

Name	*Township*	*Description*	*Acreage*
BUCKS COUNTY			
Bridgeton Elementary School	Springfield Township	Public School Recreation Area	24.0 acres
Springfield Elementary School	Springfield Township	Public School Recreation Area	20.0 acres
LACKAWANNA COUNTY			
Covington	Covington Township	Undevlpd Cnty Prklnd	413.0 acres
Covington Elementary	Covington Township	Public School Recreation Area	2.0 acres
State Game Lands No. 91	Spring Brook Township	State Game Lands	1499.7 acres
LEHIGH COUNTY			
Alburtis Playground	Alburtis Borough	Community Park/Center	1.0 acres
Alburtis School	Alburtis Borough	Public School Recreation Area	5.0 acres
Allen High School	Allentown City	Public School Recreation Area	8.0 acres
Ancient Oak West	Lower Macungie Township	Neighborhood Park	9.8 acres
Ancient Oaks South	Lower Macungie Township	Neighborhood Park	3.7 acres
Balliet Stadium	Coplay Borough	Neighborhood Park	6.6 acres
Berger Park	Salisbury Township	Neighborhood Park	0.5 acres
Borough Ballfield	Alburtis Borough	Baseball field	1.0 acres
Borough of Coplay Parkway System	Coplay Borough	Baseball Field	18.0 acres
Bridgeview Terrace	South Whitehall Township	Open Space	0.1 acres
Brookside Villa	Lower Macungie Township	Open Space	2.6 acres
Bungalow Park	South Whitehall Township	Neighborhood Park	1.2 acres
Canal Park (National Heritage Corridor)	Hanover Township	Heritage Corridor	0.9 acres
Candy Cane Park	Catasauqua Borough	Neighborhood Park	1.3 acres
Cedar Crest Gardens	South Whitehall Township	Open Space	3.8 acres
Central Elementary	Allentown City	Public School Recreation Area	1.0 acres
Cetronia Elementary School	South Whitehall Township	Public School Recreation Area	10.0 acres
Chestnut Grove Park System	Hanover Township	Neighborhood Park	3.3 acres
Church Lane Park	Lower Macungie Township	Neighborhood Park	13.6 acres
Cleveland Elementary	Allentown City	Public School Recreation Area	1.0 acres
Coplay Parkway	Coplay Borough	Neighborhood Park	11.3 acres
Covered Bridge Park	South Whitehall Township	Community Park/Center	89.3 acres
Deerfield	South Whitehall Township	Open Space	4.3 acres
Devonshire Park	Salisbury Township	Neighborhood Park	13.0 acres
Dieruff High School	Allentown City	Public School Recreation Area	10.0 acres
Dodd Elementary	Allentown City	Public School Recreation Area	10.0 acres
Dodson Park	Salisbury Township	Neighborhood Park	5.0 acres
Donald Memorial Playground	South Whitehall Township	Neighborhood Park	0.8 acres

RECREATION AREAS WITHIN THE LEHIGH RIVER WATERSHED *(continued)*

Name	*Township*	*Description*	*Acreage*
East Texas	Lower Macungie Township	Community Park/Center	9.1 acres
Emmaus High School	Emmaus Borough	Public School Recreation Area	30.0 acres
Emmaus Jr. High School	Emmaus Borough	Public School Recreation Area	10.0 acres
Eyer Jr. High School	Macungie Borough	Public School Recreation Area	19.5 acres
Farmington Hills	Lower Macungie Township	Flood Plains	17.1 acres
Fernwood Terrace	South Whitehall Township	Neighborhood Park	10.0 acres
Fogelsville Elementary School	South Whitehall Township	Public School Recreation Area	11.0 acres
Franko Farm Park	Salisbury Township	Open Space	76.8 acres
Friedens Playground	Washington Township	Neighborhood Park	3.0 acres
Golden Oaks	South Whitehall Township	Open Space	2.0 acres
Grandlawn Baseball Association Field	South Whitehall Township	Neighborhood Park	1.5 acres
Grandview Terrace	South Whitehall Township	Open Space	1.0 acres
Green Acres Park	Salisbury Township	Neighborhood Park	5.0 acres
Grove Street Park	South Whitehall Township	Neighborhood Park	0.5 acres
Hamson Morton Middle	Allentown City	Public School Recreation Area	4.0 acres
Harry S. Truman Elementary School	Salisbury Township	Public School Recreation Area	12.0 acres
Hidden Valley Park	Lower Macungie Township	Neighborhood Park	5.7 acres
Hopewell Elementary School	Upper Saucon Township	Public School Recreation Area	23.0 acres
Ironton Elementary School	South Whitehall Township	Public School Recreation Area	12.0 acres
Jackson Elementary	Allentown City	Public School Recreation Area	2.0 acres
Jacoby Park	South Whitehall Township	Neighborhood Park	1.4 acres
Jasper Park	Upper Milford Township	Neighborhood Park	26.7 acres
Jefferson Elementary	Allentown City	Public School Recreation Area	2.0 acres
Jefferson School	Emmaus Borough	Public School Recreation Area	2.3 acres
Joseph Michael Prater Memorial Park	Lower Macungie Township	Neighborhood Park	3.8 acres
Kernsville Elementary School	North Whitehall Township	Public School Recreation Area	22.0 acres
Kings Highway Elementary	Upper Milford Township	Public School Recreation Area	4.0 acres
Kratzer Elementary School	South Whitehall Township	Public School Recreation Area	12.0 acres
Laubach Park	Salisbury Township	Community Park/Center	13.0 acres
Lehigh Parkway Elementary	Allentown City	Public School Recreation Area	5.0 acres
Lenape Park	Upper Milford Township	Neighborhood Park	12.0 acres
Liberty Bell Elementary School	Coopersburg Borough	Public School Recreation Area	24.0 acres
Lincoln Elementary	Allentown City	Public School Recreation Area	1.0 acres
Lincoln Elementary School	Emmaus Borough	Public School Recreation Area	2.1 acres
Lindberg Park	Salisbury Township	Community Park/Center	20.0 acres
Louise Park	Salisbury Township	Neighborhood Park	1.5 acres
Lower Macungie School	Macungie Borough	Public School Recreation Area	8.0 acres

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RECREATION AREAS WITHIN THE LEHIGH RIVER WATERSHED *(continued)*

Name	*Township*	*Description*	*Acreage*
Lower Macungie Twp Brookside Mun. Campus	Lower Macungie Township	Community Park/Center	30.0 acres
Lower Macungie Twp Park	Lower Macungie Township	Community Park/Center	90.8 acres
Lower Milford Elementary School	Lower Milford Township	Public School Recreation Area	20.0 acres
Macungie Elementary School	Lower Macungie Township	Public School Recreation Area	7.5 acres
Macungie Memorial Park	Macungie Borough	Community Park/Center	42.0 acres
McKinley Elementary	Allentown City	Public School Recreation Area	1.0 acres
Mossen Elementary	Allentown City	Public School Recreation Area	31.0 acres
Muhlenberg Elementary	Allentown City	Public School Recreation Area	3.0 acres
Municipal Building Property	North Whitehall Township	Community Park/Center	10.5 acres
Northwestern Lehigh Rec. Comm.Park	Heidelberg Township	Community Park/Center	32.3 acres
Northwestern Recreation Commission	Heidelberg Township	Neighborhood Park	44.0 acres
Ott Street Playground	Allentown City	Public School Recreation Area	10.0 acres
PA Gamelands	Lowhill Township	State Game Lands	1100.0 acres
Parkland Farms	South Whitehall Township	Open Space	3.5 acres
Parkland Senior High School	South Whitehall Township	Public School Recreation Area	91.0 acres
Parkway Court	South Whitehall Township	Open Space	1.0 acres
Parkway Manor	South Whitehall Township	Neighborhood Park	0.4 acres
Parkway Manor Elementary	South Whitehall Township	Public School Recreation Area	17.0 acres
Raub Middle School	Allentown City	Public School Recreation Area	6.0 acres
Ritter Elementary	Allentown City	Public School Recreation Area	1.0 acres
River Road Park	Salisbury Township	Neighborhood Park	1.5 acres
Rodale Park	Lower Macungie Township	Neighborhood Park	10.2 acres
Roosevelt Elementary	Allentown City	Public School Recreation Area	3.0 acres
Sagamore Hills	South Whitehall Township	Neighborhood Park	0.6 acres
Salisbury High School	Salisbury Township	Public School Recreation Area	19.0 acres
Salisbury Middle School	Salisbury Township	Public School Recreation Area	15.0 acres
Saucon Valley Living Memorial	Upper Saucon Township	Neighborhood Park	3.0 acres
Schnecksville Elementary School	North Whitehall Township	Public School Recreation Area	13.3 acres
Shepherd Hills Park	Lower Macungie Township	Neighborhood Park	3.0 acres
Sheridan Elementary	Allentown City	Public School Recreation Area	2.0 acres
Sherwood Park	Hanover Township	Neighborhood Park	4.9 acres
Shoemaker School	Lower Macungie Township	Public School Recreation Area	13.5 acres
Slatedale Recreation Park	Washington Township	Neighborhood Park	11.0 acres
South Mountain Middle	Allentown City	Public School Recreation Area	10.0 acres
South Whitehall Chase	South Whitehall Township	Neighborhood Park	2.4 acres
Southern Lehigh High School	Upper Saucon Township	Public School Recreation Area	58.0 acres
Southern Lehigh Middle School	Upper Saucon Township	Public School Recreation Area	53.0 acres

RECREATION AREAS WITHIN THE LEHIGH RIVER WATERSHED *(continued)*

Name	*Township*	*Description*	*Acreage*
Spring Valley Estates	North Whitehall Township	Open Space	1.1 acres
Springhouse Junior High School	South Whitehall Township	Public School Recreation Area	54.0 acres
Springhouse West	South Whitehall Township	Open Space	1.7 acres
Spruce St. Recreation Area	Macungie Borough	Passive Rec. Area	3.3 acres
State Game lands 217	Washington Township	State Game Lands	4876.9 acres
State Game lands No. 205	Lowhill Township	State Game Lands	1302.8 acres
Stoneridge Terrace	South Whitehall Township	Open Space	1.4 acres
Trexler Lehigh Game Preserve	West Lebanon Township	Wildlife Refuge	0.3 acres
Trexler Middle School	Allentown City	Public School Recreation Area	16.0 acres
Troxell Junior High School	South Whitehall Township	Public School Recreation Area	13.0 acres
Twin Grove	South Whitehall Township	Open Space	2.0 acres
Union Terrace Elementary	Allentown City	Public School Recreation Area	5.0 acres
Washington Elementary	Allentown City	Public School Recreation Area	2.0 acres
Wedgewood Park	South Whitehall Township	Open Space	2.9 acres
Wescosville Elementary School	Lower Macungie Township	Public School Recreation Area	13.3 acres
Wescosville Park	Lower Macungie Township	Community Park/Center	6.2 acres
Western Salisbury Elementary School	Salisbury Township	Public School Recreation Area	13.0 acres
Whitehall-Colay School District	Whitehall Township	Schl. Dist.Rec. Area	100.0 acres
Wilson Elementary	Allentown City	Public School Recreation Area	4.0 acres
Winchester Estates	South Whitehall Township	Open Space	1.0 acres
Winchester Heights	South Whitehall Township	Open Space	6.6 acres
Winding Brook	Lower Macungie Township		13.3 acres
LUZERNE COUNTY			
A.D. Thomas Elementary School	Hazleton City	Public School Recreation Area	0.7 acres
Agmar Playground	Foster Township	Community Park/Center	1.0 acres
Arthur St. Elementary School	Hazleton City	Public School Recreation Area	0.7 acres
Bear Creek Elementary School	Bear Creek Township	Public School Recreation Area	2.6 acres
Bear Creek Twp Recreational Site	Bear Creek Township	Community Park/Center	30.0 acres
Bear Creek Twp Trailwood	Bear Creek Township	Community Park/Center	22.5 acres
Butler Twp Recreational Area	Butler Township	Community Park/Center	7.1 acres
Della Croce Field	Freeland Borough	Community Park/Center	3.7 acres
Dennison Twp. Municipal Bldg	Dennison Township	Neighborhood Park	0.3 acres
E. A. Encke Elementary School	Hazle Township	Public School Recreation Area	0.7 acres
Eckley Miner's Village	Foster Township	National Register Historic Site	85.0 acres
Foster Twp Playground	Foster Township	Neighborhood Park	2.0 acres
Fourth Ward Park	Freeland Borough	Community Park/Center	3.8 acres

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RECREATION AREAS WITHIN THE LEHIGH RIVER WATERSHED *(continued)*

Name	*Township*	*Description*	*Acreage*
Freeland Elementary School	Foster Township	Public School Recreation Area	3.5 acres
Freeland Jr. High School	Foster Township	Public School Recreation Area	4.0 acres
Freeland Public Park	Freeland Borough	Community Park/Center	5.2 acres
Hazle Elementary School	Hazle Township	Public School Recreation Area	23.6 acres
Hazle Twp Community Park	Hazle Township	Community Park/Center	162.0 acres
Hazleton Area Career Center	Hazle Township	Public School Recreation Area	32.0 acres
Hazleton Jr. High School	Hazleton City	Public School Recreation Area	4.5 acres
HemlockStreet Park	White Haven Borough	Neighborhood Park	0.3 acres
Lackawanna State Forest, District 11	Buck Township	State Forest	2106.0 acres
Legion Park	Butler Township	Neighborhood Park	0.8 acres
Lehigh Gorge Prk	White Haven Borough	State Park	0.7 acres
Lehigh Park	White Haven Borough	Community Park/Center	8.6 acres
Linesville Park	White Haven Borough	Community Park/Center	26.0 acres
Locust St. Elementary School	Hazleton City	Public School Recreation Area	0.7 acres
Nescopeck State Park	Butler Township	State Park	360.0 acres
Pine St. Tennis /Basketball Court	White Haven Borough	Neighborhood Park	2.8 acres
Pine Street Neighborhood Park	White Haven Borough	Neighborhood Park	0.2 acres
State Game Lands No. 149	Foster Township	State Game Lands	1334.4 acres
State Game Lands No. 187	Butler Township	State Game Lands	8186.2 acres
State Game Lands No. 91	Jenkins Township	State Game Lands	14459.1 acres
Trailwood-Gen. Sullivan Camp Ground	Bear Creek Township	Community Park/Center	22.5 acres
White Haven Community Building	White Haven Borough	Community Center	7020.0 acres
MONROE COUNTY			
Blanche D. Price Memorial Park	Tobyhanna Township	Community Park/Center	23.4 acres
Burnley Softball Field	Hamilton Township	Softball Field	4.0 acres
Chestnuthill Twp Park	Chestnuthill Township	Neighborhood Park	33.8 acres
Coolbaugh Elementary Center	Coolbaugh Township	Public School Recreation Area	42.7 acres
Coolbaugh Twp Municipal Park	Coolbaugh Township	Community Park/Center	77.2 acres
Delaware State Forest	Tunkhannock Township	State Forest	8582.0 acres
Fenner/Snyder/Robacker Homestead	Hamilton Township	Community Park/Center	5.0 acres
Gouldsboro State Park	Coolbaugh Township	State Park	2594.0 acres
Hamilton Elementary School	Hamilton Township	Public School Recreation Area	10.2 acres
Hamilton Softball Field	Hamilton Township	Softball Field	2.0 acres
Monroe Cnty Rec. Off. & Multi-Purpose	Hamilton Township		8.5 acres
Old Mill	Hamilton Township	Community Park/Center	5.5 acres
Pleasant Valley Brodheadsville Complex	Chestnuthill Township	Public School Recreation Area	112.0 acres
State Game Lands No. 127	Tobyhanna Township	State Game Lands	25527.4 acres

RECREATION AREAS WITHIN THE LEHIGH RIVER WATERSHED *(continued)*

Name	*Township*	*Description*	*Acreage*
State Game Lands No. 129	Tunkhannock Township	State Game Lands	738.1 acres
State Game Lands No. 168	Eldred Township	State Game Lands	692.2 acres
State Game Lands No. 38	Tunkhannock Township	State Game Lands	5488.6 acres
Tobyhanna Elementary Center	Tobyhanna Township	Public School Recreation Area	26.9 acres
Tobyhanna State Park	Coolbaugh Township	State Park	5143.0 acres
Tunkhannock Twp Municipal Park	Tunkhannock Township	Community Park/Center	1.0 acres
Twp of Tobyhanna Keiper Ballfield	Tobyhanna Township	Community Park/Center	9.0 acres
WAYNE COUNTY			
Gouldsboro State Park	Lehigh Township	State Park	206.0 acres
State Game Lands No. 312	Sterling Township	State Game Lands	3708.6 acres
Sterling Township	Sterling Twp	Community Park/Center	4.0 acres
Tobyhanna State Park	Lehigh Township	State Park	296.0 acres
NORTHAMPTON COUNTY			
#4 Firehouse	Easton City	Passive Park	0.2 acres
12th & Wood Ave. Triangle	Easton City	Passive Park	0.1 acres
14th Street Playground	Bethlehem Township	Neighborhood Park	0.8 acres
26th Street Playground	Northampton Borough	Neighborhood Park	5.6 acres
4th Street Playground	Northampton Borough	Neighborhood Park	3.0 acres
8th Street Steps	Easton City	Passive Park	0.3 acres
Alliance Playground	Northampton Borough	Neighborhood Park	0.9 acres
Archibald Johnston Conservation Area	Bethlehem City	County Park	51.6 acres
Bangor Area S.D.- Five Points Campnts Recreation Area	Upper Mount Bethel Township 100.0 acres		Public School
Bangor Community Center	Bangor Borough	Community Park/Center	0.8 acres
Bangor Memorial Park	Bangor Borough	Community Park/Center	33.8 acres
Bangor Town Hall Park	Bangor Borough	Neighborhood Park	0.1 acres
Bear Swamp County Park 245.4 acres	Upper Mount Bethel Township		County Park
Berlinsville Ball Field	Lehigh Township	Municipal Rec. Site	28.0 acres
Bethlehem Township Bike Path	Palmer Township	Multi Purpose Trail	5.0 acres
Bethlehem Township Municipal Park	Bethlehem Township	Community Park/Center	100.0 acres
Birchwood Park	Hanover Township	Neighborhood Park	1.3 acres
Bob Rute Field	Easton City	Community Park/Center	30.8 acres
Boro Meadow Park	Bath Borough	Community Park/Center	12.0 acres
Briarcliffe Park	Palmer Township	Neighborhood Park	17.2 acres
Bushkill Elementary School	Bushkill Township	Public Schl.Bldg	9.0 acres

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RECREATION AREAS WITHIN THE LEHIGH RIVER WATERSHED *(continued)*

Name	*Township*	*Description*	*Acreage*
Bushkill St. Tot Lot	Easton City	Neighborhood Park	0.9 acres
Canal Street Park Complex	Northampton Borough	Community Park/Center	36.4 acres
Centennial Park	Easton City	Neighborhood Park	0.6 acres
Center Square	Easton City	Passive Park	0.5 acres
Cheston Elementary School	Easton City	Public School Recreation Area	7.7 acres
Chetwin Terrace	Bethlehem Township	Neighborhood Park	1.0 acres
College Heights Park	Hanover Township	Neighborhood Park	1.0 acres
College Hill Fire Station	Easton City	Passive Park	0.5 acres
Comer Park	Bethlehem Township	Neighborhood Park	1.5 acres
Condron Park	Easton City	Neighborhood Park	0.6 acres
Constitution Avenue Park	Hellertown Borough	Community Park/Center	1.6 acres
Cottingham Stadium	Easton City	Public School Recreation Area	5.0 acres
Cowling Field	Bath Borough	Neighborhood Park	6.5 acres
Danielsville Ball Field	Lehigh Township	Municipal Rec. Site	11.4 acres
Delaware Canal	Easton City	State Park	121.7 acres
Delta Manor Park	Hanover Township	Neighborhood Park	4.1 acres
Dimmick Park	Hellertown Borough	Community Park/Center	17.0 acres
Easton Area High School	Palmer Township	Public School Recreation Area	45.0 acres
Eddyside Park	Easton City	Community Park/Center	3.6 acres
Fairview Park	Palmer Township	Community Park/Center	15.5 acres
Flory Parkway	Bangor Borough	Fishing Area	37.0 acres
Floyd R. Shafer Elementary School	Nazareth Borough	School Building	10.0 acres
Forks Elementary School	Forks Township	Public School Recreation Area	25.0 acres
Forks Twp Municipal Park System	Forks Township	Community Park/Center	136.0 acres
Former Railroad Property	Stockertown Borough	Frmr Railroad Prop	15.0 acres
Franklin Elementary School	Northampton Borough	Public School Recreation Area	1.5 acres
Frost Hollow County Park	Forks Township	County Park	2.5 acres
Fry's Run County Park	Williams Township	County Park	5.7 acres
George wolf Elementary School	Bath Borough	Public School Recreation Area	25.6 acres
Georgetown Road Park	Lower Nazareth Township	Open Space	5.0 acres
Gertrude Fry County Park	Bethlehem Township	County Park	7.1 acres
Gracedale	Bushkill Township	County Park	368.1 acres
Gregory Park	Hellertown Borough	Neighborhood Park	0.3 acres
Grist Mill Park Complex	Hellertown Borough	Community Park/Center	20.0 acres
Hahn Meadow	Lower Nazareth Township	Open Space	15.0 acres
Heil Park - Ballfields	Easton City	Community Park/Center	15.9 acres
Heil Park Pool	Easton City	Community Park/Center	15.9 acres

RECREATION AREAS WITHIN THE LEHIGH RIVER WATERSHED *(continued)*

Name	*Township*	*Description*	*Acreage*
Hellertown Dimmick Municipal Pool	Hellertown Borough	Municipal Pool	3.7 acres
Hellertown Municipal Plaza	Hellertown Borough	Neighborhood Park	0.2 acres
High Street Playground	Hellertown Borough	Neighborhood Park	0.2 acres
Howerton Park	Allen Township	Community Park/Center	17.5 acres
Huge Moore Park	Easton City	Historic Site	260.0 acres
Hunter - Martin Museum/Cemetery	Lower Mount Bethel Township	Historic Site	1.0 acres
Indiantrail Park	Lehigh Township	Community Park/Center	5.7 acres
Jackson St. Tot Lot	Easton City	Neighborhood Park	0.2 acres
Jacobsburg Environmental Education Center	Bushkill Township	Environ. Ed. Center	1166.5 acres
Jax Park	Bangor Borough	Open Space	0.1 acres
Jeffery Field	Wilson Borough	Ball Park	2.5 acres
Jones Memorial Park	Bangor Borough	Open Space	0.1 acres
Kennedy Park	Easton City	Neighborhood Park	0.4 acres
Keystone Park	Palmer Township	Community Park/Center	10.5 acres
Keystone Park (Green Street Park)	Bath Borough	Community Park/Center	6.0 acres
Kiefer Park	Lower Mount Bethel Township	Ballfield Little League	3.0 acres
Knox Triangle	Easton City	Passive Park	0.2 acres
LA Barre Park	Palmer Township	Neighborhood Park	3.0 acres
Lachenour Park	Easton City	Community Park/Center	10.5 acres
Lehigh Canal-Bethlehem Twp Section	Bethlehem Township	Canal & Towpath	27.0 acres
Lehigh Elementary School	Lehigh Township	Public School Recreation Area	14.7 acres
Liberty Playground	Wilson Borough	Neighborhood Park	0.5 acres
Liebert Park	Upper Nazareth Township	Neighborhood Park	2.0 acres
Little Lachenour/Smith St. Steps	Easton City	Open Space	2.1 acres
Little Stone House	Easton City	Passive Park	0.1 acres
Louse W. Monroe County Park	Bethlehem Township	County Park	129.4 acres
Lower Hackett Park	Wilson Borough	Community Park/Center	21.2 acres
Lower Mount Bethel Twp. Municipal Bldg..	Lower Mount Bethel Township	Municipal Building	5.0 acres
Lower Nazarthe Twp Park	Lower Nazareth Township	Community Park/Center	18.0 acres
Macada North Park	Hanover Township	Neighborhood Park	4.3 acres
Madison St.	Easton City	Passive Park	0.1 acres
Maunch Chunk Park	Easton City	Neighborhood Park	1.5 acres
Mauser Track	Allen Township	County Park	81.8 acres
McIlwame Meadows County Park	Bethlehem Township	County Park	8.0 acres
McInterny & Luwellen Farm	Williams Township	Open Space	150.0 acres

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RECREATION AREAS WITHIN THE LEHIGH RIVER WATERSHED *(continued)*

Name	*Township*	*Description*	*Acreage*
Meuser Park	Wilson Borough	Community Park/Center	14.0 acres
Milton St.	Easton City	Neighborhood Park	1.4 acres
Mini Park	Upper Nazareth Township	Neighborhood Park	2.0 acres
Moore Elementary School	Bath Borough	Public School Recreation Area	17.8 acres
Mud Run County Park	Northampton Borough	County Park	11.9 acres
Municipal Park	Northampton Borough	Community Park/Center	22.6 acres
Municipal Tract and Pool	Hanover Township	Community Park/Center	40.5 acres
Nazareth Area High School	Nazareth Borough		15.0 acres
Nazareth Area Middle School	Nazareth Borough		12.0 acres
Neighborhood Center	Easton City	Community Park/Center	2.6 acres
Nesquohoning Park	Easton City	Neighborhood Park	0.4 acres
Nevin Park	Easton City	Neighborhood Park	5.5 acres
Newburg Park	Palmer Township	Neighborhood Park	1.2 acres
Ninth Street Park	West Easton Borough	Neighborhood Park	0.9 acres
Northampton and Beth Railroad	Upper Nazareth Township	County Park	68.4 acres
Northampton Area Jr. High School	Northampton Borough	Public School Recreation Area	6.5 acres
Northampton Area Senior High School	Northampton Borough	Public School Recreation Area	26.7 acres
Old Orchard Park	Palmer Township	Neighborhood Park	6.4 acres
Packard & Glendon Sts. Triangle	Easton City	Passive Park	0.1 acres
Palmer Comple	Palmer Township	Community Park/Center	22.9 acres
Palmer Elementary School	Palmer Township	Public School Recreation Area	35.0 acres
Paxinosa Elementary School	Forks Township	Public School Recreation Area	25.0 acres
Penn Pump Park	Palmer Township	Community Park/Center	6.4 acres
Pharo Park	Hanover Township	Neighborhood Park	2.3 acres
Philip F. Laurer Middle School	Wilson Borough	Public School Recreation Area	35.0 acres
Pioneer Park	Easton City	Neighborhood Park	0.6 acres
Plainfield Elementary School	Plainfield Township	Public School Recreation Area	10.7 acres
Plainfield Twp. Farmers Grove	Plainfield Township	Community Park/Center	40.0 acres
Plainfield Twp. Recreation Trail	Plainfield Township	Trails	6.5 acres
Reinhard Elementary	Hellertown Borough	Public School Recreation Area	3.0 acres
Rentzheimer Park	Hellertown Borough	Neighborhood Park	4.2 acres
Reservoir Park	Hellertown Borough	Watershed & Park Ave	5.0 acres
Riverside Park	Easton City	Community Park/Center	3.6 acres
Riverview Park	Palmer Township	Community Park/Center	47.8 acres
Saint Joseph's St. Park	Easton City	Neighborhood Park	0.3 acres
Saucon Valley Community Center	Hellertown Borough	Community Park/Center	0.3 acres
Scott Park	Easton City	Community Park/Center	5.5 acres

RECREATION AREAS WITHIN THE LEHIGH RIVER WATERSHED *(continued)*

Name	*Township*	*Description*	*Acreage*
Seventh St. Tot Lot	Easton City	Passive Park	0.7 acres
Shawnee Intermediate School	Forks Township	Public School Recreation Area	39.0 acres
Spruce & Raspberry Sts. Tot - Lot	Easton City	Neighborhood Park	0.2 acres
State Game Lans No. 168	Moore Township	State Game Lands	4891.5 acres
Stephens Street Park	Palmer Township	Neighborhood Park	0.9 acres
Sullivan Park	Easton City	Community Park/Center	5.1 acres
Tracy Elementary School	Palmer Township	Public School Recreation Area	21.0 acres
Upper Hackett Park	Wilson Borough	Community Park/Center	53.2 acres
Valley St. Tot Lot	Easton City	Neighborhood Park	0.1 acres
Vanderveer Park	Easton City	Neighborhood Park	0.3 acres
Village View	Hanover Township	Neighborhood Park	6.0 acres
Washington Elementary School	Northampton Borough	Public School Recreation Area	2.3 acres
Water Street Park	Hellertown Borough	Neighborhood Park	4.3 acres
Welcome to Easton	Easton City	Passive Park	0.1 acres
West Easton Recreation Field	West Easton Borough	Community Park/Center	2.8 acres
Westgate Park	Hanover Township	Neighborhood Park	1.0 acres
Whittaker Street Park	Hellertown Borough	Neighborhood Park	2.1 acres
William Street Triangle	Easton City	Passive Park	0.1 acres
Williams Twp Elementary School	Williams Township	Public School Recreation Area	19.1 acres
Wilson Area High School	Wilson Borough	Public School Recreation Area	14.4 acres
Wind Gap Middle School	Plainfield Township	Public School Recreation Area	23.5 acres
Wolf Elementary School	Northampton Borough	Public School Recreation Area	8.5 acres
Wolf's Run	Palmer Township	Community Park/Center	46.9 acres
Wy-Hit-Tuk County Park	Northampton Borough	County Park	23.0 acres
SCHUYLKILL COUNTY			
Buehler Memorial Park	Tamaqua Borough	Community Park/Center	4.8 acres
John M. Ryan Recreational Park	Rush Township	Neighborhood Park	26.2 acres
Kelayres Playground	Kline Township	Neighborhood Park	3.5 acres
Lincoln Street Park	Rush Township	Neighborhood Park	0.2 acres
McAdoo-Kelayres Elementary School	McAdoo Borough	Public School Recreation Area	5.0 acres
McKeansburg Playground	East Brunswick Township	Neighborhood Park	1.4 acres
Miller Park	Rush Township	Neighborhood Park	2.9 acres
Quakake Park	Rush Township	Neighborhood Park	0.4 acres
Rush Elementary School	Rush Township	Public School Recreation Area	4.0 acres
State Game Lands No. #227	Rush Township	State Game Lands	1496.9 acres
State game Lands No. 217	West Penn Township	State Game Lands	601.2 acres

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RECREATION AREAS WITHIN THE LEHIGH RIVER WATERSHED *(continued)*

Name	*Township*	*Description*	*Acreage*
State Game Lands No. 227	Rush Township	State Game Lands	1505.8 acres
State Game lands No. 257	Tamaqua Borough	State Game Lands	3416.7 acres
State Game Lands No. 308	Kline Township	State Game Lands	1068.5 acres
Tamaqua Elementary School	Tamaqua Borough	Public School Recreation Area	32.0 acres
Tamaqua Jr. High School	Tamaqua Borough	Public School Recreation Area	2.0 acres
Tamaqua Sr. High School	Tamaqua Borough	Public School Recreation Area	30.0 acres
Triangle Park	Rush Township	Neighborhood Park	0.2 acres
Tuscarora State Park	Rush Township	State Park	1716.0 acres
W.Penn Township Community Park	West Penn Township	Community Park/Center	12.0 acres
West Penn Elementary School	West Penn Township	Public School Recreation Area	25.0 acres
West Penn Twp Comm. Park	West Penn Township	Community Park/Center	12.0 acres
Willing Memorial Park	Tamaqua Borough	Community Park/Center	1.2 acres

Appendix C-2.

STATE PARK RECREATIONAL INFORMATION

Source: Pennsylvania Recreational Guide and Highway Map. Pennsylvania Department of Conservation and Natural Resources. 2003

	Beltzville	***Gouldsboro***	***Hickory Run***	***Lehigh Gorge***	***Tobyhanna***
County/Counties	*Carbon*	*Monroe*	*Carbon*	*Luzerne/Carbon*	*Monroe/Wayne*
Contact Information	*(610) 377-0045*	*(570) 894-8336*	*(570) 443-0400*	*(570) 443-0400*	*(570) 894-8336*
OVERNIGHT FACILITIES					
Park Acreage	2,972	2,800	15,700	4,548	5,440
Number of Campsites (Tents only-T, Backpack only-B)			381		140
Site Charge (Modern-A, Primitive-B, Electric Hookup-E)			A/B/E		B
Camping Seasons (S, L, & Y. REFER TO KEY BELOW FOR MORE INFO)			S/L		L
Toilets (Flush-F, Pit-P), Showers (S)			P/F/S		P
Sanitary Dumping Station			YES		YES
Store (within 5 miles)-S, Laundromat (within 5 miles)-L	S	S	L/S		L/S
Organized Group Camping (Tenting-T, Cabins-C, Trailer-R)			T/C		Tobyhanna
Cabins (Modern-M, Rustic-R) Camping Cottages(CC) Walled Tent-(WT) Yurts (Y)					
DAY USE FACILITIES AND RECREATIONAL ACTIVITIES					
Natural Areas (N) and Historical Landmarks (H)			N		N
Picnicking (Pavilion Rental - R), (Picnick Grove Rental-G)	YES-R	YES-R	YES-R		YES-R
(Playfield-F, Children's Playground-G)		FG		FG	FG
Swimming Pool-P, Beach-B	B	B	B		B
Visitor Center-V, Historical Center-H			V		
Environmental Education and Interpretation Y-year-round	YES		YES-R		
Water Acreage	949	250	17	RIVER	170
Fishing (Cold water species-C, Warm water species-W)	WC	W	C	C	WC
Boat Rentals	YES	YES			YES

continued on next page

STATE PARK RECREATIONAL INFORMATION *(continued)*

	Beltzville	***Gouldsboro***	***Hickory Run***	***Lehigh Gorge***	***Tobyhanna***	
County/Counties	*Carbon*	*Monroe*	*Carbon*	*Luzerne/Carbon*	*Monroe/Wayne*	
Contact Information	*(610) 377-0045*	*(570) 894-8336*	*(570) 443-0400*	*(570) 443-0400*	*(570) 894-8336*	
DAY USE FACILITIES AND RECREATIONAL ACTIVITIES *(continued)*						
Boat Mooring-M, Boat Launching-L, Canoes Only-C)	ML	ML			ML	
Boating Permitted (REFER TO KEY BELOW FOR MORE INFO)	UN	E		W	E	
Marina						
Hunting	YES	YES	YES	YES	YES	
Hiking (Backpack Trailhead-B)	15	10	10	30	12	
Horseback Riding Trail Miles (Trailhead-TH)						
Bicycling (Rental-R) Mt. Biking-M				YES-M	YES	
Ice Sports (Ice Boating-B, Ice fishing-F, Ice skating-S)		BF	F	F	SF	
Snowmobile Trails (Miles-M, Acres-A, Trailhead-TH)		5m			15m	5mTH
Skiing Downhill-D, Cross Country-X, Sledding-S		X	X	X	X	X

Key

CAMPING SEASONS

Y - open year round.

L - open second Friday in April to the last day of antlerless deer season in December.

S - open second Friday in April to third Sunday in October.

BOATING PERMITTED

UN - all qualified boats including unlimited horsepower motors. Water skiing permitted in designated areas.

E - all qualified non-powered boats and registered boats with electric motors.

W - whitewater boating available.

Appendix C-3.

LOCAL HIKES WITHIN THE LEHIGH RIVER WATERSHED

Souce: Wildlands Conservancy's Walk For Wellness Program.

Name of Hike	*City Location*	*Address*	*Highlights*	*Description and Trail Conditions*
Allentown Rose Garden	Allentown	Cedar Crest Blvd	Fitness workout stations; Rose Garden; Open park and ponds	1 mile flat fine gravel path
Bake Oven Knob and Bear Rocks	Rt. 73	Blue Mountain;	Mostly flat but rocky; Spectacular views; Rocky section of the Appalachian Trail	Unpaved trails
Beltzville State Park		Pohopoco Dr.	Old orchard; Dense hemlock forest; Waterfall and Wild Creek Cove	Unpaved trails
Bethlehem Township Municipal Park	Bethlehem	Farmersville Road	20-station exercise system; Open field	1 1/2 miles flat smooth stone walking surface
Bob Rodale Cycling and Fitness Park	Trexlertown	Mosser Road	Mixed forests; Fields and natural wetlands	Mostly level. Paved trails and trails of wood chips
Delaware & Lehigh Trail	Allentown/ Bethlehem/ Easton	Start Sand Island, Bethlehem	Walk along the canal	12 miles of trails of well groomed and flat trails
Glen Onoko	Jim Thorpe	Rt. 903	60 ft waterfall; trail rises over 900 feet through a mature forest to top of Glen Onoko Run	1.25 mile path; Railroad trails; Unpaved trails
Gouldboro State Park	Gouldsboro Lake	Rt. 507	Abandoned road along a swamp; Rocky ridge and mature woods; Ideal bird watching	5.7 mile unpaved trail loop
Graver Arboretum		Rt. 512	Wildflower Meadow; Conifer Arboretum; Seven year-round pond habitats; native woods; Over 3,000 rhododendrons	Unpaved trails
Hickory Run State Park	Jim Thorpe	Rt. 534	Unique rock formations and past dams and old logging mill ruins that date back to the 1800's; Birdwatching	Over 45 miles of trails; Unpaved trials and roads
Ironton-Whitehall Rail-Trail	Whitehall	Rt. 145	Saylor Park Cement Industry Museum; Industrial park ruins; Troxell-Steckel House	Loop Trail; Easy walking; Unpaved
Jacobsburg Environmental Education Center	Jacobsburg	Rt. 33	Network of four trails; Bushkill Creek	12 miles of trails hard-packed dird and crushed stone
Jordan Creek Park	Allentown	Lehnert Road	Two short connected trails; Passes over Jordan Creek and mature woods	Wide, flat, and a mix of dirt, grass and stone
Lehigh Gorge State Park		Lehigh Gorge	Deep gorge; Dramatic rock outcroppings and many waterfalls; Steep walls up to 900 feet; part of the Delaware and Lehigh National Heritage Corridor	26 mile trail follows the abandoned level railbed

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LOCAL HIKES WITHIN THE LEHIGH RIVER WATERSHED *(continued)*

Name of Hike	*City Location*	*Address*	*Highlights*	*Description and Trail Conditions*
Lehigh University Fields	Hellertown	Lehigh University Fields	Athletic playing fields; Rural open space; Rolling hills with vistas	Mowed grass trails
Little Lehigh Parkway	Allentown	Little Lehigh Parkway	Idyllic tree-filled park	Well-maintained stone and dirt paths
Louise W. Moore Park	South Nazerth	Rt. 22 and Rt. 33	Windmill; Woodland setting of mature oaks	More than 5 miles of varied unpaved trails
Monocacy Way	Bethlehem	Illick's Mill Road	Burnside Plantation; Monacacy Nature Center; Wooded Glen	2 miles unpaved trails.
Nor-Bath Rail-Trail	East Allen Township	Savage Road	Rail-Trail; Country atmosphere; Fields and woodland	2 miles flat
Northampton Canal Park - Lehigh Canal Towpath	Northampton Borough	Canal St. and Bridge St.	Path along Lehigh River; Gazebo and picnic areas; Easy access to river	Paved 1-mile path
Palmer Township Recreation Path	Palmer Township	Freemansburg Road	Follows the Lehigh River	Wide paved and flat 6-mile trial
Pool Wildlife Sanctuary	Emmaus	3701 Orchid Place	Well marked trails; Streams, ponds, woodlands, birds and other wildlife	Well marked trails; 2.3 miles; unpaved; Boardwalk
Reimert Memorial Bird Haven	Macungie	Rt. 100 and Church St.	Natural trail on gentle hillside slope in a mature forest	Some portions of trail rocky; Well marked with white blazes.
Saucon Creek Park	Hellertown/ Bethlehem	Rt. 412	Picnic pavilions; Playgrounds; Beautiful stone walls; Sycamore lined trail	Four-foot-wide paved paths; Short-loop walk
Seem Seed Farm Conservation/ Demonstration Project	Vera Cruz	Church View Road	Farm field; Raised boardwalk through wetlands and large pond	Unpaved trails; Raised boardwalk
South Mountain Preserve	South Mountain	Emaus Ave.	Old Quarries; Mature forest of hardwood trees	Hillside trails wind through rocks; Easy walking, some uphill climbs.
Switchback Railroad Trail	Jim Thorpe / Mauch Chunk Lake	Broadway (SR 3012)	Mature forest; Mountain wildlife; Historic scenic trail	Unpaved trails
Tobyhanna State Park	Tobyhanna Lake	Rt. 423	Trail circles Tobyhanna Lake and passes through mixed hardwood	Ideal for families with children and accessible trails
Trexler Memorial Park	Allentown	Springhouse Road	Historic Log Cabin; Scenic 1-mile path; Overlook	12-foot-wide paved path
Walnutport Canal Park	Walnutport	Main Street	Restored Canal Lock; Locktender's House/Museum	Over 3 miles of unpaved level trails
Weissport Canal Walk	Weissport	Rt. 209	Tow Path; Very scenic	Well maintained towpath

Appendix C-4.

"Class A" Wild Trout Waters within the Lehigh River Watershed

Source: Pennsylvania Fish and Boat Commission 2003 List of Class A Wild Trout Waters

County	Stream Name	Nearest Town	PFBC Water-shed	Designation	Section #	Limits	Section Length (km)	Section Length (miles)	% Open 1	Owner-ship 1	% Open 2	Owner-ship 2	% Closed	Owner-ship 3
Carbon	Aquashicola Creek	Wind Gap	502B	Mixed Wild Brook/Brown Trout	3	Bridge on T-372 downstream to Chicola Lake	3.8	2.4	88	Private			12	Private
Carbon	Little Bear Creek	Jim Thorpe	502B	Wild Brook Trout	1	From headwaters downstream to confluence with Big Bear Creek	3	1.9	100	Private				
Carbon	Black Creek	White Haven	502A	Wild Brown Trout	2	From Weider Tract downstream to the mouth	4.8	3	85	Public	15	Private		
Carbon	Hickory Run	White Haven	502A	Wild Brown Trout	3	From Sand Spring Run downstream to mouth	2.6	1.6	100	Public				
Lackawanna	Ash Creek	Clifton	502A	Wild Brook Trout	2	From SGL #135 downstream to mouth	3	1.9	50	Public			50	Private
Lehigh	Cedar Creek	Emmaus	502C	Wild Brown Trout	2	From SR1019 Bridge downstream to Lake Muhlenberg	1.8	1.1	99	Public	1	Private		
Lehigh	Little Lehigh Creek	Breinigsville	502C	Wild Brown Trout	3	From T-476 downstream to the confluence with Spring Creek	2.5	1.6	N/A	N/A	N/A	N/A	N/A	N/A

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"CLASS A" WILD TROUT WATERS WITHIN THE LEHIGH RIVER WATERSHED *(continued)*

County	Stream Name	Nearest Town	PFBC Water-shed	Designation	Section #	Limits	Section Length (km)	Section Length (miles)	% Open 1	Owner-ship 1	% Open 2	Owner-ship 2	% Closed	Owner-ship 3
Lehigh	Trout Creek	Allentown	502C	Wild Brown Trout	2	From 1st bridge on Dixon Street downsrteam to mouth at Little Lehigh Creek	2.6	1.6	100					
Monroe	Pohopoco Creek	Brodheadsville	502B	Wild Brown Trout	2	From bridge on SR3016 downstream to SR0209 bridge in Kresgeville	12.9	8	98	Public	2	Private		
Monroe	Singer Run	Tobyhanna	502C	Wild Brook Trout	2	From SGL #127 downstream to the mouth	1.6	1	100	Public				
Northampton	Monocacy Creek	Bethlehem	502C	Wild Brown Trout	2	From SR0987 bridge downstream to SR0248 bridge	3.1	1.9					100	Private
Northampton	Monocacy Creek	Bethlehem	502C	Wild Brown Trout	7	From Gertrude Fox Conservation Area downstream to Illick's Mill Dam	3.1	1.9	100	Private				
Northampton	Nancy Run	Freemansburg	502C	Wild Brown Trout	2	From bridge on SR3007 downstream to mouth	2.6	1.6	3	Public	97	Private		
Northampton	Saucon Creek	Hellertown	502C	Wild Brown Trout	5	From confluence of Black River downstream to SR 0412	3.4	2.1	19	Public	81	Private		

Total number of miles of "Class-A" Wild Trout Waters: 31.6

Total # of miles of Class A Wild Trout Waters within Lehigh River Watershed: 63.2

Appendix C-5.

SPECIAL REGULATION AREAS WITHIN THE LEHIGH RIVER WATERSHED

Source: Pennsylvania Fish and Boat Commission 2003 Summary of Fishing Regulations and Laws.

County	*Stream Name*	*Special Regulation Category*	*Special Regualtion Area Length (miles)*	*Special Regualtion Area Boundaries*
Carbon	Hickory Run	Catch and Release	2.88	From the outlet of Saylorsville Dam downstream to the mouth
Carbon	Mud Run	Delayed Harvest Artificial Lures Only	2.5	In Hickory Run State Park
Lehigh	Little Lehigh Creek	Heritage Trout Angling	1	From upstream face of Fish Hatchery Road Bridge downstream to near the 24th Street Bridge
Lehigh	Little Lehigh Creek	Delayed Harvest Fly Fishing Only	1.8	From the downstream face of the bridge on T-508 (Wild Cherry Lane) downstream to the upstream face of the bridge on T-510 (Millrace Road)
Monroe	Tobyhanna Creek	Delayed Harvest Artificial Lures Only	1	From the confluence of Stil Swanp Run, downstream to the PPL service bridge
Northampton	Monocacy Creek	Trophy Trout	1.9	From Illick's Mill Dam upstream to and including Gertrude Fox Conservation Area
Northampton	Saucon Creek	Selective Harvest	2.1	From the upstream boundary of the City of Bethlehem property downstream to the SR 0412 bridge

Total number of miles of Special Regulation Waters: 13.18

Appendix C-6.

FISH CONSUMPTION ADVISORIES WITHIN THE LEHIGH RIVER WATERSHED

Source: Pennsylvania Fish and Boat Commission 2003 Summary of Fishing Regulations and Laws.

County	*Waterway*	*Area Under Advisory*	*Contaminant*	*Species*	*Meal Frequency*
Carbon	Beltzvile Lake	Entire Lake	Mercury	Walleye	2 meals/month
Carbon, Monroe	Tobyhanna Creek	Pocono Lake Dam to mouth	Mercury	Smallmouth Bass	2 meals/month
Northampton	Lehigh River	Confluemce of Saucon Creek to mouth	Mercury	American Eel	2 meals/month

Appendix D–1.

NOTES FROM THE FINAL PUBLIC HEARING

Lehigh River Watershed Conservation Management Plan Public Meeting

October 28, 2003

Wildlands Conservancy hosted and conducted its Final Hearing for the Lehigh River Watershed Conservation Management Plan on Tuesday, October 28, 2003. Listed below are the notes from the meeting.

MEETING ATTENDEES:

Scott J. Christman, Pennsylvania Fish and Boat Commission

Michael J. Cox, Cora L. Brooks Foundation

Lee Creyer, Pennsylvania Fish and Boat Commission

Kevin Fazzini, Pennsylvania Department of Conservation and Natural Resources

Tom Gettings, Wildlands Conservancy

Robert Hamill, Whitewater Boater

Tom Kerr, Wildlands Conservancy

Chris Kocher, Wildlands Conservancy

Debra Lermitte, Wildlands Conservancy

Matt Mac Connell, Lehigh River Stocking Association

Diane Matthews-Gehringer, Wildlands Conservancy

Nelson Markley, Wildlands Conservancy

Kate Quigley, Wildlands Conservancy

Geoff Reese, Lehigh Valley Planning Commission

Gene Sharle, Allentown Hiking Club

Brian Vadino, Wildlands Conservancy

Gregory Wacik, United States Army Corp of Engineers

Forrest Wessner, Heidelberg Township

Todd Wood, Pennsylvania Department of Environmental Protection

Al Zagovsky, Times News

MEETING OBJECTIVES:

The objectives of this meeting were to allow Wildlands Conservancy an opportunity to provide the general public with 1) an explanation of the goals and objectives of the Lehigh River Watershed Conservation Management Plan, 2) an update on the current status of the Plan, 3) a description of the various components contained within the Plan, and 4) an opportunity to ask questions, receive information and provide recommendations and input in regard to the Plan. The meeting was conducted and facilitated by Chris Kocher, Director of Rivers Program, Wildlands Conservancy.

QUESTIONS/ISSUES:

- How will the Plan be made accessible/distributed to the general public?
- Is Lausanne Tunnel addressed in the Plan?
- How long does it take for the Plan to be listed on the Rivers Registry?
- Are recommendations within the Plan prioritized?
- Does the Plan contain information about recreational opportunities, such as fishing, within the watershed?
- Can fisheries data be collected from tagging programs to identify areas in which fish stockings should or should not be conducted? If so, will this information be incorporated into the Plan?
- Does the plan address storage/water releases from Francis E. Walter Reservoir?
- Have discussions between the Lehigh Valley Canoe Club and US Army Corps of Engineers in regard to water releases from Francis E. Walter Reservoir taken place?
- How will an action plan be created?
- Are water quality parameters being continuously monitored on the Lehigh River?
- Any possibility of creating a series of "non-static"maps as part of the Plan? Can we make this a recommendation?
- Will the Plan address the topic of access to the river?
- Will the plan be continuously updated? If so, how?
- Ownership/status of low-head dam at Palmerton.
- Ownership/status of 329 dam.

Appendix D-2.

PA DEP GROWING GREENER PROJECTS WITHIN THE LEHIGH RIVER WATERSHED (AS OF AUGUST 2002)

Source: Pennsylvania Department of Environmental Protection Growing Greener Annual Report (2002) and PA DEP Growing Greener Grants Awarded page (website).

GG Grant Year	County	Municipality	Grant Program	Grantee Organization	Grant Amount	Project Description
4	Carbon	Borough of Jim Thorpe	Growing Greener - DEP	Borough of Jim Thorpe	$50,555.00	Restoration and protection of the Slaughter House Creek Watershed
4	Carbon	Jim Thorpe Borough, SummitHill Borough	Growing Greener - DEP	Carbon County Conservation District	$36,231.17	Stabilization of Mauch Chunk Lake Campground Road
4	Carbon	Multiple	Growing Greener - DEP	Wildlands Conservancy	$47,561.00	Development of natural resource and land protection strategy for the Lehigh River Watershed
4	Lehigh	Borough of Macungie	Growing Greener - DEP	Borough of Macungie	$55,090.25	Phase 1 of the Mountain Creek Watershed assessment and restoration design
4	Lehigh	Multiple	Growing Greener - DEP	City of Allentown	$198,980.00	Assessment of sedimentation problems in the Little Lehigh Creek
4	Lehigh	Multiple	Growing Greener - DEP	Lehigh Carbon Community College	$84,900.40	Assessment of the Nesquehoning Creek Watershed
4	Lehigh	Lower Macungie, Salisbury	Growing Greener - DEP	Wildlands Conservancy	$77,928.25	Little Lehigh Creek fluvial geomorphology stream assessment and restoration
4	Lehigh	Multiple	Growing Greener - DEP	Wildlands Conservancy	$202,674.00	Education and outreach program in the Lehigh River Watershed
4	Monroe	Chestnut Hill, Eldred, Polk, Ross, Towamensing	Growing Greener - DEP	Monroe County Conservation District	$12,700.00	Formation of the Aquashicola and Pohopoco Watershed Conservancy
4	Wayne	Lehigh, Sterling, Clifton	Growing Greener - DEP	North Pocono C.A.R.E. (Citazens Alert Regarding the Environment)	$9,618.20	Development of a monitoring program for the headwaters of the Lehigh River
4	Multiple	Multiple	Growing Greener - DEP	Wildlands Conservancy	$69,387.47	5th Annual Pennsylvania Watershed Conference

PA DEP Growing Greener Projects within the Lehigh River Watershed (as of August 2002) *(continued)*

GG Grant Year	County	Municipality	Grant Program	Grantee Organization	Grant Amount	Project Description
3	Carbon	Summit Hill Borough	Growing Greener - DEP	County of Carbon	$62,506.00	Mauch Chunk Creek/Lake Watershed assessment and protection plan
3	Carbon	Nesquehoning Borough	Growing Greener - DEP	Carbon County Conservation District	$48,745.00	Phase 1 of the First Hollow Run restoration/stabilization design
3	Lehigh	City of Allentown	Growing Greener - DEP	City of Allentown	$305,000.00	Riparian corridor stabilization and restoration at municipal golf course
3	Lehigh	Upper Milford	Growing Greener - DEP	Emmaus Borough	$104,254.00	Leibert Creek Watershed assessment and restoration plan
3	Lehigh	North Whitehall Township	Growing Greener - DEP	North Whitehall Township	$15,894.00	Coplay Creek streambank stabilization
3	Lehigh	Whitehall Township	Growing Greener - DEP	Whitehall Township	$11,000.00	Coplay Creek pollution mitigation
3	Northampton	Upper Mount Bethel	Growing Greener - DEP	Township Environmental Advisory Council	$5,000.00	Upper Mount Bethel environ mental planning outreach
3	Multiple	Multiple	Growing Greener - DEP	Heritage Conservancy	$124,274.00	Riparian buffer assessment of Lehigh and Northampton Counties
3	Multiple	Multiple	Growing Greener - DEP	Wildlands Conservancy	$249,616.00	Lehigh River Watershed education/public awareness program
3	Multiple	Multiple	Growing Greener - DEP	EMARR, Inc.	$300,000.00	Watershed assessment
2	Carbon	Multiple	Growing Greener - DEP	Carbon County Redevelopment Authority	$450,635.00	Nesquehoning Creek Watershed restoration and protection plan Phase 1
2	Lehigh	City of Allentown	Growing Greener - DEP	City of Allentown	$31,392.00	Robinhood comprehensive restoration
2	Lehigh	City of Allentown	Growing Greener - DEP	City of Allentown	$33,000.00	Allentown Area stormwater inlet emblems
2	Lehigh	City of Allentown	Growing Greener - DEP	City of Allentown	$58,112.00	Alliance for the Little Lehigh Watershed long-term monitoring program
2	Lehigh	Multiple	Growing Greener - DEP	Lehigh Valley Planning Commission	$48,830.00	Monocacy Creek Erosion Assessment
2	Lehigh	Whitehall Township	Growing Greener - DEP	Whitehall Township	$50,000.00	Jordan Creek flood and pollution mitigation

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PA DEP GROWING GREENER PROJECTS WITHIN THE LEHIGH RIVER WATERSHED (AS OF AUGUST 2002) *(continued)*

GG Grant Year	County	Municipality	Grant Program	Grantee Organization	Grant Amount	Project Description
2	Lehigh	Lower Macungie, Borough of Emmaus	Growing Greener - DEP	Wildlands Conservancy	$15,003.00	Little Lehigh Creek habitat improvement and riparian buffer planting
2	Lehigh	Multiple	Growing Greener - DEP	Wildlands Conservancy	$91,816.00	Watershed education and outreach program in multiple counties
2	Lehigh	Lower Nazareth	Growing Greener - DEP	Wildlands Conservancy	$26,178.00	Monocacy Creek stream restoration project at Lower Nazareth Rod and Gun Club in Northampton County
2	Monroe	Tobyhanna	Growing Greener - DEP	Tobyhanna Creek/ TunkhannockCreek Watershed Association	$137,900.00	Tobyhanna and Tunkhannock Creek Watershed protection
1	Berks	Lower Macungie, Longswamp	Growing Greener - DEP	Wildlands Conservancy	$16,101.00	Little Lehigh stream bank fencing, habitat improvement, and riparian buffer project
1	Lehigh	City of Allentown	Growing Greener - DEP	City of Allentown	$40,000.00	Trout Creek bank stabilization
1	Lehigh	Multiple	Growing Greener - DEP	Wildlands Conservancy	$6,543.00	Little Lehigh Watershed Alliance incorporation
1	Luzerne	Bear Creek	Growing Greener - DEP	Luzerne County Conservation District	$1,207.00	Lake Aleeda watershed protection/lake monitoring
1	Multiple	Multiple	Growing Greener - DEP	Lehigh Valley Educational Television Corporation WLVT-TV	$160,000.00	Water We Share initiative
1	Multiple	Multiple	Growing Greener - DEP	Wildlands Conservancy	$15,098.00	Stream management, stream restoration and riparian man agement education program

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LEHIGH RIVER WATERSHED MAPS

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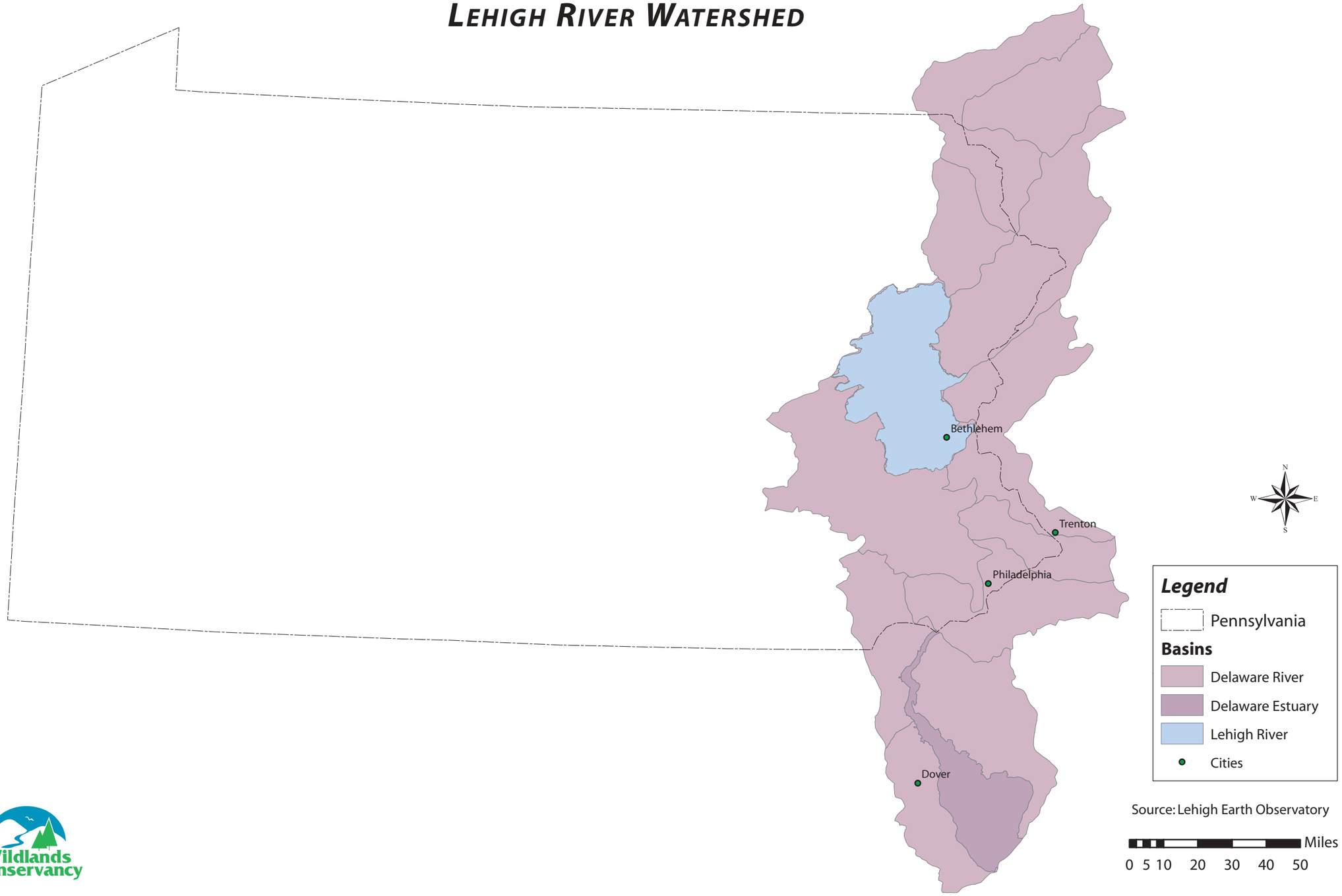
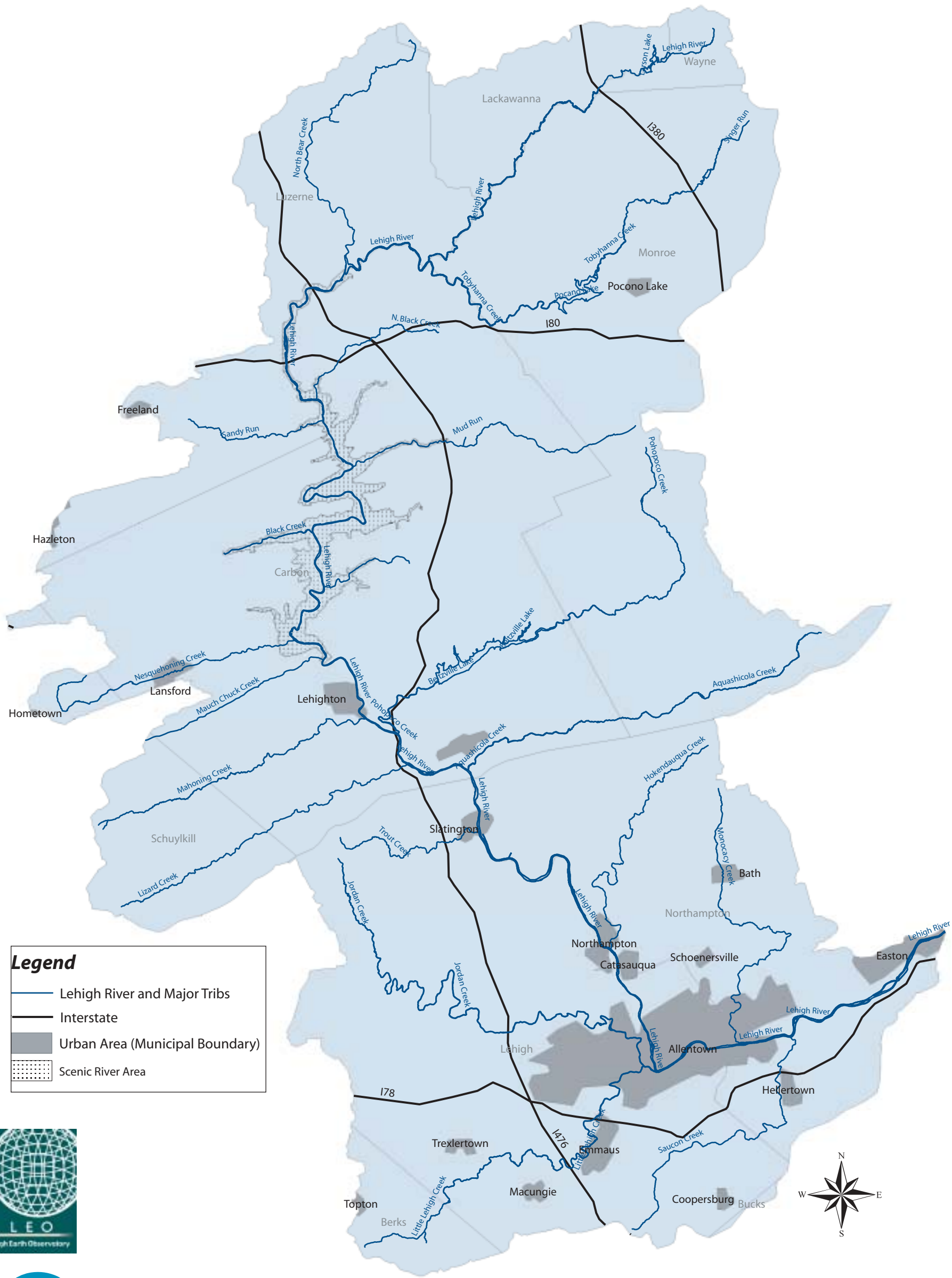
Map 1-1 The Lehigh River Basin Within the Delaware River Basin
Lehigh River Watershed



Map 1-2 Lehigh River and Major Tributaries
Lehigh River Watershed

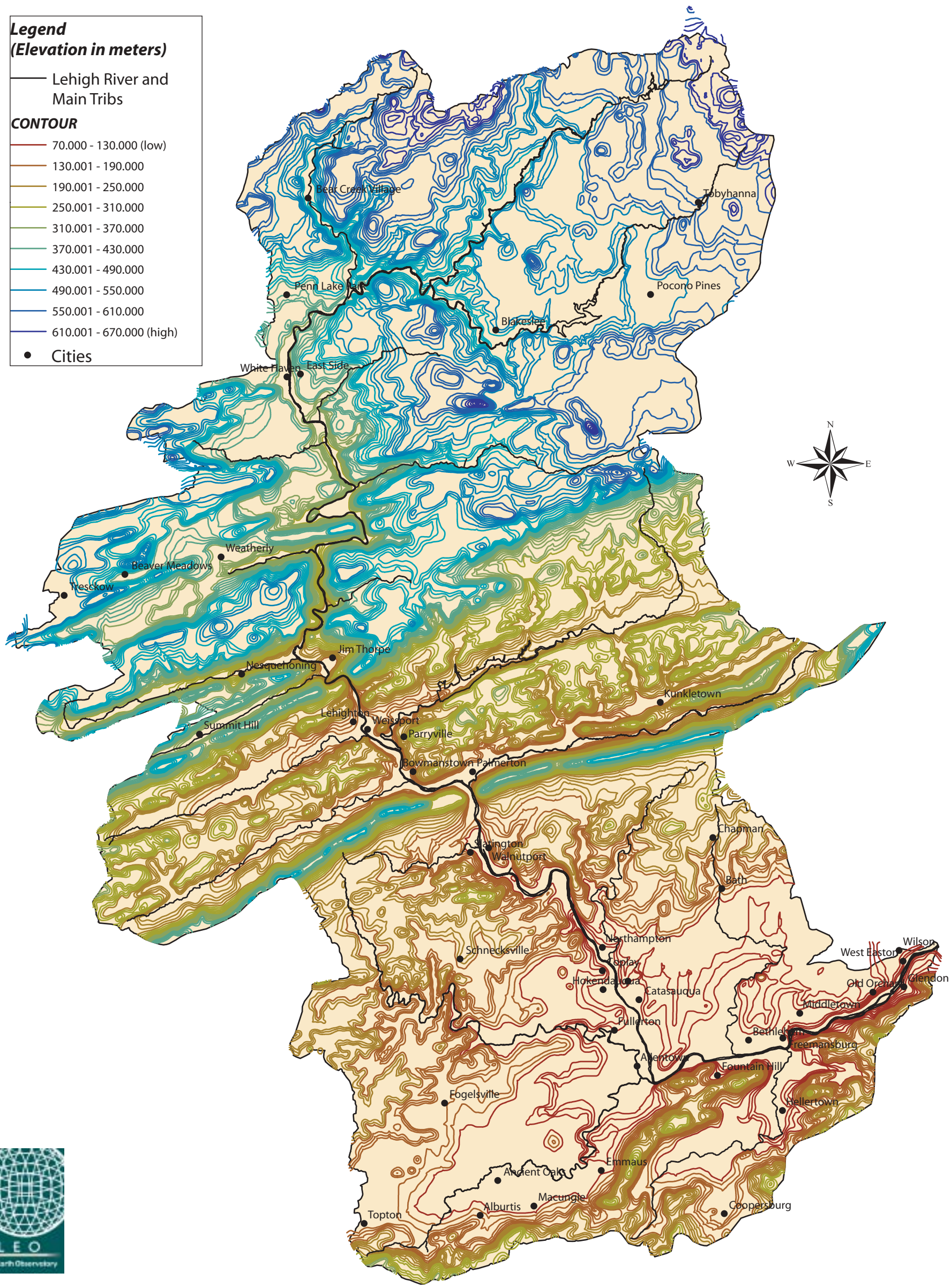


LEO
Lehigh Earth Observatory

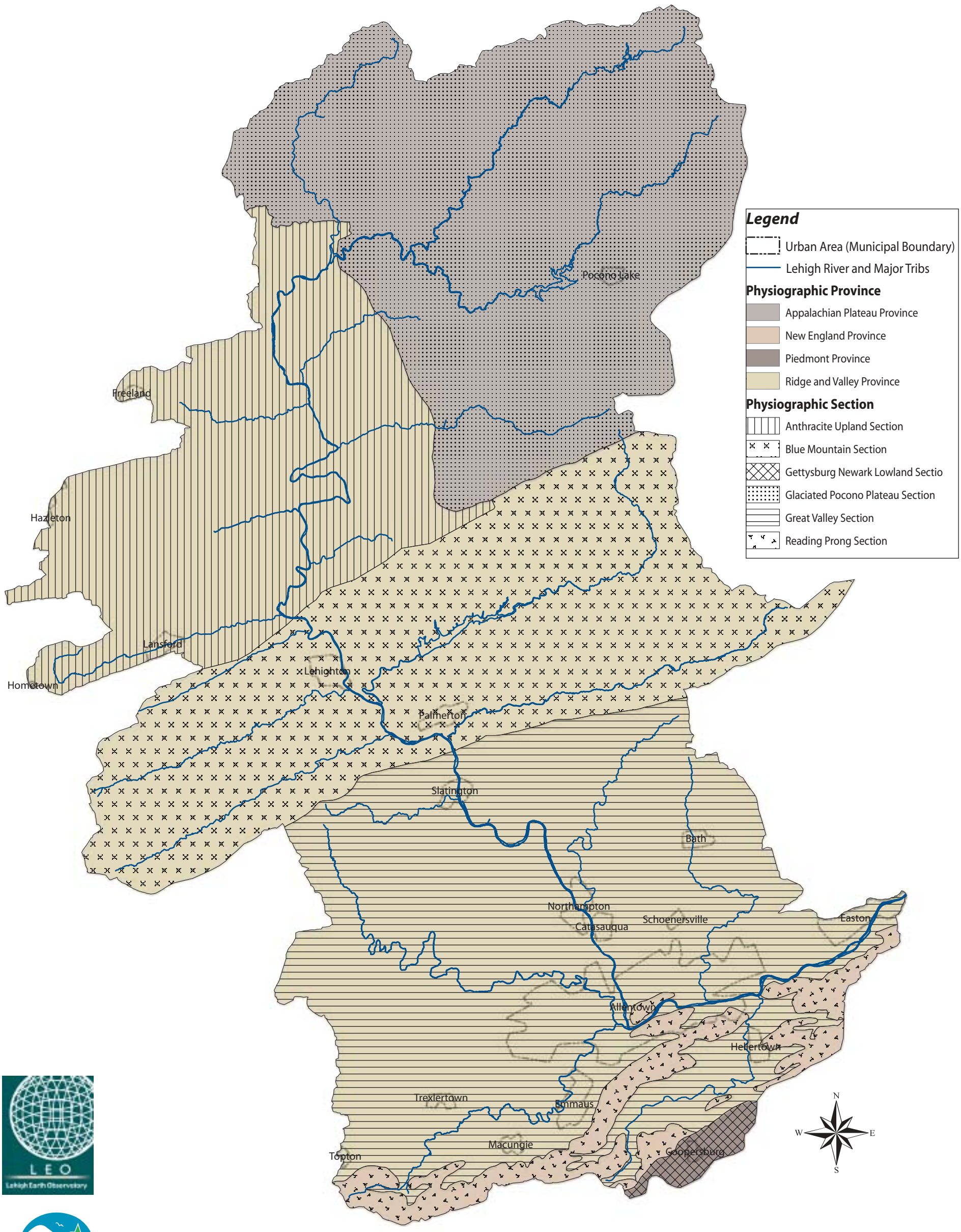
Wildlands Conservancy

DCNR

Map 1-3 Topography
Lehigh River Watershed



Map 1-4 Physiographic Provinces and Sections
Lehigh River Watershed



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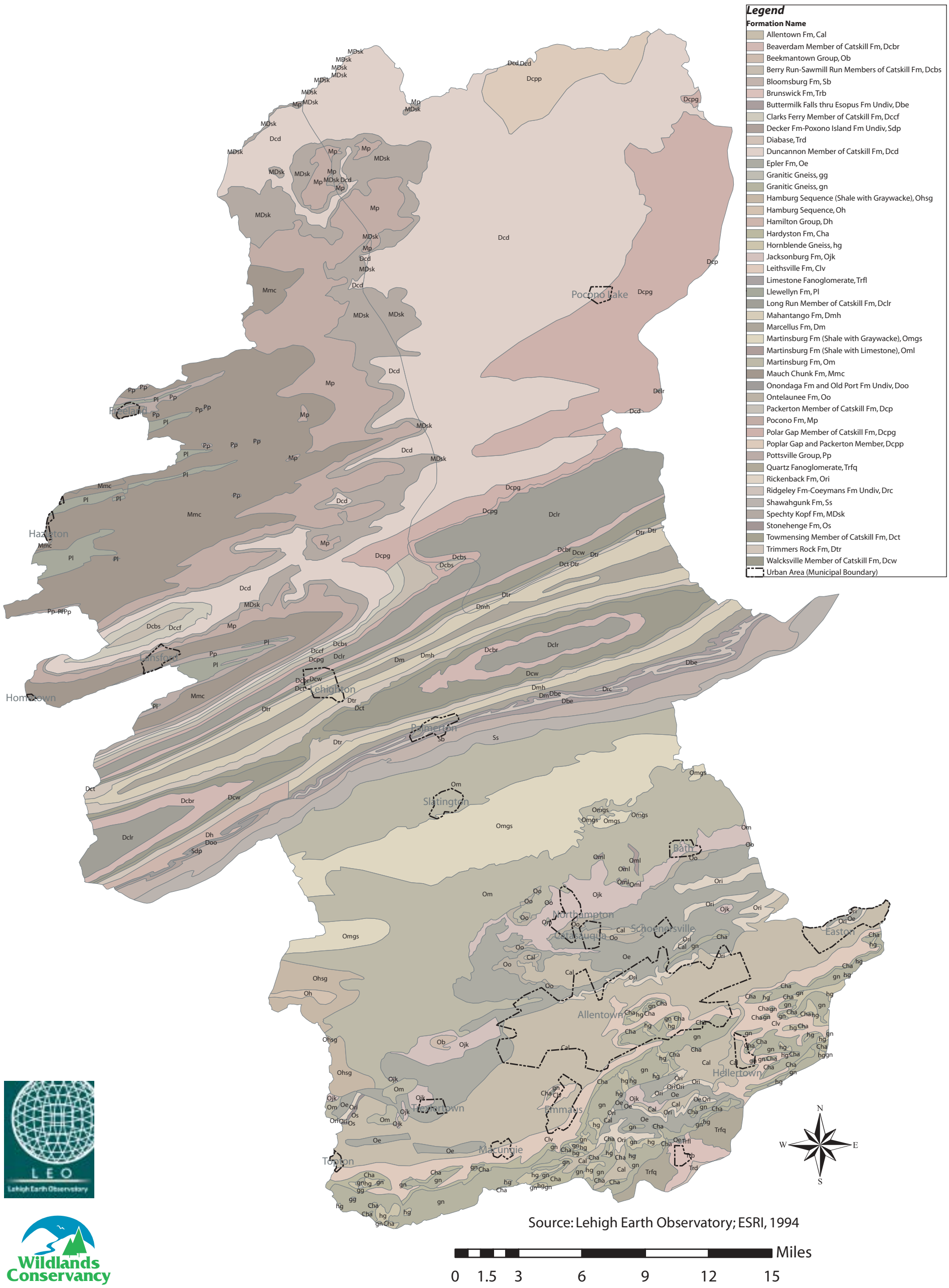
Map 1-5 Geology
Lehigh River Watershed



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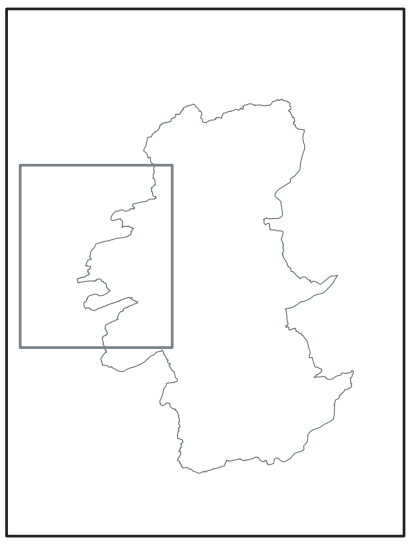
Map 1-6 Abandoned Mine Drainage Features
Lehigh River Watershed



Legend

- AMD Discharge Locations
- Abandoned Mine Land
- Anthracite Fields
- City
  - Jim Thorpe
- Streams
- Stream Basin

N W E S

Source: Lehigh Earth Observatory; USGS, 1998

0 0.5 1 2 3 Miles

Pond Creek
Sandy Run
SANDY RUN BASIN
Owl Hole
Buck Mountain #1
BUCK MOUNTAIN CREEK BASIN
Hazel Brook
SOUTH BLACK BASIN
Quakake Tunnel
NESQUEHONING BASIN
Lausanne Tunnel
Jim Thorpe

WRIGHT CREEK
PINE CREEK
FAWN RUN
LINESVILLE CREEK
SHANTY RUN
HAYES CREEK
FOURTH RUN
IRISHTOWN RUN
POND CREEK
SANDY RUN
DULDS RUN
HICKORY RUN
LESLIE RUN
BUCK MOUNTAIN CREEK
INDIAN RUN
HAZLE CREEK
DRECK CREEK
BLACK CREEK
BRUSHY HOLLOW
LEHIGH RIVER
PENN SPRINGS
BEAVER CREEK
WETZEL CREEK
QUAKAKE CREEK
OBERSON RUN
ROBERTSON RUN
SILKMILL RUN
JEANS RUN
NESQUEHONING CREEK
DEEP RUN
BROAD RUN
DENNISON RUN
GRASSY MEADOW RUN
SWARTZ RUN
CROOKED RUN
BEAVERDAM RUN
BEAR CREEK
MAUCH CHUNK CREEK
MAHONING CREEK
WASH CREEK
BERGERS CREEK
LIZARD CREEK
BIG TROUT CREEK
JORDAN CREEK

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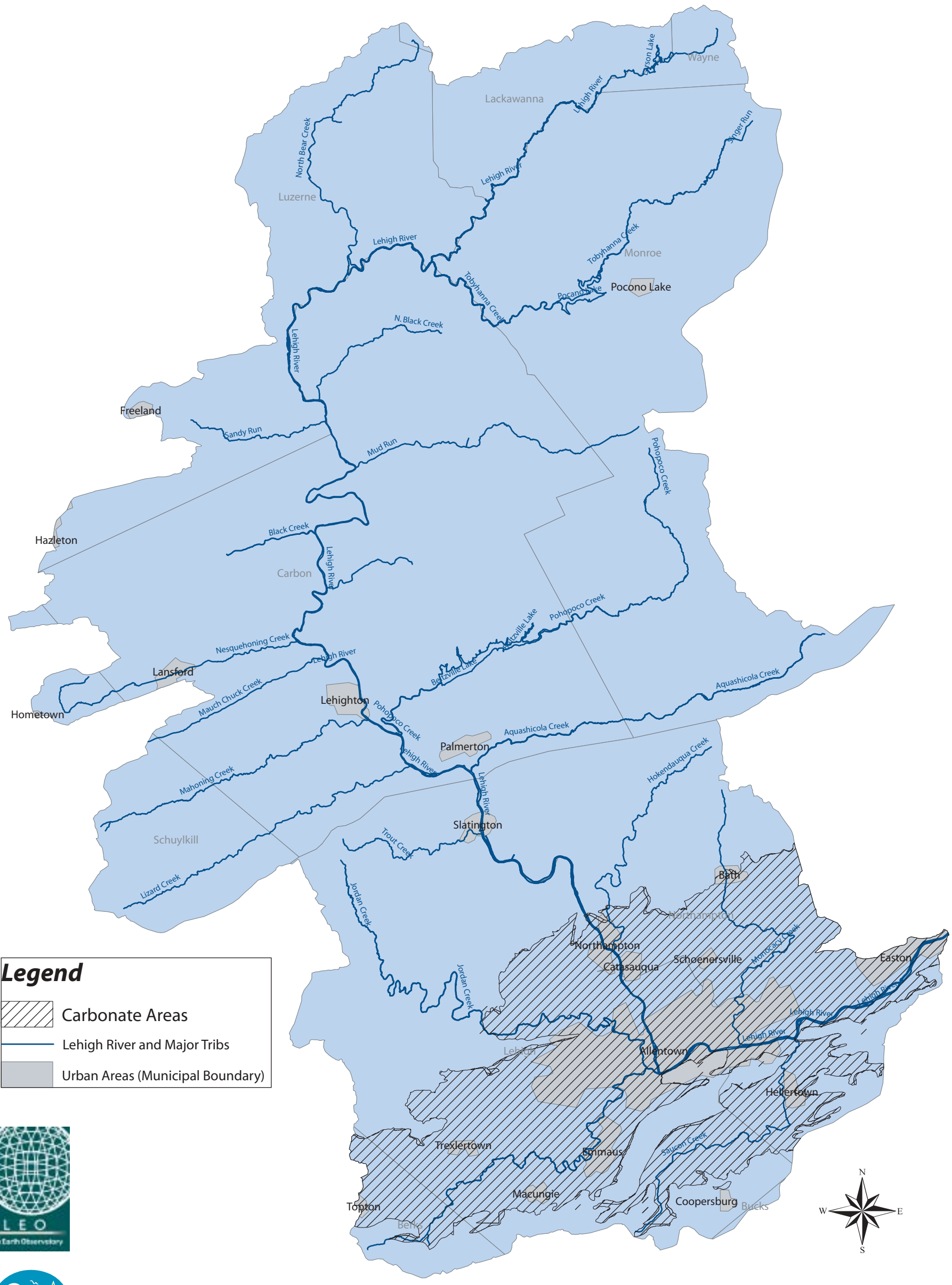
Map 1-7 Carbonate Areas
Lehigh River Watershed



Legend

- Carbonate Areas
- Lehigh River and Major Tribs
- Urban Areas (Municipal Boundary)

Source: Lehigh Earth Observatory; ESRI, 1996

Miles

0 1.25 2.5 5 7.5 10 12.5

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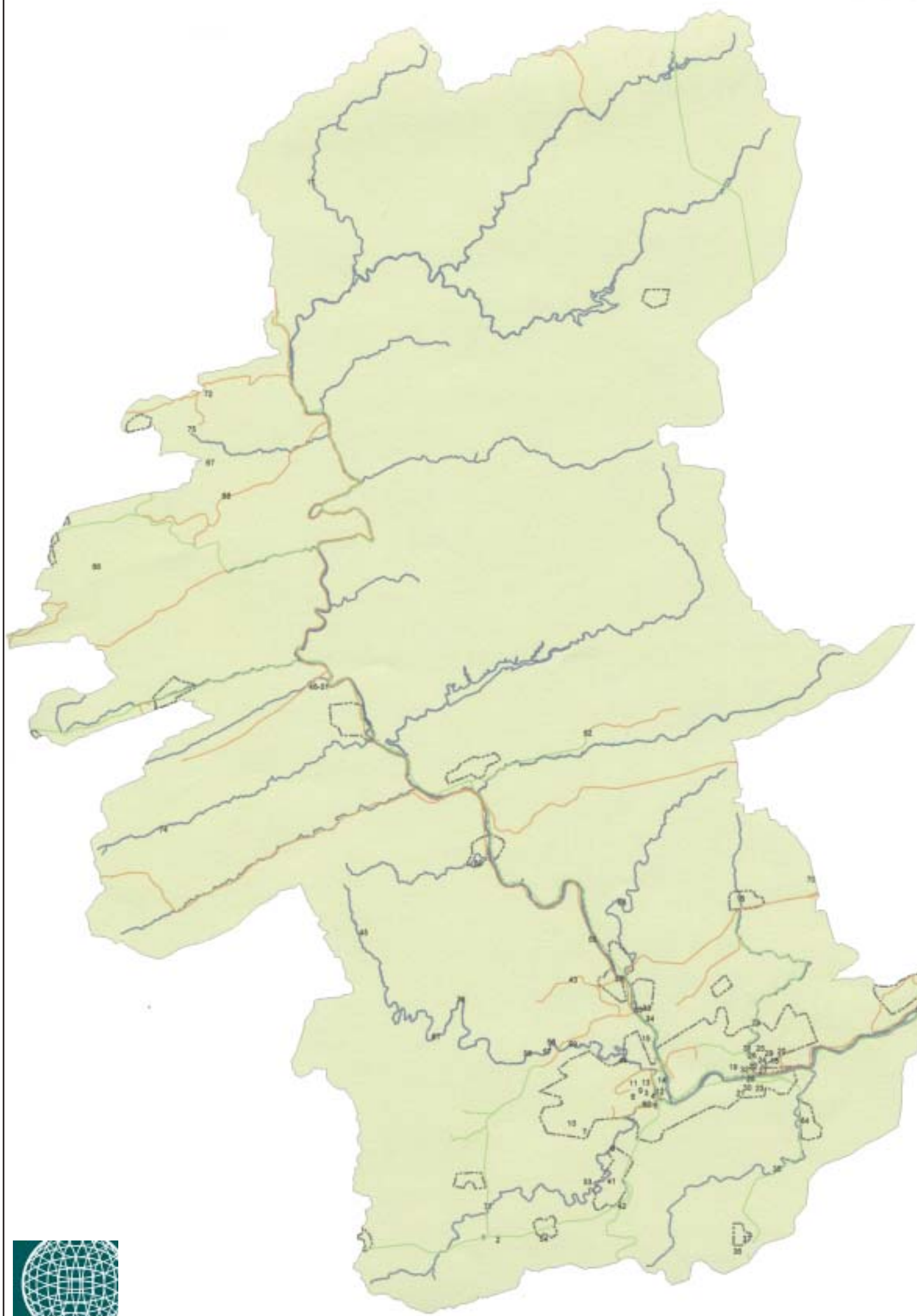
Map 2-1 Historical Locations
Lehigh River Watershed



Legend

Historical Locations

1. SCHLICHER GEORGE F HOTEL
2. LOCK RIDGE FURNACE COMPLEX
3. ZOLLINGER HAMED CO BUIDING
4. TROUT HALL
5. GAUFF ROTH HOUSE
6. BOGERTS COVERED BRIDGE
7. DORNEYVILLE CROSSROADS SETTLEMENT
8. AMERICUS HOTEL
9. HIGH GERMAN EVANGELICAL REFORMED CHURCH
10. HAINES MILL
11. DIME SAVINGS AND TRUST
12. HOTEL STERLING
13. OLD LEHIGH COURTHOUSE
14. NEUWIELER BREWERY
15. DENT HARDWARE FACTORY COMPLEX
16. STECKEL DANIEL HOUSE
17. BEAR CREEK VILLAGE HISTORICAL DISTICT
18. ELMWOOD PARK HISTORICAL DISTRICT
19. MOUNT AIRY HISTORICAL DIST
20. PEMBROKE VILLAGE HISTORICAL DIST.
21. LEHIGH SILK MILLS
22. THE TANNERY
23. PACKER MEMORIAL CHURCH
24. OLD WATERWORKS
25. MORAVIAN SUN INN
26. GRISTMILLERS HOUSE
27. GERMEINHAUS LEWIS DAID DE SCHWEINTZ
28. LEHIGH VALLEY RAILROAD HEADQUARTERS
29. CENTER OF BETHLEHEM HISTORICAL DISTRICT
30. CENTER OF FOUNTAIN HILL HISTORICAL DIST.
31. BURNSIDE PLANTATION
32. BETHLEHEM ARMORY
33. CENTER OF CATASAQUA RESIDENTIAL AREA
34. CENTER OF BIERYS PORT HISTORICAL DISTRICT
35. CENTENNIAL BRIDGE
36. LIDEN GROVE PAVILLION
37. COOPERSGURG HISTORICAL DISTRICT
38. COPLAY CEMENT KILNS
39. PARSONS TAYLOR HOUSE
40. CHAIN BRIDGE
41. KEMMERER HOUSE
42. SHELTER HOUSE
43. TROXEL STECKEL HOUSE
44. HELFRICH SPRINGS GRIST MILL
45. BRIDGE IN HEIDELBERG TOWNSHIP
46. CENTRAL RAILROAD OF NEW JERSEY STATION
47. HARRY PACKER MANSION
48. ASA PACKER MANSION
49. ST MARKS EPISCOPAL CHURCH
50. CARBON CO JAIL
51. CENTER OF OLD MAUCH CHUNK HISTORICAL DISTRICT
52. LITTLE GAP COVERED BRIDGE
53. RODAL ORGANIC GARDENING EXPERIMENTAL FARM
54. WEAVER VALENTINE FARM
55. COLD SPRINGS BRIDGE
56. MASSES GUTH COVERED BRIDGE
57. GEIGER COVERED BRIDGE
58. REX COVERED BRIDGE
59. WHER COVERED BRIDGE
60. FIREMANS DRINKING FOUNTAIN
61. FRANTZ'S BRIDGE
62. ALBERTUS L MEYER'S BRIDGE
63. GEROGE TAYLOR HOUSE
64. EHRHARTS MILL HISTORICAL DISTRICT
65. KREIDERSVILLE COVERED BRIDGE
66. BEAVER MEADOW COLLIERY
67. BUCK MOUNTAIN COLLIERY
68. BUCK MOUNTAIN COLLIERY (HISTORICAL)
69. EASTON CHILDRENS HOME
70. GRACEDALE COUNTY HOME
71. MERKEL STATION
72. POND CREEK COLLIERY
73. SAINT FRANCIS RETREAT
74. SAINT MICHAELS HOME
75. SANDY RUN COLLIERY
76. SCHLICHER COVERED BRIDGE

Lehigh River and Major Tribs

Lehigh Canal

Active Railroad

Inactive Railroad

Urban Area (Municipal Boundary)

Source: Lehigh Earth Observatory, National Registry of Historical Places

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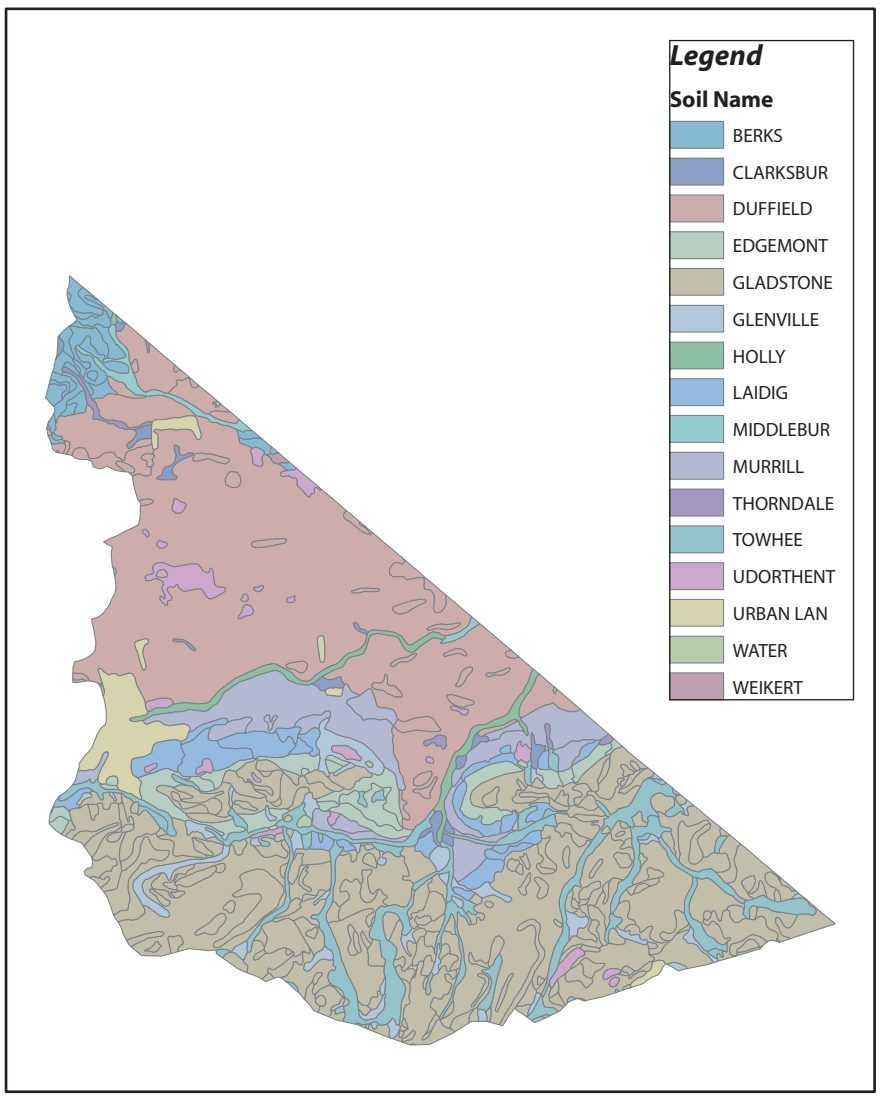
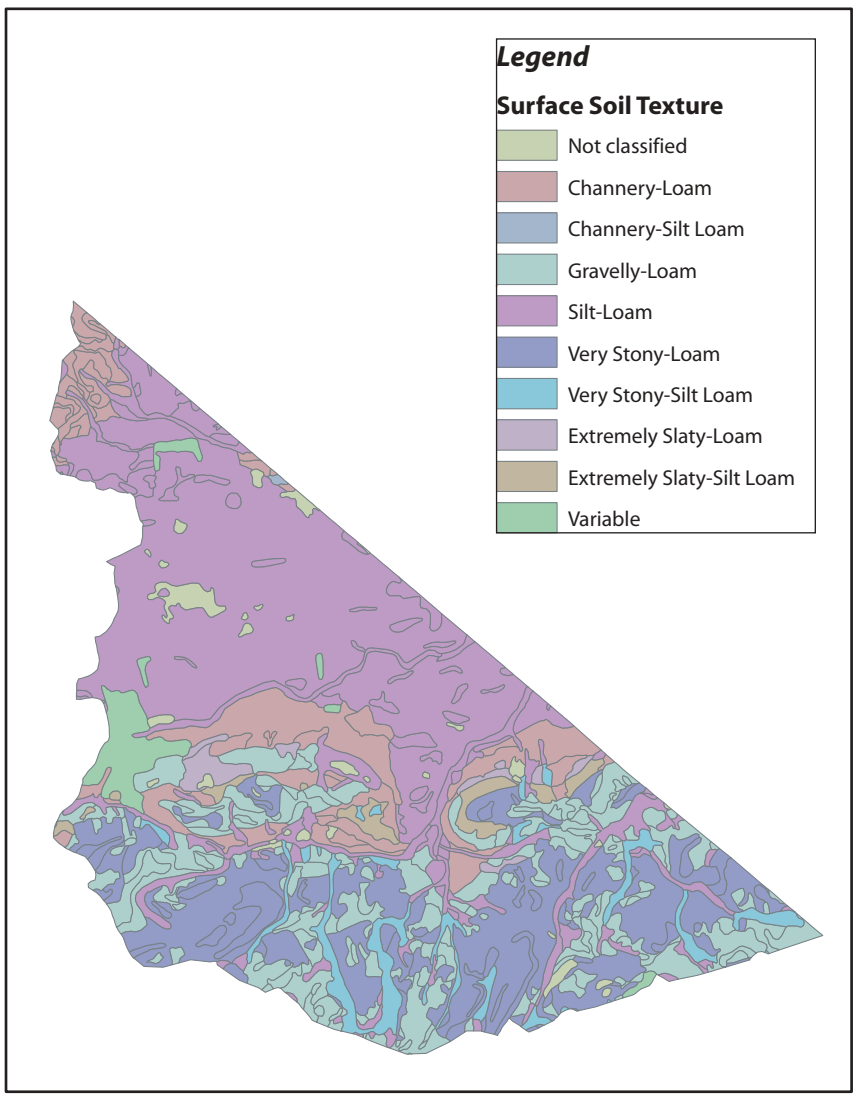
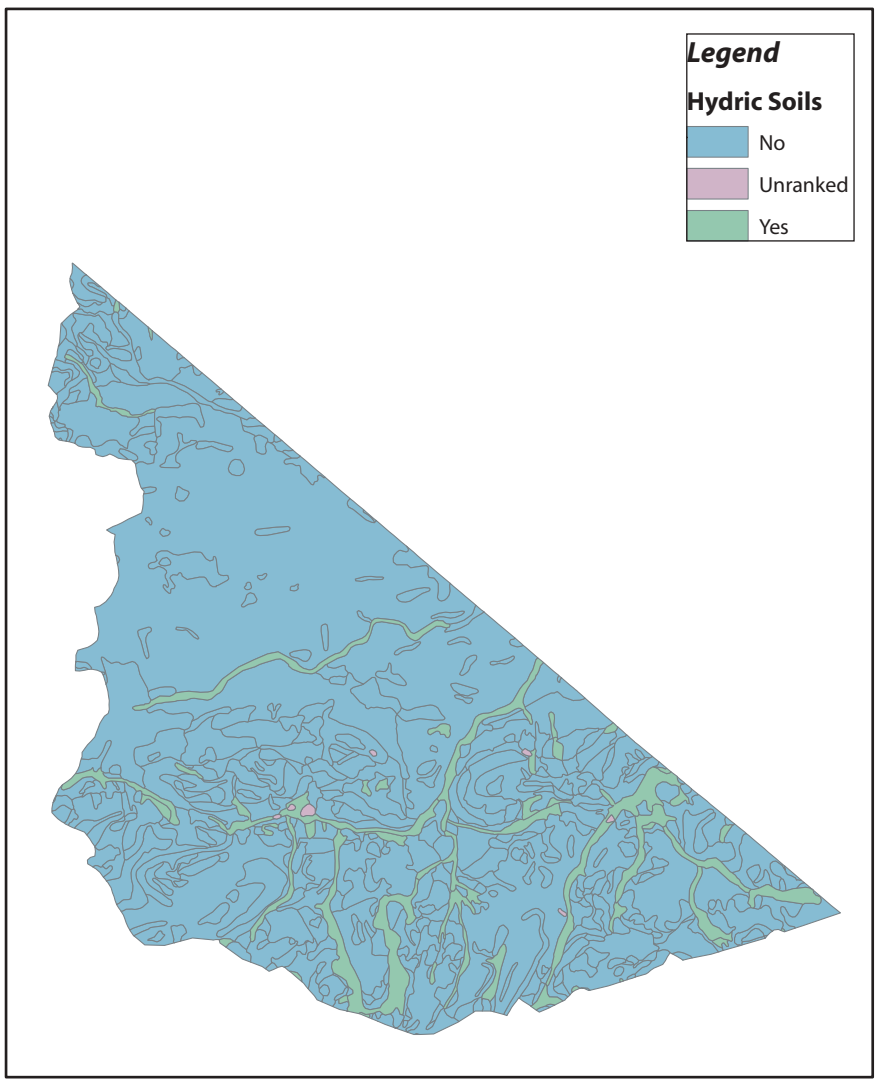
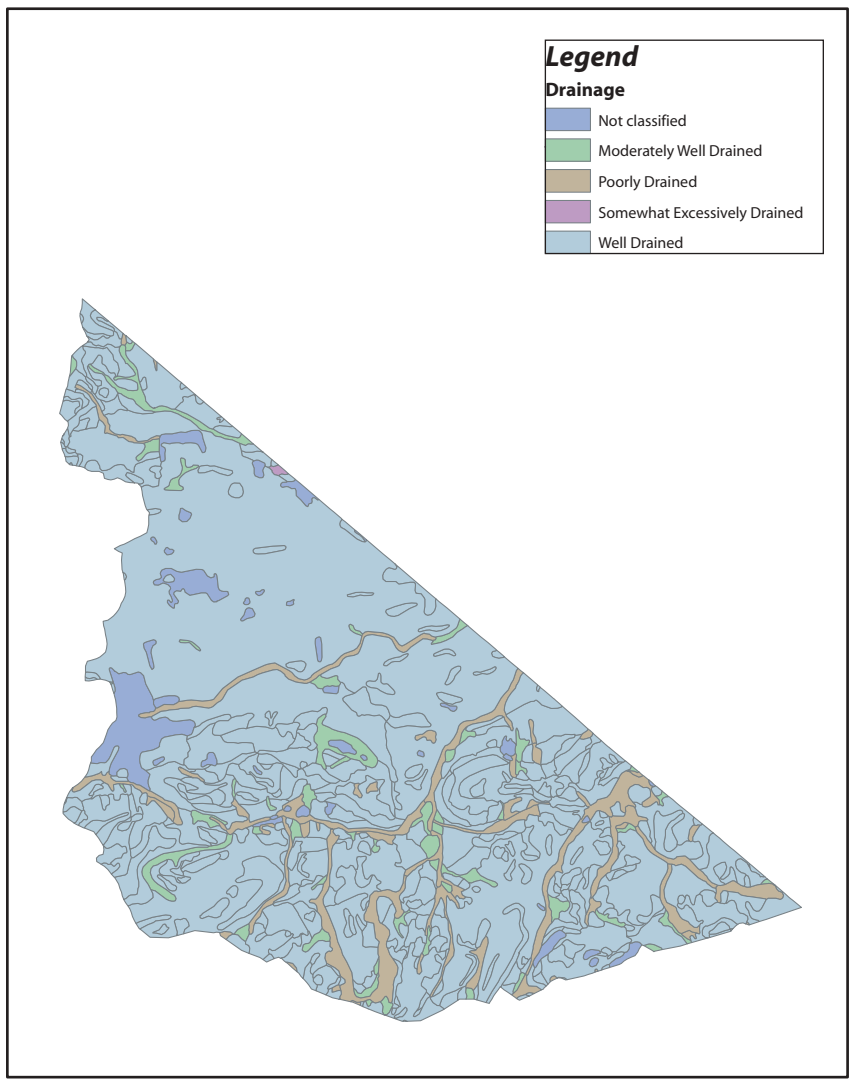
Map 1-8 Soil Characteristics in Berks County Lehigh River Watershed



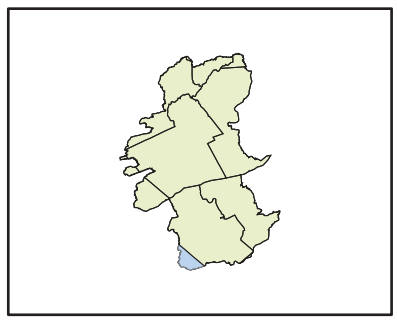






Source: USDA Natural Resources Conservation Service

3 1.5 0 3 Miles



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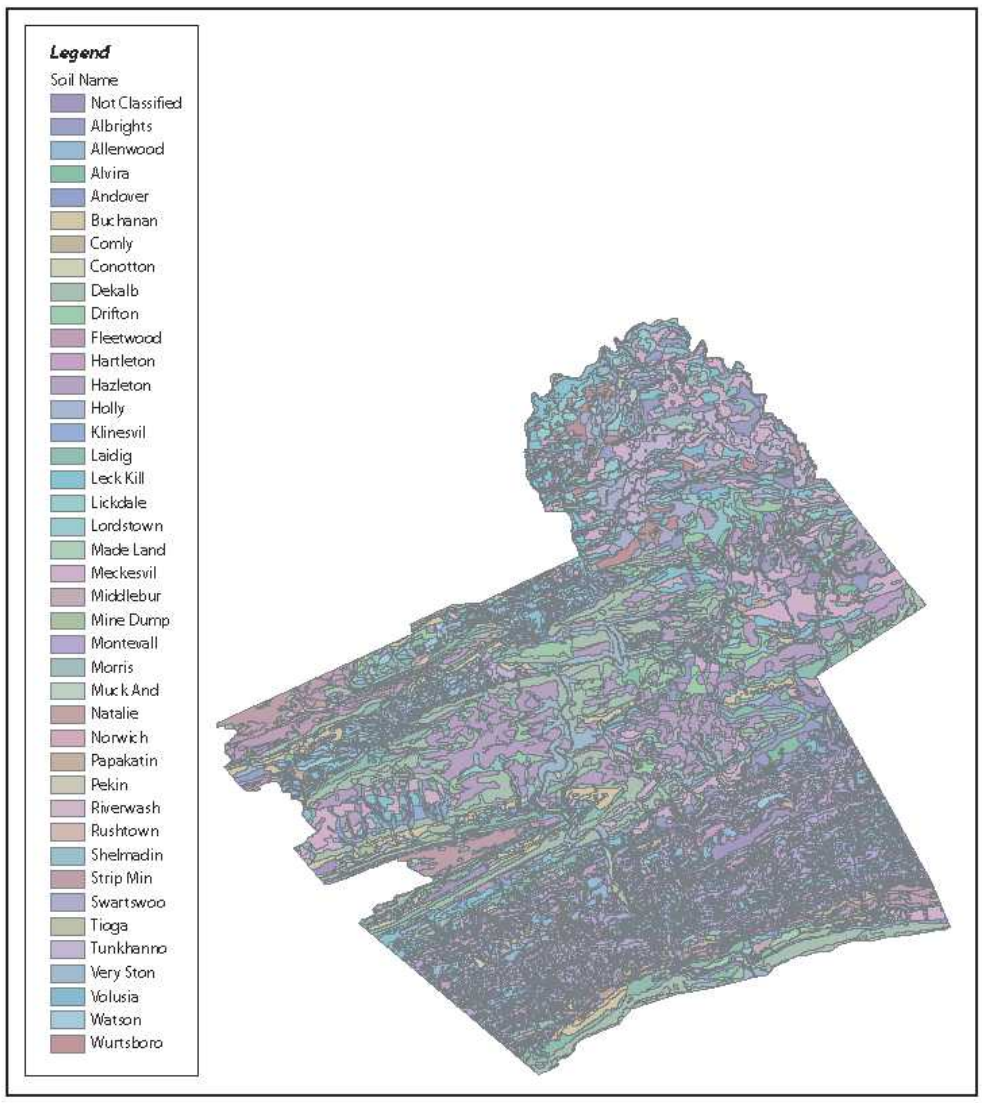
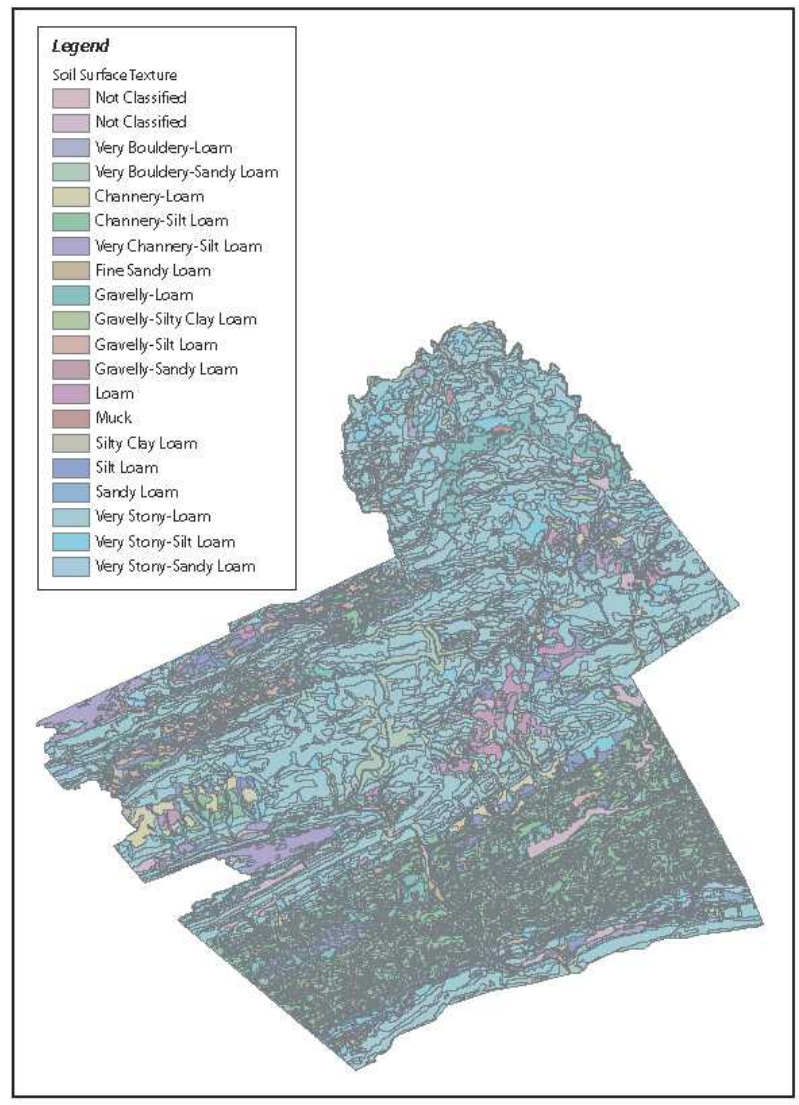
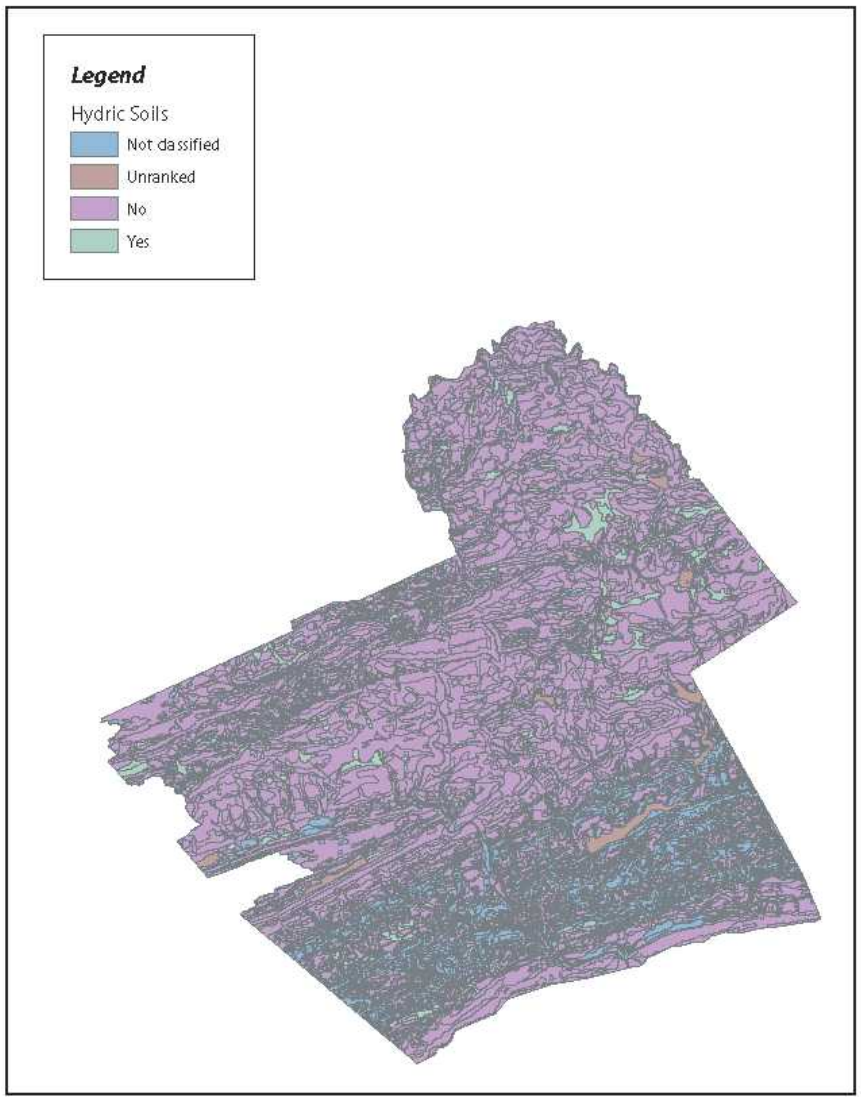
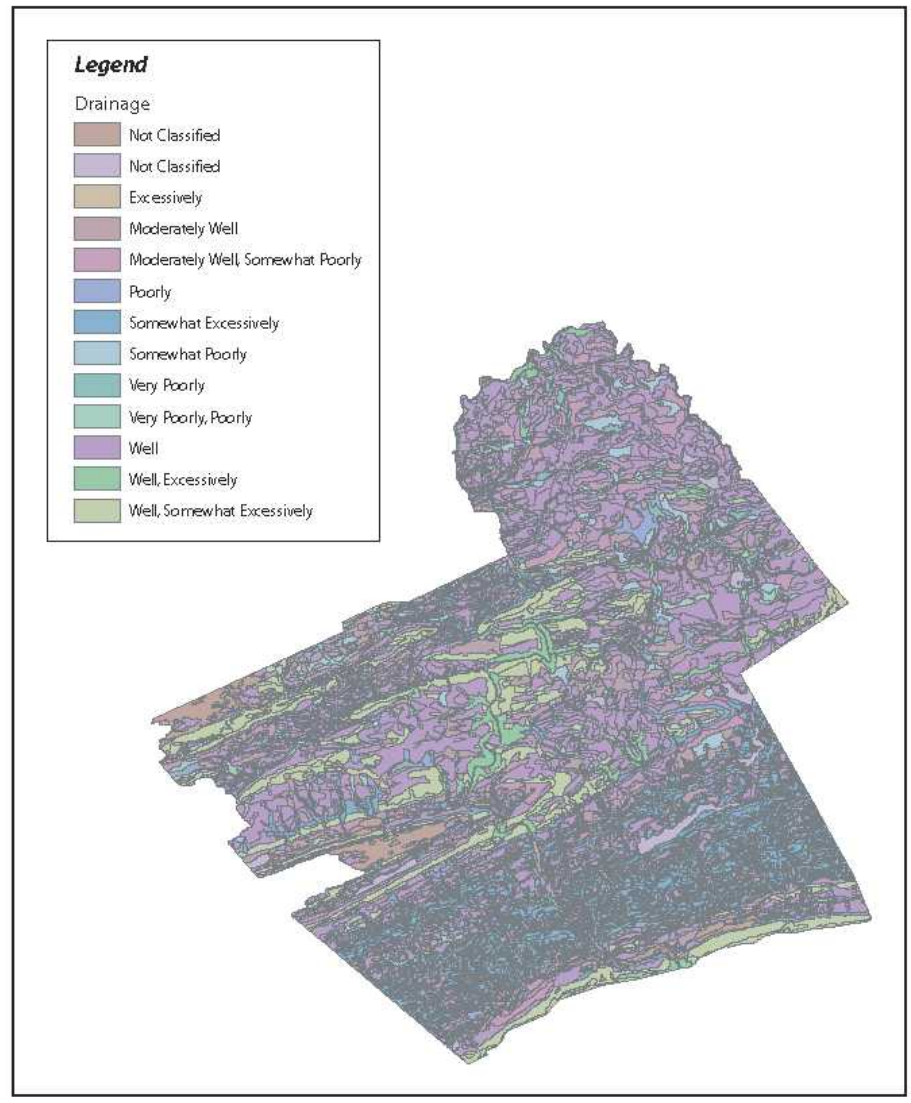
MAP 1-9 SOIL CHARACTERISTICS IN CARBON COUNTY
LEHIGH RIVER WATERSHED



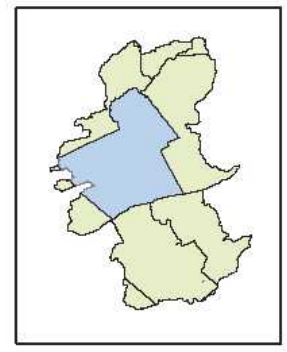




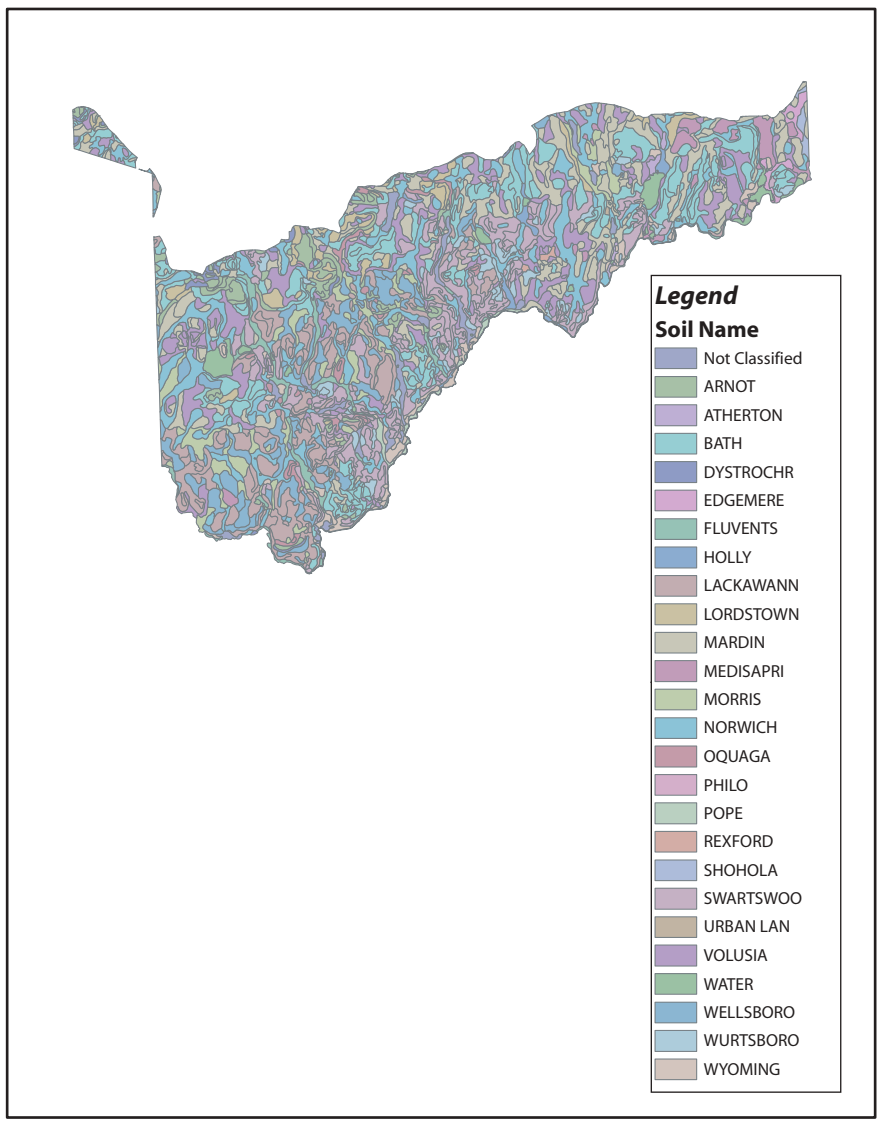


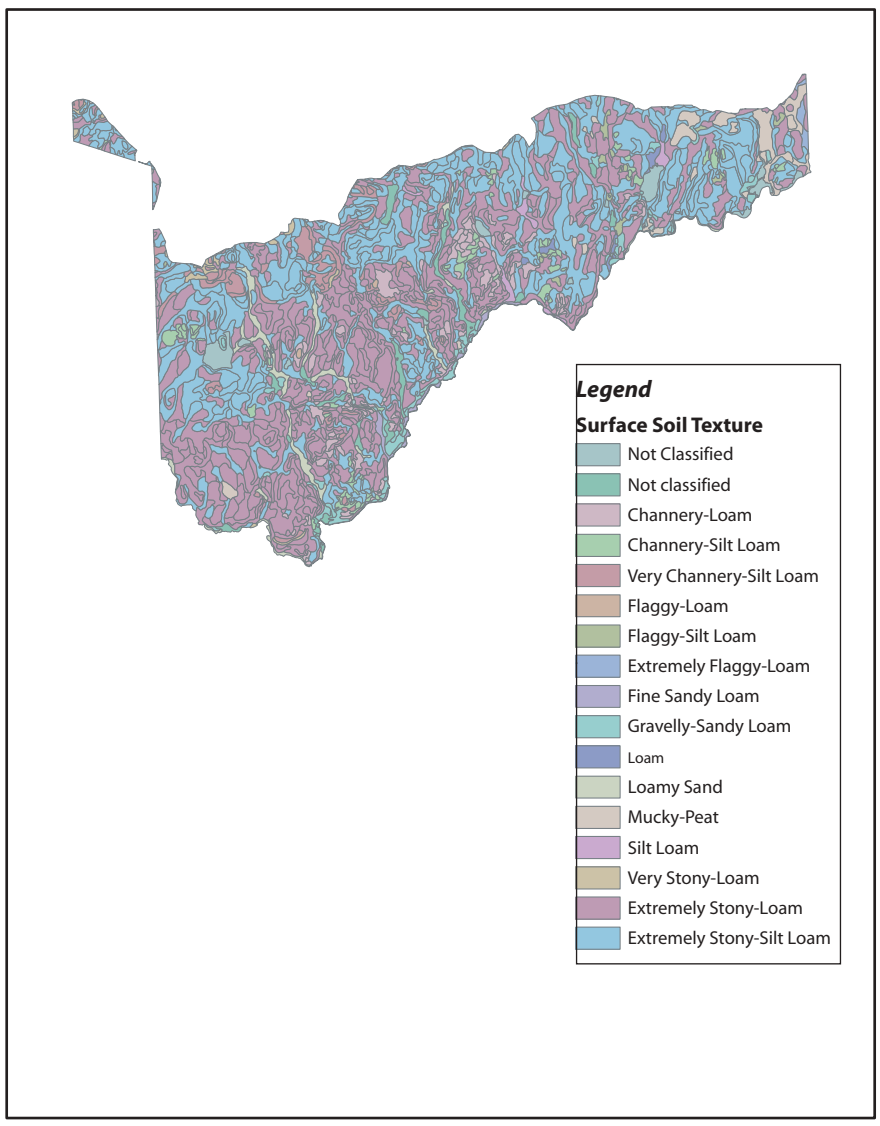
Source: USDA Natural Resources Conservation Service

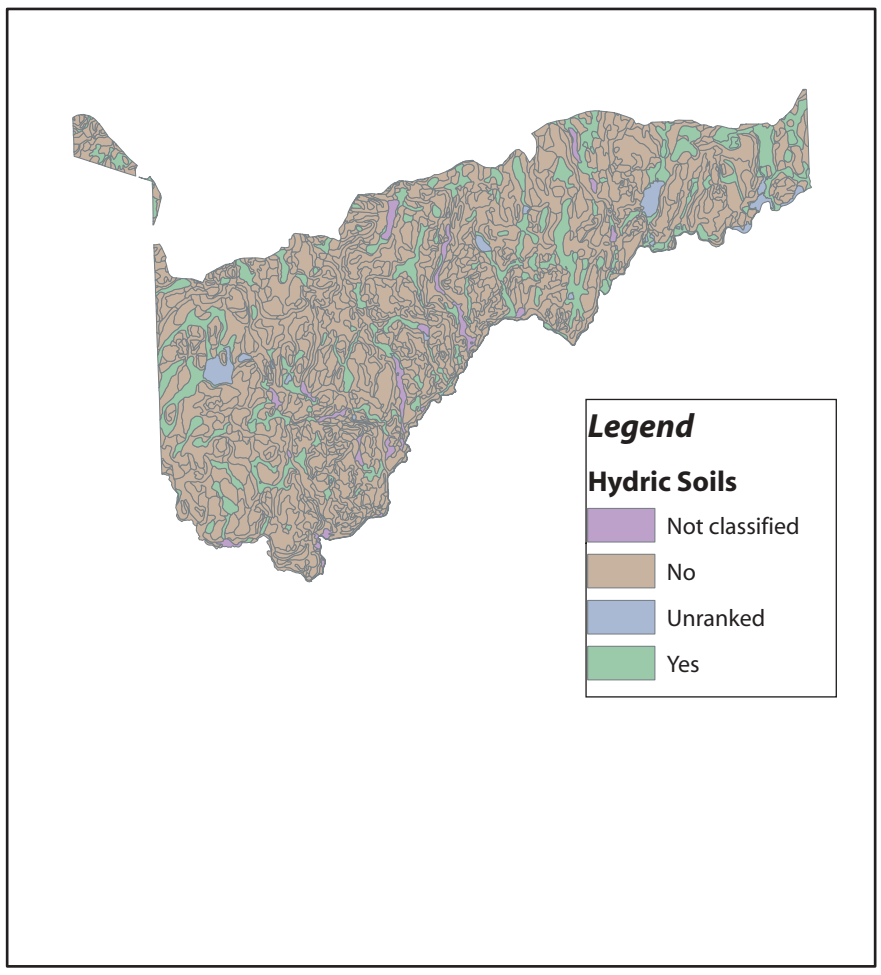
10 5 0 10 Miles

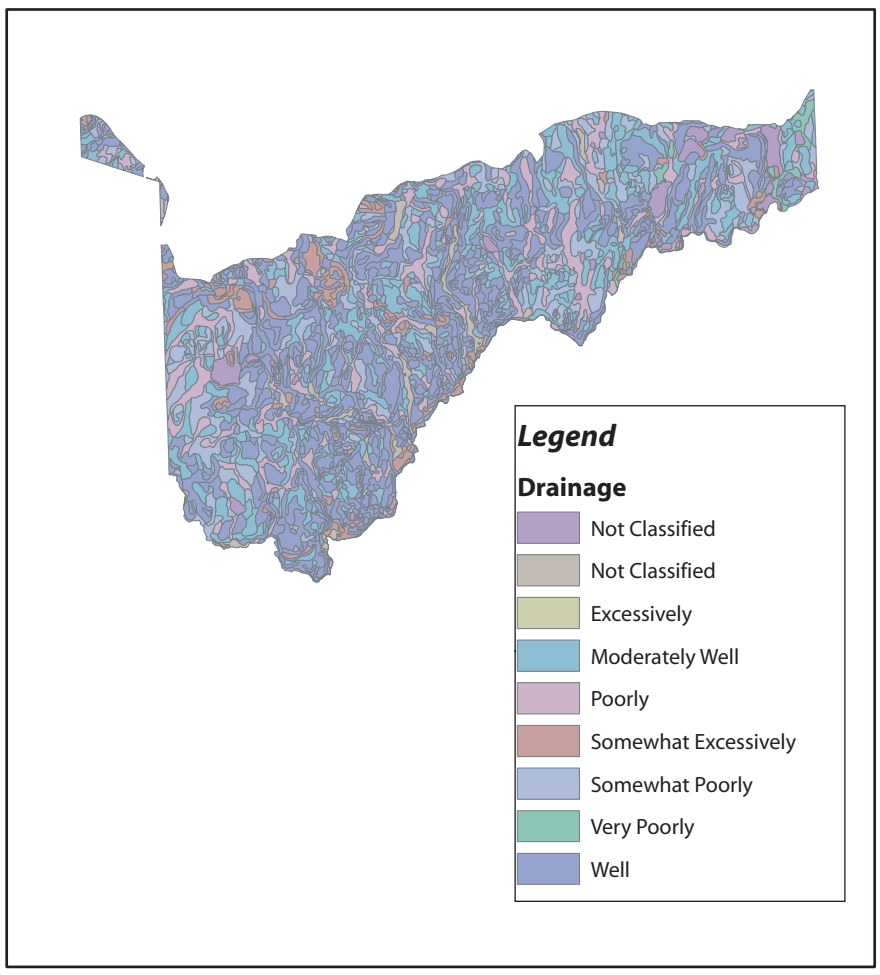


Map 1-10 Soil Characteristics in Lackawanna County Lehigh River Watershed

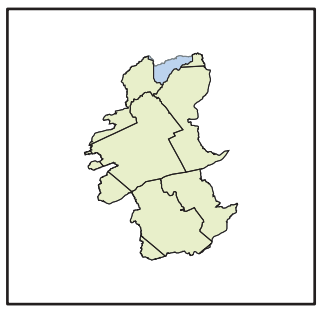




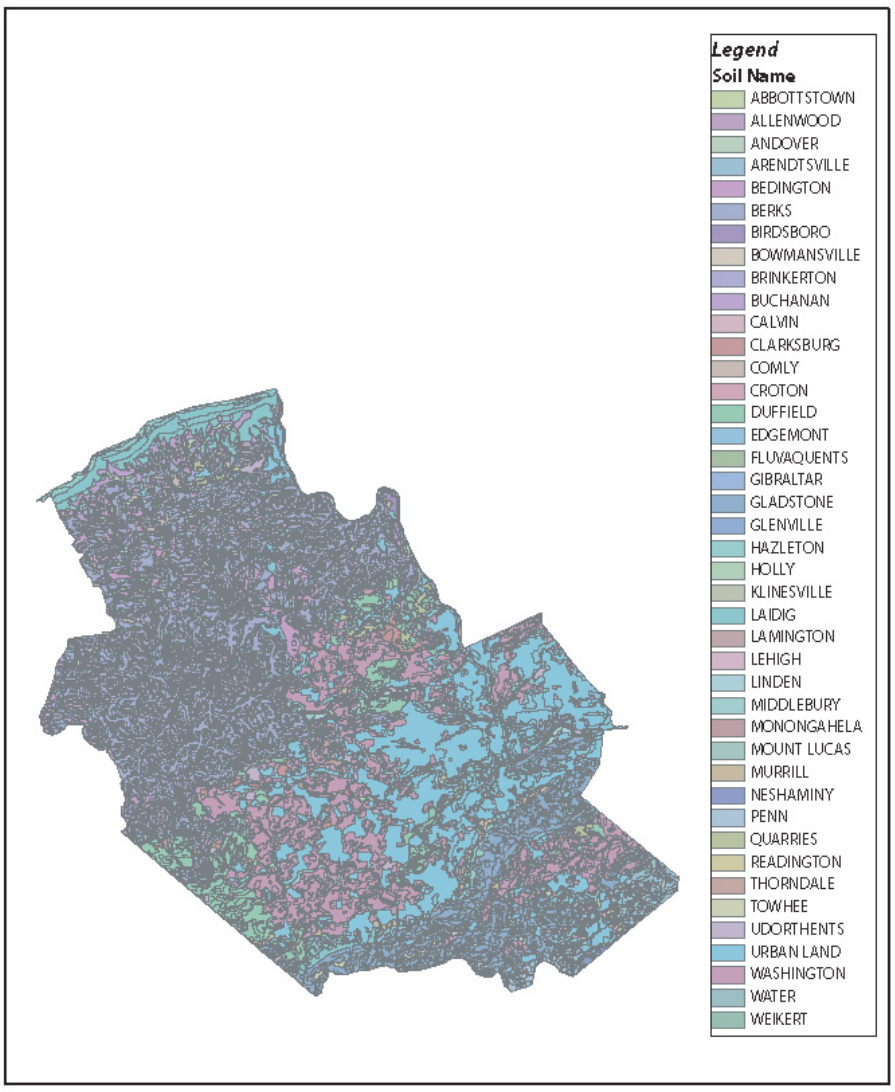


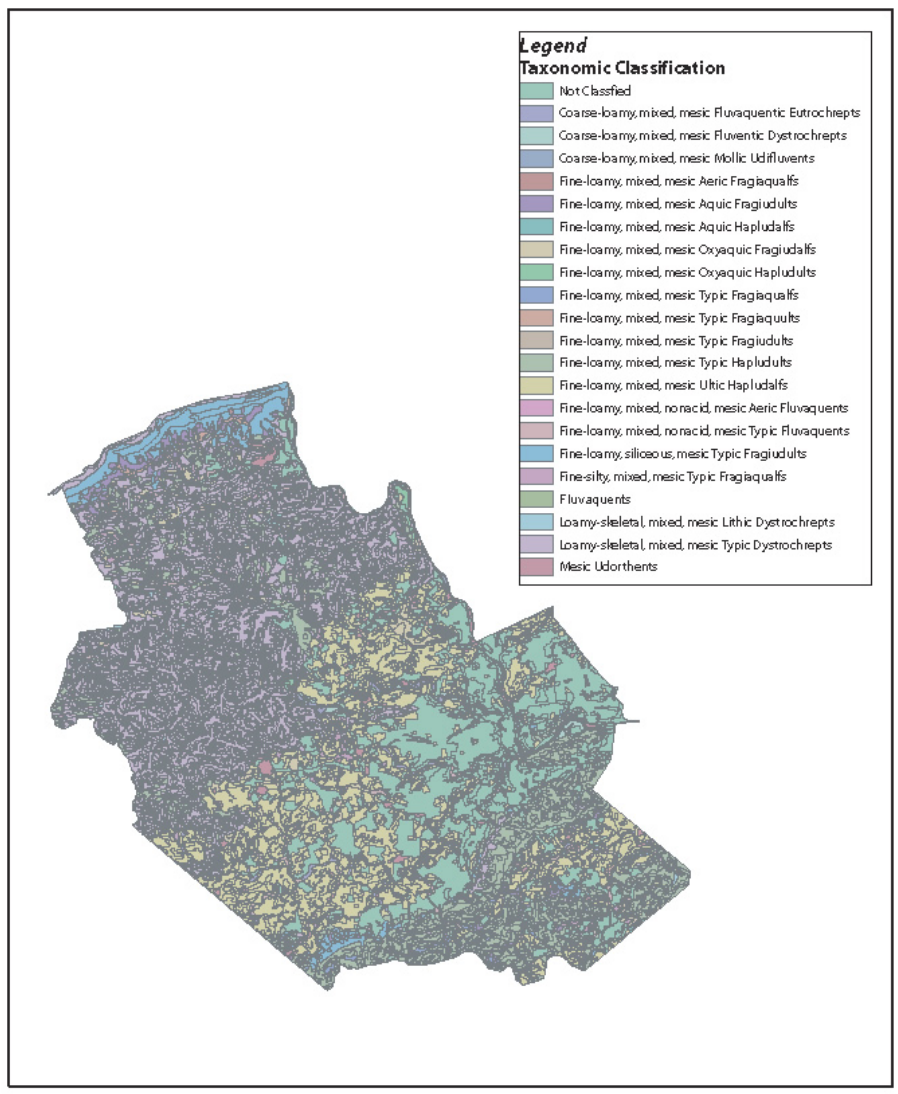


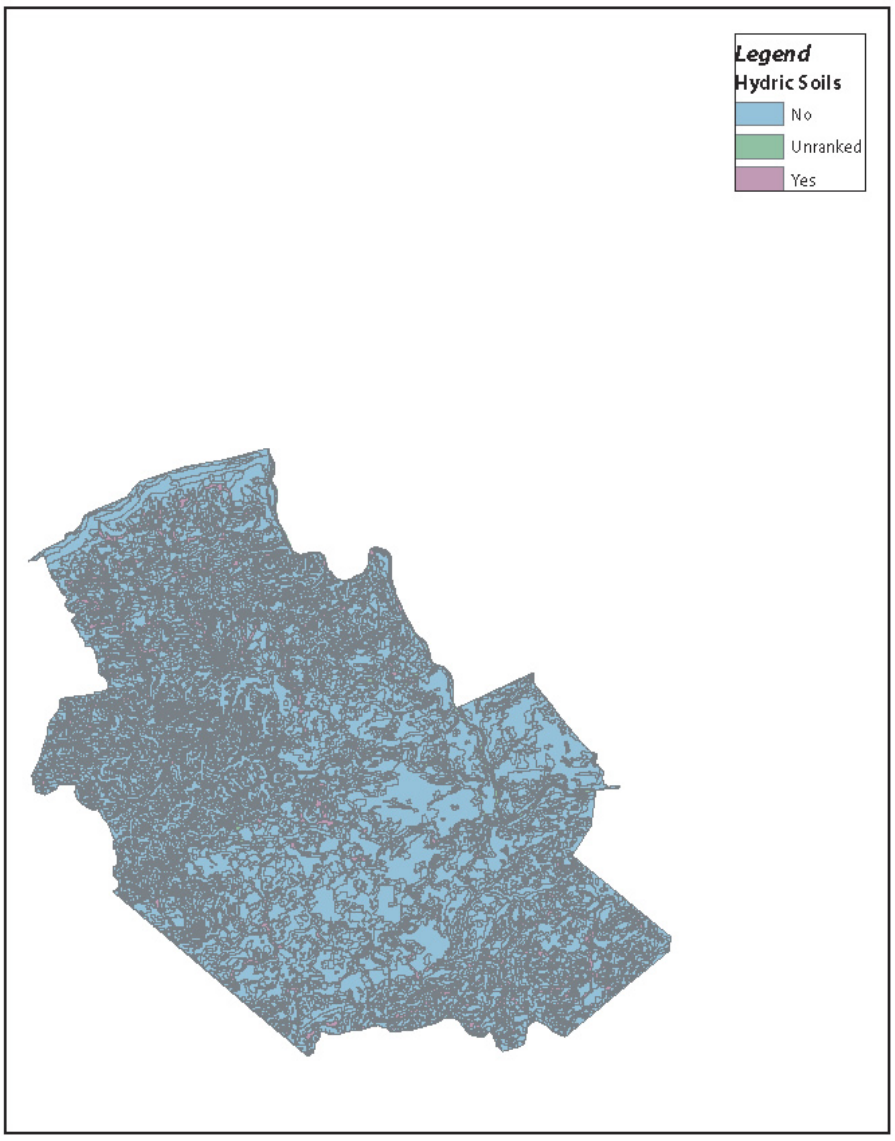
Source: USDA Natural Resourources Conservation

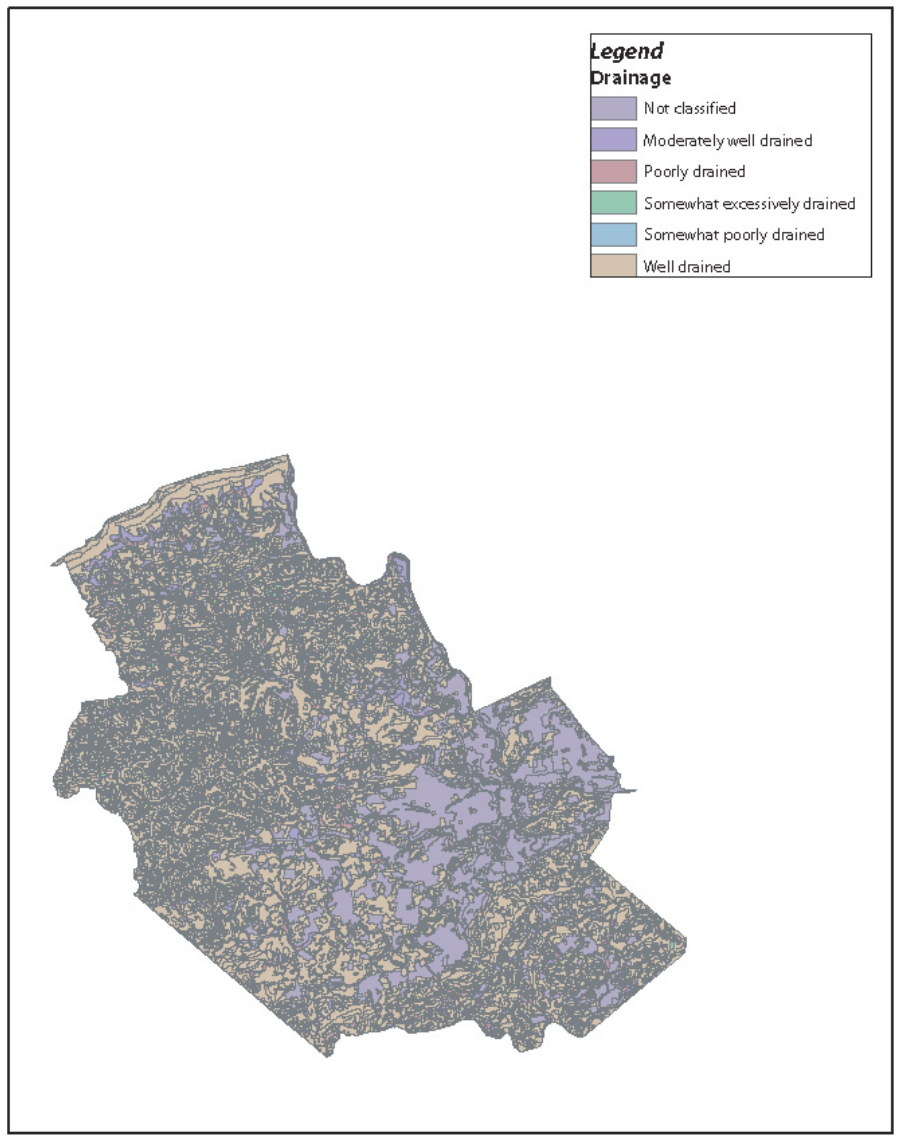


MAP 1-11 SOIL CHARACTERISTICS IN LEHIGH COUNTY
LEHIGH RIVER WATERSHED



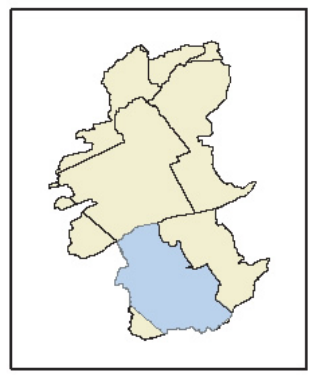






Source: USDA Natural Resource Conservation Service

10 5 0 10 Miles



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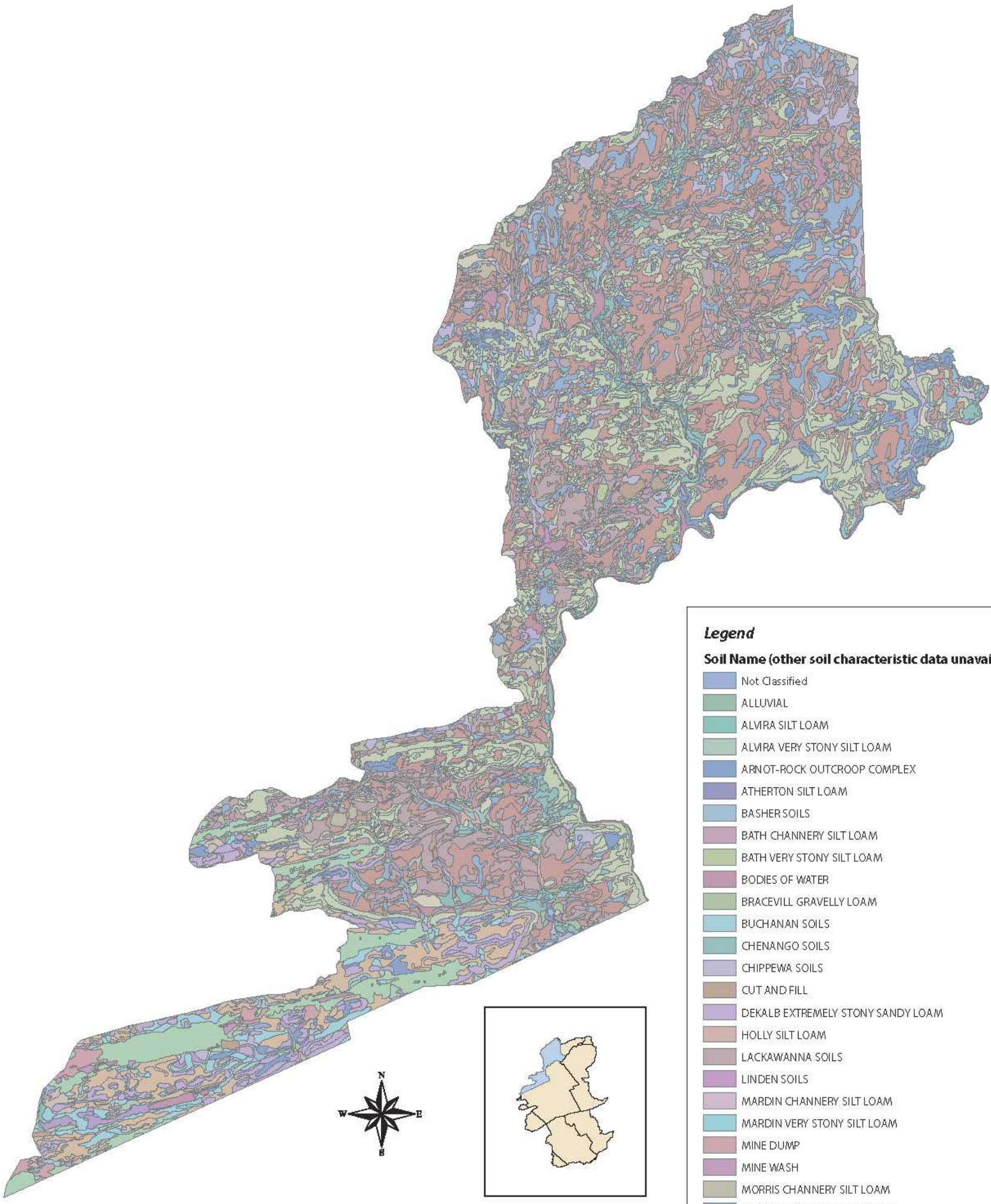
Map 1-12 Soil Names in Luzerne County
Lehigh River Watershed



Source: USDA Natural Resources Conservation Service

3 1.5 0 3 Miles

Legend

Soil Name (other soil characteristic data unavailable)

- Not Classified
- ALLUVIAL
- ALVIRA SILT LOAM
- ALVIRA VERY STONY SILT LOAM
- ARNOT-ROCK OUTCROOP COMPLEX
- ATHERTON SILT LOAM
- BASHER SOILS
- BATH CHANNERY SILT LOAM
- BATH VERY STONY SILT LOAM
- BODIES OF WATER
- BRACEVILL GRAVELLY LOAM
- BUCHANAN SOILS
- CHENANGO SOILS
- CHIPPEWA SOILS
- CUT AND FILL
- DEKALB EXTREMELY STONY SANDY LOAM
- HOLLY SILT LOAM
- LACKAWANNA SOILS
- LINDEN SOILS
- MARDIN CHANNERY SILT LOAM
- MARDIN VERY STONY SILT LOAM
- MINE DUMP
- MINE WASH
- MORRIS CHANNERY SILT LOAM
- MORRIS VERY STONY SILT LOAM
- MUCK
- OQUAGA AND LORDSTOWN
- POCONO EXTREMELY STONY SANDY LOAM
- POCONO GRAVELLY SANDY LOAM
- POPE SOILS
- REXFORD LOAM
- SHELMADINE SOILS
- STRIP MINE
- URBAN LAND
- VOLUSIA VERY STONY SILT LOAM
- WAYLAND SOILS
- WEIKERT AND KLINESVILLE SOILS
- WELLSBORO SOILS
- WURTSBORO SOILS
- WYOMING GRAVELLY LOAM

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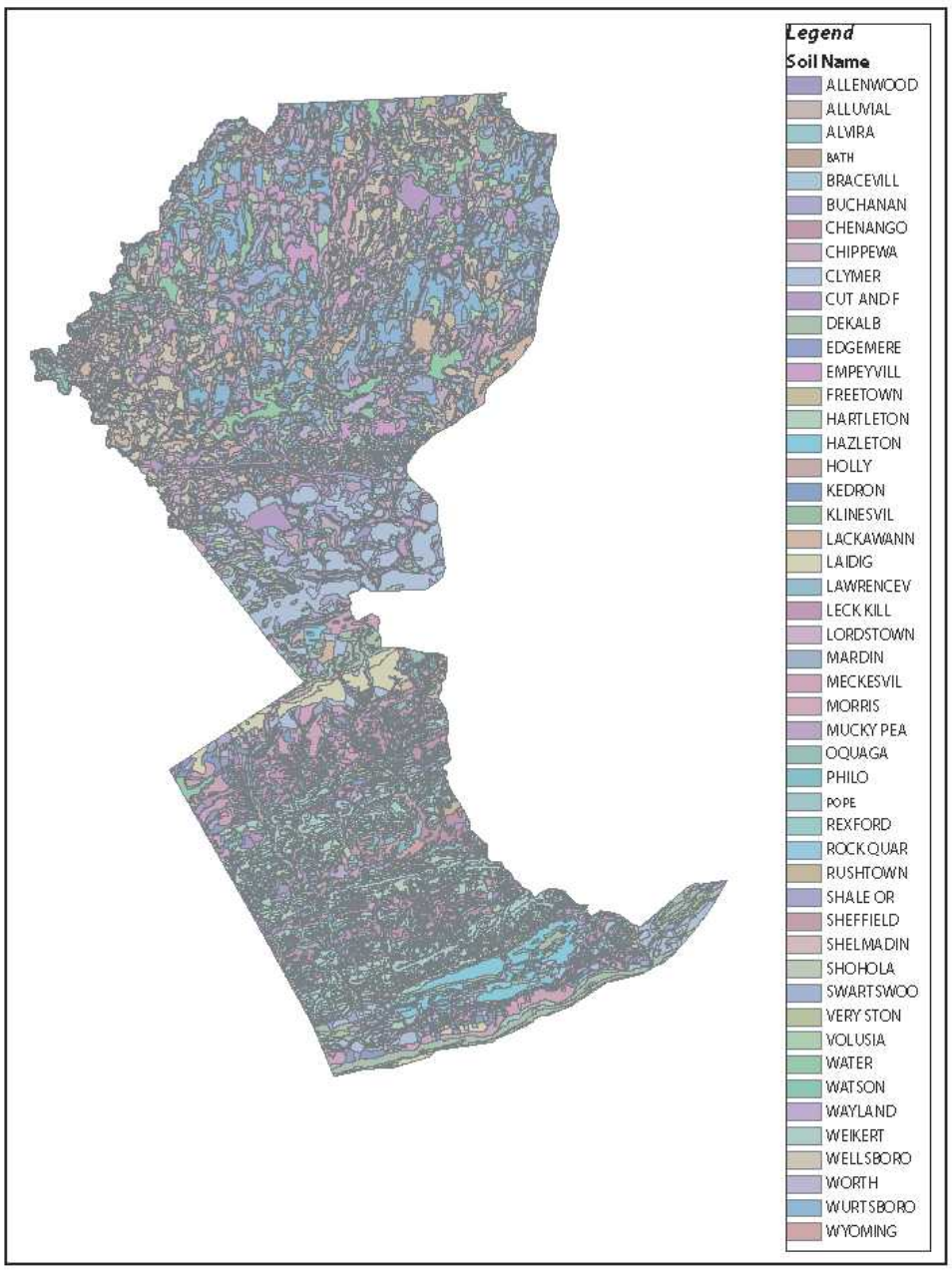
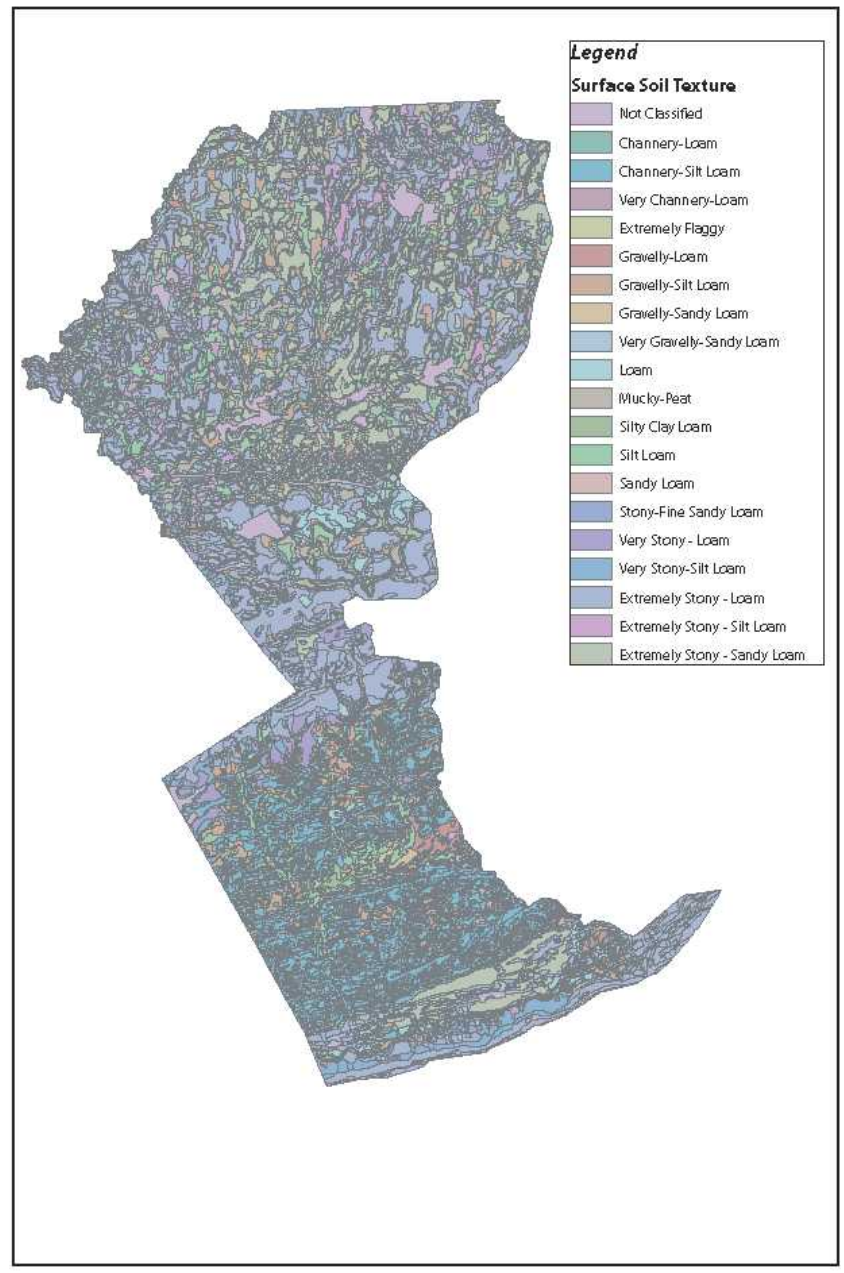
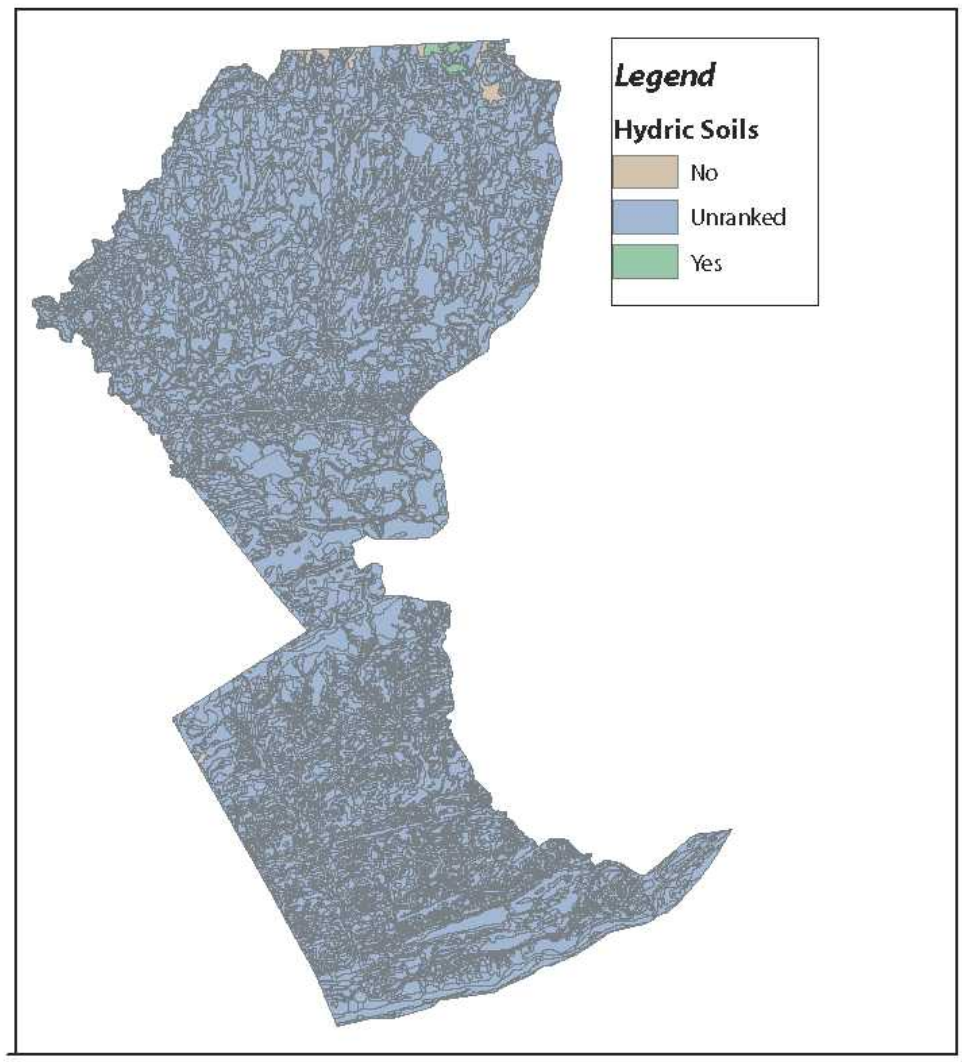
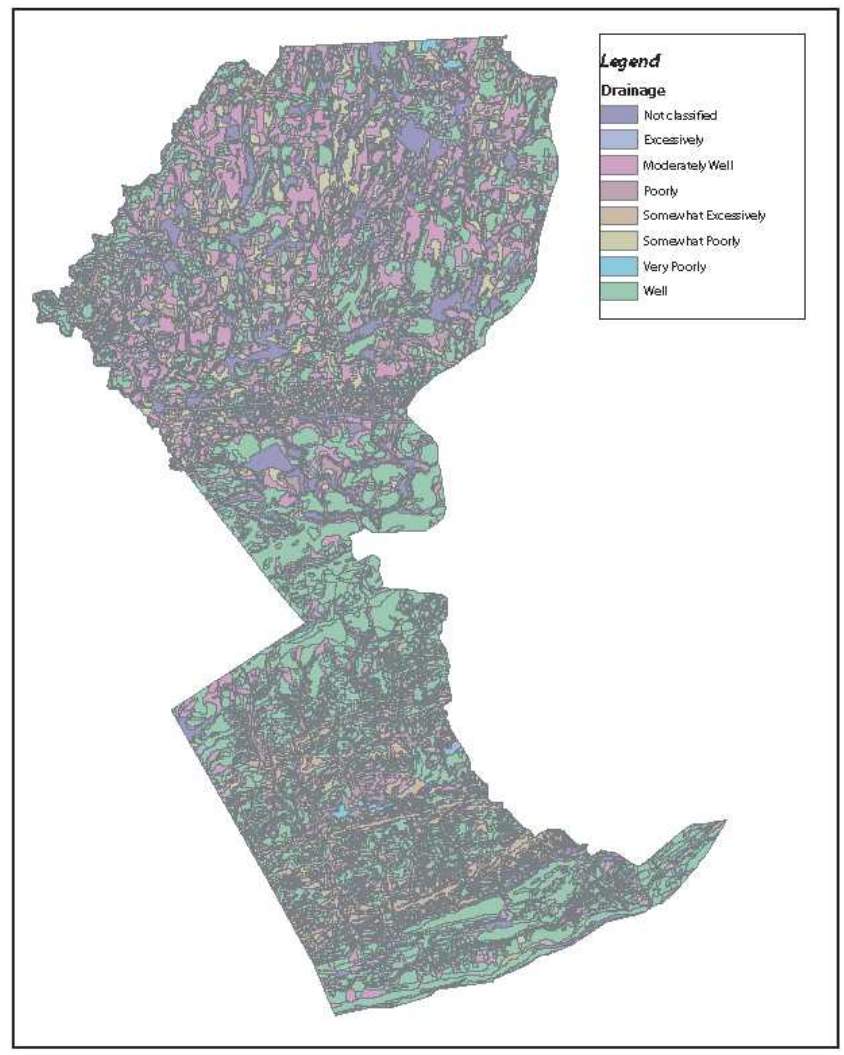
Map 1-13 Soil Characteristics in Monroe County
Lehigh River Watershed



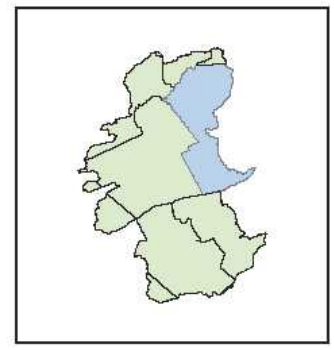




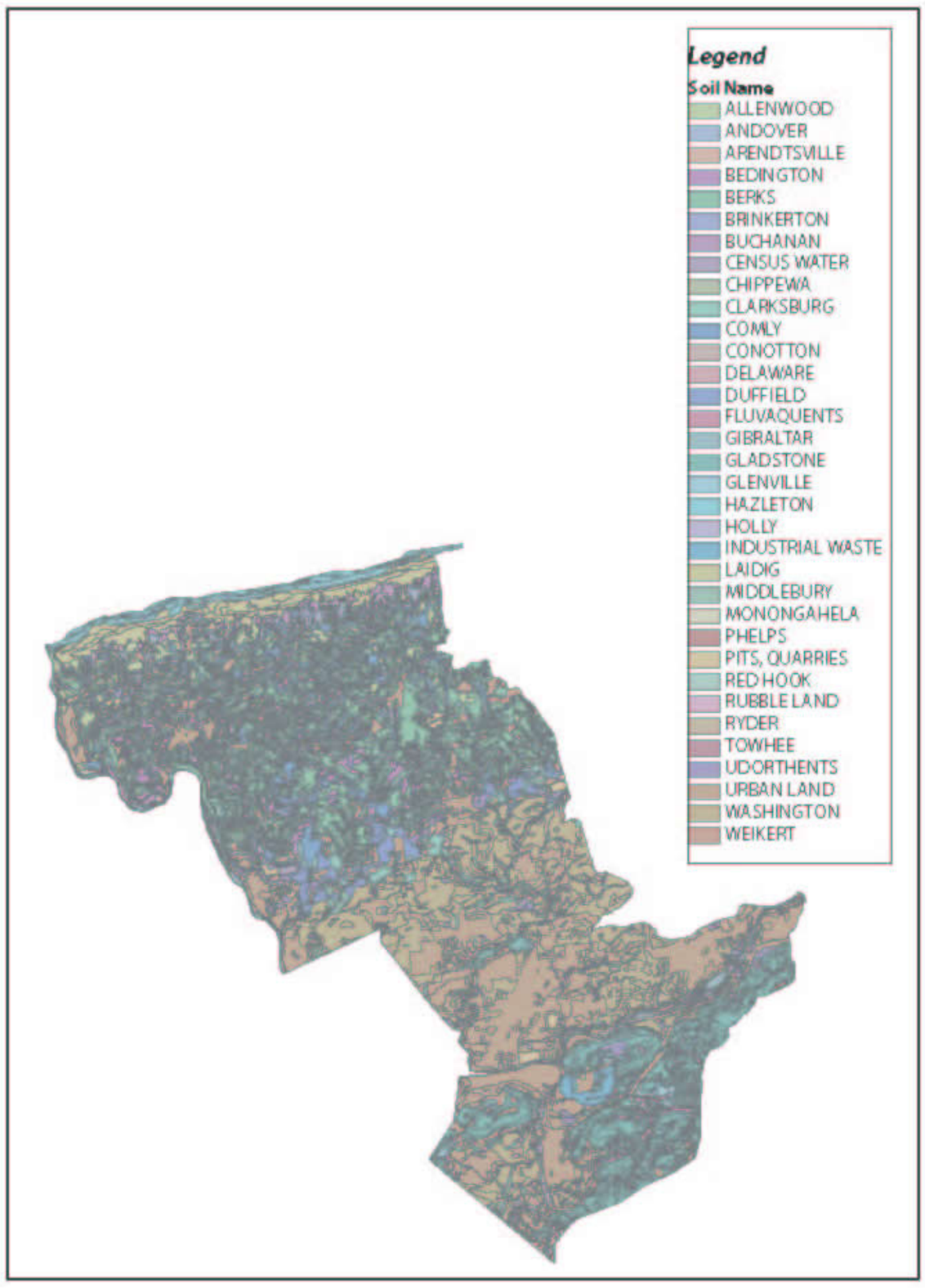


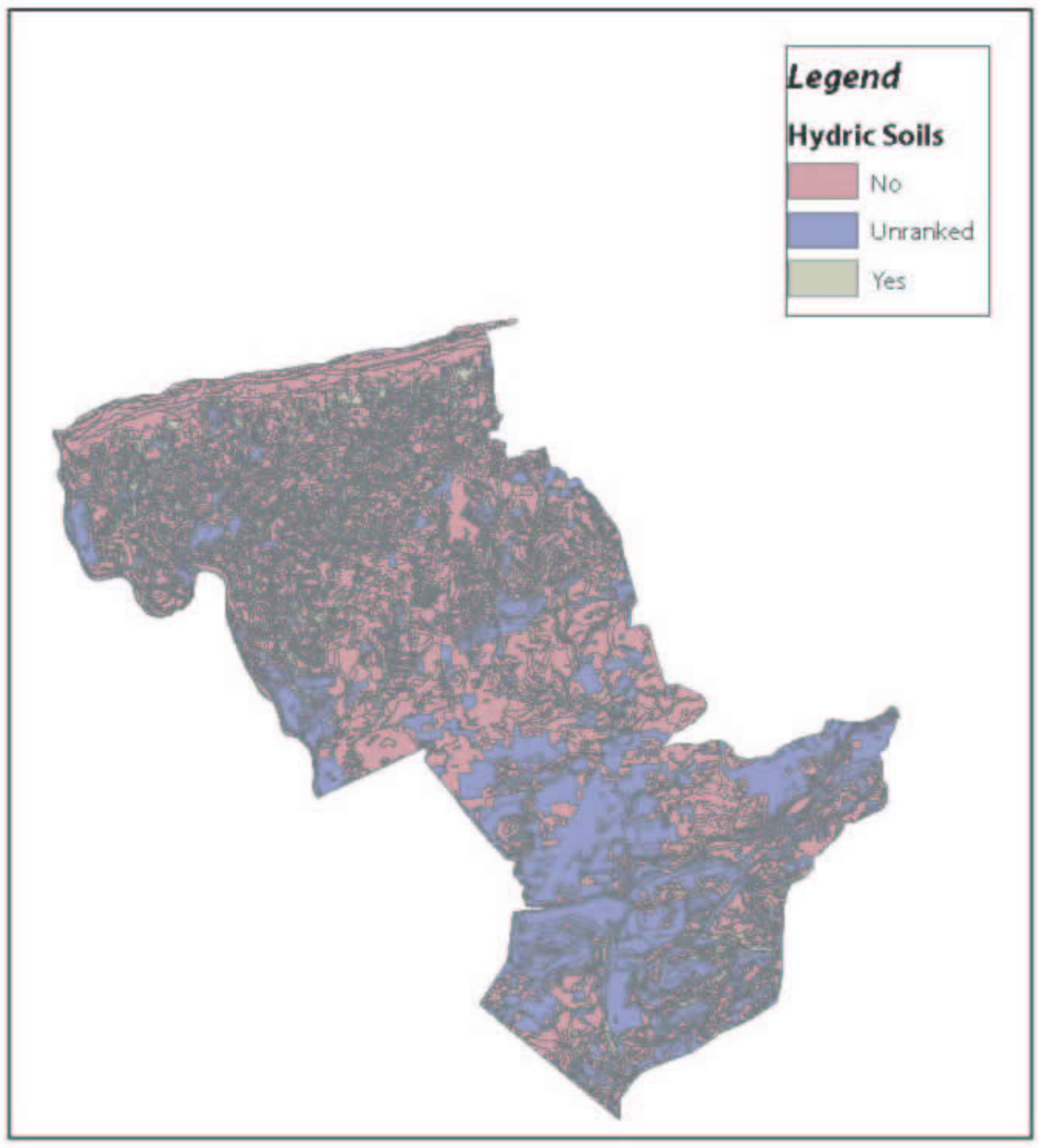
Source: USDA Natural Resources Conservation Service

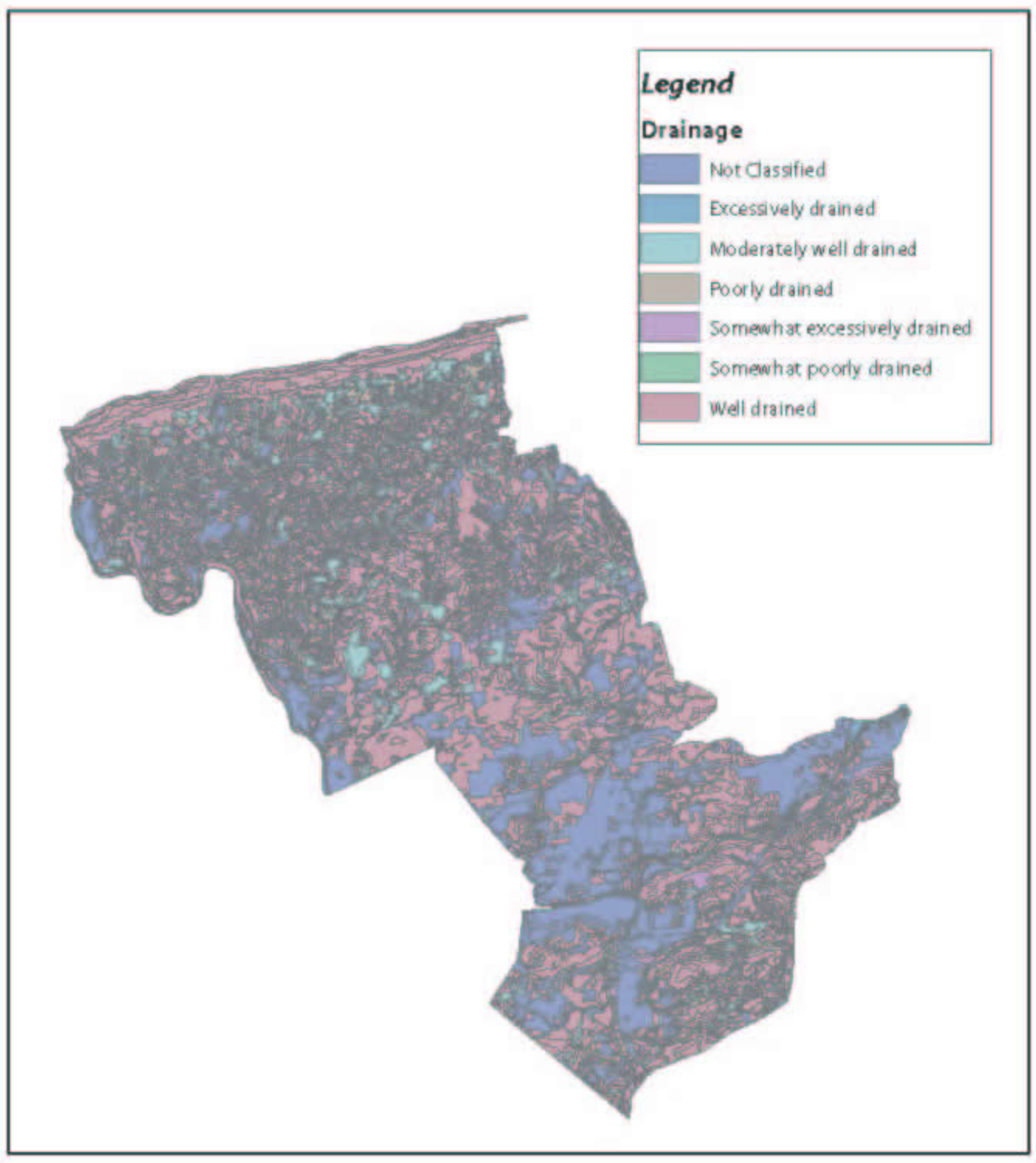
8 4 0 8 Miles

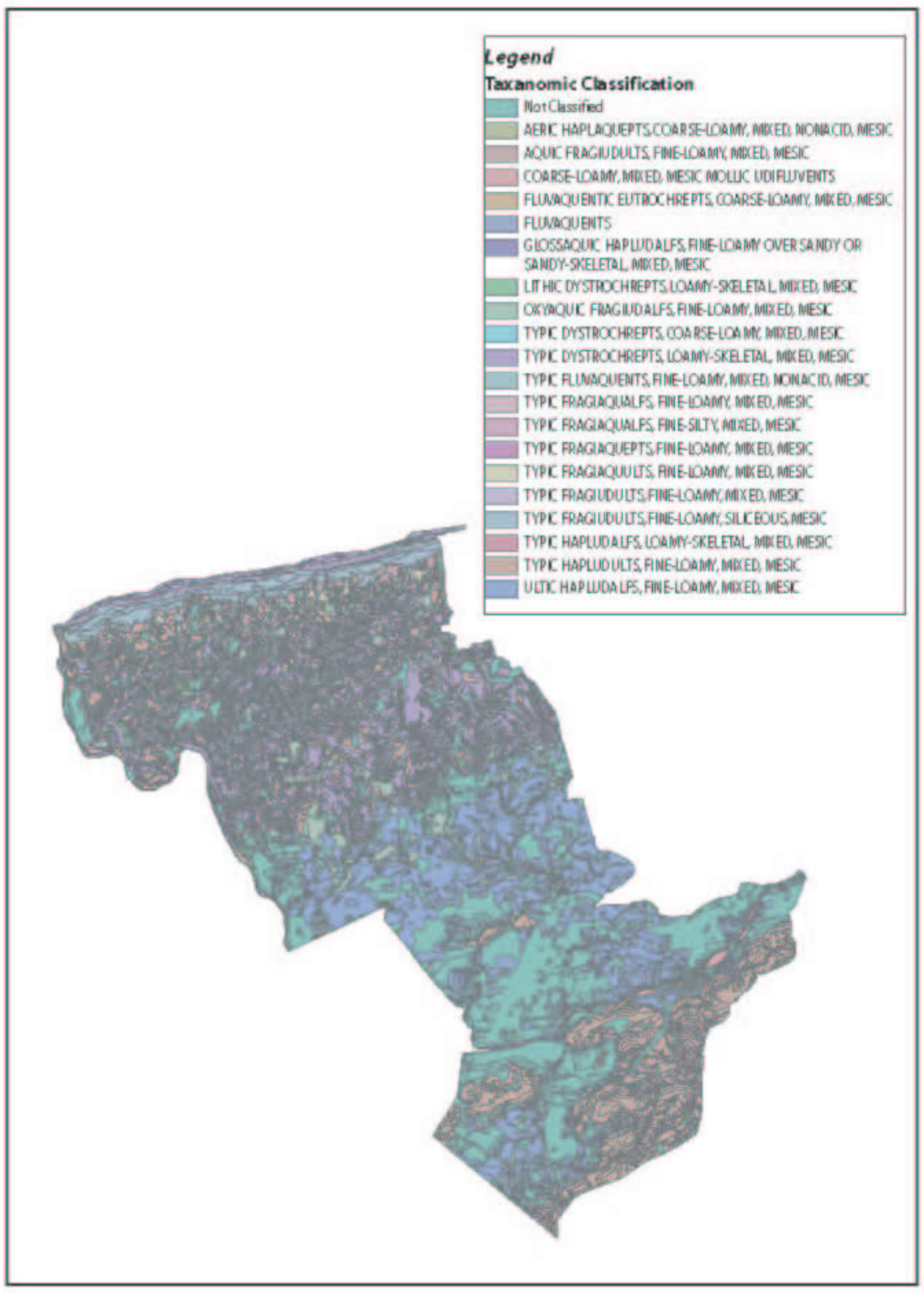


MAP 1-14 SOIL CHARACTERISTICS IN NORTHAMPTON COUNTY
LEHIGH RIVER WATERSHED



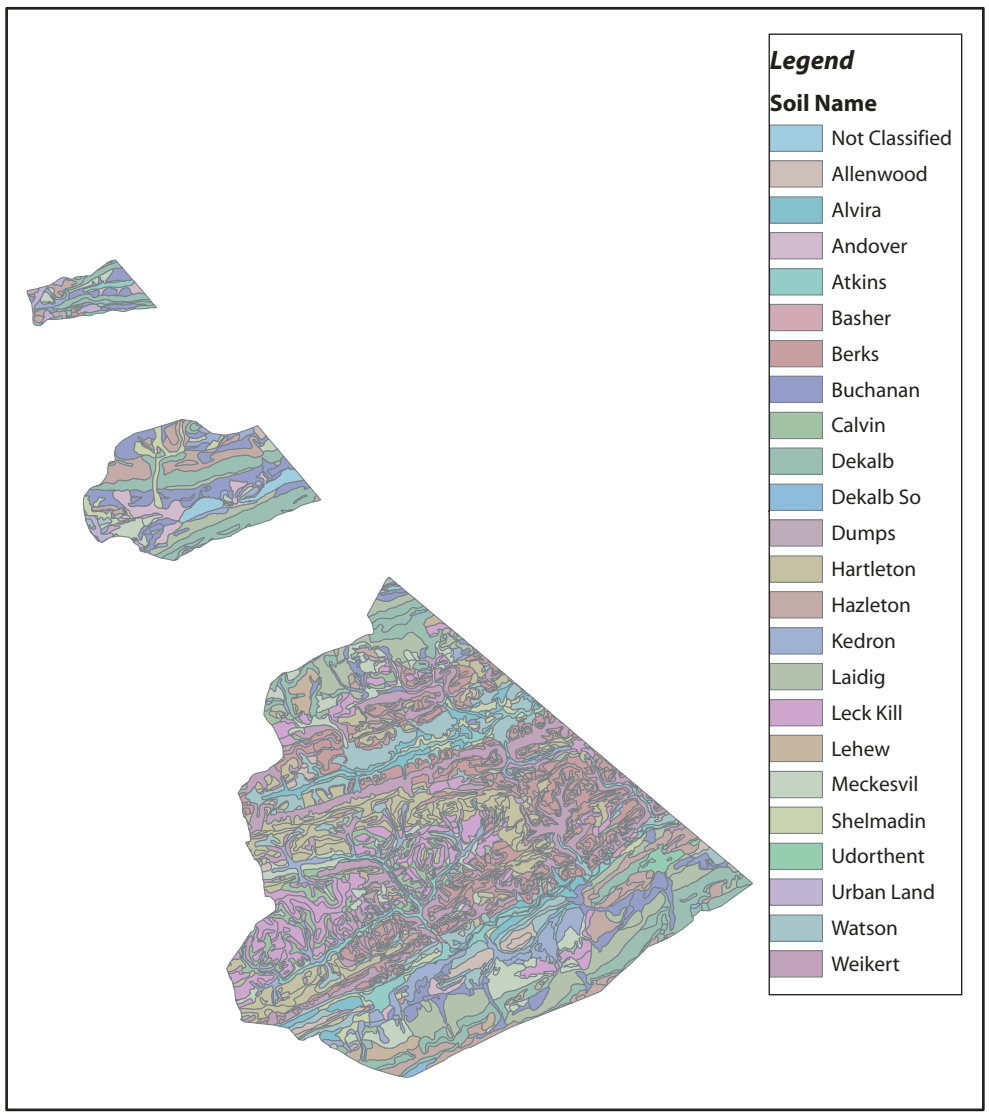


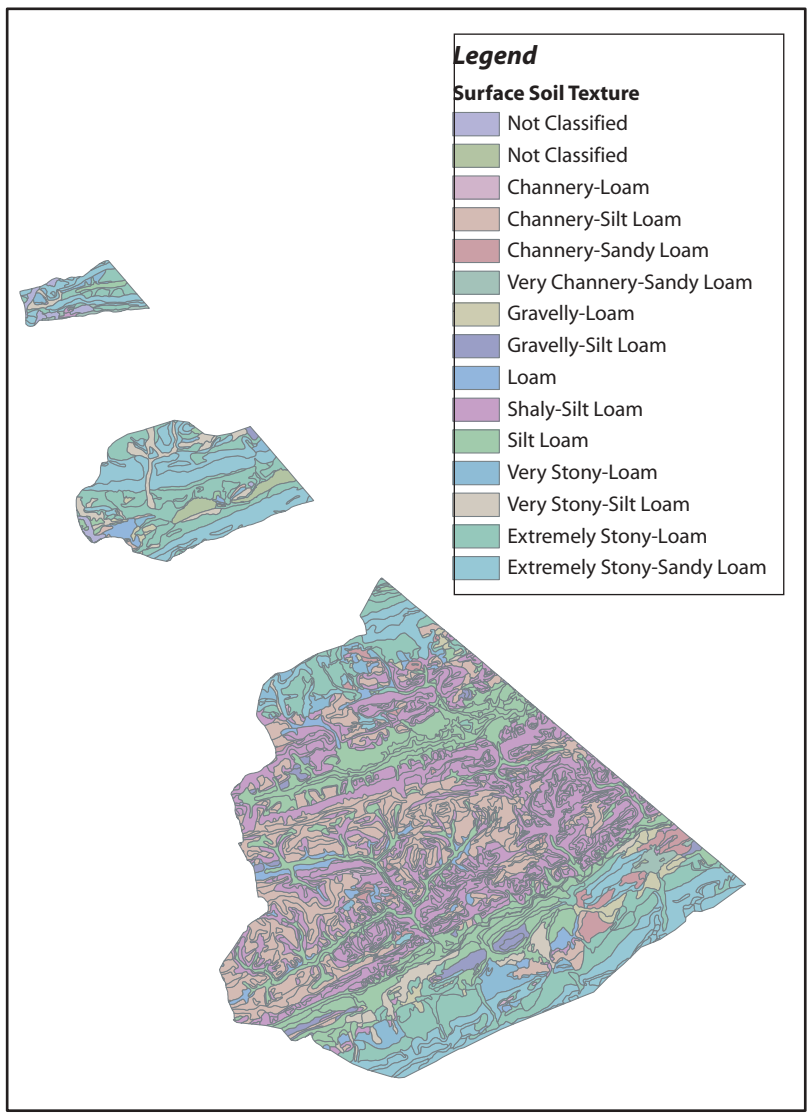


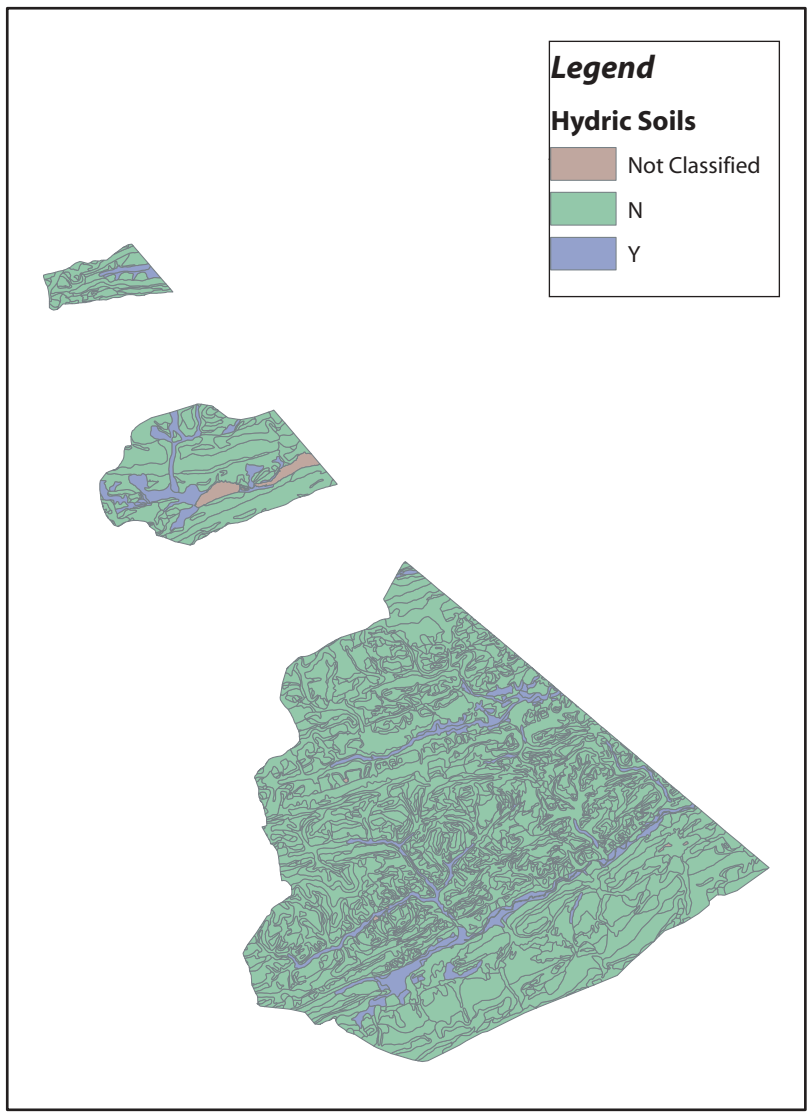


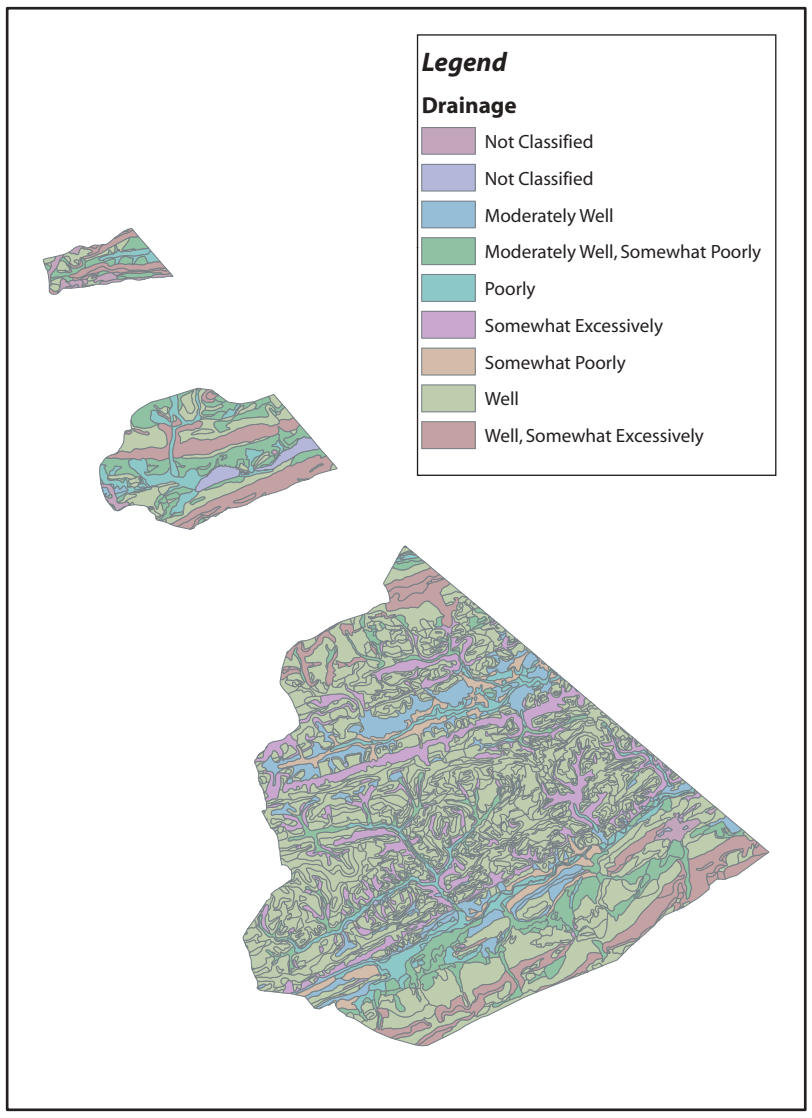
Source: USDA Natural Resources Conservation Service

Map 1-15 Soil Characteristics in Schuylkill County
Lehigh River Watershed

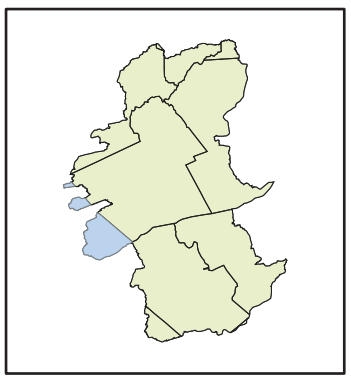




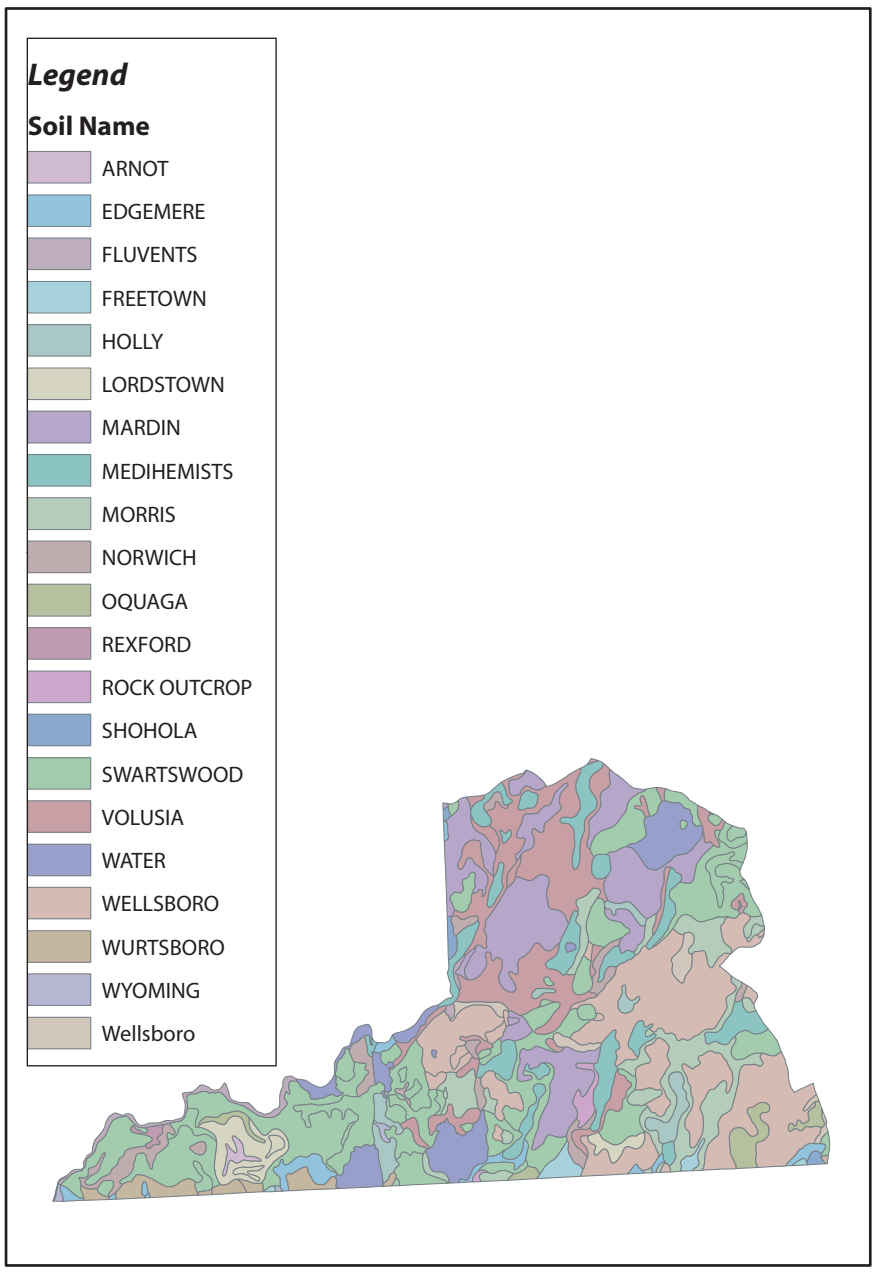


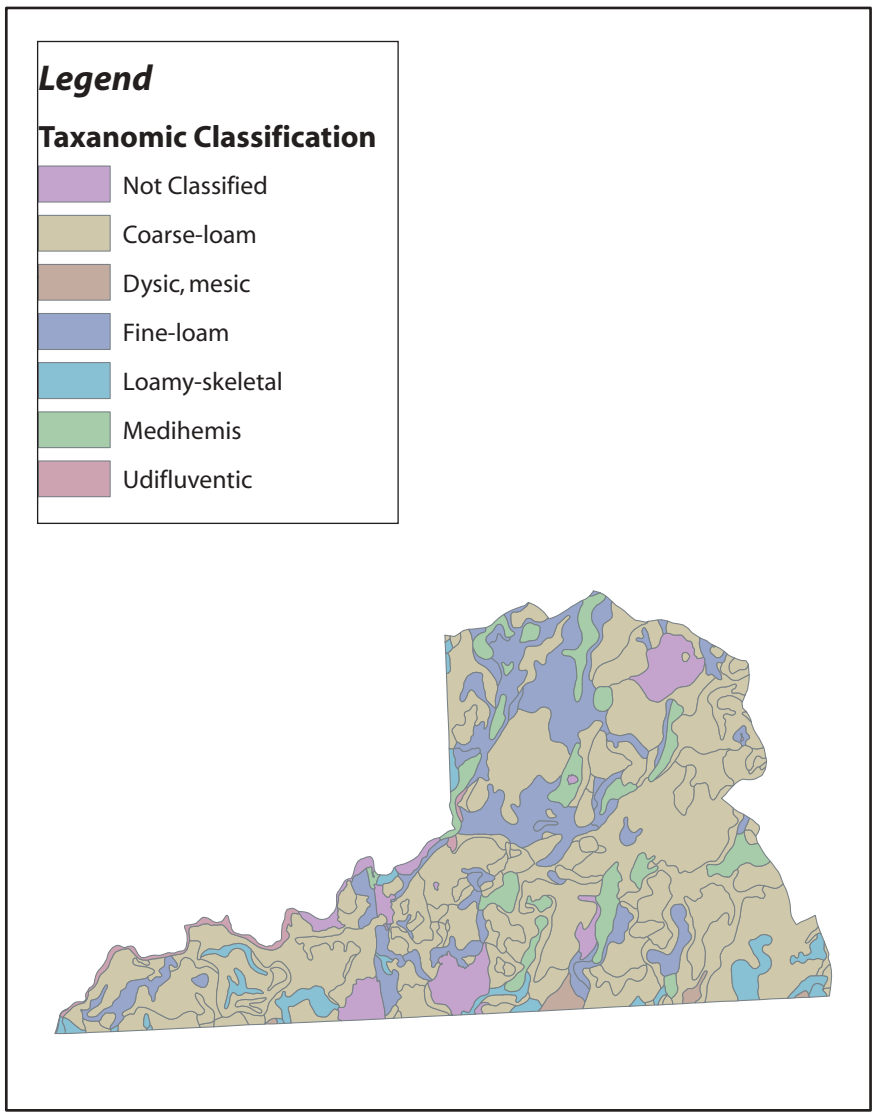


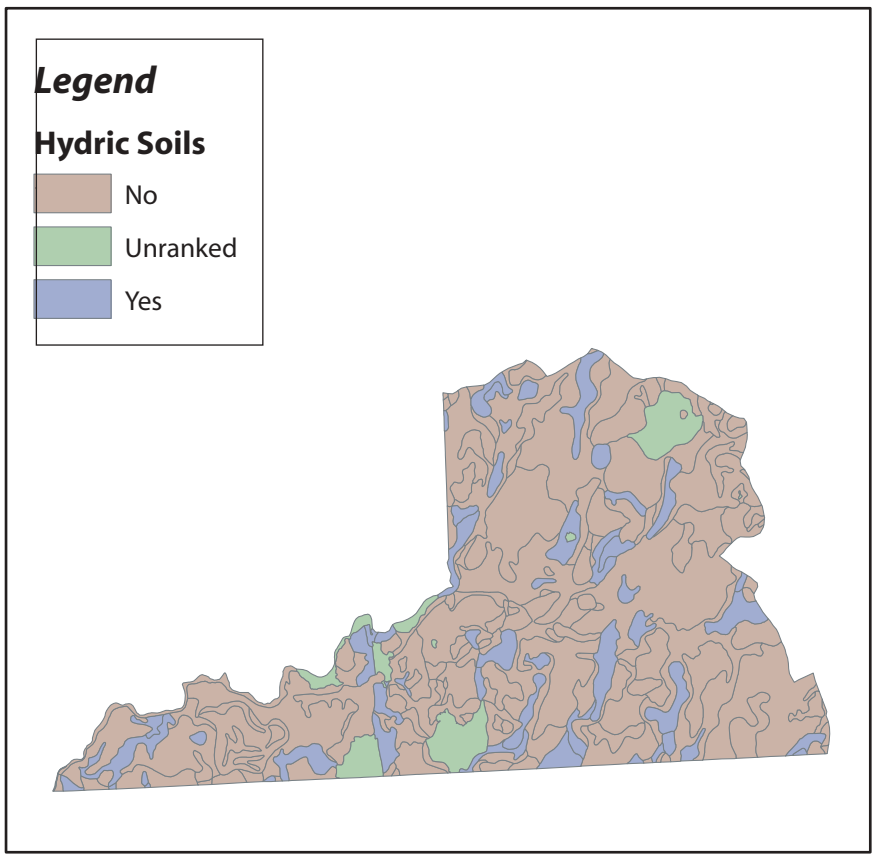
Source: USDA Natural Resource Conservation Service

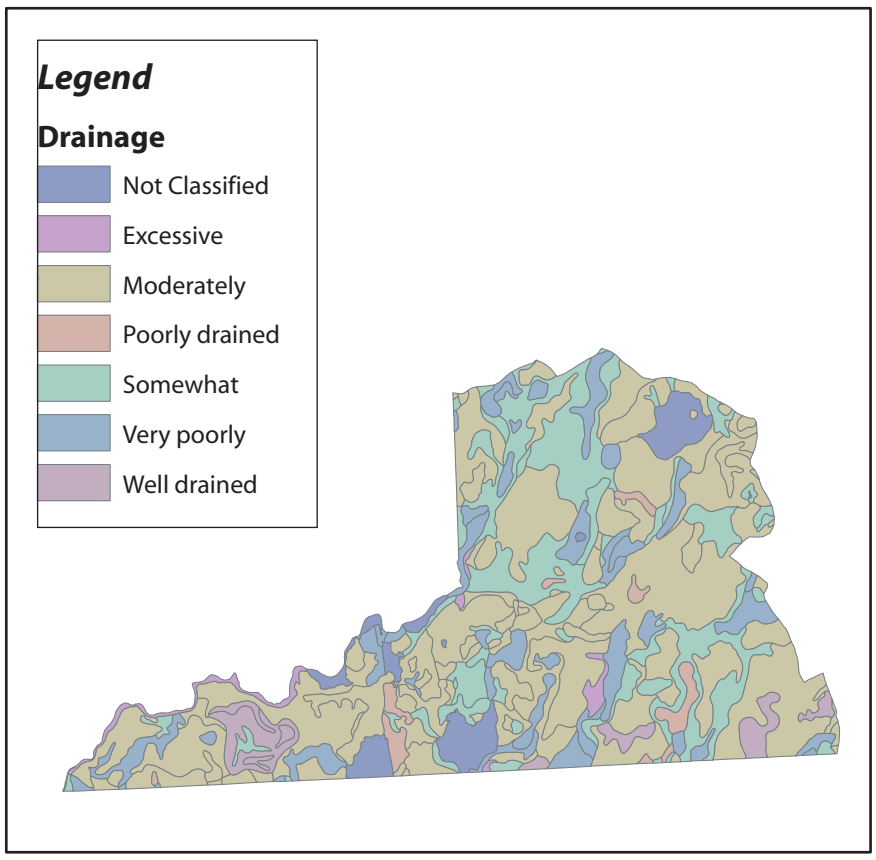


Map 1-16 Soil Characteristics in Wayne County
Lehigh River Watershed

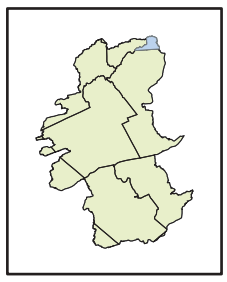




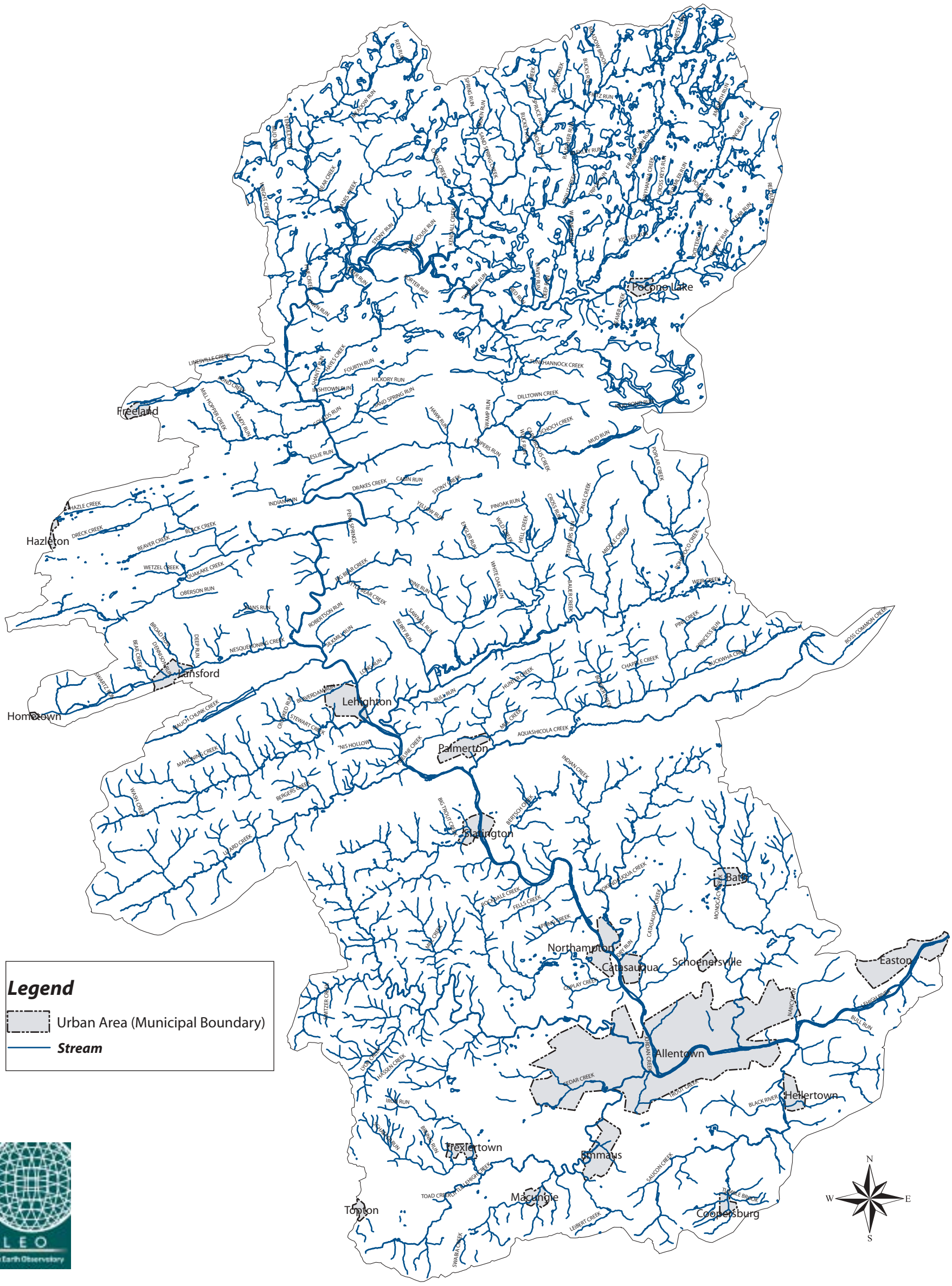




Source: USDA Natural Resource Conservation Service



Map 3-1 Lehigh River and Streams
Lehigh River Watershed

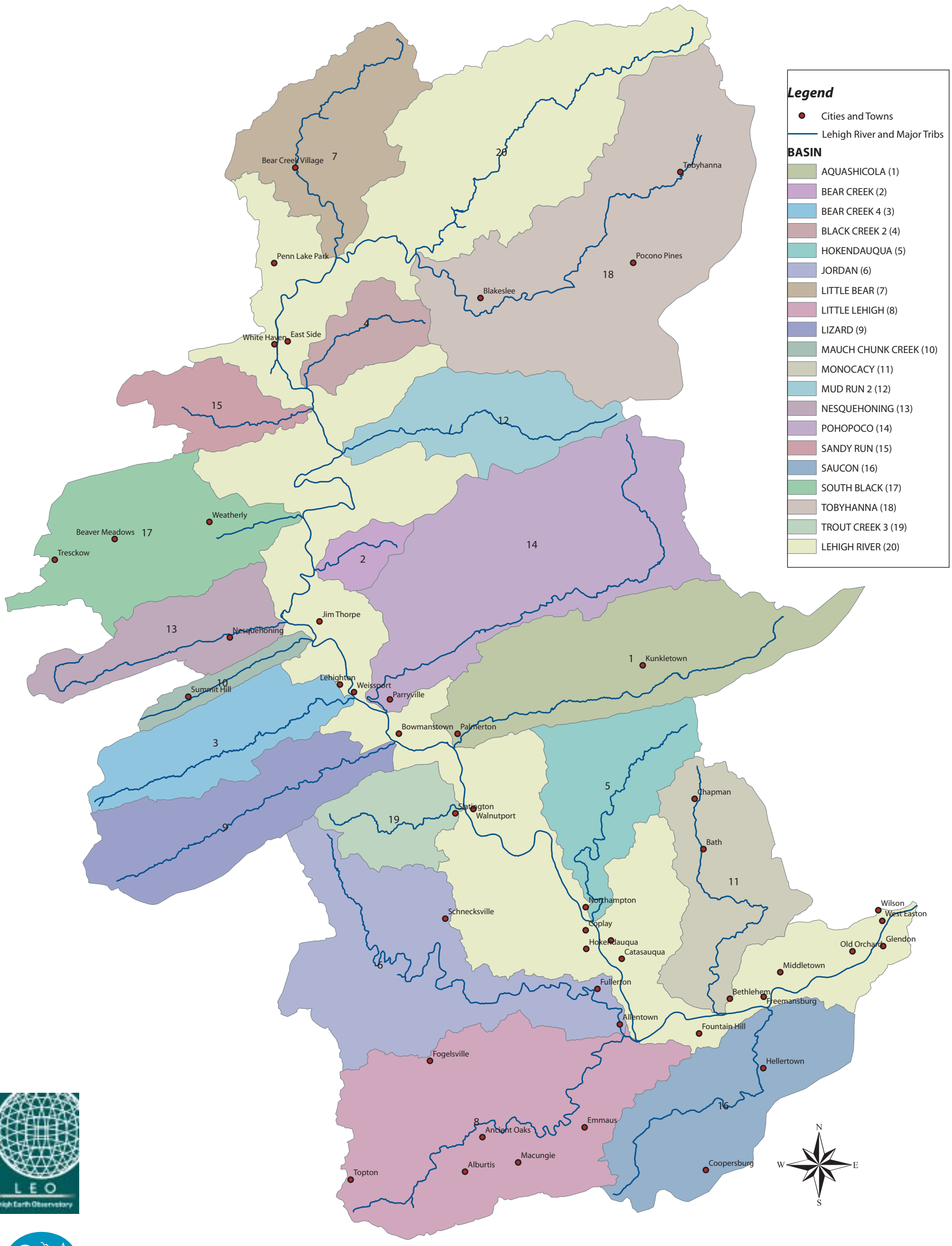


Source: Lehigh Earth Observatory; Myers, Bishop, Argent, 2000

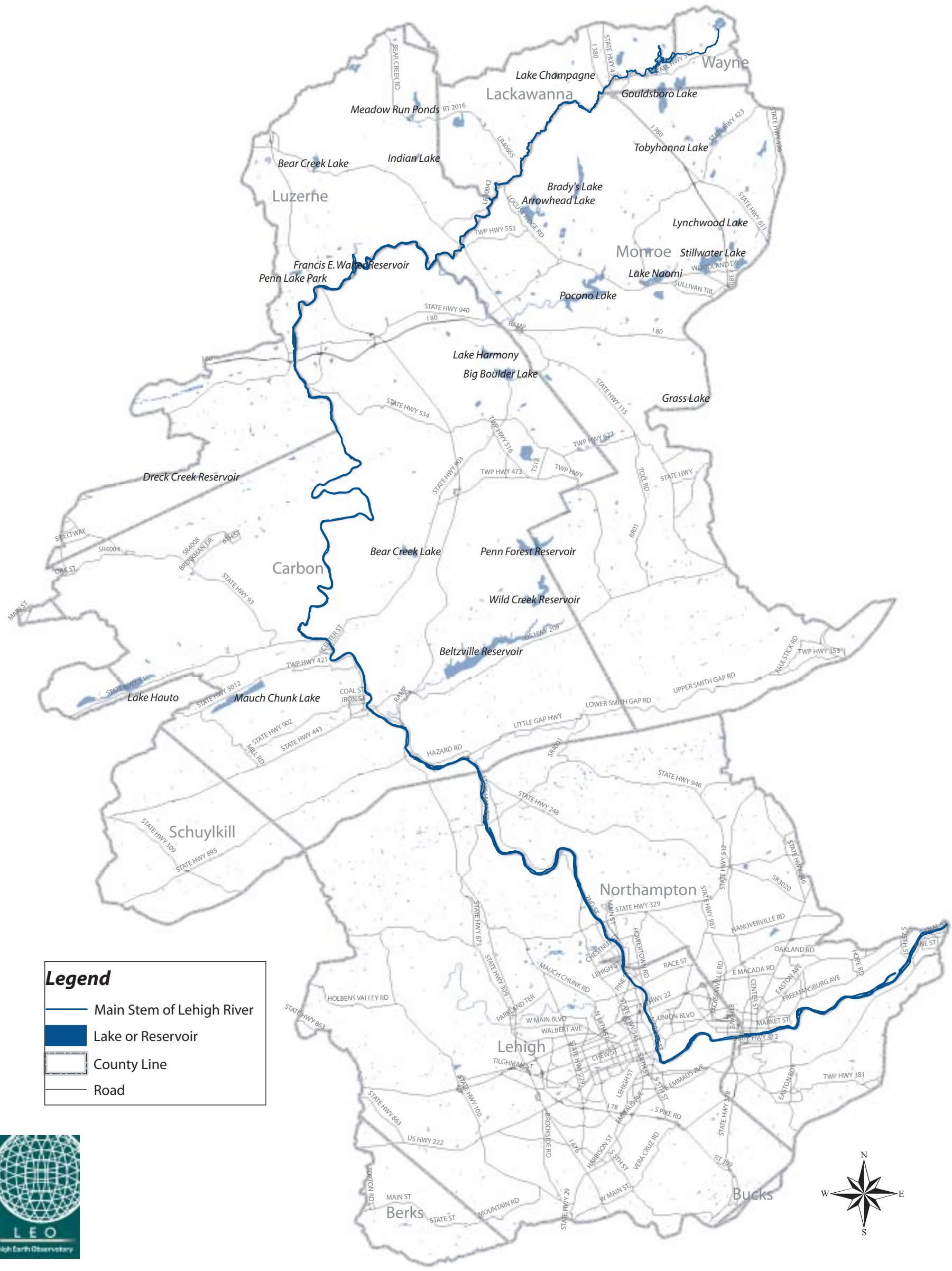
Miles

0 1.5 3 6 9 12 15

Map 3-2 Sub-Basins
Lehigh River Watershed



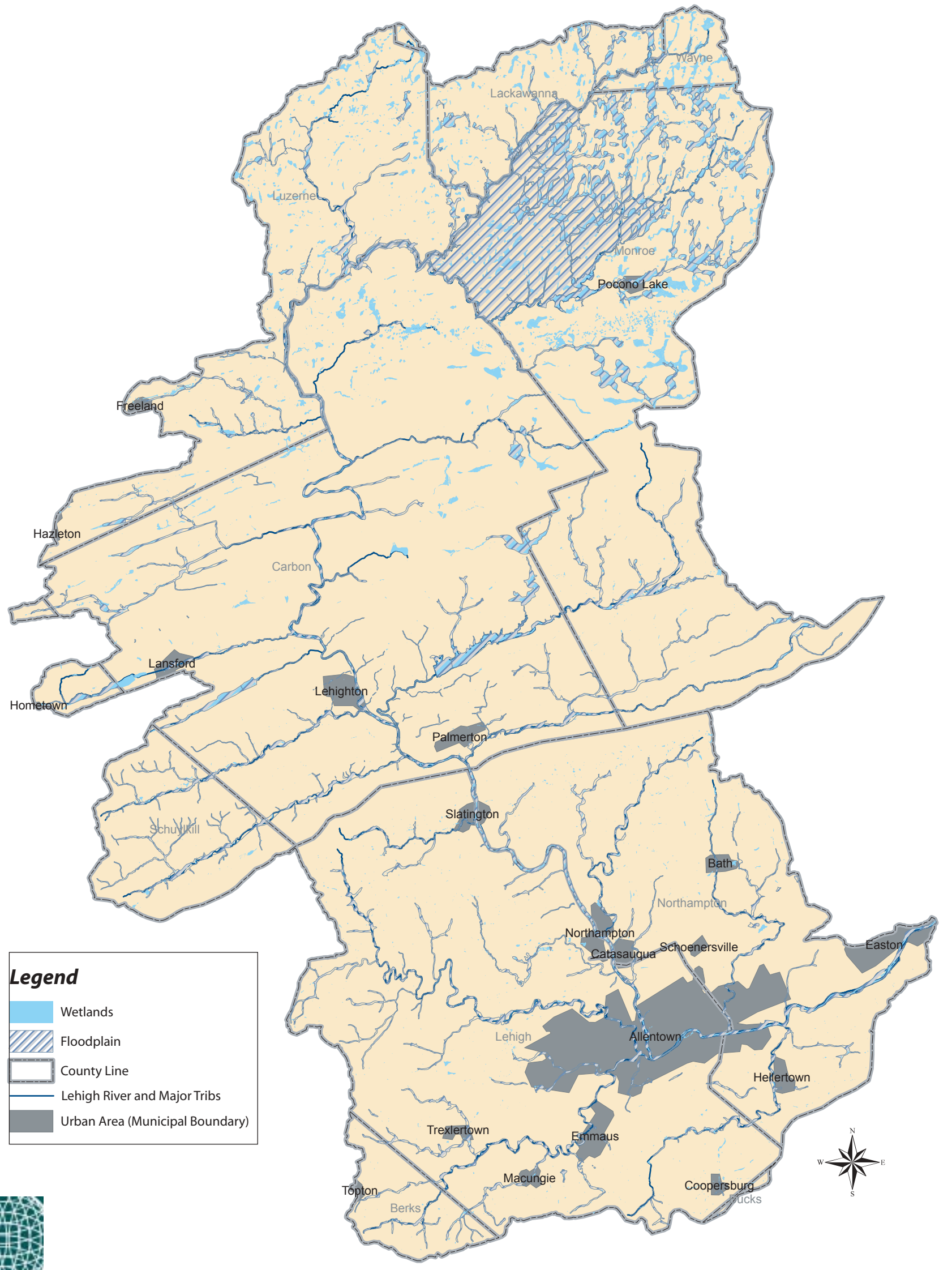
Map 3-3 Lakes and Reservoirs
Lehigh River Watershed



Source: Lehigh Earth Observatory; Meyers , Bishop, 2000

0 1.5 3 6 9 12 15 Miles

Map 3-4 Wetlands and Floodplains
Lehigh River Watershed



Source: Lehigh Earth Observatory; Meyers and Bishop, 2000; Environmental Resources Research Institute, 1998

Miles

0 1.5 3 6 9 12 15

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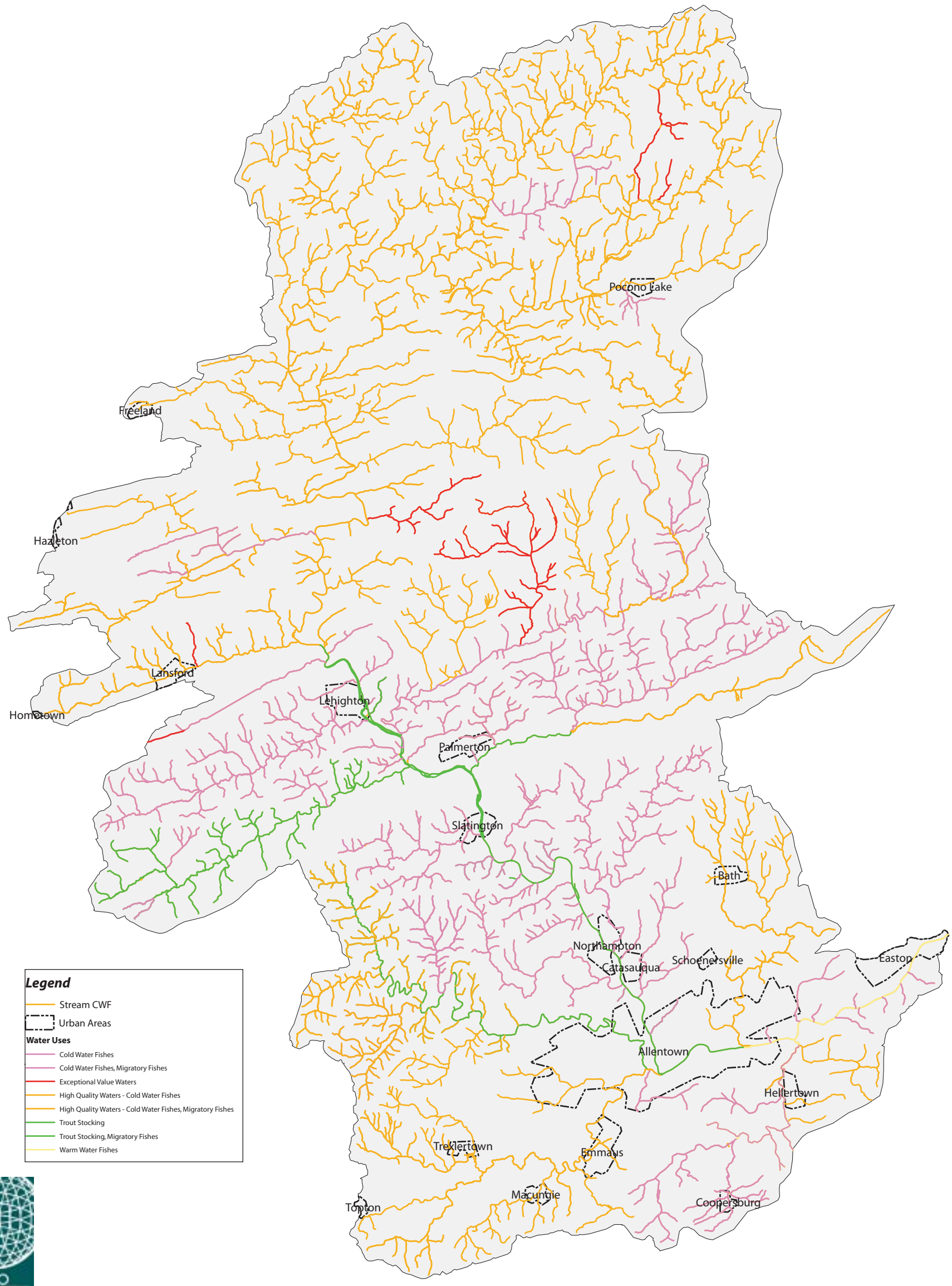
Map 3-5 Protected Water Uses Under Chapter 93 Water Quality Standards
Lehigh River Watershed



Source: 025 Pa. Code ß 93.9d. Drainage List D

0 1.5 3 6 9 12 15 Miles

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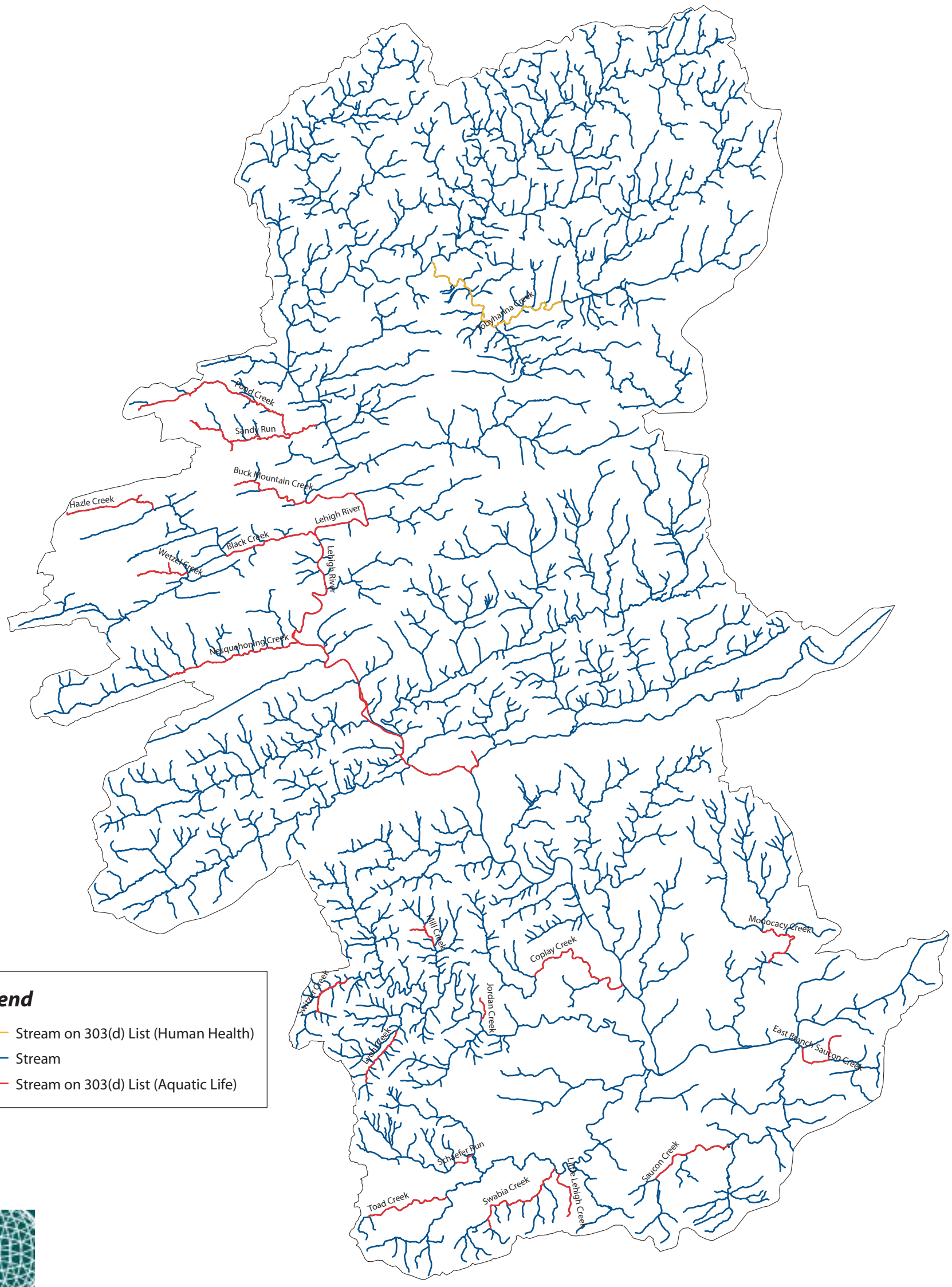
Map 3-6 Streams on 303(d) List
Lehigh River Watershed



Legend

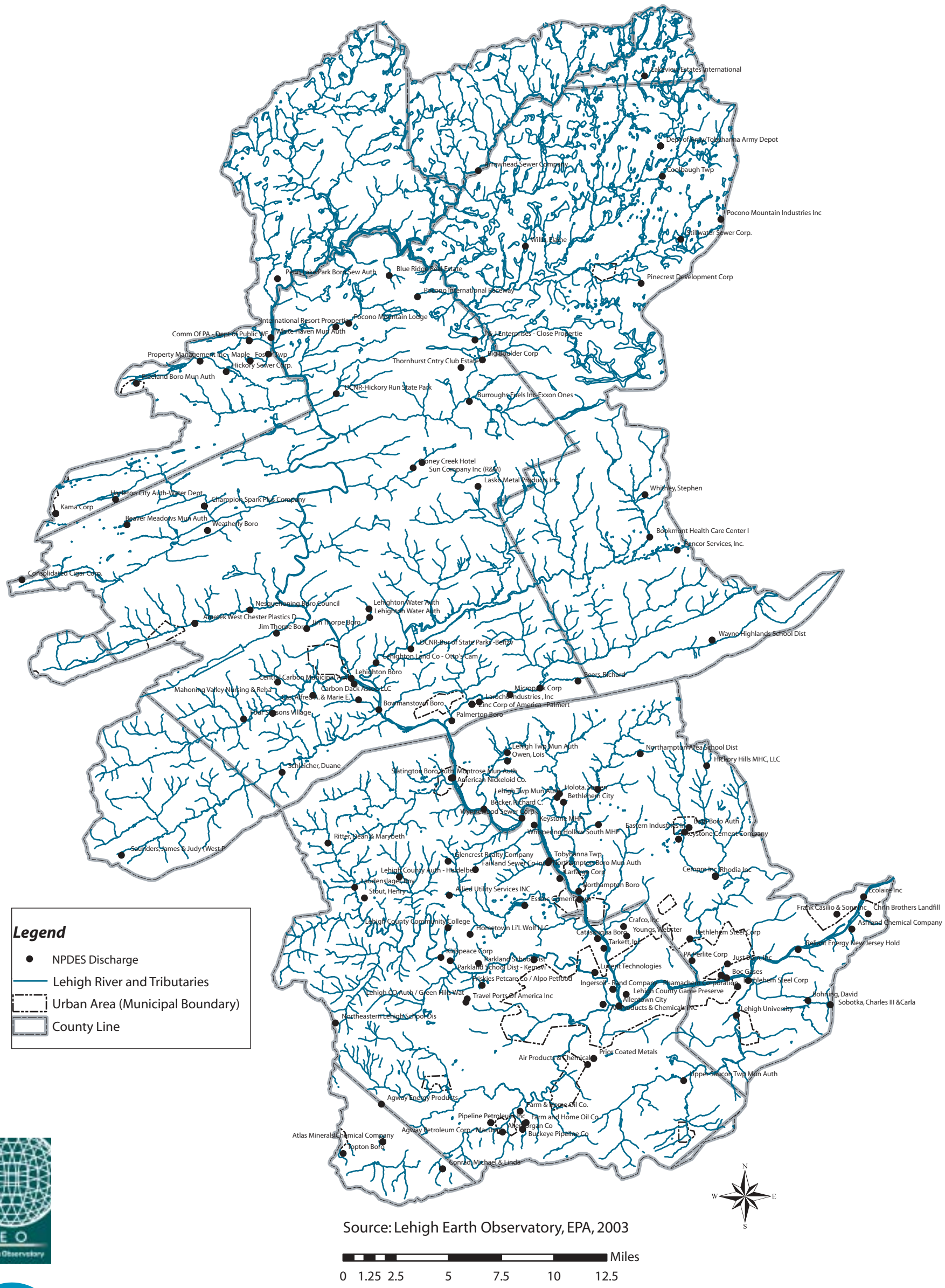
- Stream on 303(d) List (Human Health)
- Stream
- Stream on 303(d) List (Aquatic Life)

Source: Lehigh Earth Observatory, PA DEP 303 (d) report, 2002

Miles

0 1 2 3 4 5

Map 3-7 Location of NPDES Discharges Lehigh River Watershed



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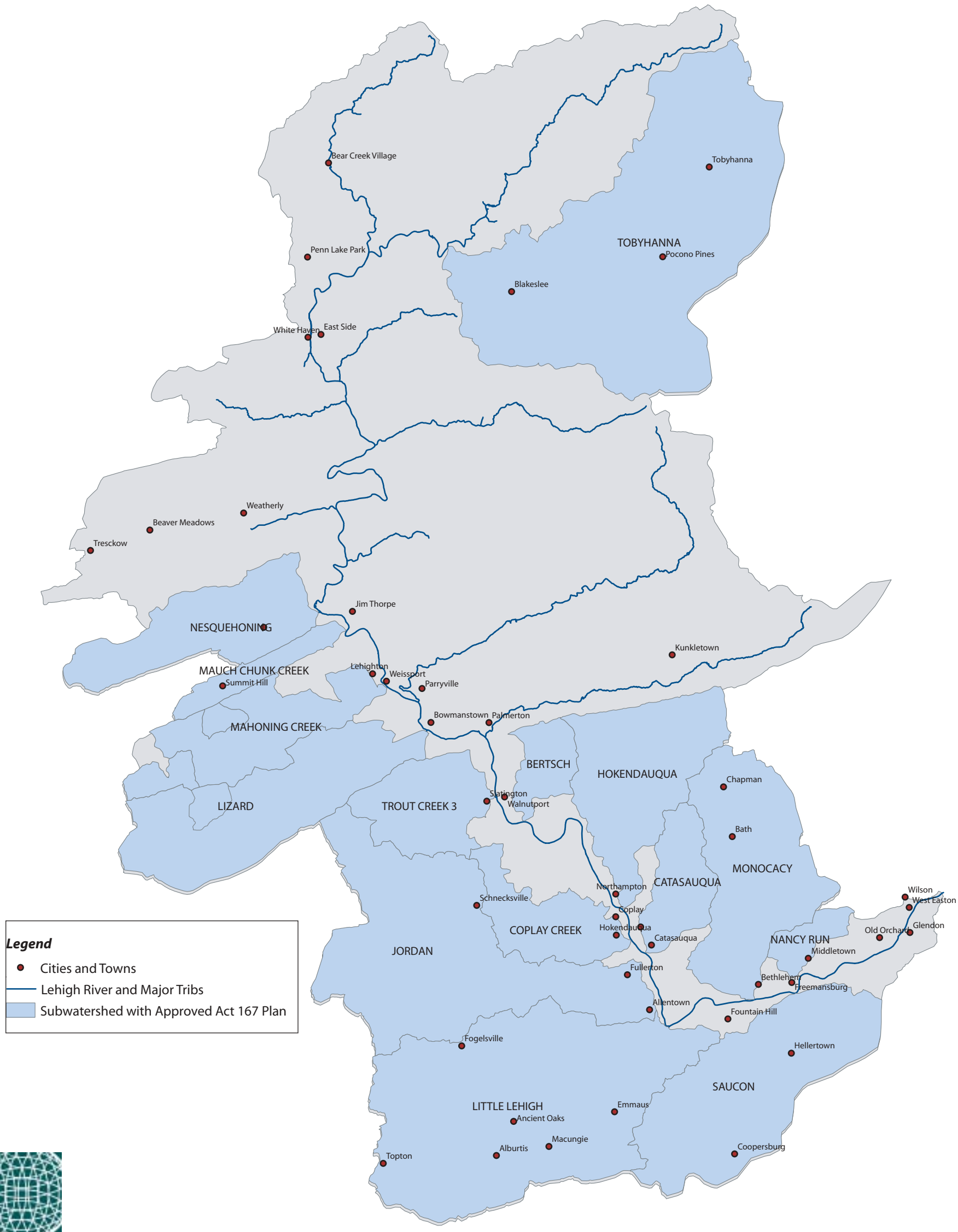
Map 3-8 Subwatersheds with Approved Stormwater Management Plans
Lehigh River Watershed



Source: Lehigh Earth Observatory, PADEP, 2003

Map 3-9 Location of Facilities Listed on the Toxic Release Inventory Lehigh River Watershed

Legend

Lehigh River and Tributaries

Urban Area (Municipal Boundary)

1. A TREAT BOTTLING CO
2. ACME CRYOGENICS INC.
3. ADVANCED ENVIRONMENTAL RECYCLING CO LLC
4. AIR PRODS & CHEMICALS INC. GARDNER CRYOGENICS
5. ALSTOM ENERGY SYS.
6. AMERICAN NATL. CAN CO
7. AMERICAN NICKELOID CO
8. AMETEK WESTCHESTER PLASTICS
9. AMPAL INC
10. APOLLO METALS LTD
11. ASHLAND ACT
12. ASHLAND SPECIALITY CHEMICAL COMPANY
13-16 ATLAS MINERALS & CHEMICALS INC*
17-18 B. BRAUN MEDICAL INC MFG DIV*
19-20 BEATRICE CHEESE INC*
21 BELL AND HOWELL PHILLIPSBURG CO
22-23 BETHLEHEM APPARATUS CO INC*
24-27 BETHLEHEM STEEL CORP STRUCTURAL PRODS DIV*
28-30 BETHLEHEM STEEL CORP STRUCTURAL PRODS CORP METALS OPS*
31 BETHLEHEM STRUCTURAL PRODUCTS COPR COKE DIV
32. BLUE RIDGE PRESSURE CASTINGS INC
33. BOC GASES
34. BONNEY FORGE CORP
35. BRIDESBURG FNDY CO
36-37 BURRON MEDICAL INC*
38. CALORIC CORP
39-40 CARPENTER INSULATION CO INSULATION DIV*
41. CENTEC ROLL CORP
42-49 CHAMPION AVIATION*
50. COCA COLA BOTTLING CO OF LEHIGH VALLEY
51. CONAGRA FLOUR MILLING CO
53. COPLAY CEMENT CO
54. DENT MFG INC
55. DOANE PET CARE CO
56-57 ER CARPENTER CO INC*
58. ELECTRO-SPACE FABRICATORS
60. ENCORE COATINGS INC
61. EXIDE CORP
62. FOAM DESIGN INC
64. FRISKIES PETCARE CO INC
65. G&T INDS OF PA
67 GEO SPECIALITY CHEMICALS TRIMET PROD GRP
68-69 HORSEHEAD RESOURCE DEV CO INC*
70. HOUGHTON INTL INC
71. IMS WAYLITE INC
72. INGERSOLL DRESSER PUMP CO
74 JR PETERS INC
75-76 KAMA CORP*
77. KEYSTONE CEMENT
78. KNOLL GRP
79. KJRAFT FOODS INC
80. LAFARGE CORP WHITEHALL
81. LAROCHE INDS INC
82. LEBANON CHEMICAL CORP
83. LEHIGH CULTURED MARBLE INC
84. LEHIGH HEAVY FORGE CORP
85. LEHIGH VALLEY DAIRIES INC
86. LIFETIME DOORS INC
87. LIQUID CARBONIC
88. LUCENT TECHS INC
89. MA HANNA COLOR
90-91 MACK TRUCKS INC*
92. MANCOR PA INC
93. MINRAD INC
94. OPTOELECTRONICS CENTER
95. PABST BREWING CO
96. PACKAGING CORP OF AMERICA
97. PANTHER CREEK ENERGY FACILITY
98. PENNSYLVANNIA METALURGICAL INC
99. PFIZER PIGMENTS INC
101-102 PHARMACHEM CORP*
103. PHOENIX FORGING CO INC
104. PILLSBURY CO
105. POLYMER DYNAMICS INC
106. PRAXAIR DISTRIBUTION CO INC
107-108 PRINCE MFG CO*
109. PRIOR COATED METALS
110. SPECIALITY BRANDS DURKEE FRENCH PLANT
111. SPIRAX SARCO INC
112. STANLEY STORAGE SYSTEM
113. SYNTHETIC THREAD CO INC
114. TARKETT INC
115. TECHNICAL OIL; PRODS INC
116. TOWER PRODUCTS INC
117. TRI CITY MARBLE INC 130130
118. TYLER PIPE CO
119-124 US ARMY TOBYHANNA ARMY DEPOT*
125. VICTUALIC CO OF AMERICA - ALBURTIS FACILITY
126. VICTOR BALATA BELTING CO
127-134 WAGNER LIGHTING*
135 WEATHERLEY CASTING AND MACHINE CO
136-137 ZINC CORP OF AMERICA*

*indicates more than one listing

Source: Lehigh Earth Observatory, Toxic Release Inventory (TRI) database, maintained by the U.S. Environmental Protection Agency (EPA)

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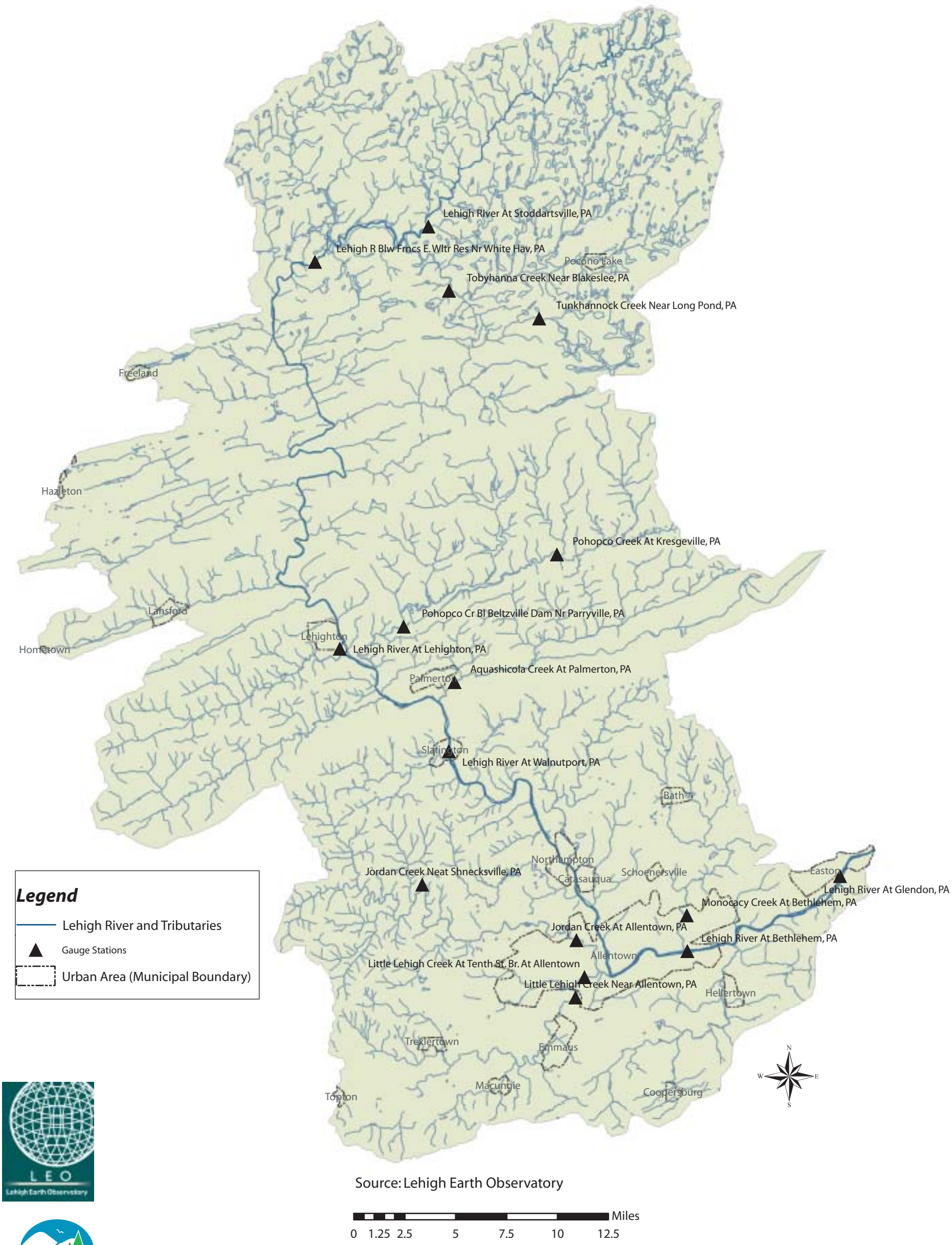
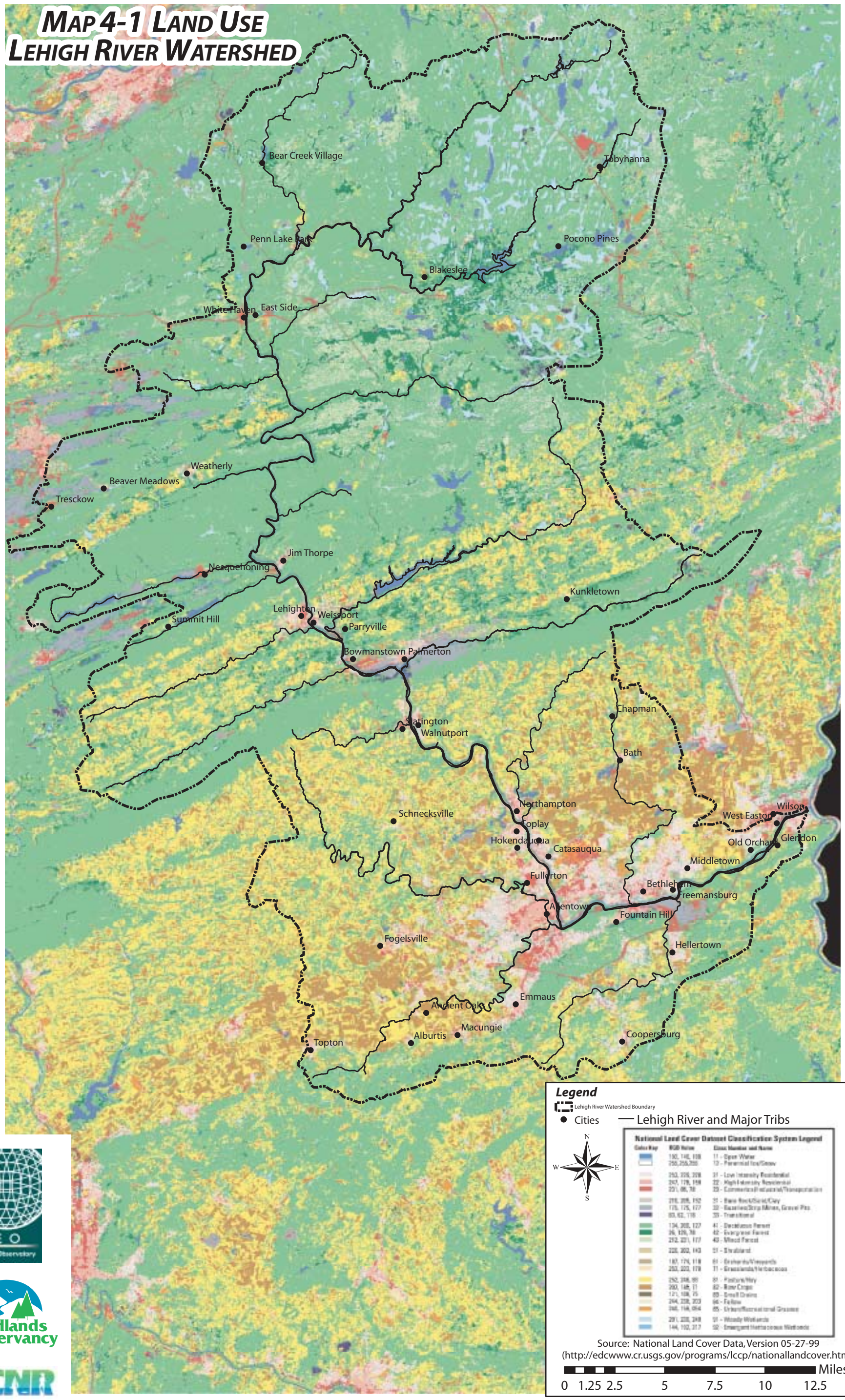
Map 3-10 USGS Stream Gauge Stations
Lehigh River Watershed



Map 4-1 Land Use
Lehigh River Watershed



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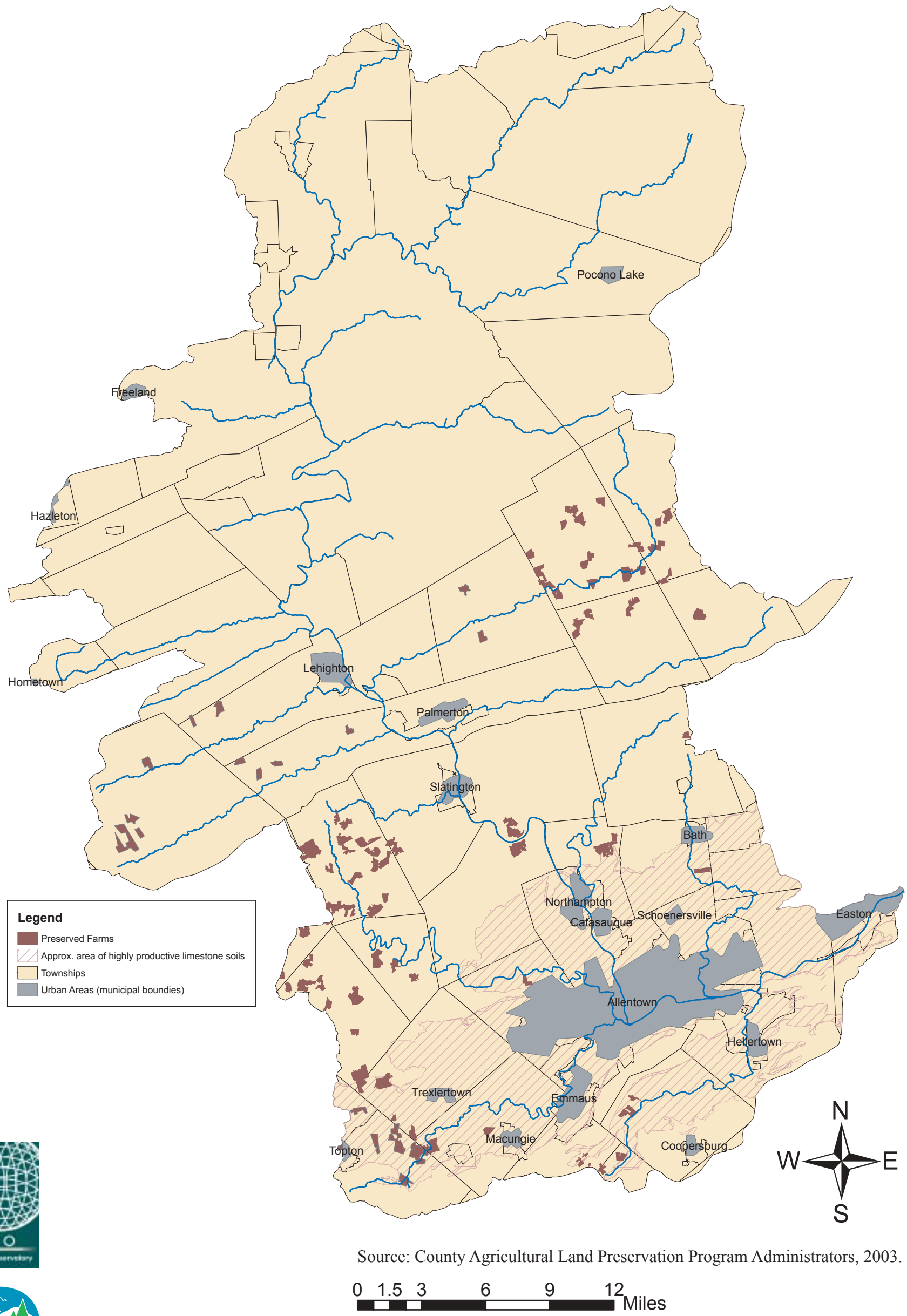
Map 4-2 Preserved Farmland
Lehigh River Watershed



Source: County Agricultural Land Preservation Program Administrators, 2003.

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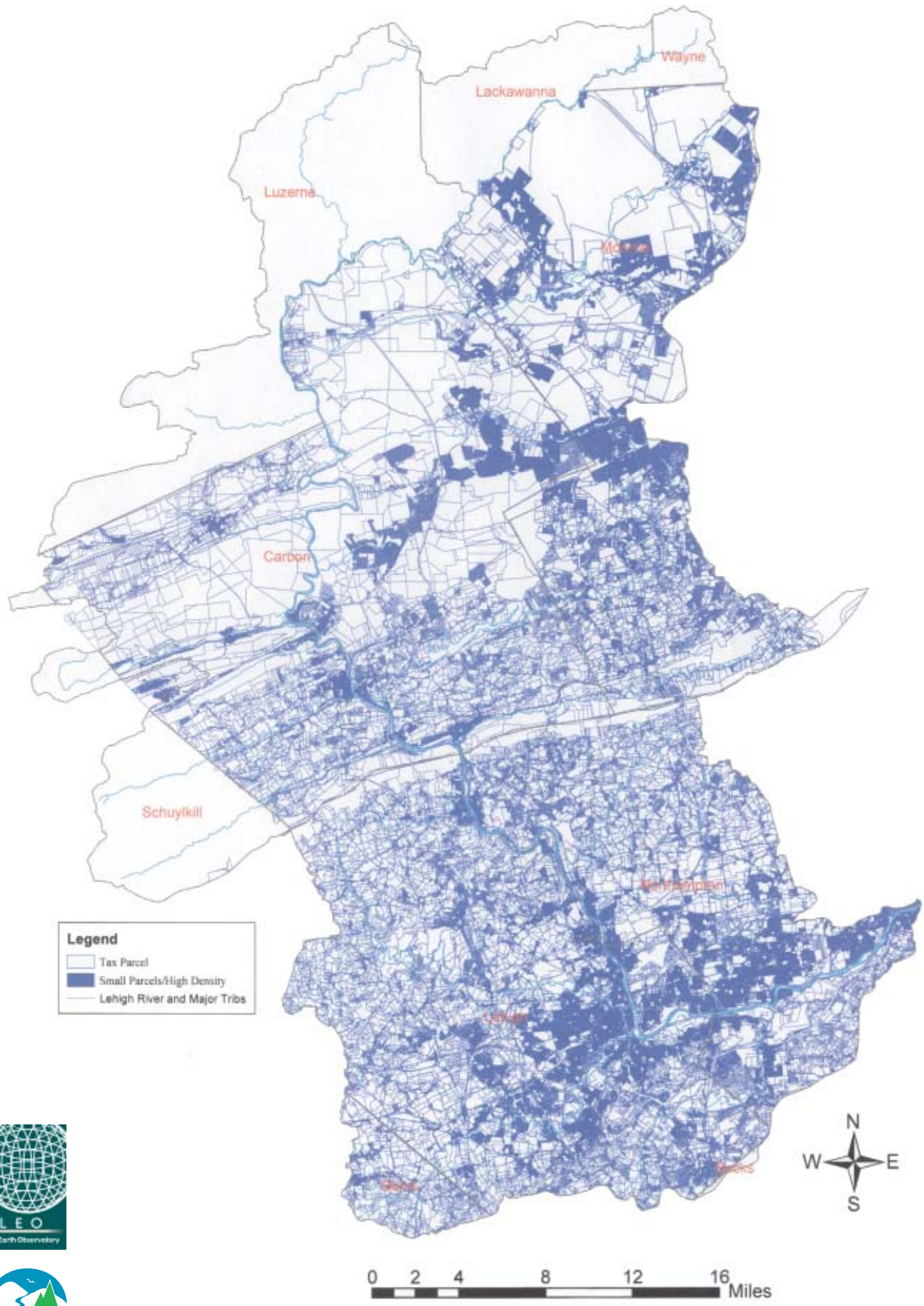
Map 4-3 Parcel Map
Lehigh River Watershed



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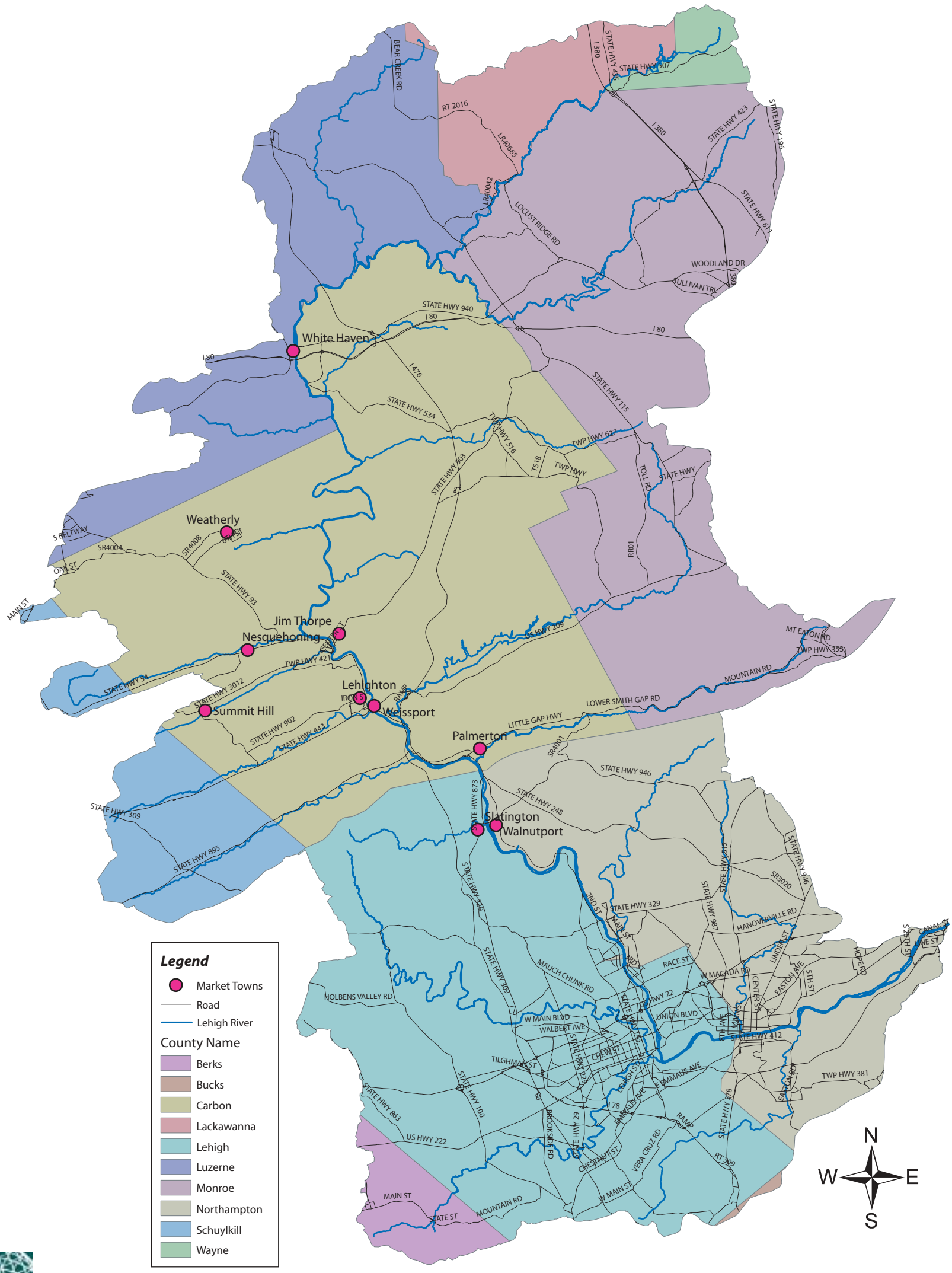
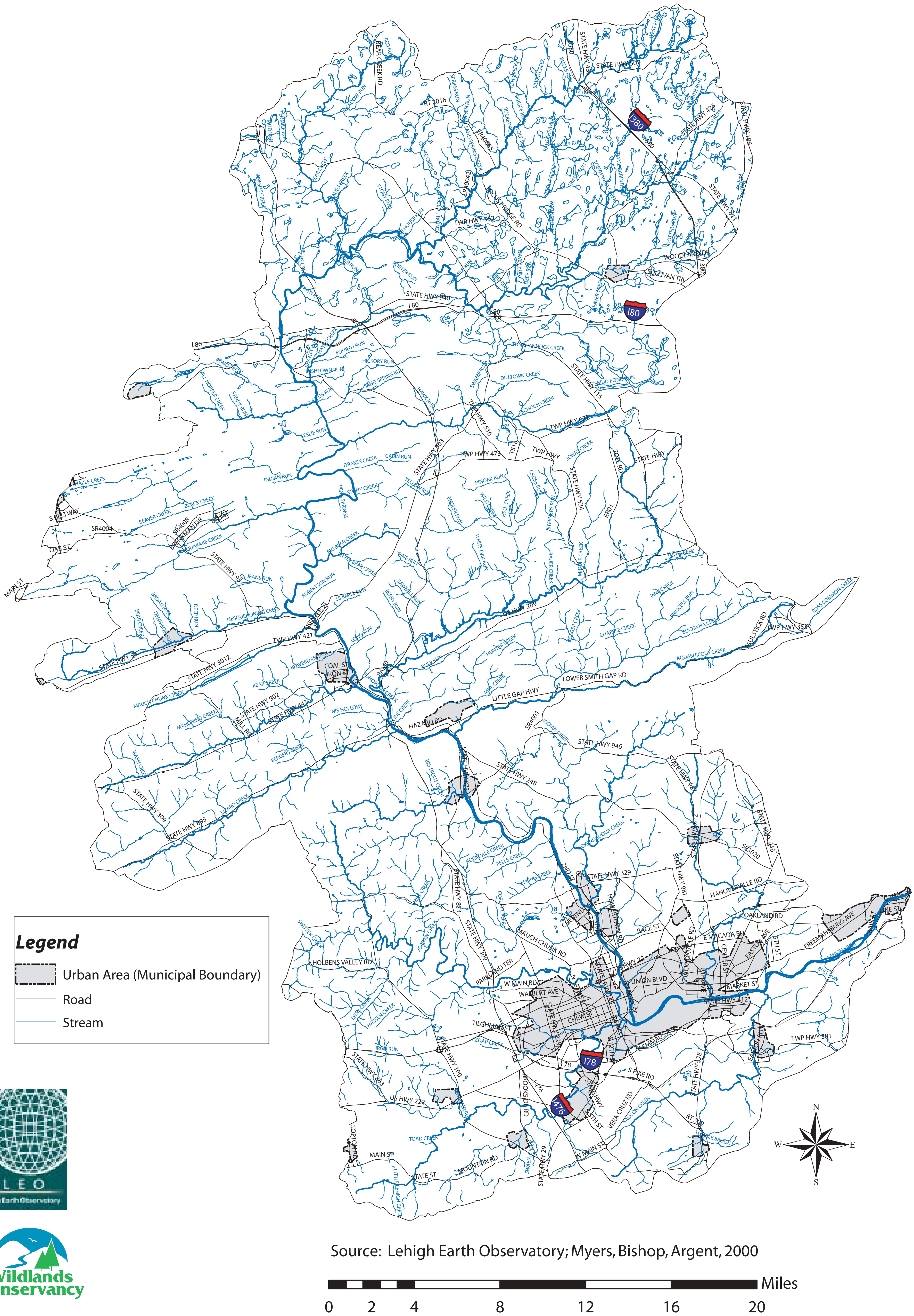
Map 4-4 Market Town Initiative map
Lehigh River Watershed



Source: Delaware and Lehigh National and State Heritage Corridor Commission (D&L)

0 2 4 8 12 16 Miles

Map 4-5 Major Roadways and Streams
Lehigh River Watershed



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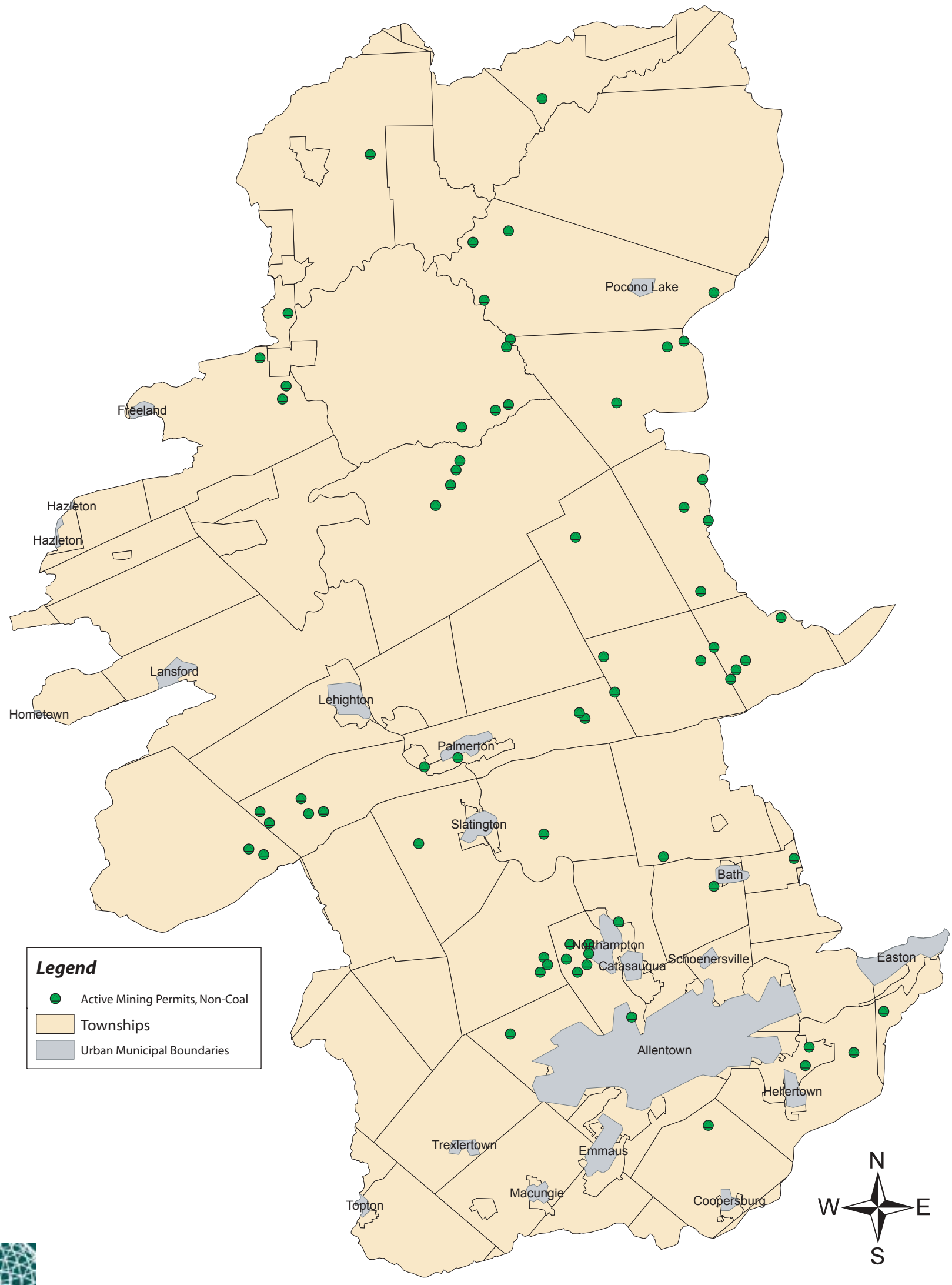
Map 4-6 Non-coal Mining Sites
Lehigh River Watershed



Source: PA DEP, Pottsville District Mining Office, 2003.

0 2.5 5 10 15 20 Miles

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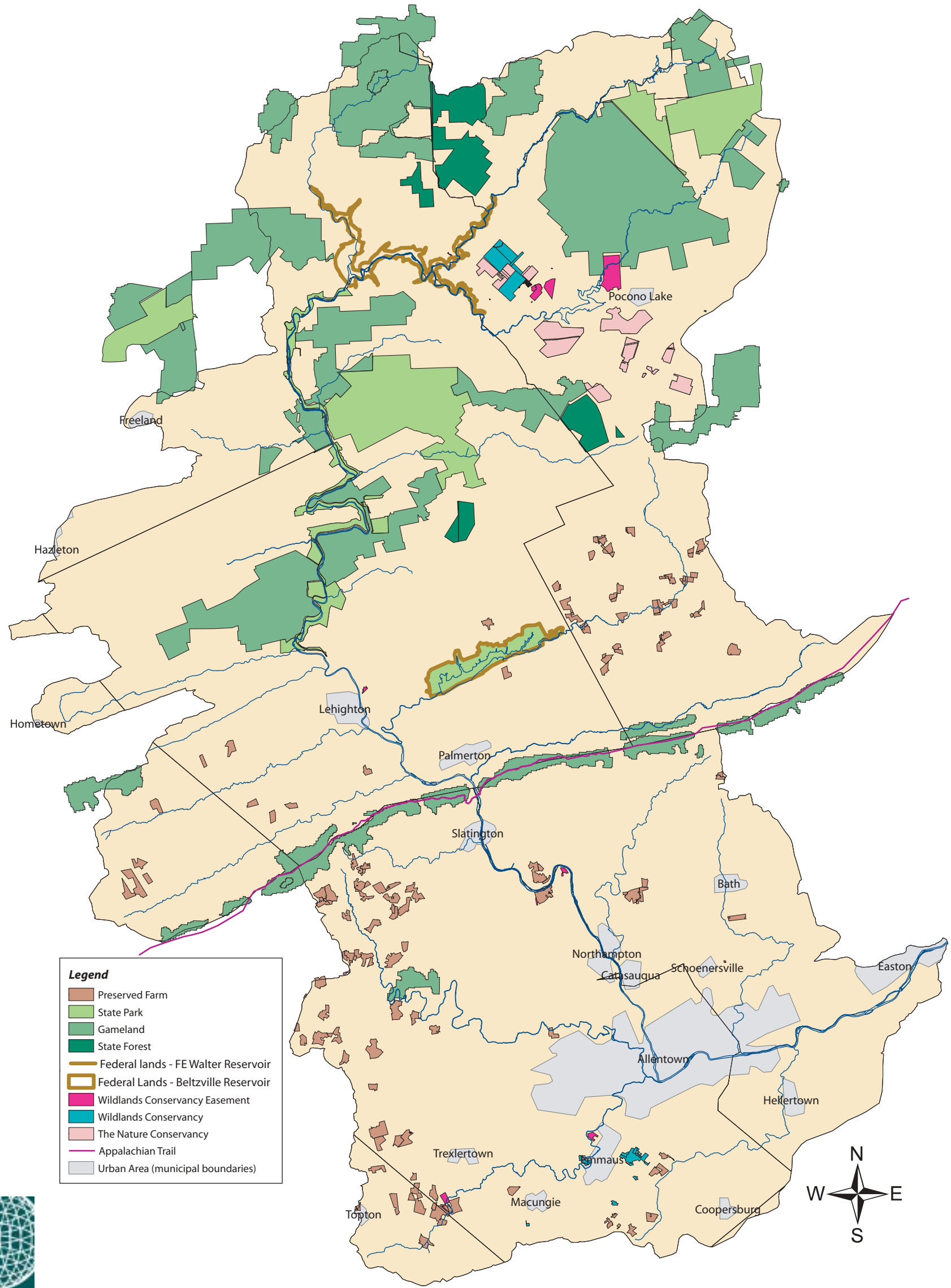
Map 4-7 State Forests, Gamelands, Parks, Preserved Farms and Conservancy Lands

Lehigh River Watershed



Source: Lehigh Earth Observatory, DCNR, USACE, The Nature Conservancy, Wildlands Conservancy, County Agricultural Land Preservation Program Administrators

0 1.5 3 6 9 12 Miles

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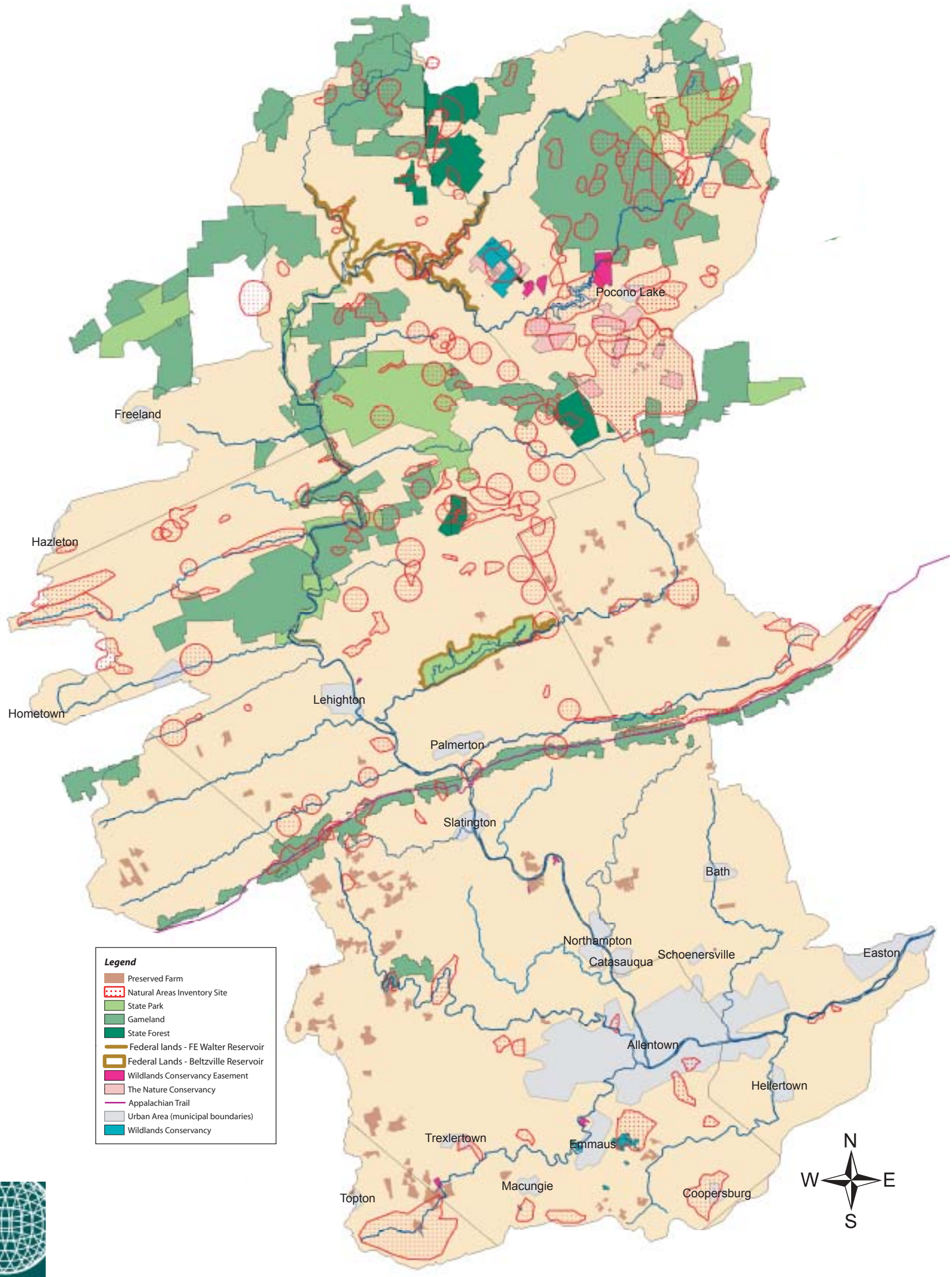
Map 4-8 Natural Areas Inventories in the Counties Lehigh River Watershed



Source: County Natural Areas Inventory Reports
Note: Carbon County field verification of NAIs in progress.

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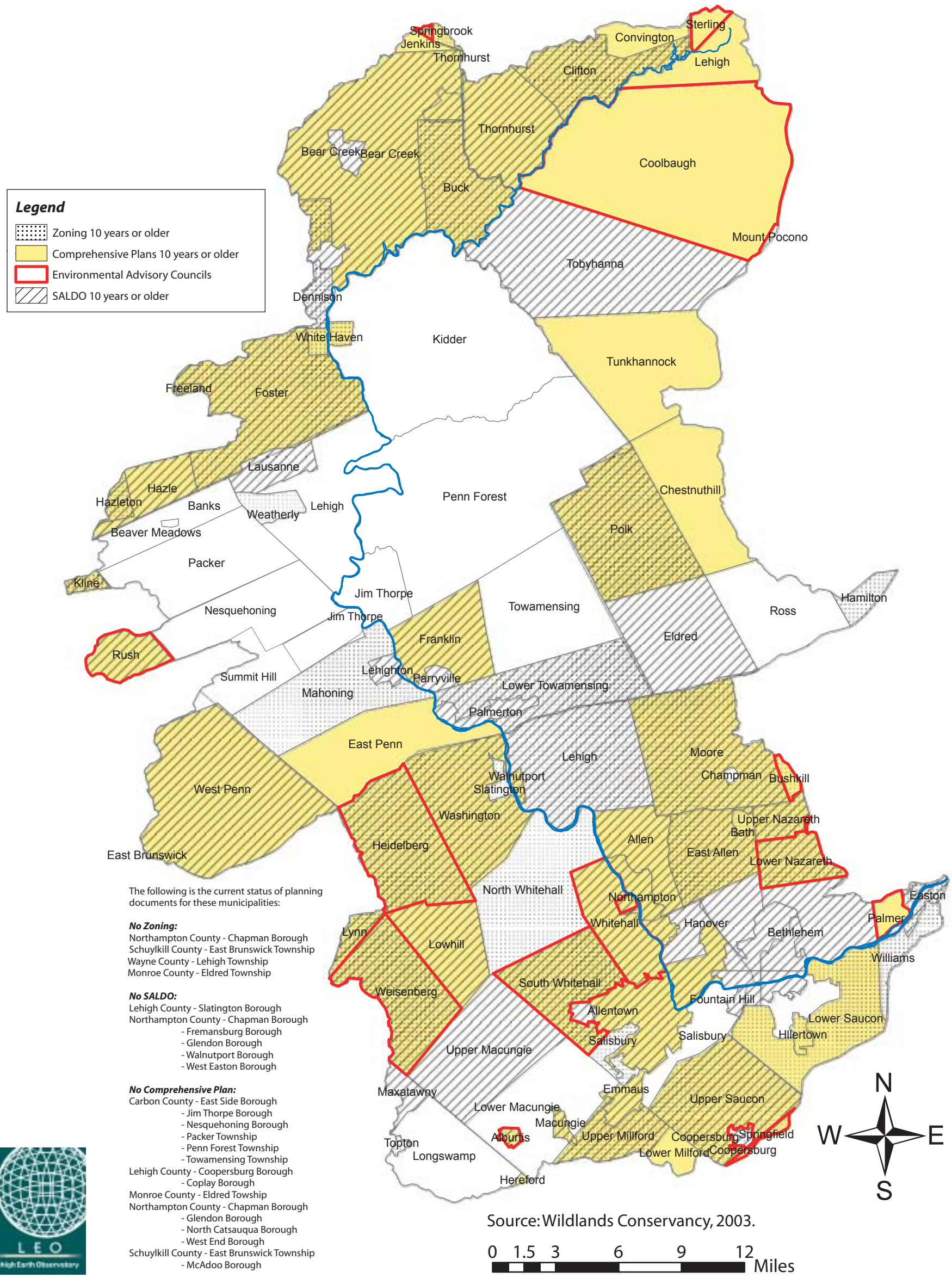
Map 4-9 Status of Municipal Plans and Environmental Advisory Councils
Lehigh River Watershed



The following is the current status of planning documents for these municipalities:

No Zoning:
Northampton County - Chapman Borough
Schuylkill County - East Brunswick Township
Wayne County - Lehigh Township
Monroe County - Eldred Township

No SALDO:
Lehigh County - Slatington Borough
Northampton County - Chapman Borough
- Fremansburg Borough
- Glendon Borough
- Walnutport Borough
- West Easton Borough

No Comprehensive Plan:
Carbon County - East Side Borough
- Jim Thorpe Borough
- Nesquehoning Borough
- Packer Township
- Penn Forest Township
- Towamensing Township

Lehigh County - Coopersburg Borough
- Coplay Borough

Monroe County - Eldred Township
Northampton County - Chapman Borough
- Glendon Borough
- North Catsauqua Borough
- West End Borough

Schuylkill County - East Brunswick Township
- McAdoo Borough

Source: Wildlands Conservancy, 2003.

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Map 5-1 Streams with Forest Buffer
Lehigh River Watershed

Source: Lehigh Earth Observatory

Miles

0 1 2 4 6 8 10

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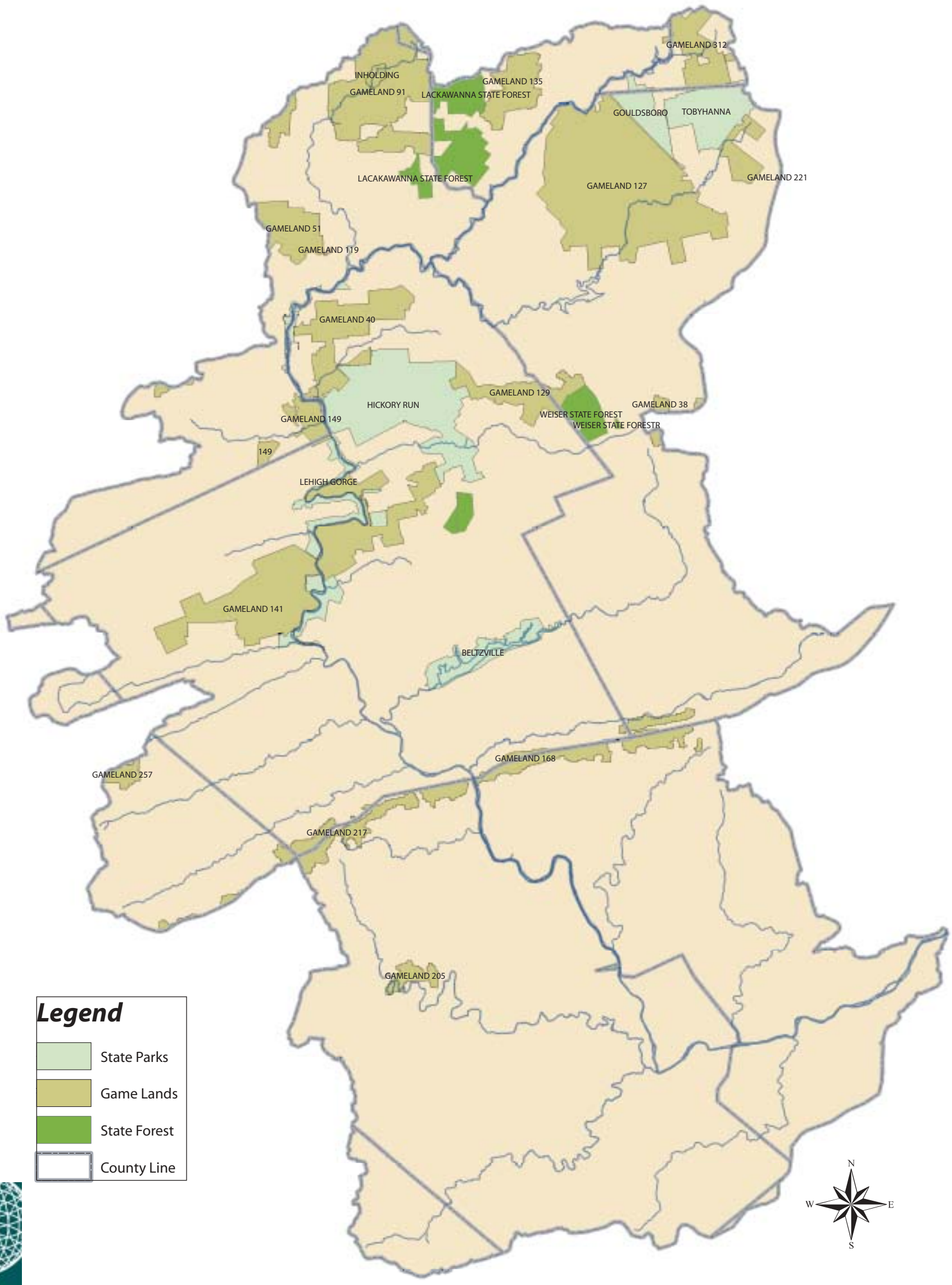
Map 6-1 State Parks, Gamelands, and Forests
Lehigh River Watershed



Source: Lehigh Earth Observatory and DCNR, 2003

Miles
0 1.25 2.5 5 7.5 10 12.5

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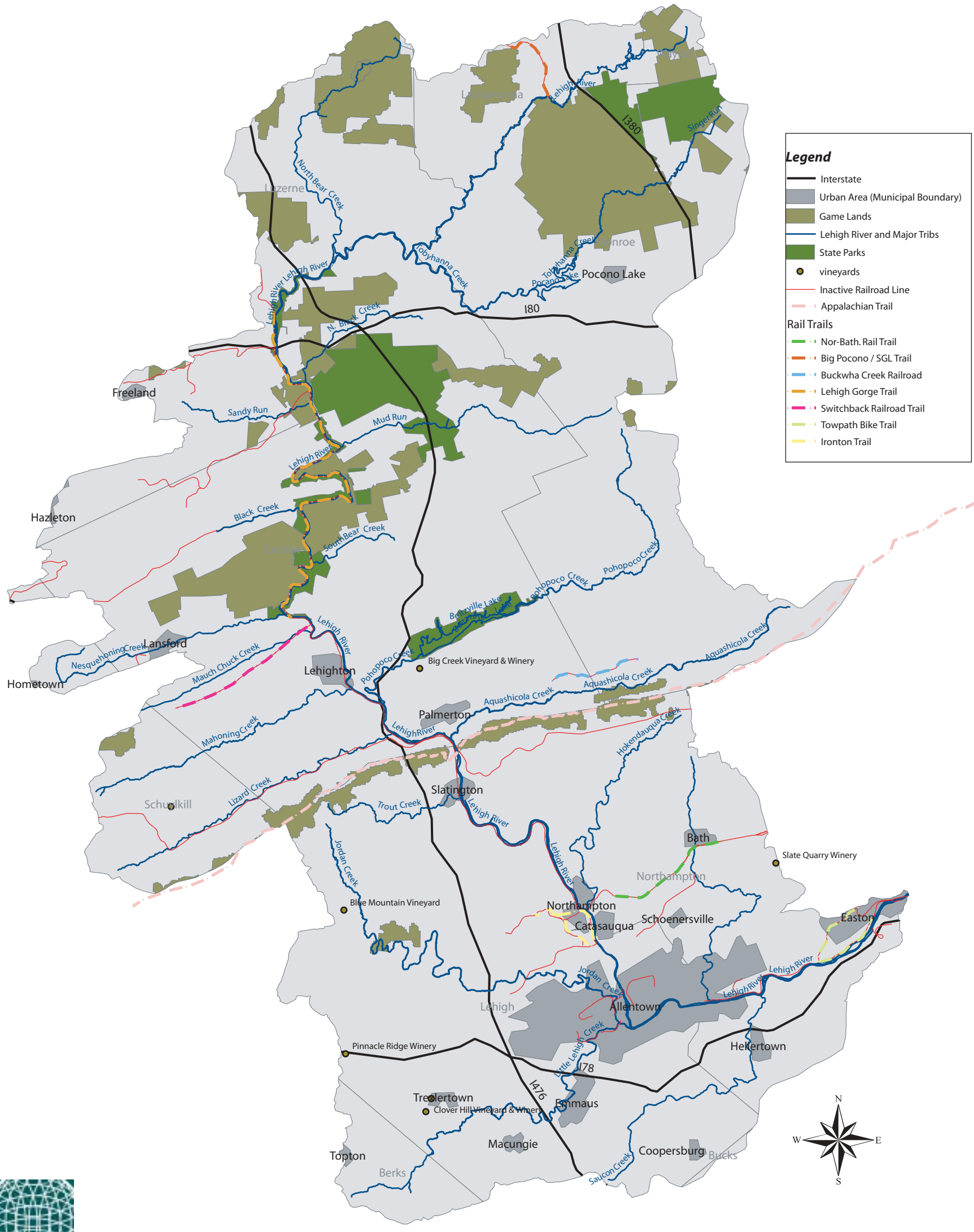
Map 6-2 Vineyards, Appalachian and Rail Trails, and Abandoned Rail Lines
Lehigh River Watershed



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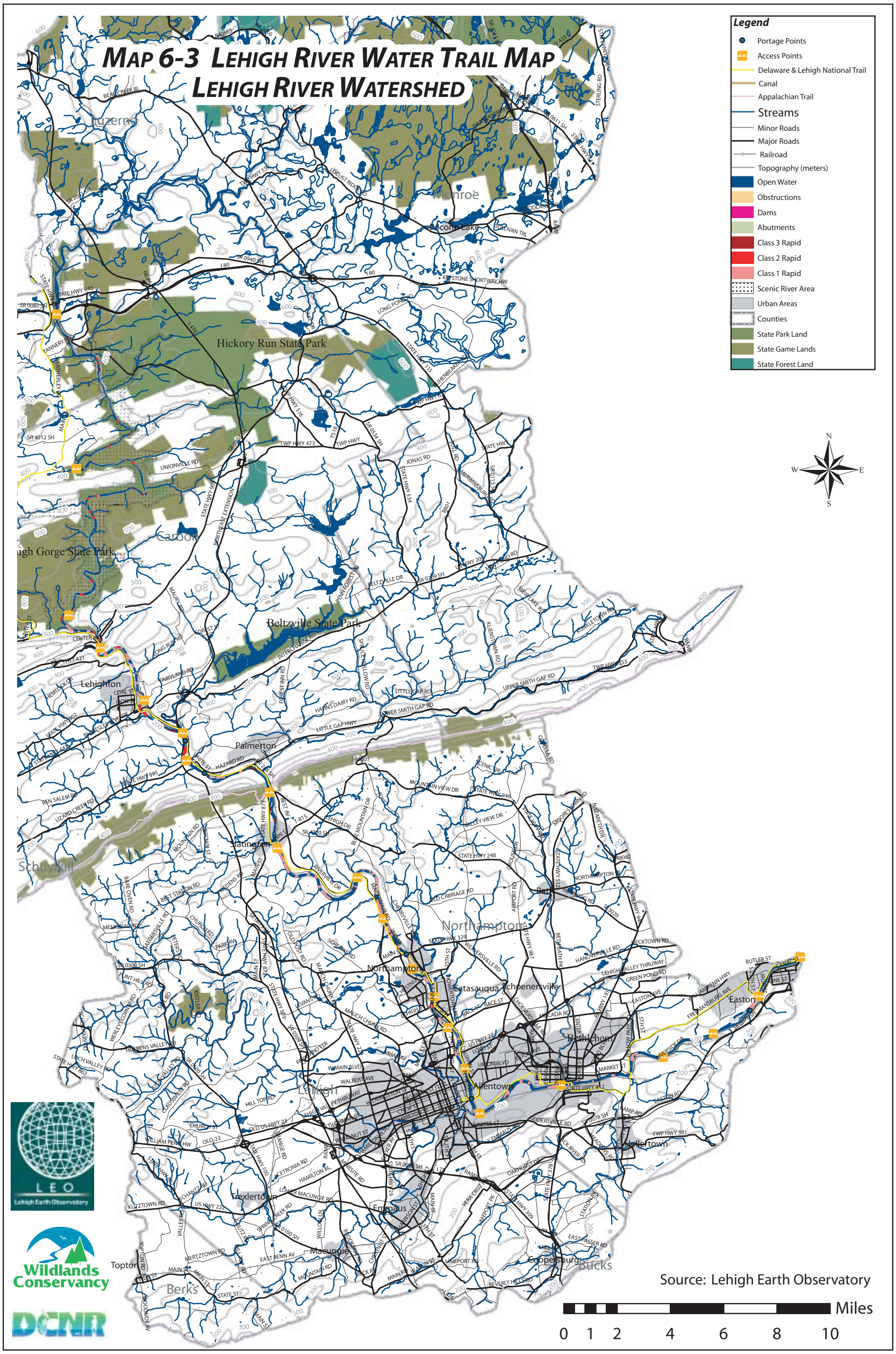
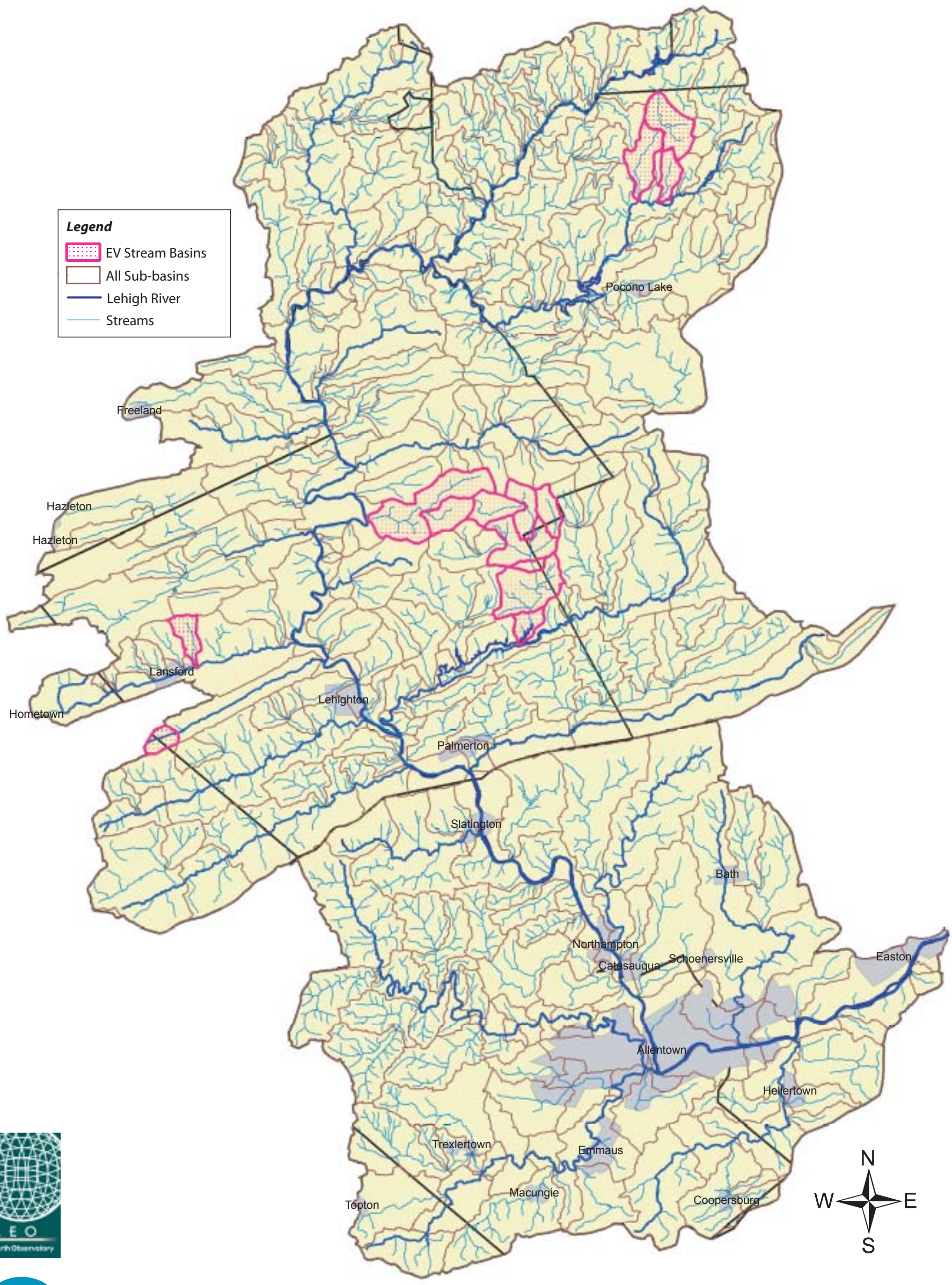

MAP 6-3 LEHIGH RIVER WATER TRAIL MAP
LEHIGH RIVER WATERSHED
Legend
Portage Points
Access Points
Delaware & Lehigh National Trail
Canal
Appalachian Trail
Streams
Minor Roads
Major Roads
Railroad
Topography (meters)
Open Water
Obstructions
Dams
Abutments
Class 3 Rapid
Class 2 Rapid
Class 1 Rapid
Scenic River Area
Urban Areas
Counties
State Park Land
State Game Lands
State Forest Land
N
S
E
W
Luzerne
Monroe
Pocono Lake
Hickory Run State Park
Carbon
Lehigh Gorge State Park
Beltzville State Park
Lehighton
Palmerton
Slatington
Schuylkill
Northampton
Catasauqua
Schoenersville
Bethlehem
Allentown
Easton
Lehigh
Trexlertown
Emmaus
Macungie
Kutztown
Topton
Berks
Bucks
Source: Lehigh Earth Observatory
Miles
0 1 2 4 6 8 10
LEO
Lehigh Earth Observatory
Wildlands Conservancy
DCNR

Map 10-1 Exceptional Value (EV) Stream Basins
Lehigh River Watershed



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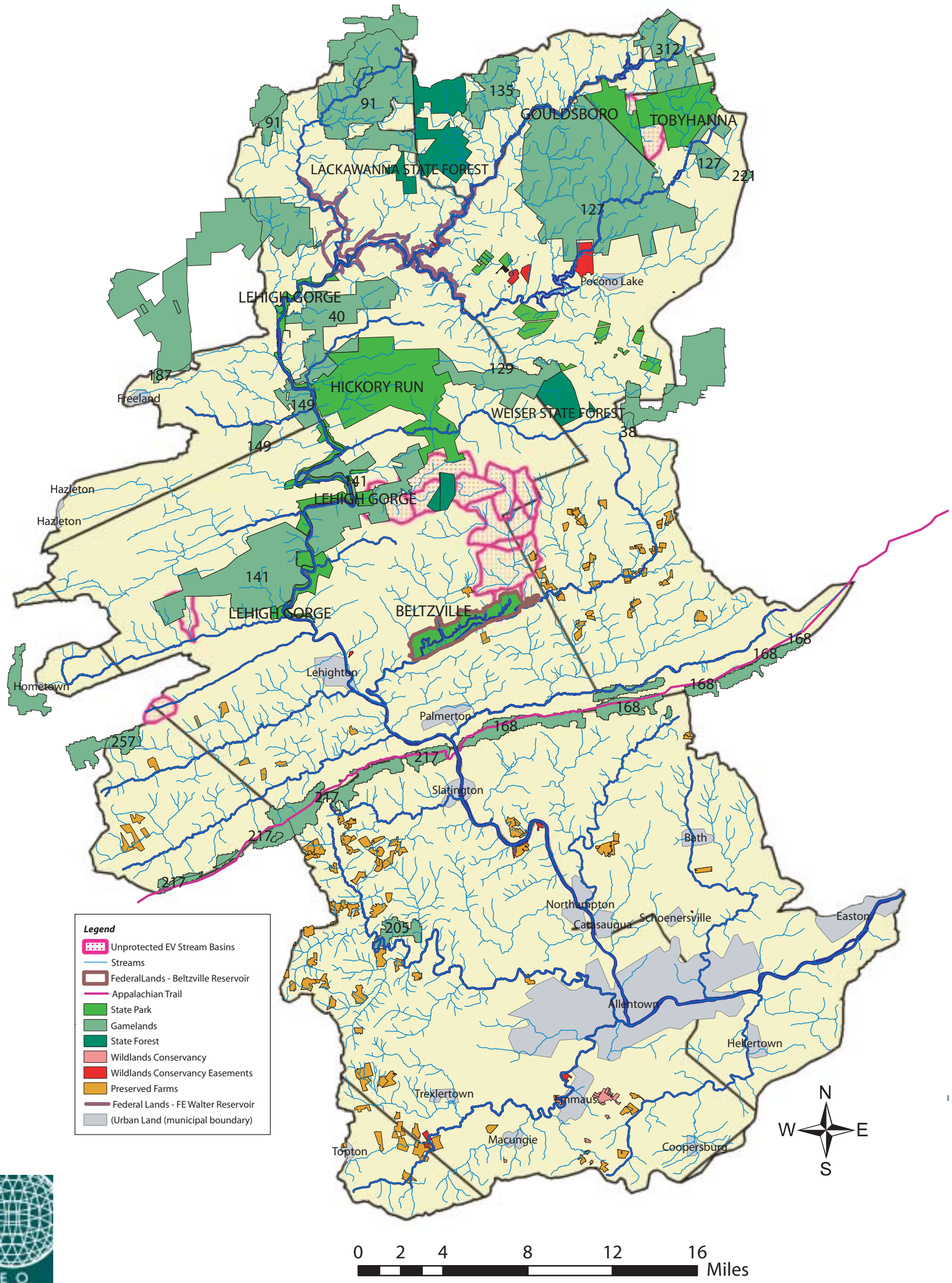
Map 10-2 Priority Lands for Protection - Unprotected Exceptional (EV) Value Stream Basins
Lehigh River Watershed



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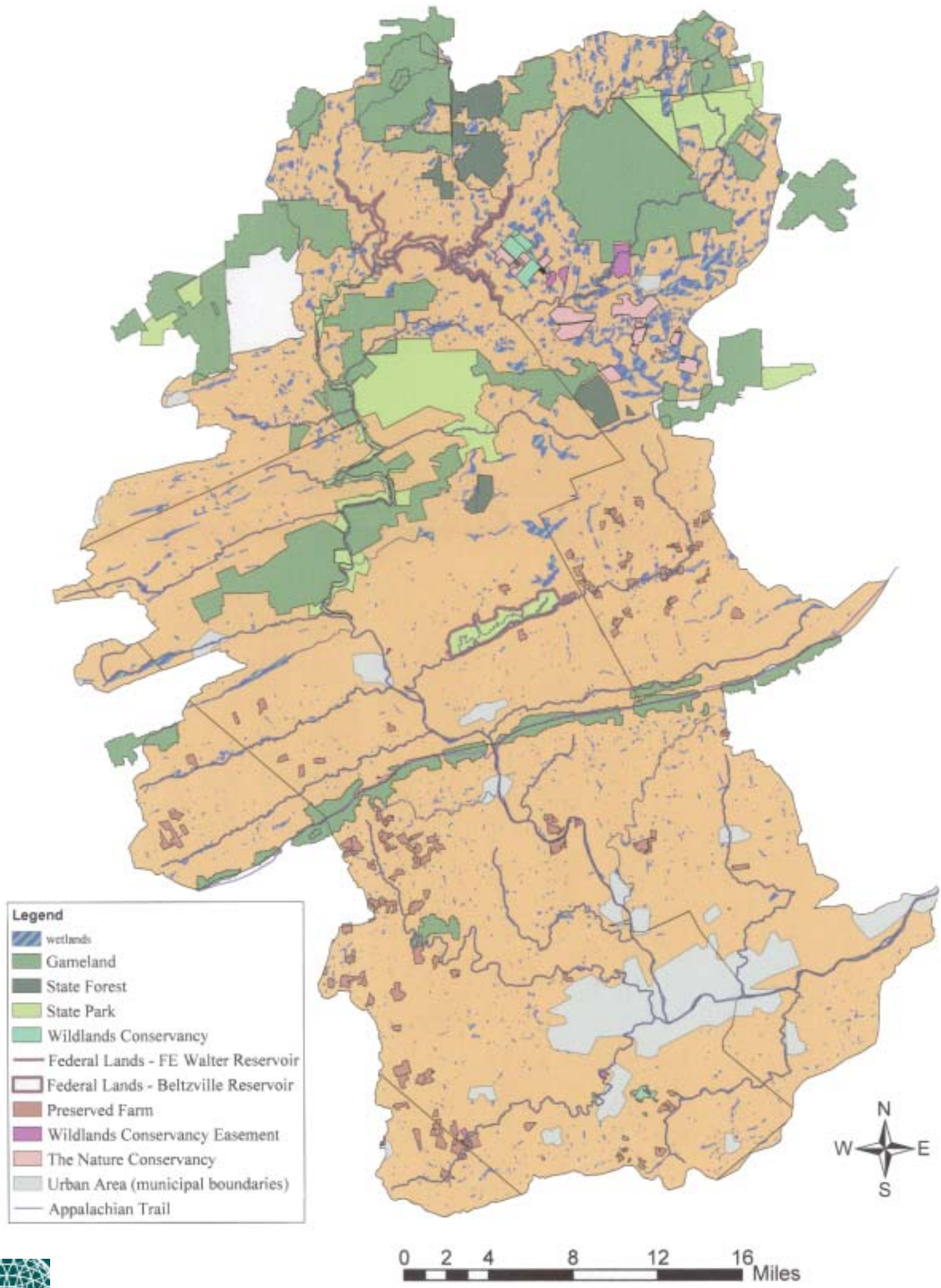
MAP 10-3 PRIORITY LANDS FOR PROTECTION – UNPROTECTED WETLANDS
LEHIGH RIVER WATERSHED



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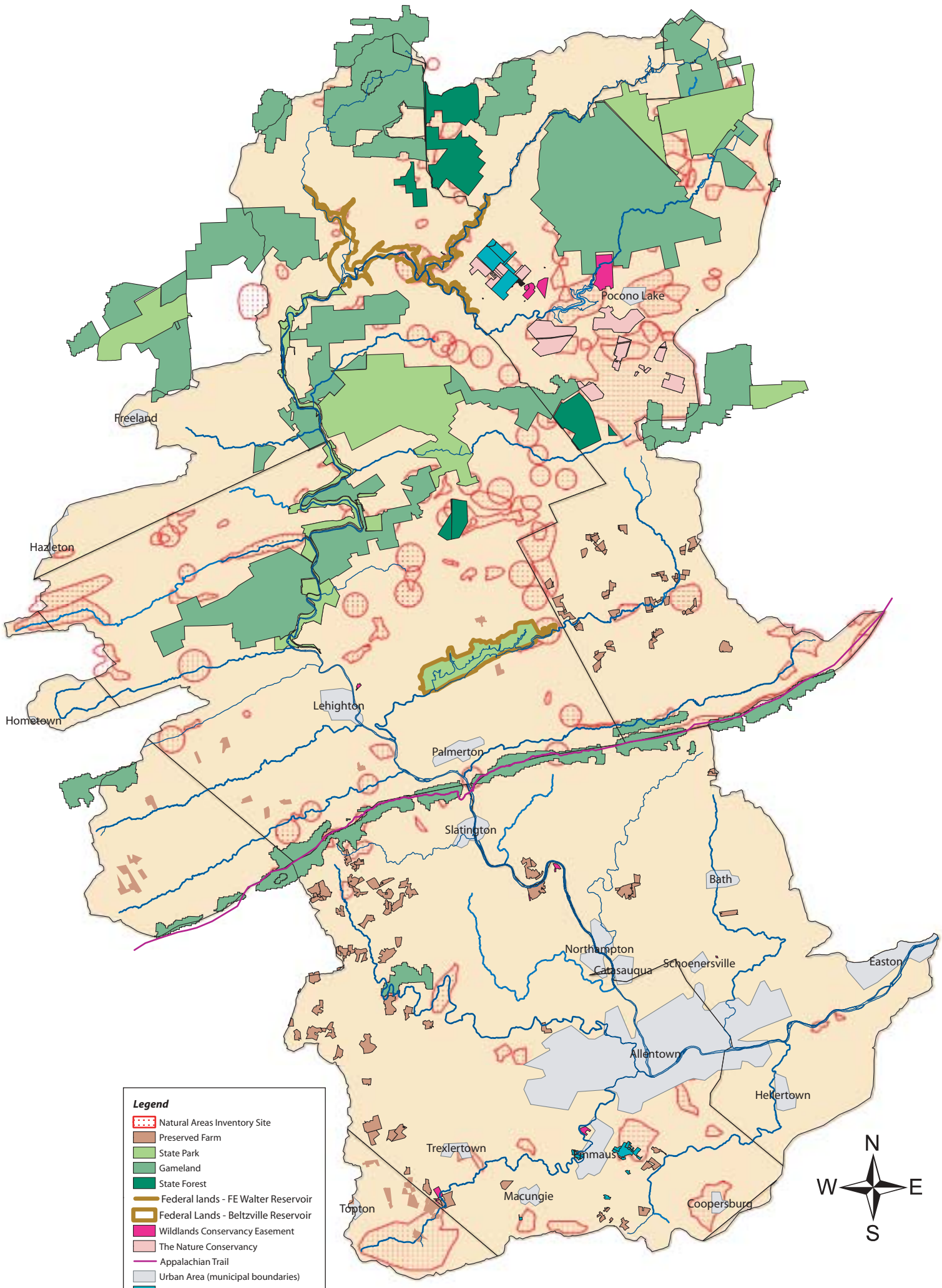
Map 10-4 Priority Lands for Protection – Unprotected Natural Areas Inventory Sites
Lehigh River Watershed



Source: County Natural Areas Inventory Reports
Note: Carbon County field verification of NAIs in progress.

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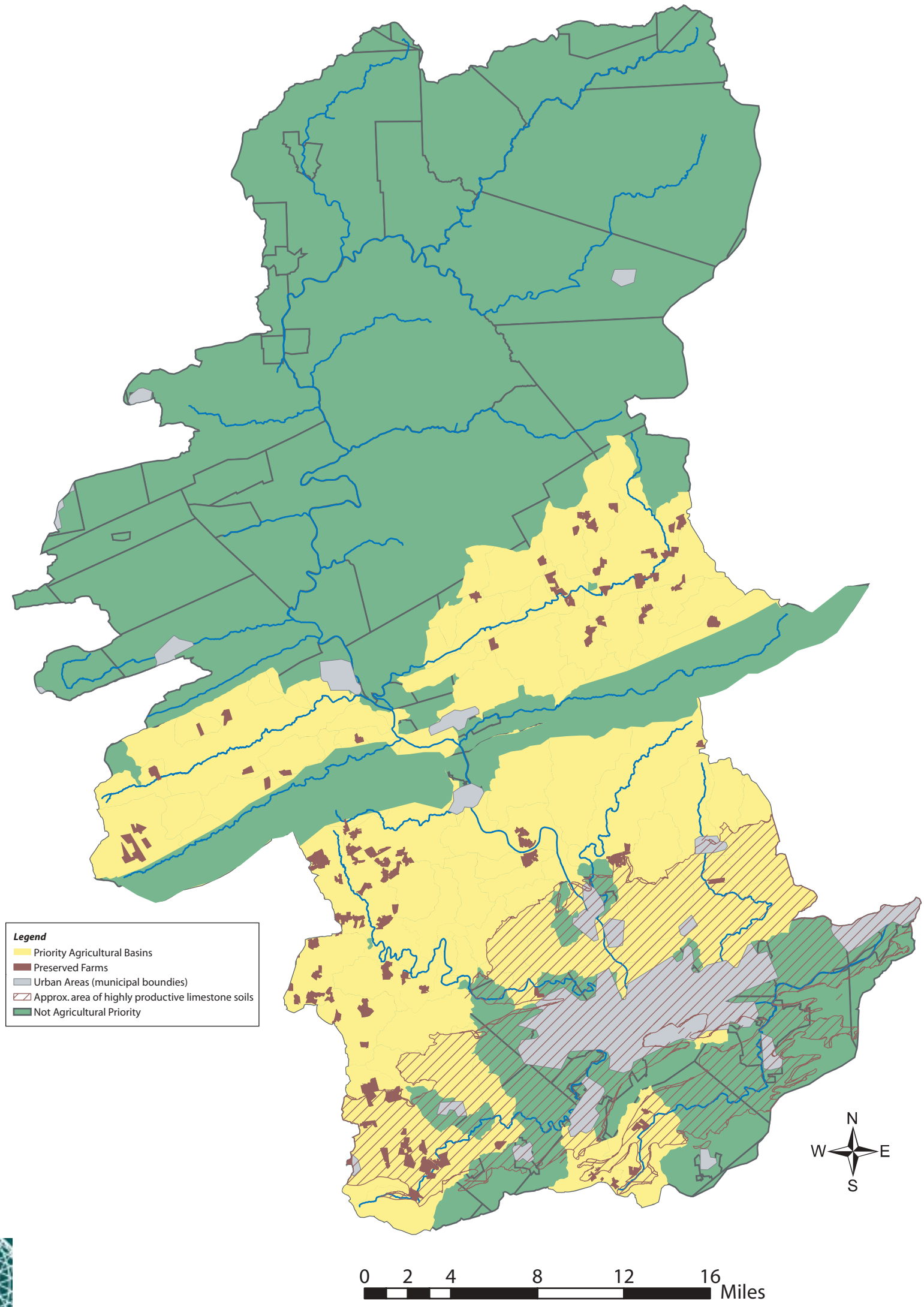
Map 10-5 Priority Lands for Protection – Unprotected Agricultural Basins
Lehigh River Watershed



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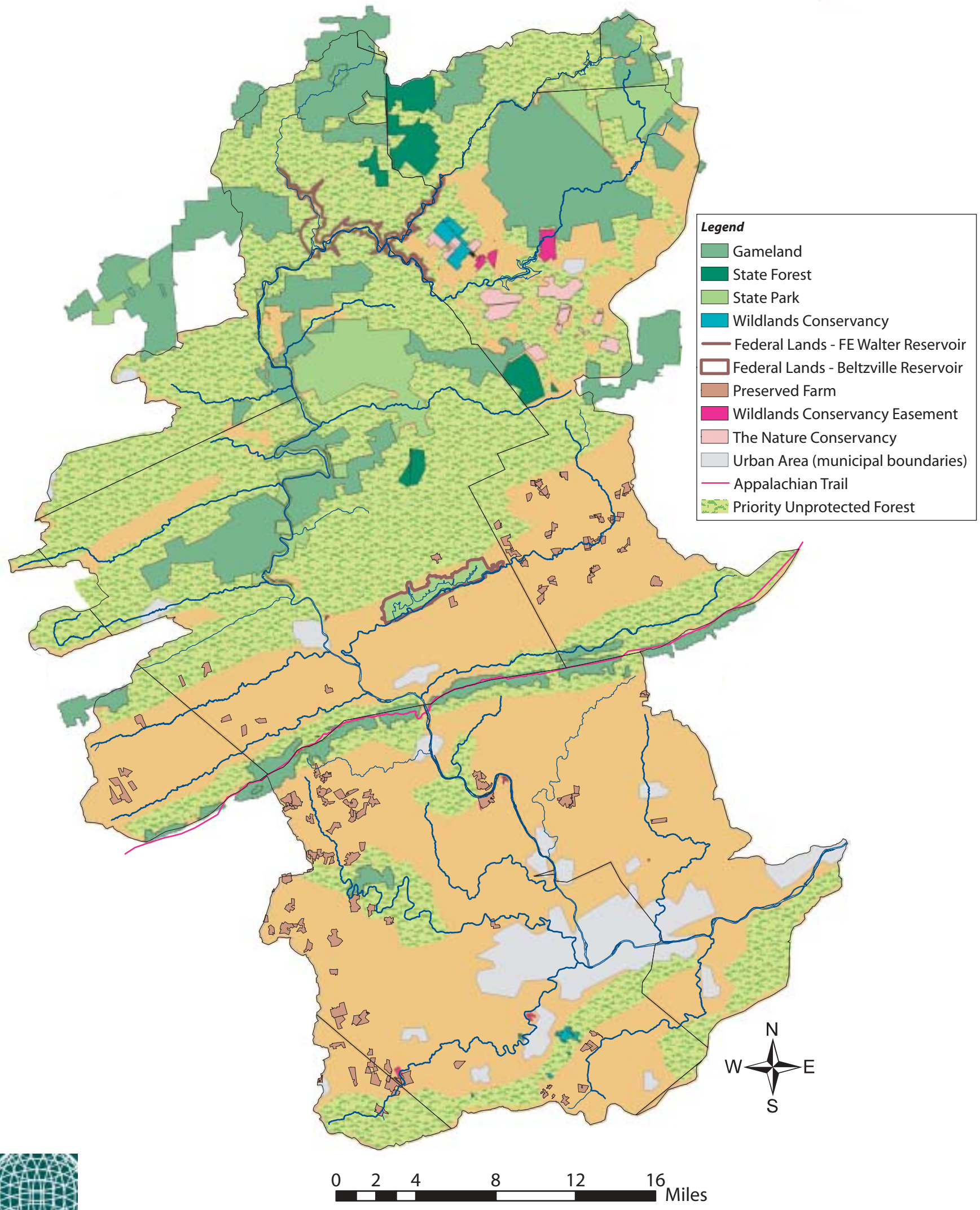
Map 10-6 Priority Lands for Protection – Unprotected Forest LandsLehigh River Watershed



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