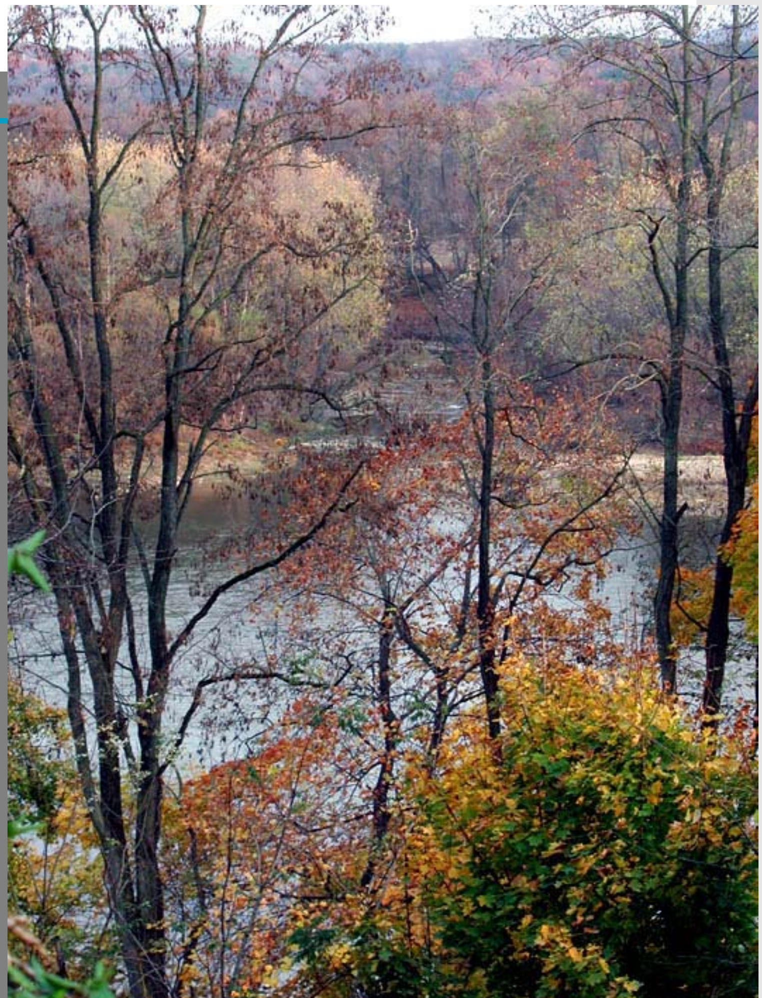
NESCOPECK CREEK WATERSHED STEWARDSHIP REPORT



Center for Watershed Stewardship Keystone Project, Spring 2002
Pennsylvania State University

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Nemo Project, University of Connecticut Cooperative Extension

Introduction

During the 2001-2002 academic semesters, a team of Pennsylvania State University graduate students from the Center for Watershed Stewardship (CWS) at University Park focused their energy and enthusiasm on the dynamics of water, land, and people in the Nescopeck Creek watershed. The watershed assessment report that follows is the result of the study and analysis of the history and culture, land, water quality, economic development, and biological resources of the watershed.

This report was developed as part of a two-year watershed stewardship graduate studies program. The core of this program is a two-semester practicum where students work in a selected watershed with community, government, and business leaders to identify and analyze natural resource problems and creatively synthesize appropriate solutions in the form of a watershed stewardship plan. The student practicum, called the Keystone Project, provides an applied educational experience for students enrolled in one of five graduate degree programs at Penn State (Forest Resources, Landscape Architecture, Wildlife and Fisheries Science, Environmental Pollution Control, and Ecology). The Keystone Project carries out the University's service mission to citizens and communities of the Commonwealth by providing pre-professional services of graduate students and the commitment of CWS faculty time and other resources while accomplishing the academic goal of the education and training of students in community-based watershed stewardship.

The Nescopeck Creek watershed was chosen from 18 applicant Pennsylvania watersheds to become one of two 2001-2002 Keystone Projects based on its potential educational value for students, its nature and scope, the degree of community participation, the likelihood of leveraging other local, state, or federal resources, and the potential constructive effect of the student team on the local community. The sponsoring organization, the Friends of the Nescopeck and other community stakeholders, proposed the following primary goals and objectives for the Keystone Project:

Primary Project Objectives

· Characterize and evaluate the environmental and cultural facets of the watershed. Examine problems and opportunities and affirm goals and objectives identified through stakeholder involvement in the watershed planning process.

· Generate a Watershed Stewardship Plan of organizational strategies and actions recommended for completion through community partnerships, and build upon the Wildlands Conservancy's Little Nescopeck Creek Watershed Management Plan (2000) so that the two plans can be merged into a well-integrated approach for the entire watershed.

Project Objectives: Assessment and Analysis Phase

· Relate the cultural development of the watershed to the use of natural resources within the watershed.

· Conduct a comprehensive assessment and analysis of the natural resources of the watershed including: fisheries resources, aquatic ecology, recreational opportunities, sensitive natural areas, streamside areas, stream habitat conditions, and polluted runoff impacts on water quality.

· Review existing municipal land use and development ordinances and comprehensive plans for consistency related to water resources, open space, and protection of environmentally sensitive areas.

· Join with community partners in supporting community meetings to communicate project objectives and gain stakeholder input on priority issues.

· Generate a Geographic Information Systems (GIS) database of resource information and thematic data from various sources and specific assessment information generated by the Keystone team.

Project Objectives: Management Strategies Phase

· Identify and evaluate management strategies, means of implementation, and potential funding to address watershed stewardship goals and resource protection needs.

· Produce a watershed stewardship plan in printed and digital format that could be made available to the watershed community and other organizations.

The Nescopeck Creek Keystone Project team comprised the graduate students and CWS faculty listed below. Beneath each student's name is the graduate degree program in which he or she is enrolled.

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The Nescopeck Creek Keystone Project Team
University Park, PA
May 10, 2002

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Executive Summary

Project Background

This document is the product of a "Keystone Project" conducted over two semesters by graduate students in the Center for Watershed Stewardship at the Pennsylvania State University, University Park. A Keystone Project is an interdisciplinary educational opportunity that provides students with real world experience in coordinating an environmental assessment of a watershed. During this process, students interact with community-based sponsors, various natural resource and agricultural agencies, concerned citizens, and local municipality officials. Seven graduate students from the School of Forest Resources and Department of Landscape Architecture participated in the project.

The objectives of this project were to conduct a comprehensive assessment of the cultural and physical landscape of the Nescopeck Creek watershed, identify key issues confronting residents of the watershed based upon the assessment findings, and to formulate goals, recommendations, and strategies for managing, protecting, and restoring the natural resources within the watershed. Primary sponsors of the project were a local community group, the Friends of the Nescopeck, and the Pennsylvania State University, Hazleton.

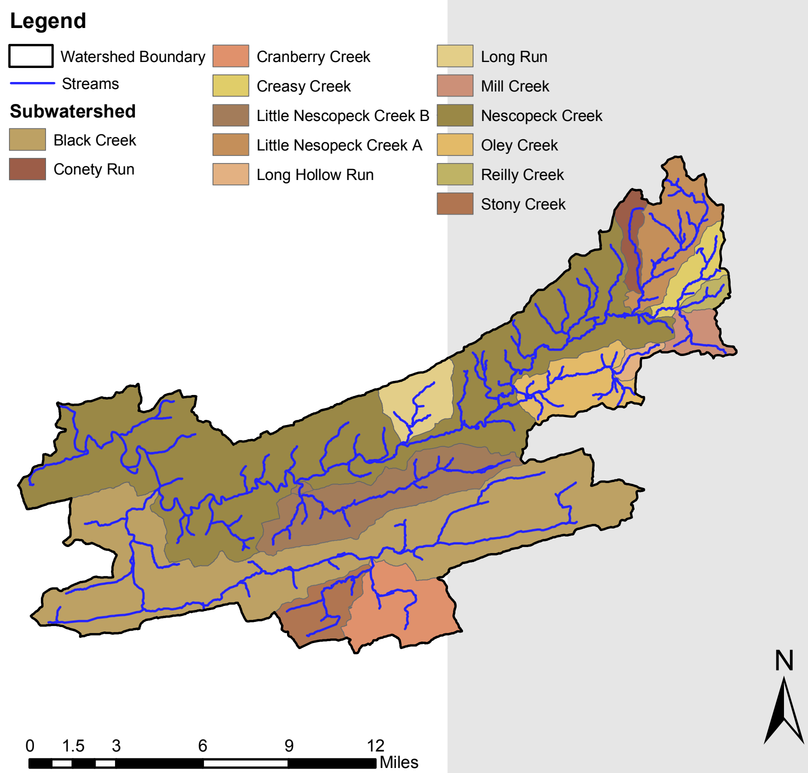

Figure i Named sub-watersheds in the Nescopeck Creek watershed.

Assessment

Setting

Nescopeck Creek is situated in the Ridge and Valley physiographic province in the northeastern region of Pennsylvania. It is characterized by flat, fertile valleys and steep, rugged ridges. The watershed boundary of Nescopeck Creek covers over 170 mi^2 of forest, agricultural, and developed land and has over 200 miles of named and unnamed streams. Major tributaries in the watershed include Black Creek, Little Nescopeck Creek, Oley Creek, Creasy Creek, and Long Run. Nescopeck Creek is also located in the heart of eastern Pennsylvania's anthracite coal region (Figure i).

The Cultural Landscape

William Penn, who had begun the widespread expansion of European settlements in the region, introduced the many changes that would drastically alter the face of the region and the Nescopeck Creek watershed.

Coal Breaker at Eckley Miners' Village.(Source: Project Team)

Main channel of the Black Creek. (Source: Project Team)

View of the Sugarloaf Valley. (Source: Project Team)

Prior to these settlements, Native American tribes such as the Lenni Lenape and other tribes of the Iroquois nations inhabited the Nescopeck Creek watershed. Native Americans derived sustenance from the dense forests, streams, and abundant wildlife. European settlers, with warrants purchased from the Penn family, used existing Native American trails to explore and settle the region beginning in the early 1700s. These trails were also the sites of numerous skirmishes between encroaching settlers and resident Native Americans. The Lehigh Path, the site of the Sugarloaf Massacre where members of the Seneca nation ambushed a detachment of soldiers in 1780, was a major transportation route through the watershed and beyond.

Rivers and streams were the primary modes of transportation in the early days of European settlement. Their banks and floodplains served as fertile lands for agricultural development. The streams also helped power timber and gristmills with the first mill built in the watershed by 1788. Forests of oak, chestnut, and hemlock provided ample raw materials for the burgeoning light industries.

Villages and towns began to dot the landscape as resource extraction activities extended further into the hinterland. The watershed's largest city, Hazleton, owes its origin to the strategic position at the crossroads of two major Native American trails, one of which would become the Berwick Turnpike. Jacob Drumheller recognized the need for services along the turnpike and created the first settlement in what would become downtown Hazleton. With the slow and steady growth of lumbering and tanning industries in the upper reaches of the watershed, populations grew accordingly in small towns like White Haven, Freeland, and Hazleton.

The first recorded discovery of anthracite coal in the Hazleton area occurred in 1813, at Beaver Meadows and within a decade the first coal company in the area had formed and begun mining coal. A need to transport the coal from the mines to the market led to the construction of the areas first railroad in 1833. Coal mining necessarily involved impressive engineering achievements as tracks and trains climbed steep grades, snaked around ranges of mountains and penetrated valleys through water gaps where the streams had broken through mountain walls.

Coal provided the necessary power to fuel the industrial revolution. Pushed by the economics of supply and demand, and pulled by trade and the promise of profits and affluence, developing industries accelerated creative advances in science and technology. The greater demand for coal also required a labor force to conduct the mining activities. Mass migrations of European immigrants began to seek fortune, religious tolerance, and the promise of a better life.

Technological changes created a new reliance upon sources of energy other than coal. Textile mills increased in popularity upon Hazleton receiving electric power. Electricity also made a trolley system in Hazleton possible. By 1936, coal companies came into the ownership of banks and investment houses and the industry began to decline rapidly. Reliance on the automobile and petroleum further

affected the industry.
Since this time, numerous local groups have formed with the intent to preserve the economic stability and quality of life in the watershed. Groups such as the Chamber of Commerce, Hazleton Industrial Development Council, and CAN DO seek to increase the number of jobs and industries in the area.

Recreation
Recreation opportunities are plentiful in the Nescopeck Creek watershed. State game lands and Nescopeck State Park offer opportunities for fishing, swimming, hiking, biking, hunting, boating, snowmobiling, among others. There are also golf courses, scenic overlooks, skiing, community parks, and driving tours that add to the value of the watershed.

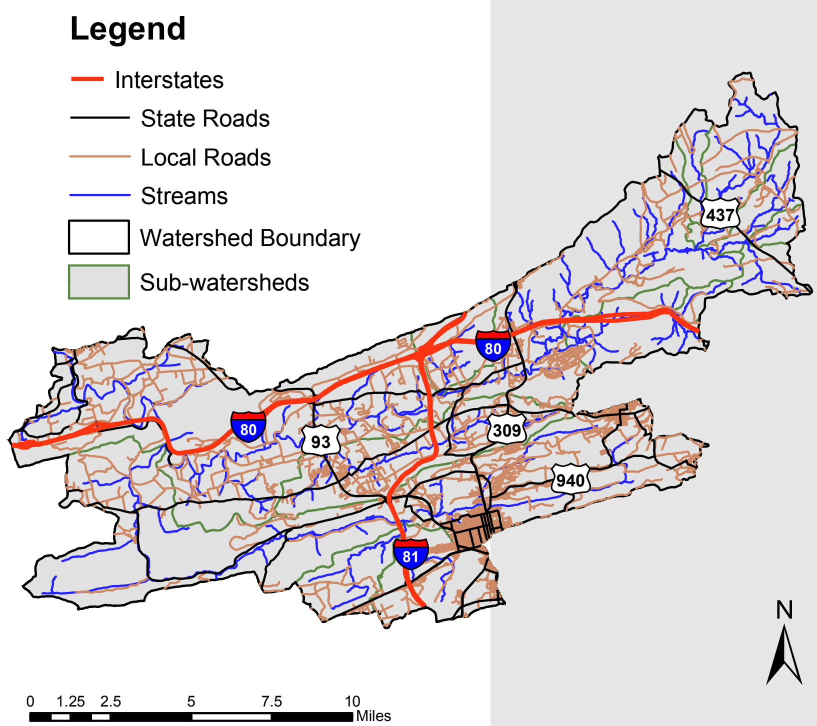

Figure ii Road infrastructure in the Nescopeck Creek watershed.

Local Government and Infrastructure
Most of the watershed is in Luzerne County, with small portions extending into Schuylkill County and Columbia County in the southwest corner. There are 13 townships in the watershed with Sugarloaf, Dennison, Butler, Hazle, and Black Creek Townships covering a large majority of the watershed (Figure vii).

Several major transportation routes traverse the watershed. Major roads include I-80, I-81, S.R. 93, and S.R. 309. The watershed has a rough total of 910 road miles, which includes interstates, state roads, and local roads. Approximately 40% of the roads lie within 100 ft. of streams and creeks (Figure ii).

A majority of individuals in the watershed are served by private septic systems. Individuals connected to public sewer systems are served by the Greater Hazleton Joint Sewer Authority, and the St. Johns, White Haven, and Conyngham sewage treatment plants. Additional sewage service extensions are planned for Hazle Township.

The Physical Landscape

Land Resources

Geology
Several major geologic formations are found in the watershed. Major formations include the Mauch Chunk, Llewellyn, Pocono, and Pottsville formations while minor formations include Spechty Kopf, Catskill, and Hamilton formations. The Llewellyn formation holds the greatest amounts of coal deposits. The Mauch Chunk formation produces high quality groundwater in and around the watershed.

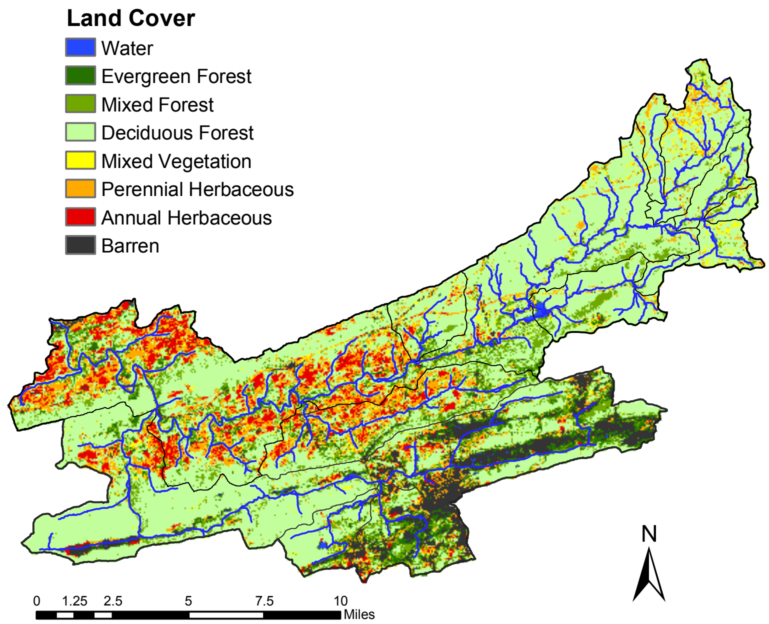

Figure iii Land cover within the Nescopeck Creek watershed.

Land Coverage

Land cover refers to the predominant vegetative composition of a particular landscape and provides information about the land use in that area (Figure iii). Approximately 95% of the Nescopeck Creek watershed is characterized as rural. The remaining 5% of the land in the watershed is urban or suburban. The primary land coverage within the watershed is deciduous forests (e.g. elm, oak, and maple trees), composing almost 57% of the watershed. Deciduous forests are present throughout the entire watershed. Mixed forest and perennial herbaceous compose approximately 11% and 12% of the watershed, respectively.

Water Resources

Surface Water

The Nescopeck Creek watershed contains 13 named streams. There are over 111 miles of named streams and over 106 miles of unnamed streams in the Nescopeck Creek watershed. The sub-watersheds in the Nescopeck Creek drainage range in size from 1.1 square miles (Long Hollow) to 67.3 square miles (Nescopeck Creek).

The Nescopeck Creek watershed has been the subject of a number of studies; most have focused on Little Nescopeck Creek[B] and the lower half of the watershed. The Pennsylvania Fish and Boat Commission (PFBC) measurements of pH for the headwaters were generally high (6.5 to 7). The Susquehanna River Basin Commission (SRBC), Department Environmental Protection (DEP), and the PFBC investigations all found a significant decline in pH after Little Nescopeck Creek[B] entered Nescopeck Creek. The headwater data collected by PFBC indicated fairly low alkalinity values (<10 mg/L) for these streams. Alkalinity values increased in the mainstem of Nescopeck Creek until the confluence with Little Nescopeck Creek[B], where alkalinity decreased from 12 mg/L to 0 mg/L.

In the headwaters, the PFBC measured specific conductivity and found low specific conductance at all sampling locations. However, specific conductivity was around 250-300 µmhos in Little Nescopeck Creek[B] and 20-60 µmhos in Black Creek. Iron and aluminum concentrations in Nescopeck Creek increased from 0.11 mg/L to 1.26 mg/L and from 0.04 mg/L to 7.45 mg/L respectively after Little Nescopeck Creek[B] input (SRBC unpublished data, 2001). The DEP determined that the Jeddo outfall and Black Creek contributed toxic concentrations of copper, zinc, and lead.

We used a watershed model (AVGWLF version 3.2) to estimate the phosphorus and nitrogen loads in the headwaters and we analyzed the entire watershed to determine nutrient loads by sub-watershed and by varying land uses. The average yearly amount of nitrogen discharging from the Nescopeck Creek watershed is about 318,000 kg. Close to half of that amount comes from the land areas surrounding the mainstem of Nescopeck Creek. The three major sources of nitrogen were 33% from land sources, close to 60% from groundwater, and about 6% from septic systems. Croplands, quarries, deciduous forest areas, coal mines, and areas of high intensity development represent the major contributors of phosphorus.

Groundwater

There are 80 public water supply well systems in the watershed, most of which are owned by local businesses. Each well system may have more than one well. The Mauch Chunk and Pottsville formations contain the major aquifers in this region, with the Mauch Chunk being the most productive groundwater source.

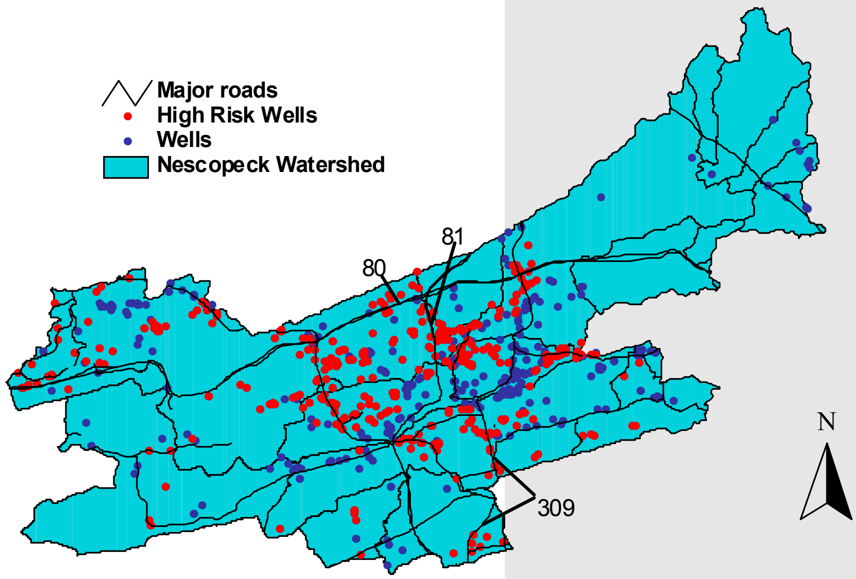

Figure iv Location of high risk wells.

To determine groundwater pollution potential, we used a system called DRASTIC. DRASTIC ratings for the Nescopeck Creek watershed are relatively low in the headwaters, and increase in the southern and central regions. There are 396 wells, or almost 55%, listed within areas that are more vulnerable to ground water pollution (Figure iv). Seventy-five percent (296 wells) of these wells are domestic, while 7% (29 wells) are public supply. The DRASTIC model also indicated that the Llewellyn formation coincides with high sensitivity to ground water pollution.

Biological Resources

The Pennsylvania Science Office of the Nature Conservancy identified seven natural areas within the watershed that are important for conserving biological integrity. These areas are Arbutus Peak, Edgewood Vernal Pools, Valmont Industrial Park, Black Creek Flats, Nescopeck Creek Valley, Nescopeck Mountain Barrens, and Humboldt Barrens. These areas are of concern as they are not protected from development.

An analysis of vegetative cover within 100 m of streams provided insight into the integrity of riparian buffers in the watershed. Over 80% of the riparian buffers in the watershed are composed of forestland. Most sub-watersheds contained little barren and agricultural land within 100 m of streams with Black Creek and Little Nescopeck Creek B containing the highest proportions, respectively.

The Bird Community Index (BCI) is a songbird-based indicator of the ecological condition of a land area. Since the particular type of songbird community present in an area is strongly correlated with the percentage of natural or undisturbed habitat, the BCI uses land cover as an indicator of ecological integrity. Based upon BCI scores, the Nescopeck Creek watershed is dominated by medium and low ecological integrity (Figure v).

In the summer of 1999 the PFBC conducted an extensive fish survey of the entire Nescopeck Creek watershed. This survey documented the presence of 20 fish species in the Nescopeck Creek watershed. Fifteen of the species had been captured during previous PFBC surveys, while five species were documented for the first time in the watershed. A number of the smaller streams in the Nescopeck Creek watershed maintain substantial wild brook trout (*Salvelinus fontinalis*) population. The larger streams in the drainage were found to be either polluted by acid mine drainage or exceeded temperature tolerance limits during the summer to support wild trout. Streams in the Nescopeck Creek watershed ranged from Class A to Class D status for wild trout based on PFBC criteria.

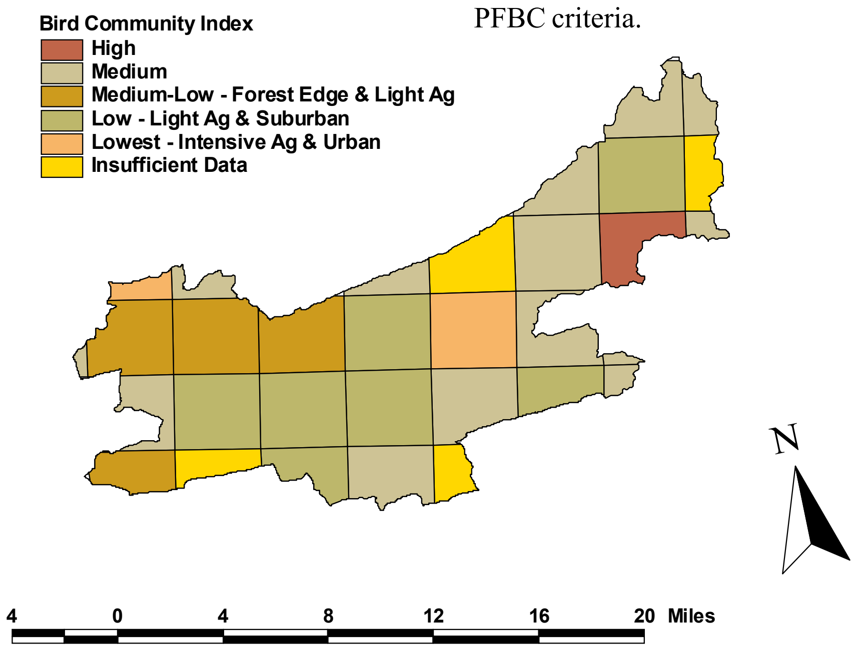

Figure v Bird community index scores for the Nescopeck Creek watershed. (Source: J. Bishop & T. O'Connell 2002)

Recommendations

The assessment phase of the Keystone Project highlighted three broad topics that addressed long-term stewardship of Nescopeck Creek. These topics included: outreach and organizational development, water quality, and land-use and ecosystem planning.

Outreach and Organization Development

There is a definitive need for an official watershed coalition consisting of municipal governments, citizens and community organizations like the Friends of the Nescopeck, and natural resource and agricultural agencies. An initial phase for the coalition, as the steering body of the organization, is the development of a strategy to implement good watershed stewardship practices. A central component of this phase is the expansion of stakeholder involvement and the promotion of watershed awareness and identity (Figure vi).

To garner public support for implementing watershed stewardship practices the coalition can utilize existing environmental educational opportunities to promote awareness of the Nescopeck Creek watershed. Two initial resources are the Environmental Education Center at the Nescopeck State Park and the Eastern Pennsylvania Coalition for Abandoned Mine Reclamation. In addition, other potential partners include the Pennsylvania Environmental Council, the North Branch Lands Trust, the Wildlands Conservancy, the Pennsylvania Audubon Office, and local businesses, industries, schools and colleges.

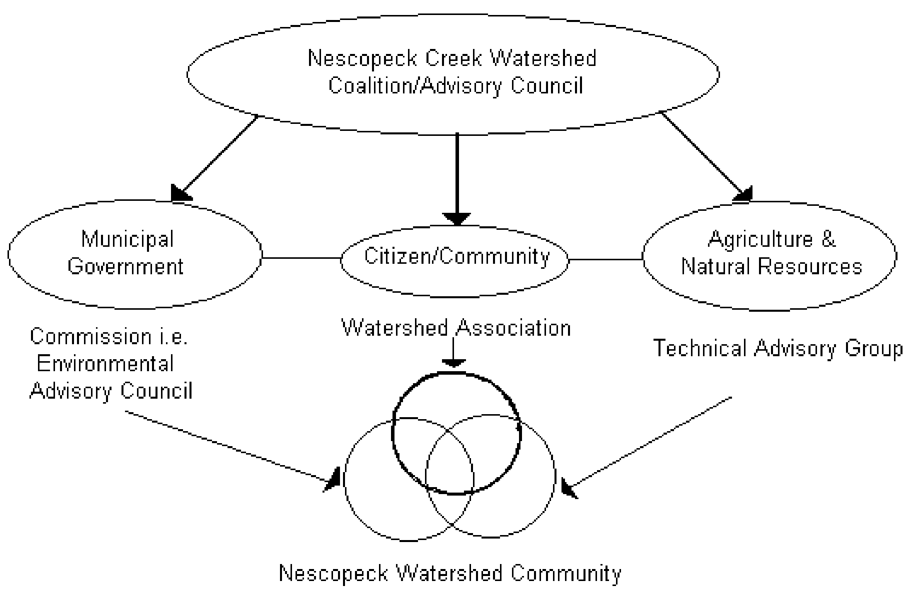

Figure vi Potential Nescopeck Creek Watershed Coalition/Advisory Council structure.

Landscape and Ecosystem Planning

As local governments are the primary decision-makers concerning land use issues in communities, they can either react to situations in their communities, or develop environmentally-sensitive plans that allow a proactive stance towards issues like suburban sprawl, polluted runoff, and other land use pressures. There are many mechanisms available that governments can follow, including the establishment of multi-municipal frameworks or the encouragement of Environmental Advisory Councils, or EACs (Figure vii).

The Pennsylvania Municipalities Planning Code (MPC) provides counties and municipalities the power to promote cooperative, regional long-term planning and partnerships in a multi-municipal framework, as well as funding for the development or amendment of comprehensive plans. These partnerships affect the development and conservation of natural resources by adopting or altering land use plans and ordinances as consistent forms of control.

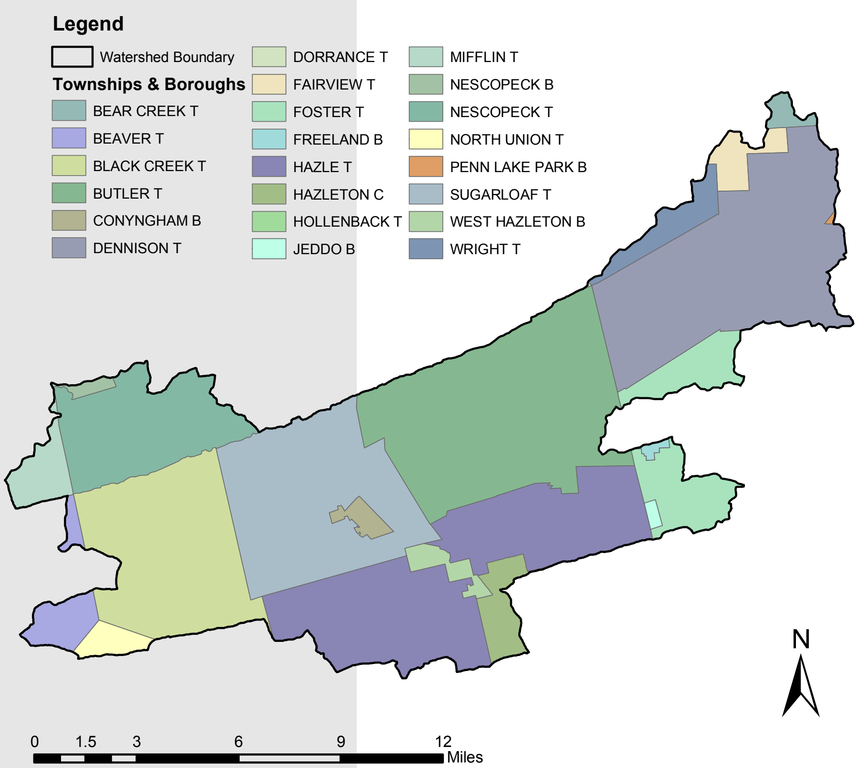

Figure vii Municipalities with jurisdictions located in the Nescopeck Creek watershed.

A number of townships are gaining insight and assistance from citizen-based EACs. EACs, a project of the Pennsylvania Environmental Council, act to provide a forum for select community residents to interact, in an advisory role, with municipal officials on the protection, conservation, management, promotion, and use of environmental resources within its territorial limits.

An additional component of ecologically based planning is determining how to plan for natural resources. The implementation of a comprehensive riparian and streamside buffer program would conserve or protect intact streamside areas, restore or enhance other areas, and educate landowners and citizens about the importance of streamside zones. Riparian buffers and streamside areas were identified as an important issue within the Nescopeck Creek watershed.

Water Quality

To address water quality concerns individuals must first know more about the water. Implementing water quality and quantity monitoring programs can provide vital information about the improvement or degradation of water resources (Figure viii).

A multi-municipal stormwater management plan should be developed and implemented. The purpose

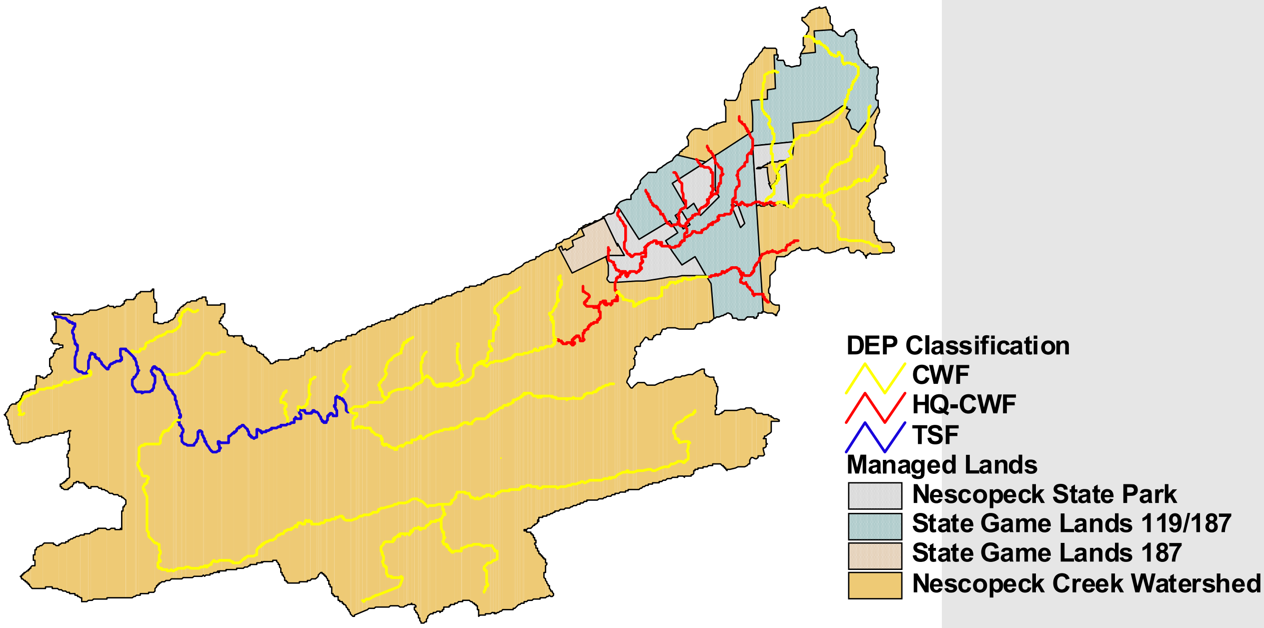

Figure viii DEP protected uses classification for the Nescopeck Creek watershed.

of a stormwater management plan is to solve problems arising from uncontrolled stormwater, such as erosion, sedimentation, and polluted runoff. Acting together, municipalities would assess current facilities, prioritize problem areas, explore alternative strategies and support one another in the search and provision of funding opportunities.

A complicated problem associated with stormwater, polluted runoff can be a product of everyday human activities. Sources include the use of chemicals in the form of fertilizers or pesticides, urban development, and agricultural activities. One of the best ways to control non-point source pollution is environmental education at the public level. At the municipal level, planning can control land use activities to minimize pollution and mitigate degrading effects. An example of planning for water quality is a wellhead protection area, which restricts degrading activities in well recharge areas and thus limits pollution from entering drinking water sources.

Culture and History of the Watershed

While natural resources are materials exploited by people to serve specific needs, cultural resources are both the reflection and substance of human interaction and intervention with the landscape. It is how people settle the land and use its soils, water, minerals, vegetation, and climate to their advantage and for their sustenance. These settlements include the establishment of farms and the development of timber, milling, mining operations, and communities in response to human lifestyle patterns and needs. However, cultural resources extend far beyond physical appearances. They are essential to the understanding of how people made these landscapes their homes, gardens, or workplaces, and how this interaction then influenced human relationships and expression. As such, cultural and historic landscapes hold significance as both the visible repositories and the expression of our higher awareness, of thoughts, dreams, and aspirations for the future, and as reflections of how our predecessors lived with the landscape and with one another.

Cultural Landscapes are images of a fleeting past, captured and interpreted by a present that is inextricably tied to those earlier times. This is the significance of these landscapes of memory; they are a part of us, and once lost, are impossible to replace.

Physical Setting

The Nescopeck Creek watershed is located in the Ridge and Valley physiographic province of northeast Pennsylvania (Figure 1.1). The watershed encompasses an area of roughly 174 square miles in Luzurne County and small portions of Columbia and Schuylkill Counties. Nescopeck Creek originates at the confluence of Creasy Creek and the upstream outlet of Lake Olympus in Dennison Township, Luzerne County. From its headwaters, the stream flows southwesterly into Black Creek Township. In Black Creek Township the stream turns and flows northwesterly to its union with the North Branch of the Susquehanna River in the Borough of Nescopeck. The total length of Nescopeck Creek, from its headwaters to its rendezvous with the North Branch of the Susquehanna River, is approximately 35 miles.

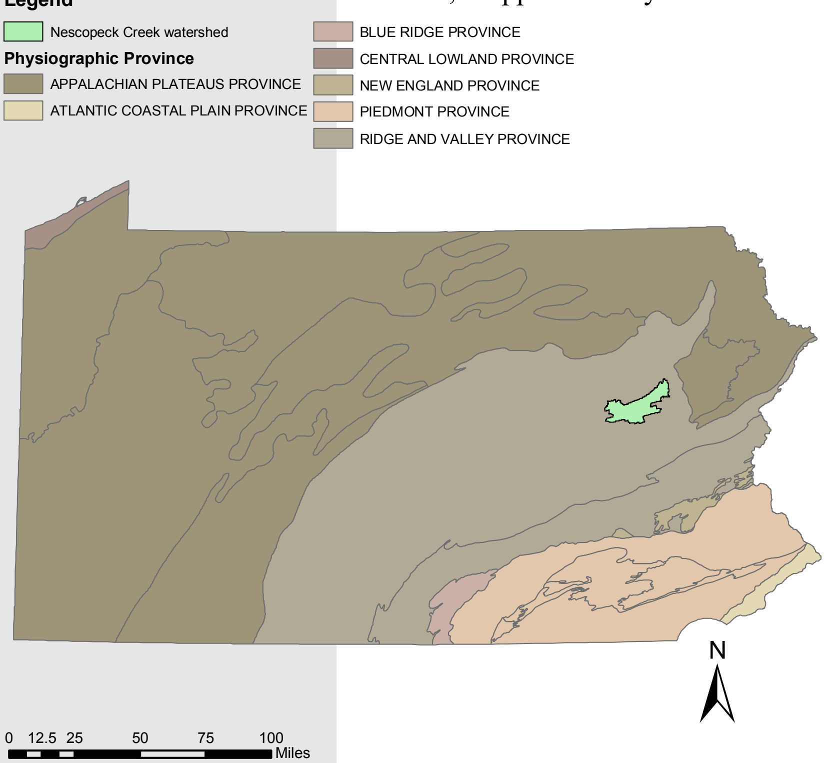

Figure 1.1 Physical setting of the Nescopeck Creek watershed (Source: Project Team).

Meteorological

The duration and intensity of precipitation is an important factor in the timing and amount of water entering a lake or stream. If precipitation falls over a long period of time the ground may become saturated. Once the ground becomes saturated, the infiltration of precipitation ceases and overland flow rates increase. This can also happen during rains of short duration and high intensity. Any time the precipitation rate exceeds infiltration rate, overland flow occurs. Overland flow can cause erosion and potentially carry large amounts of sediment to rivers and streams. This sediment can have adverse effects on the stream flora and fauna.

The amount of water that falls as rain and snow on the Nescopeck Creek watershed varies, depending on the time of year. The heaviest amounts of precipitation generally fall between the months of May and August, while January and February experience the least amount of precipitation (Table 1.1). Storms of short duration and high intensity can happen at any time of the year, but these also generally occur between the months of May and August in the Nescopeck Creek watershed.

Air temperature is another important factor affecting lakes, rivers, and springs. Air temperature plays a major role in determining the rate of evapotranspiration. Evapotranspiration is the movement of moisture from the earth to the atmosphere as water vapor by the evaporation of surface water and the transpiration of water from plants (Figure 1.2). Air temperature, along with other factors, such as canopy cover and groundwater inputs, determine what type of fish and aquatic invertebrates may inhabit

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Avg. High Temp.	29 °F	31 °F	41 °F	54 °F	65 °F	73 °F	76 °F	75 °F	67 °F	57 °F	45 °F	33 °F
Avg. Low Temp.	13 °F	14 °F	23 °F	34 °F	45 °F	53 °F	58 °F	57 °F	49 °F	39 °F	29 °F	18 °F
Mean Temp.	21 °F	23 °F	33 °F	44 °F	55 °F	63 °F	68 °F	66 °F	59 °F	49 °F	38 °F	26 °F
Ave. Precip.	2.90 in	2.80 in	3.00 in	3.90 in	4.50 in	4.50 in	4.40 in	4.60 in	4.20 in	3.70 in	4.20 in	3.30 in
Record High	70 °F	69 °F	80 °F	89 °F	90 °F	95 °F	98 °F	96 °F	97 °F	86 °F	76 °F	65 °F
(Year)	1932	1985	1945	1976	1962	1952	1955	1930	1953	1941	1950	1984
Record Low	-20 °F	-24 °F	-7 °F	5 °F	20 °F	27 °F	37 °F	30 °F	23 °F	16 °F	-1 °F	-15 °F
(Year)	1985	1934	1986	1975	1986	1986	1986	1986	1984	1986	1929	1983

Table 1.1 Meteorological data for Hazelton, PA (Source: www.weather.com).

lakes and streams. A stream that has minimal groundwater inputs and little canopy cover is prone to increased water temperatures during summer months. These streams are also much more likely to be affected by anchor ice and frazil ice during the winter months. Anchor ice is the ice formed on substrate or objects beneath the water surface. Frazil ice is fine specks of ice formed in the water column (i.e. slush) too turbulent to allow the formation of anchor ice.

Like precipitation, temperature is variable throughout the year in the Nescopeck Creek basin. July brings the warmest temperatures and January represents the coldest (Table 1.1). Overall, the average monthly high temperature varies between 29° F (January) and 76° F (July) and the average low temperature varies between 13° F (January) and 58° F (July) throughout the year. On average, the difference between the monthly high temperature and the monthly low temperature is approximately 18° F for any given month.

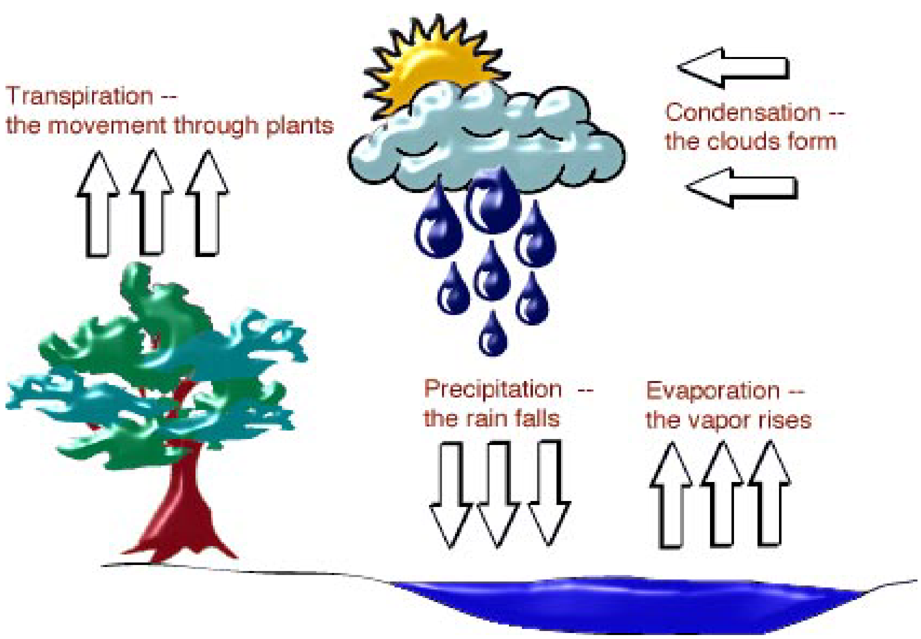

Figure 1.2 The Water Cycle (Source: mbgnet.mobot.org/fresh/cycle/cycle.htm).

Image 1.1 View over the Conyngham Valley from the campus of Penn State, Hazleton (Source: Project Team).

Cultural Landscape Assessment

There are many ways to approach the assessment of a cultural landscape. For the purpose of this document, we will approach the cultural landscape as fact rather than theory. Thus, the contemporary cultural landscape is the latest product of the historical interaction of human beings and their environment. While acknowledging that theoretical concepts, such as belief systems, attitudes, societal values, and symbolic meanings influence cultural landscapes, we tried to understand and communicate the interactions between the landscape's physical form and origin with the changes brought about by human hands. To do this, we studied the environmental and cultural conditions and processes that influenced how people consciously or unconsciously changed these landscapes.

Nescopeck Creek Watershed Identity

The Nescopeck Creek watershed is located in the anthracite coal mining region of northeastern Pennsylvania, approximately 100 miles northwest of Philadelphia. These mine-scarred landscapes show the close relationships of natural physical forces and the inborn human drive to sacrifice, survive, prosper, and otherwise rise above limitations of time and technology. For just as culture, and therein history, relates to place, place also relates to the biophysical, environmental, and ecological makeup of landscape. So evolves the paradox of natural processes and systems as people look upon landscape characteristics as expendable natural resources.

Physiographic Regions

A combination of diverse factors, including the actions of such monumental processes as movement, time, pressure, temperature, and water resulted in the folded landscapes, geology, and physiographic regions

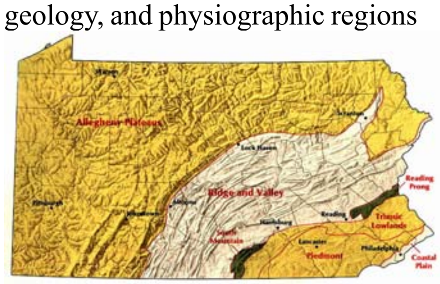

Image 1.2 The Physiographic Regions of Pennsylvania (Source: Pennsylvania Atlas).

of Pennsylvania. As processes of continental drift forced up mountainous reaches between lower valleys, time and water eroded these forms down to the contemporary physiographic regions of the Appalachian Ridge and Valley, the Appalachian Plateau, and the Blue Ridge or Piedmont physiographic provinces.

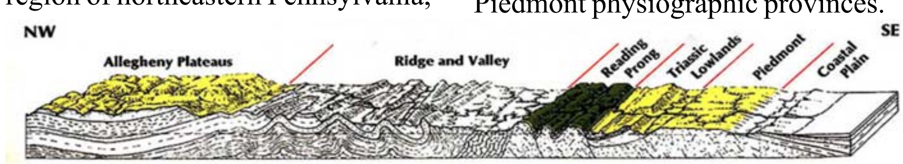

Figure 1.3 A Generalized Cross-Section of the Physiographic Regions of Pennsylvania. This graphic illustrates the characteristic folded landscapes of the Ridge and Valley region wherein lies the Nescopeck Creek Watershed (Source: Pennsylvania Atlas).

Definition of Place

The human perception of "place" refers to the unique combinations of physical, cultural, historical, and mythological characteristics that are associated with specific geographical locations or regions.

The Nescopeck Creek watershed lies within the Ridge and Valley province, that extends over 1,500 miles as a nearly continuous, northeasterly-running mountain belt from Alabama to Lake Champlain in New York State. The watershed's succession of parallel or nearly parallel ridges and uniform valleys of varying width and relatively horizontal relief are characteristic of the Ridge and Valley topography (Berger 1976) (Figure 1.3).

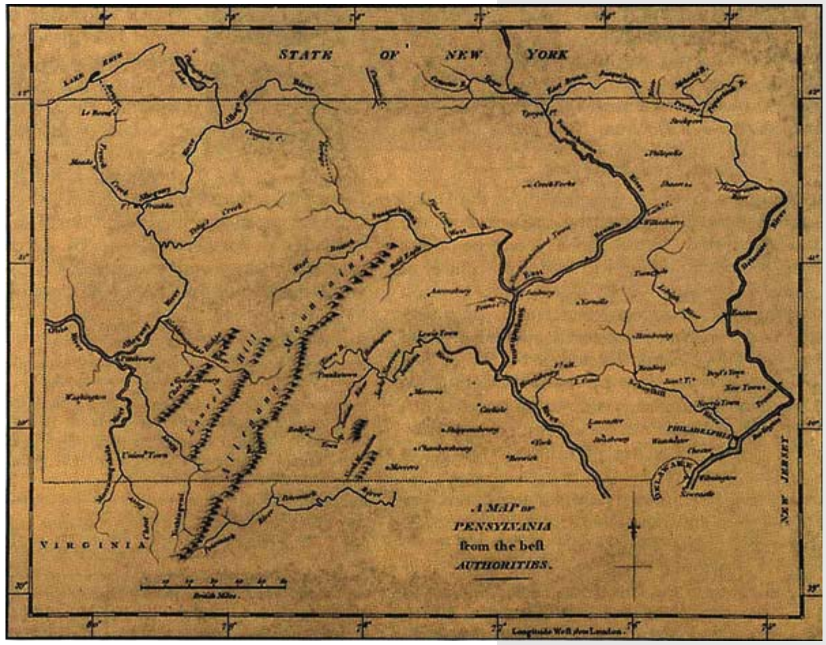

Image 1.4 Morse Map (1794). A Map of Pensylvania from the best Authorities, showing the major river networks of early Pennsylvania (Source: Pennsylvania Atlas).

William Penn and Symbolism

Luzerne County

Since time immemorial, abundant rivers of the eastern United States acted as major corridors of transportation and dictated regional patterns of settlement. Originally used by

Image 1.3 The confluence of Nescopeck Creek at the Susquehanna River (Source: Project Team).

Native American tribes, eastern rivers provided accessible routes for Euro-American trappers, settlers, entrepreneurs, and speculators. Rivers allowed for the transportation of goods, products, and natural resources and the provision of services into the remote frontiers. In doing so, the westward spread of the American colonies was advanced. The Susquehanna River, in eastern Pennsylvania, was one such avenue that allowed passage into the otherwise inaccessible interiors of William Penn's early colony. Nescopeck Creek, a tributary of this great river, wound down from its headwaters through great rapids and over the Nescopeck Falls to empty on the Susquehanna's wide, sandy shores.

Nestled within the foothills of the Pocono Mountains, the Nescopeck Creek watershed lies in Luzerne County, one of the oldest counties in the Commonwealth of Pennsylvania. Founded on the 25th of September in 1786, the County was named after the French Ambassador, Chevalier de la Luzerne, in gratitude to France for military aid given to the fledgling United States during the American Revolutionary War. Now the fifth largest county in the Commonwealth and home to over 327,000 people, Luzerne County boasts numerous rivers, streams, creeks, and lakes, including the largest natural body of water in the state, Harvey's Lake (www.courthouse.luzerne.pa.us).

Historic Native American Influences in the Watershed

Euro-American settlement was not the earliest recorded history of human modification in Luzerne County, nor in the Nescopeck Creek watershed. Approximately one thousand years before Euro-Americans arrived in the watershed, the seemingly uninhibited reaches were home to the Lenni Lenape, of the Algonquin Nation. By the 1600s, the Lenni Lenape covered extensive areas of Pennsylvania, living a hunter-gatherer existence in the region's rich landscapes of folded mountain ridges, substantial valleys, and rough plateaus before turning to semi-permanent, agricultural settlements along its extensive floodplains. Although no conclusive records indicate permanent settlements in the watershed's interior, evidence indicates that the Lenni Lenape set up temporary camps in the area now forming Nescopeck State Park. In addition, archeological remains of a large Nescopeck village, circa 1756, governed by Chief Nutimus, were found along the banks of the Susquehanna River at the mouth of Nescopeck Creek. It is upon this early settlement that the town of

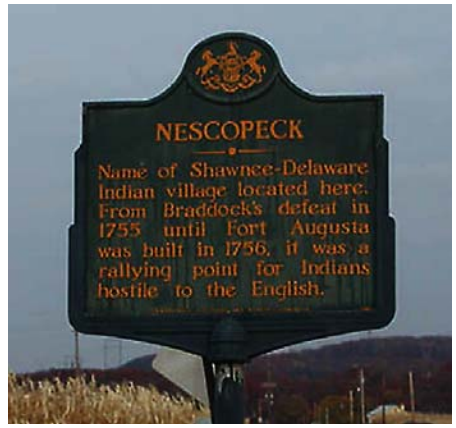

Image 1.6 Historic Site Marker, the Village of Nescopeck, Pennsylvania (Source: Project Team).

Nescopeck, in Nescopeck Township was built (Pearce 1890, Bradsby 1893). The settlement is termed as a Delaware village by Bradsby, with Delaware being the name colonists called the Lenni Lenape. Additionally, it appears that the Nescopecks' were members of the Lenni Lenape tribe. (Bradsby 1893, Kocher et al. 2000)

A number of Native American relics and artifacts have been found in the Conyngham Valley, where a Native American burial ground reportedly lies beneath the foundations of the former Conyngham school building. Artifacts found on the Jacob Bittenbender farm west of Nescopeck Creek indicate the floodplain along the river was a popular campsite for Native American tribes. These relics and artifacts, along with others like them, represent precious and irreplaceable cultural and historic resources of the watershed, and are protected under the Pennsylvania Consolidated Statute on Historic Preservation, Title 37 (37 P.C.S. § 501 et seq.), and enforced by the Pennsylvania Game Commission on State Game Lands where they have jurisdiction. The Commission, in a supervisory role, has prosecuted

Image 1.5 Nescopeck Creek flowing through the Nescopeck State Park (Source: Diane Madl).

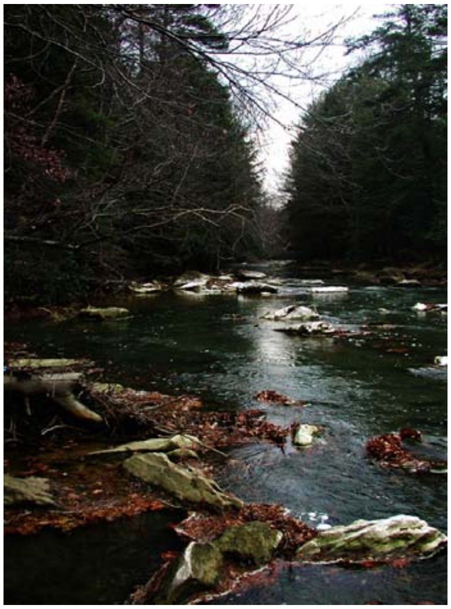

Image 1.7 Nescopeck Creek, at the crossing of State Route 93 (Source: Project Team).

several people throughout the 1990s for illegally collecting cultural artifacts from state lands in the upper reaches of Nescopeck Creek (Kocher et al. 2000).

Nescopeck Creek, flowing through their seasonal camping grounds, might have made a natural transportation route for the Lenni Lenape on their travels down to the Susquehanna, or "Shallow River."

Calling the creek "Nescopeck", which signified "deep black water" in their native tongue, the Lenni Lenape may have shared the lush forested landscape of the watershed with the Susquehannocks of the Iroquois Nation, who occupied the lands north. By the 1700s, the Lenni Lenape were being forced out of the region due to encroachment by Euro-Americans and the militarist Six Nations of the Iroquois, who had established primacy over the region from their stronghold in the Wyoming Valley.

Transportation and Cultural Transitions

Overland routes of transportation were essential in the watershed, as Nescopeck Creek was seasonally unnavigable due to the abundance of rapids, tight curves, and episodes of flooding. Indeed, the stream's wild nature afforded a limited period of protection from Euro-American encroachment into the watershed's interior. Paradoxically, the creek also deposited rich sediments, most valued by settlers, along its reaches down to its confluence with the Susquehanna River. Over time, an interconnected system of trails grew

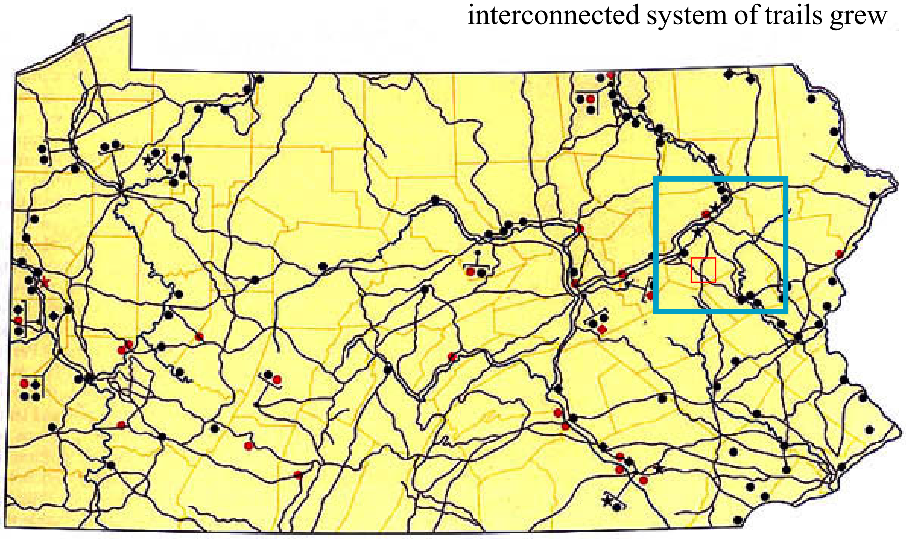

Image 1.8 A map of the historic Native American Towns and Trails, Pennsylvania (Source: Pennsylvania Atlas).

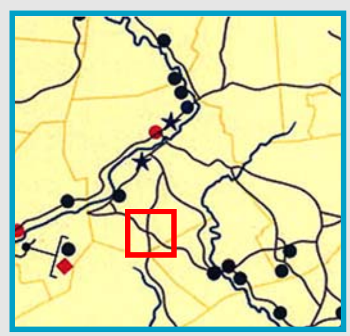

Image 1.9 Native American Towns and Trails of Pennsylvania, focusing on Luzerne County. The area within the outline defines the crossing of the two major trails at what would become Broad and Vine Streets in downtown Hazleton (Source: Pennsylvania Atlas).

Image 1.10 Historic Site Marker, The Lehigh Path. This marker is located in the Nescopeck State Park (Source: Diane Madl).

Image 1.11 The Sugarloaf Massacre Memorial (Source: Wildlands Conservancy).

The Sugarloaf Massacre

There were many incidents of violence between the Native Americans and the Colonists. The skirmishing reached its peak in 1788 when 226 people were killed in the Wyoming Massacre at the site of present day Wilkes Barre. To counter the situation Capt. Daniel Klader set out from Stroudsburg with his company of 41 soldiers but never reached their destination. They were ambushed by a group of Seneca Indians and Tories along the Little Nescopeck Creek. This was known as the Sugarloaf Massacre and ultimately played a large role in the settlement of Hazleton (Bradsby 1893).

along the creek and through the rugged interior landscapes of the watershed. These networks were used by Native American tribes for migration, trading, and raiding to regions beyond the watershed's boundaries. Primary trade routes crossed the watershed from east to west, while the military routes, serving the far-flung Iroquois Federation, ran roughly north to south.

The two major trails passing through these wild landscapes, the "Warrior's Trail" and the "Trade Trail", intersected at the crossroads of what would become Broad and Vine Streets in the city of Hazleton. The "Warrior's Trail," or the "Lehigh Path," was used extensively during the 17th and 18th centuries connecting Mauch Chunk, present-day Jim Thorpe, on the Lehigh River in the south, to the beautiful Wyoming Valley in the north. This path would become notorious in the annals of the watershed when, on September 11, 1780, the Sugarloaf Massacre took place. The Sugarloaf Monument, erected in 1933 and located approximately one-half mile east of the present Borough of Conyngham, stands in memorial of this event.

While this rendition occurs in Bradsby's work, it should be noted that a second narrative relates the casualty toll as 13 men, who, as a detachment of Captain John Van Etten's Company of the Northumberland County Militia, were surprised by a band of Senecas and Tories led by the Seneca Chief Roland Montour. Nonetheless, whichever narrative one chooses to accept, this site and memorial remains one of the watershed's numerous cultural and historic sites (Kocher et al. 2000).

Euro-American Settlement and a Change in Vision

Episodes of emotionally and violently-charged cultural interaction derived, in part, from a difference of perception among the Native Americans of the region and the increasing numbers of Euro-American settlers. The newcomers saw the frontier as sparsely settled, unclaimed land, which in reality it was not. Moreover, the philosophies of each faction differed radically. The Algonquin believed that the Earth and her resources should be held in great reverence, and further, should be nurtured and cared for with equal respect (Kocher et al. 2000).

The Pennamite settlers of William Penn's advancing colony viewed these same landscapes as their homeland of religious tolerance, a haven from the religious persecution of the Old World. Further, Penn's symbolic vision established the notion of active management and stewardship of the land, which necessarily translated into the ownership and the working of the land to be fruitful and productive. These practices conflicted with the more holistic lifestyles of the resident Native American tribes, who did not share this notion of exclusive ownership over the land. This differing perception of natural resource use and management would deepen with the continuing expansion of Euro-American colonization and settlement.

Adding to an already troubled time between 1750 and 1800 were the sporadic, and often fierce, conflicts over the Commonwealth's boundaries between the Pennamites of Pennsylvania and the Connecticut Yankees, who had claimed sovereignty over all lands west of their original colony. A decision in favor of the Pennsylvanians settled the dispute in 1781, after the end of the Revolutionary War. By this time, the Penn family had already purchased additional land from the Six Nations of the Iroquois. These Iroquois land sales, while seemingly in conflict with the Native American concept of private property ownership, is actually reflective of the Iroquois practice of selling immense tracts of land while apparently considering the deeds to be personally unsubstantial. Furthermore, these regions that the Iroquois willingly sold to Euro-American interests were not necessarily within their sphere of influence or control.

However viable the selling practices were between the Iroquois and the Penn family, these purchases were recognized as legal transactions by the colonial governments and systems. As such, the family gained control of large tracts of land on both sides of the Susquehanna River, including the headwaters of several tributaries in territory that would, in part, later become Luzerne County. While William Penn's original colony had been established in 1682, the continuing land purchases by the Penn family provided a steady stream of available warrants and properties for eager settlers from many European countries.

Enticed by advertisements circulated in European regions suffering under the yoke of religious intolerance, prejudice, and persecution, immigrants flocked to the New World grasping the hope of employment opportunities and private landownership, a concept virtually unattainable in their homelands. They believed in a land brimming with abundant natural resources and apparently unlimited possibilities, and anticipated a better life for themselves, their families, and their future. Thus began the greatest transition of the watershed by the hand of humankind. For even as the departing Lenni Lenape, Susquehannocks, and Iroquois left little influence, the now increasing numbers of Euro-American settlers permanently altered and modified the watershed's natural resources, as a number of small industries slowly began to grow along Nescopeck Creek.

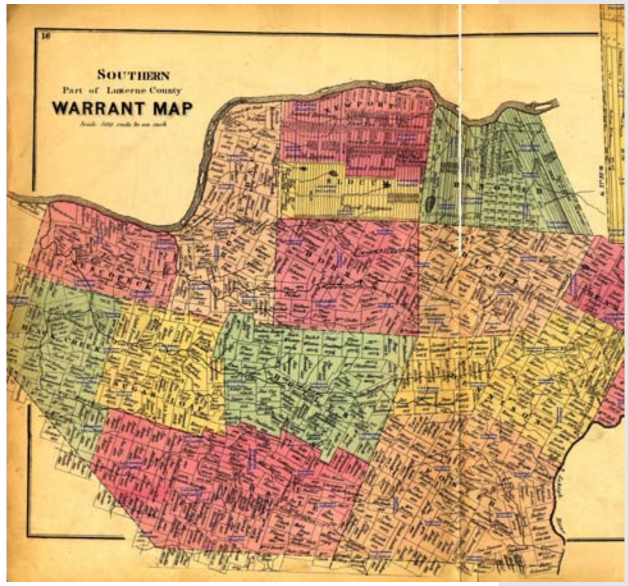

Image 1.12 Warrant map, Southern Luzerne County, 1873 (Source: http://www.roots.web.com).

Image 1.13 Settlement and Industry along Nescopeck Creek in the contemporary vicinity of the Nescopeck State Park (Source: Diane Madl).

The Berwick Turnpike, 1810

"In its day this was an important internal improvement, and the old four-horse Concord coaches, with the great stage driver, his whip and horn waking the echoes that had so long slept on the surrounding mountain sides, were an era that must have thrilled the very souls of the early settlers." (Pearce 1860).

Image 1.14 A two-lane road within the watershed,with green fields and ridges in autumnal colors (Source: Project Team).

The Early Age of Industry

Rivers and streams formed the major mode of transportation in this era of expansion, while their banks and fertile floodplains provided choice areas for the first settlements. Water was, and still is today, crucial for human sustenance and agriculture. During this settlement phase, free-flowing water was also extremely important for the generation of power to fuel timber and gristmills, with the first mills on Nescopeck Creek built by 1788. The remnants and ruins of these water-powered mills and dams found along the banks of creeks bear striking evidence of the abundance of available power.

Rich forests of oak, chestnut, and hemlock supplied raw materials, initially for construction, shipbuilding, and tanning, and later for the mining industries, while the construction of Owen's Road in 1786 provided transportation beyond the watershed's boundaries. Named after its builder, Evan Owens, the road ran from Berwick along the old Nescopeck Trail, crossing Nescopeck Creek below Nescopeck Falls. It passed through what would become the village of Conyngham and the city of Hazleton before arriving at the Lehigh River at Mauch Chunk. Additional settlers soon followed the milling activities, with Nescopeck Creek's first families arriving by 1791 (Pearce 1860). The lumbering industry of the period, while minor, comprised the watershed's first economic benefit as timber now made its way to urban markets, mainly in Philadelphia.

Early Settlement

Hazleton owes its origin to a strategic location at the crossroads of the area's major transportation corridors. Building over the old Native American trail and Owen's Road, the Lehigh and Susquehanna Turnpike Co. began construction on the Berwick Turnpike in 1810 to transport timber from lands in Bradford County. As the need of a boarding house for construction workers became evident, an enterprising blacksmith, Jacob Drumheller, soon built a stage stop adjacent to the crossroads along the side of the new turnpike. Reportedly the first settler in what would become downtown Hazleton, Drumheller ushered in the next era of development in the watershed with new services and provisions catering to economic advancement and increased settlement. Additionally, with the advent of canal building in the 1830s, the Berwick Turnpike would further extend, and accelerate, the watershed's impact on the major manufacturing areas by connecting with the new North Branch Canal in Berwick and the Lehigh Canal in Mauch Chunk. The growth of trails, roads, turnpikes, future railroads, and settlement patterns were thus linked to the extraction of the watershed's natural resources, first those of timber and water, and later, that of coal.

With the slow and steady growth of lumbering and tanning industries in the upper reaches of the watershed, populations grew accordingly in small towns like White Haven, Freeland, and Hazleton. Changes in technology during the late 1800s altered the water-powered mills along Nescopeck Creek into steam-powered mills, further affecting its hydrology. Between the 1780s and the 1850s, the frequency and destructiveness of flooding in Nescopeck Creek and tributaries brought ruin to properties and loss of life on numerous occasions. The Pumpkin Flood of 1786 was renowned for the quantities of pumpkins swept out of the fields and carried down to the Susquehanna River. Yet, the most destructive flood of that period occurred when Nescopeck Creek breached a dam above the forge of S. F. Headley in September 1850, and resulted in the deaths of 22 people (Bradsby 1893).

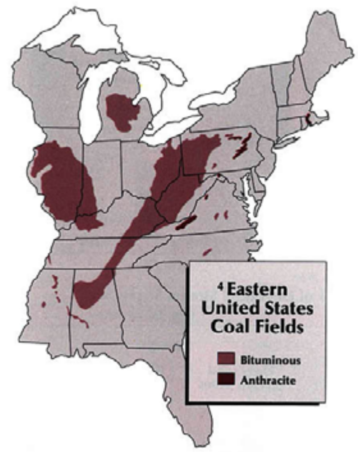

Image 1.15 The coal fields of the Eastern United States (Source: Pennsylvania Atlas).

Anthracite Coal

Coal is a product of Pennsylvania's regional landscape processes and systems. It is, and has been, an extremely important commodity in the physical, cultural, and economic landscapes of this area. Pennsylvania is currently the fourth largest coal producer in the United States, and over its 200-year period of active bituminous and anthracite coal mining, it has produced over a quarter of this country's total coal output. It is only in Pennsylvania that anthracite coal is located, with all of the major deposits found within a 770 square mile area (Rose 1981). Anthracite coal, or stone coal, with a higher heat value than coal found in western states, is a unique resource in the watershed. Additionally, due to its inherent mineral composition of extremely high-grade, almost pure carbon with particularly low volumes of volatile hydrocarbon, anthracite coal is known primarily for its clean-burning, nearly pure, white flame and its high temperatures (Figure 1.4).

As a product or natural resource created by the process of metamorphosis, coal was largely formed during the Carboniferous period, the fifth period of the Paleozoic era, ranging from 350 to 290 million years ago, although deposits also date from the Permian, Triassic, Jurassic, Cretaceous, and Tertiary periods. As the pressure of accumulated layers of overlying sediments and rock upon submerged plant matter forced out the majority of moisture and caused volatile substances to escape, it formed the nonvolatile carbon material into a more compact mass. The greater the stress exerted in the process of metamorphism, the higher

Composition of Coal

A fuel substance of plant origin, coal is almost entirely, composed of carbon with varying amounts of mineral matter. The series of carbonaceous fuels, of which coal is one, differ in the relative amounts of moisture, volatile matter, and fixed carbon they contain. Peat, the lowest in carbon content, is followed in ascending order by lignite, subbituminous coal, bituminous coal, semibituminous coal, semianthracite, and anthracite. Those materials lowest in carbon content and higher in moisture tend to crumble on exposure to air, where bituminous coal, being more consolidated, does not crumble easily, is deep black in color, burns readily, and was used extensively as fuel in industries, railroads, and coke manufacture. Anthracite, which is nearly pure carbon containing little of the volatile hydrocarbons, is very hard, black, lustrous, and was used extensively as a domestic and industrial fuel (Columbia Electronic Encyclopedia, 1994). Although anthracite coal is clean burning with a very high heat value, some types of bituminous coal burn hotter.

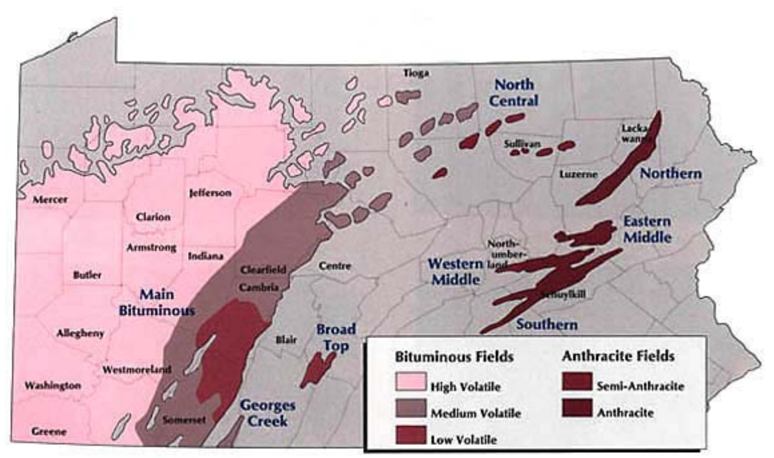

Image 1.16 Pennsylvania coal fields (Source: Pennsylvania Atlas).

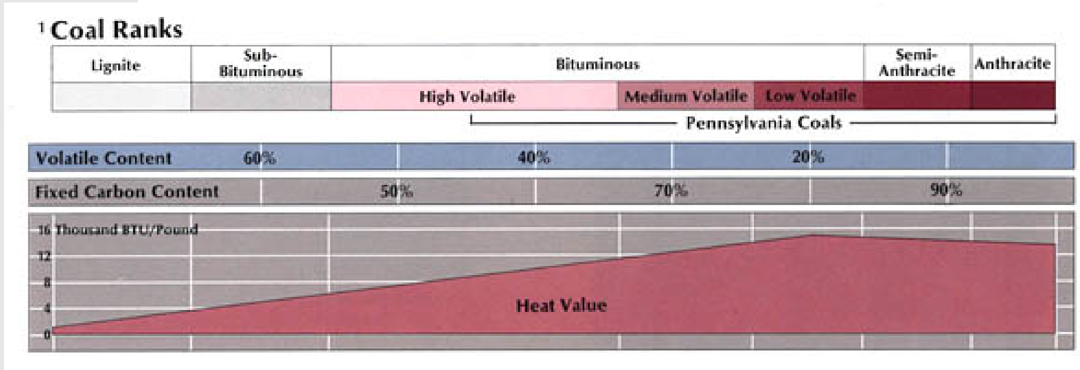

Figure 1.4 Rankings of Pennsylvania Coal (Source: Pennsylvania Atlas).

the grade of coal produced. It is this sequential change of state that most relates to the existence of anthracite coal in northeastern Pennsylvania, and in turn, the watershed. As the eastern seaboard was slowly pushed westward and folding commenced, pressure and temperature rose accordingly in moisture-rich landscapes of rivers, streams, lakes, ponds, and wetlands. In the Nescopeck watershed, it was this process of folding that produced not only the anticlinal axes of ridges with exposed summits, it is the reason why these ridges did not, in the timeframe of the region's coal extraction period, contain coal. Rather, it is the valleys, or synclines that held regularly formed coal basins with interstratified beds or seams (Figure 1.5). The coal that existed in the exposed ridges was washed away over the long span of geologic time. Even these valley deposits are but remnants of erosion processes, reflecting a minor portion of the region's vast original deposits.

It is this combination of naturally occurring factors; movement in the form of continental drift, time in the scope of geologic eons, pressure in the act of metamorphosis, temperature as a consequence of the preceding factors, abundant supplies of water, and hydrophytic forms of vegetation that produced these landscapes where coal would, for a time, be considered king. It was anthracite coal that fueled the furnaces of tenements and homes from New York City to Philadelphia from the mid-1800s into the early 1900s, revolutionized a number of industries, prompted a multitude of technological advancements, and drove mass migrations of people from the Old World to the New. It also propelled the United States past its great political and economic rival, Great Britain, in the Industrial Revolution, and ultimately caused the rapid and uneven growth of a single prominent regional industry whose advancement and decline had devastating effects on

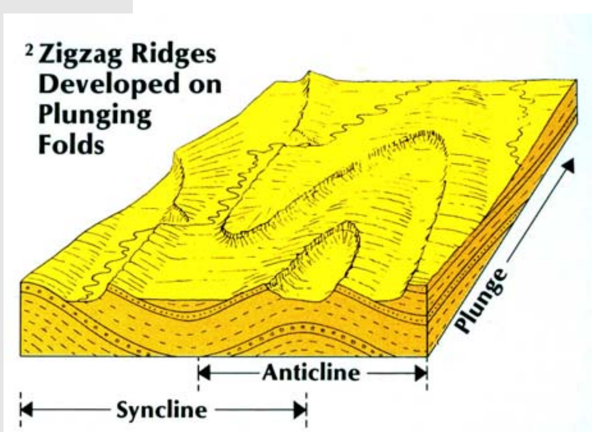

Figure 1.5 Graphic of anticlines and synclines (Source: Pennsylvania Atlas).

both the physical and cultural landscapes of an entire region (Rose 1981).

The Birth of the Anthracite Coal Industry

Coal was first discovered in Pennsylvania as early as 1750 below Saltzburg, in the form of bituminous coal. There are a number of legends and versions of stories that relate the first discovery and use of anthracite coal, with an early account appearing in Harper's Weekly in September 1857. The story related how a hunter, Philip Ginter, came across a large black stone along the Lehigh River in 1791. Thinking it was the "stone coal" he had heard about, Ginter gave the stone to Col. Jacob Weiss, who sent it off to Philadelphia. Although identified as anthracite coal, anthracite was considered an unproductive resource until a process was developed that allowed it to be effectively burned. It is interesting to note that the first shipment of anthracite coal to come out of the region in 1803 ended up as footpath surfacing material. However, after anthracite was found near Pottsville in 1810, blacksmiths began to find some degree of success with the material, and a Philadelphia chemist praised anthracite for its extraordinary heating potential. The inability to adequately fire anthracite coal produced yet another series of stories related to who was first able to burn it, and how it was done.

Coal and the Greater Hazelton Area

The history of Hazleton demonstrates the close ties between the physical and cultural landscapes of the region, and of the watershed. For in its unique geological setting are the essential factors of a coal-producing landscape; movement, temperature, pressure, water, and vegetation, while its geographical location promoted the development of paths, roads, and turnpikes. Isolated and almost inaccessible in a region of extreme physiography, with shifts in elevation from 500 to 1,700 feet and very steep slopes, hillsides of dense oak-pine forests and difficult-to-navigate streams, the original setting of Hazleton was a topographical nightmare. The summit of Broad Mountain stood approximately 1,700 feet above sea level, rising 800-900 feet above its valleys to the north and south. Measuring almost 12 miles at its widest point, the summit was not a table land; the ridges of Green Mountain, Prismire Ridge, and Spring Mountain pierced the terrain, while Beaver, Black, Deck, and Hazle Creeks drained the summit and formed narrow, wet valleys between the ridges (Aurand 1986).

Soil conditions accentuated the forbidding topography, with shallow and stony ridges that provided excellent drainage of the slope. Here,

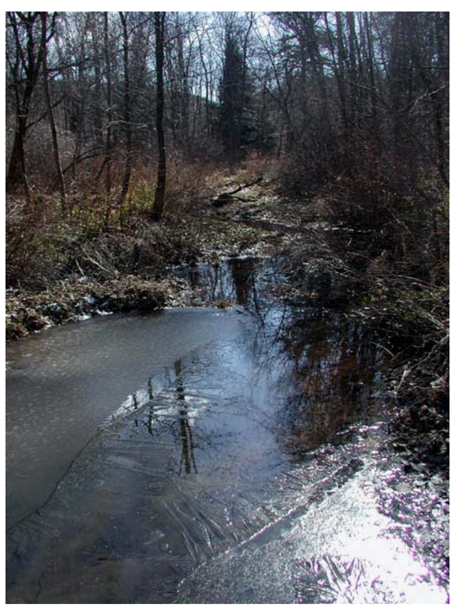

Image 1.17 Black Creek (Source: Project Team).

The Firing of Anthracite Coal

"…the proprietor of the Fairmount nail-works, with some of his men, had been engaged during the whole morning in the vain endeavor to fire up a furnace with the coal. They tried every possible expedient which skill and experience in other fuels could suggest. They raked it and they stirred it up, and poked it and blew tremendously upon it with blowers. They persevered in the task – they manipulated it with courage, with desperation – but it appears that all would not do. At length the signal for dinner was given, and utterly sick and tired of the stones, and with no complimentary epithets, the men shut fast the furnace door, pulled on their coats and proceeded to their meal. Returning at the usual time, their consternation may be imagined as they beheld the furnace door red hot, and the fire within seething and roaring like a tempest! They stood before it like men paralyzed and when, after a time they could summon courage enough to pry open the door, the white glare of the flames was beautiful to behold. Never before had such a fire been seen. And from that moment the secret of treating anthracite coal become know – it only required to be let alone."

(Source: http://www.standardspeaker.com/history)

The Eastern Middle Basin of the Anthracite Coalfields

This basin "…is remarkably free from faults or disturbances, to cause a waste of coal in mining, and the reader will observe, from the description, that, small as its area, it must have great depth. There is now a slope on the Big seam 800 feet in perpendicular depth below the surface. The full depth of the basin is estimated to be 1,500 feet. The Big seam is 30 feet thick, of which 18 feet is prime coal. Hazleton is a very small basin, but there is probably no more valuable coalfield of the same size in any other part of the world." (Source: Macfarlane 1877)

Image 1.19 Ario Pardee (Source: www.standardspeaker.com).

the ground was dry. Such was not the case in the narrow valleys below the ridges. These valleys were wet with sluggish creeks, offered poor drainage, and contained wetlands and vast areas of hazle (Aurand 1986).

Native Americans and early Euro-American explorers unenthusiastically named the area the Great Swamp or Hazle Swamp. Yet, neither could avoid the dismal region and its strategic location between the Lehigh and Susquehanna Valleys. Broad Mountain had to be crossed. Although two major paths intersected at the site of Hazleton, Native Americans never established a permanent village in the area. Hazleton was a place to pass through, not to settle (Aurand 1986). By providence, this region alternately also rests directly above the Mammoth Vein in the Eastern Middle Basin of the anthracite coalfields, which are divided into

Image 1.18 The anthracite coalfields of northeastern Pennsylvania (Source: Rose).

the Northern, Eastern Middle, Western Middle, and Southern respectively (Bradsby 1893, Rose 1981) (Image 1.18).

Coal and Transportation

The first recorded discovery of anthracite coal in the Hazleton area occurred in 1813, at Beaver Meadows. By 1826, John Charles Fitzgerald, a blacksmith from Conyngham, had found anthracite in the area and was reportedly attempting to fire it. As early as the next decade, in November of 1836, Ario Pardee (Image 1.19), the area's first premier coal baron, had formed The Hazleton Coal Company, which was incorporated on March 18, 1836. In order to bring his coal reserves into production and then on to the eastern markets, Pardee's company built the first railroad in the area at Beaver Meadows. Begun in 1833, the first trains ran from the Beaver Meadows station, down the incline planes, to the Lehigh Canal at Mauch Chunk in 1836 (Image 1.20). The local coal industry was born.

The diligence, vision, and consummate entrepreneurial attitude of Pardee, and others who followed him, cannot be fully appreciated without taking the wild landscapes of the region into consideration. This project necessarily involved impressive engineering achievements as tracks and trains climbed steep grades, snaked around ranges of mountains and penetrated valleys through water gaps where the streams had, over time, broken through mountain walls. Hence, it was this transportation to surrounding markets in relation to the native topography of the region that first necessitated a transitional advancement in the engineering design of track laying equipment, inclined planes, switchbacks, locomotive engines, steam power, and even the cars that were specifically designed to haul the maximum amount of anthracite possible. As such, this series of technological advancements affected not only the local region and the eastern United States, but also directly influenced American west-ward expansion, and ultimately, that of the developed and developing countries of the world (Rochester 1931, Miller 1998).

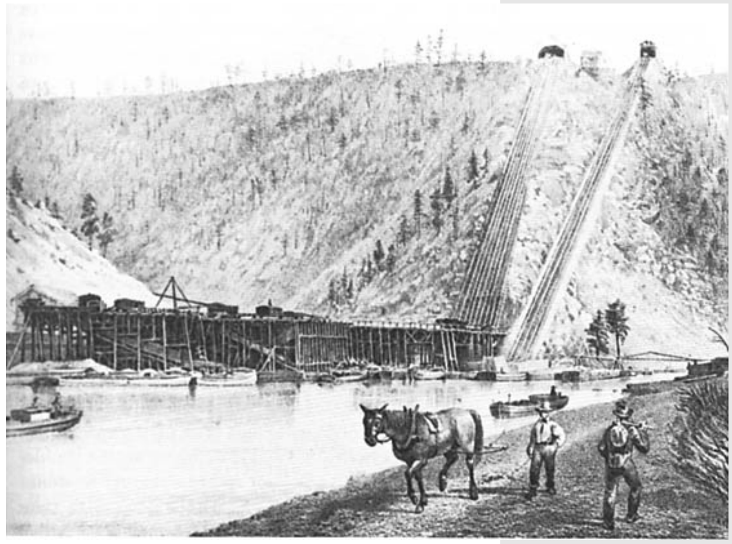

Image 1.20 The inclined plane and loading docks of Hazleton Coal Company, c.1860 (Source: Miller).

Coal and Settlement Patterns

Pardee's Hazleton Coal Company laid out the first *patchtown*, or *patch*, in the small village of Hazleton in 1836 and began selling town lots, making it one of the area's few *free towns*. Offering installment payment plans for employees to purchase the land and build their own homes, the first lots on Broad Street were sold for $150. In this way, Pardee provided the often-unattainable opportunity of home ownership for scores of poor, immigrant workers, who through their hard work and perseverance were afforded the chance of a stable future. This act of foresightedness and social commitment was the first of many community and humanitarian efforts provided by Pardee and his family. In contrast to the concept of the free town, the majority of patchtowns developed in the area were *company towns*, or those exclusively owned by the coal companies. These two prototypes, the free town and the company town, contributed the primary forms of settlement patterns developed in response to coal mining in the Greater Hazleton Area.

The majority of patchtowns in the watershed were developed between the 1830s and the 1840s. By the late 1880s, these isolated patches attended more than 30 mines, collieries, and breakers operating in the area. "In those days the patches often were referred to by number, and some of those tags remain today. Many old-timers still call South Church Street as "No. 6 Hill", after the name of a village and breaker that stood there. No. 3, near Harman-Geist Stadium, had a breaker and village, as did No. 7, located at the crest of the ridge that extends from Route 93 to Cranberry. Other coal works were located on 'Donegal Hill' on Hazleton's South Side and at Bunton Bock, in the area of the East End Playground. The biggest patches in Hazleton proper were Laurel Hill, at the western edge of today's fashionable Laurel Hill Terrace, and Upper Mines, on the west end near the No. 1 colliery" (StandardSpeaker.com).
Other entrepreneurs quickly followed in the footsteps of Pardee, establishing mining operations and patchtowns across the watershed's coal regions.

Free Towns vs. Company Towns

"One was free, with individual property owners holding land in their own names, and the other was the company town, where every parcel was the property of the company. On the Mountain, only Hazleton and Freeland were free towns. The company towns were called patchtowns and were built facing the mines; they tended to be small and isolated, made up of a row or two of standardized double houses, each half rented out to a family" (Rose, 1981).

Bradsby's Listing of Patchtowns

Jeansville, Latimer, Sugarloaf, Laurel Hill, Japan, Harleigh, Beaver Brook, Cranberry, Crystal Ridge, Stockton, Lumber Yards, Humbolt, Hollywood, Milnesville, Foundryville, Ebervale, Drifton.

The Jeddo Tunnel

"Jeddo tunnel is one of the most important improvements so far introduced into the coal industry in the anthracite regions, its daring projector being John Markle, who was president and chief engineer of the company. Like most of the world's advances, it is the creature of a commanding necessity, and had its origin in the following: On June 20, 1885, about twenty-eight acres of ground over the Harleigh mine caved in. This extended close to the Ebervale workings. About a year afterward, for fear that the immense body of water would crush the barrier between the two mines, the Ebervale Coal company drilled six holes through the barrier to release the water into the Ebervale mine, from whence it was pumped to the surface. The workings were profitably mined from that time on to January, 1886, when one of the heaviest rain storms flooded nearly every mine in this section" (Source: Bradsby 1893).

George B. Markle, whose operations included patches at Jeddo and Foundryville, and Eckley B. Coxe, whose coverage included Eckley and Drifton, along with their respective families, became involved in a variety of interrelated ventures; including mining, railroads, banks, and politics. These families established a core of power and influence within the greater Hazleton social and business hierarchy.

Unique in an era of industrial expansion and monopoly, these families were able to hold off such influential magnates as J.P. Morgan, and other eastern powerbrokers, by forming coalitions and retaining autocratic control over the region and its resources. One of the key reasons these families were able to retain absolute control lay in an innovative approach to the constant development of technological and industrial processes and practices. George B. Markle, a born mechanic, introduced many valuable improvements and inventions in mining machinery that would revolutionize the coal industry (Bradsby 1893). Nevertheless, the Markle surname remains infamous

Image 1.21 The Jeddo Tunnel (source: Project Team)

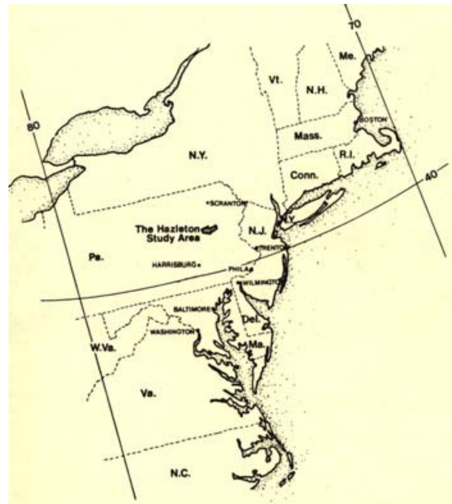

Image 1.22 The northeastern United States (Source: Rose).

due to the part John Markle played in developing the bane of the watershed, the Jeddo Tunnel. Interestingly enough, at the time of its construction, the Jeddo Tunnel was hailed for its initiative and praised for alleviating a constant problem within the deep mines of the area, that of flooding (Image 1.21).

The Era of Great Change

The importance of the Hazleton region should not be underestimated. For the "…northeastern portion of the United States was the major platform for the Industrial Revolution in the country, and the Hazleton region was, from the beginning, an integral part of the vital energy supply (Rose 1981) (Image 1.22). The phenomenon of the Industrial Revolution was fueled by the extraction of natural resources at unparalleled rates and with abundant labor forces. Anthracite coal was one of these resources in the United States, and it was now accessible to the urban markets for use as an industrial and domestic fuel source. Pushed by the economics of supply, demand, and scarcity, fueled by rapidly growing populations, and pulled by trade and the promise of profits and affluence, developing industries accelerated creative advances in science and technology.

Yet, coal mining demanded something in return; it fed upon great quantities of labor, resulting in extensive migrations to the extraction areas. This mass movement of people emigrating from Europe was unprecedented in the history of the world. Up to 1845, 5 million people had left Europe, but between 1851 and 1920, 40 million Europeans emigrated, with as many as 30 million coming to the United States. These great migrations altered the global balance of power, as predominantly white European populations flowed into the rapidly industrializing United States, forming the basis of its extensive labor pools.

In response to the changes wrought by the Industrial Revolution and mass immigrations of people, the eastern cities of the United States were rapidly filling up, placing great demands on the hinterlands for supplies of food and raw materials. Philadelphia grew from a small urban city of 67,811 in 1800 to 388,721 by 1850, an increase of 174%, and became a major manufacturing city. The demand for coal to make iron, fuel train engines, and heat the rapidly increasing number of homes made the nearby anthracite fields an opportunity and a resource not to be ignored (Rose 1981).

Migrations and Urban Growth

Single men initially responded to the promise of growth and prosperity, while later immigrants came as extended family groups. On occasion, whole neighborhoods or communities arrived as one unit to reestablish cultural patterns on American soil. In the watershed, new communities and patchtowns grew up around the old or were started from scratch to accommodate the massive influx of workers and the transitory existence of the coal mines. These dynamic changes prompted community formation, fragmentation, and disintegration, along with the advancing problems of labor management and unrest associated worldwide with

Image 1.23 A nineteenth-century coal miner (Source: Miller).

the development of energy resources. Successive waves or shifts in population deeply affected existing communities, as new workers generally followed ethnic patterns different than those preceding them. The earliest immigrants, escaping poor wages and conditions in their native countries, came from England and Wales. They were skilled in the practice of coal mining and quickly found strong positions in the burgeoning industry. After the Welsh and English, came the Irish, followed by mass immigrations of Slavic and Italian ancestry (Rochester 1931).
A booming economy and increased need for anthracite brought new waves of Eastern Europeans who were largely unskilled. Even though

The Industrial Revolution

"The phrase 'industrial revolution' ought to be reserved for this unprecedented expansion with its repercussions on every phase of economic, social, political, military, and intellectual history. The industrial revolution proper led to mining, the manufacturing, and the transport industries to dominate the economic life of nations, and brought a majority of all the workers in these industries to labor for wages away from their homes in establishments with more than a score on their payrolls. It made common for the first time vast industrial enterprises with thousands, even tens of thousands of employees. It led to widespread replacement of manual labor by machines, to the regulation of work by machines instead of by the independent decisions of men. It made possible the construction of wagons, boats, airships, and even whole cities in iron, steel, glass, and reinforced concrete…the industrial revolution harnessed much of the world's work to power, artificially obtained from coal, oil, and hydroelectricity, and perhaps eventually from atomic energy" (Nef 1963).

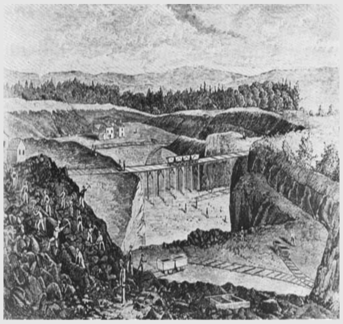

Image 1.24 The Summit Coal Mine, near Hazleton, Pa (Source: Rochester).

Image 1.25 A coal breaker operation (Source: Miller).

Breaker Boys

The majority of workers were young boys, or 'breaker boys', whose small hands fit in the machinery's tight confines. "Older and disabled miners often worked with the breaker boys, hence the miners' saying – 'twice a boy and once a man is the poor miner's life' (Source: Miller).

relegated to lower paying and less desirable jobs, they soon outnumbered the earlier groups. Already tense conditions were exacerbated by the enforced isolation and separation of the patchtowns imposed by mine owners who actively engaged in practices to oppress and control the growing mining populations (Rochester 1931).

Life in the Coal Mines and Patchtowns

Many workers and their families were given no option but to deal with company services, provided at a premium, due to the isolation of the patchtowns, the absence of transportation to adjacent areas, and practice of paying wages with company script rather than currency. This exploitation covered all necessities of daily life, from food and clothing to housing, with the company controlling virtually every aspect of their existence. Life was hard in the coalfields, and coal mining was the most dangerous occupation in the county.

Coal mines filled with immigrants as Americans pursued their fortunes out west, rather than in the cold, dark, wet, and lonely recesses of an unforgiving earth. Accidents and fatalities were commonplace at the peak of anthracite mining, with almost daily newspaper accounts of death and injury, generally from falling rock within the mines. Hazards associated with falling rock were directly tied to supervisors and mine owners who did not allow adequate compensation, time, or materials for sufficient supports in the tunnels (Rochester 1931).

Image 1.26 Workers in a coal breaker operation (Source: Miller).

Corollary impacts of these injuries and fatalities necessarily fractured miner's families. In a cruel paradox, families were traditionally large with many children who worked long hours to help support the family. Nearly one-quarter of all mine workers were under the age of 25, and of these young workers nearly one-quarter were between the ages of 14 to 18 (Rochester 1931) (Image 1.26). However, with the loss of the primary means of support, widows, lacking financial stability, had no choice but to turn to the courts for relief as large numbers of children were separated and given up for adoption.

Additional problems facing both immigrant populations and governments were the lack of health services and education. Immigrants looked to governments for the provision of these and other services, while governments, often corrupt and controlled by business concerns, looked upon the immigrants as lower class, non-American, transient populations (Rochester 1931). Compounding these issues were the increasing amounts of ecological degradation, competition for scarce resources such as clean water, inadequate public sanitation, cave-ins resulting in property damage and death, variable work hours, and economic depressions and recessions in the demand for coal.

Established communities, facing massive changes with each inundation of new immigrants, had their own cultural and social patterns and practices sectionalized across ethnic lines. Mute evidence of these vast cultural fluctuations remain today in the proliferation of ethnic neighborhoods and churches across the post-mining landscapes of the Greater Hazleton Area. However, as with much of the heritage of this region, what arose from these diverse and tempestuous beginnings is the rich cultural mélange celebrated in the vibrant contemporary character of the watershed.

Depression and Recovery

The first real explosion of population within the watershed came with the opening of the anthracite mines on a commercial basis in the 1830's. Around 1867, the price of coal started falling. The Civil War had ended and the demand for coal was not growing as rapidly as it had been during the peak years.

Emerging from the post civil war depression, new technologies like electricity, chemicals, and the petroleum-fueled automobiles were taking over. As the depression took hold, the Pennsylvania Legislature allowed transportation companies to own coal lands beginning in 1873, when the Lehigh Valley Railroad purchased more than 30,000 acres of such land (Rose 1981). The number of workdays of the miners declined resulting in wage cuts. Simultaneously, a new wave of Eastern European immigrants trickled into the coalfields. Conflicts within the ethnic groups escalated the tensions amongst the already segregated mining factions. As the country buried deep into the depression, well-respected coal companies and railroads faced bankruptcy. On the brighter side, communities continued to mature and they started paying increasing attention to the education of children working in the mines.

This was an era of changing technology in the industry. Electrification of Hazleton and surrounding areas provided a tremendous boost to the establishment of textile industries that set up shop wherever cheap labor and affordable electricity were located. These new forms of energy were used in many technological innovations that made mobility easier. One such innovation was the trolley system built in Hazleton in 1893. The Hazleton Board of Trade, a precursor of the Chamber of Commerce, was established in 1896. This was a major step undertaken to diversify the economic and social base of Hazleton and the surrounding areas. There was an increase in the numbers of businessmen, small manufacturers, and professionals in the urban areas. By the beginning of the 20th century textile mills, particularly silk mills, employed large populations in the region. The textile industry provided employment mainly for women and kept the region from going into extreme depression (Image 1.27). Even though these industries kept the region afloat during difficult times, they also exploited the situation by slashing the wages of women workers who often times were the only earning member of their families.
By 1900, the ethnic diversity had increased with many immigrant groups moving into the area. They

Definition of Cultural Ecology

"A study of how and why humans use Nature, how they incorporate Nature into society and what they do to themselves, Nature and society in the process (Rose 1981).

The Drifton School of Industry

In 1879 Eckley Coxe opened the Drifton School of Industry. However, it was only in 1895 that the Commonwealth of Pennsylvania made it compulsory for the children to attend school (Rose 1981).

Image 1.27 Duplan Textile Mill in Hazleton, Pa., 1917 (Source: www.standardspeaker.com).

Image 1.28 North Wyoming Street after the turn of the century (Source: www.standardspeaker.com).

began indulging in small time occupations like vendors selling essentials to the inhabitants of the patchtowns. Even though the region was economically improving, the coal towns were still depressed, with crime and fraud rates at an all time high. In spite of the adversities and vagaries of life, the interaction laid the foundations of a social and community living. The Eastern European immigrants had assimilated and adopted the way of life of this region and the overall industrializing country.

The leading coal company owners like Coxe and Pardee were selling their company lands to railroad companies and were fast turning into elite members of society. By 1936, both coal and transportation slipped into the hands of banks, investment houses, insurance companies, and industrial firms based in New York and Philadelphia. Major mining strikes in the years 1897, 1922, and 1925 further crippled the mining industry that was already reeling under the pressures of declining wages and rapidly rising costs of living. On a social and cultural front, the mining companies worked hard at maintaining factions amongst the mining workers of various origins. The coal industry was on a rapid decline: the cause being the rise of the petroleum oil industry. Petroleum was becoming a popular commodity not only in the industrial world but in homes as well. This changing energy bias of the people and the countries across the globe was responsible for the decline of small towns like Hazleton that were solely dependent on a single resource such as coal.

Rose, in his study of Hazleton, points out that coal production and an increase in population went hand in hand during the early 1900's (Rose 1981). This was a result of increased immigration. The dangers of working in the mines were reflected in the increasing numbers of orphaned children and widowed women. However, the total population of Hazleton reached a peak in 1940, almost 23 years after the peak coal production year (Rose 1981). This suggested that many retired mine workers had made this their home partly because the lure of coal was not yet over and during the depression this area offered opportunities similar to any other town. In fact, there is evidence to suggest that some people even returned here because it was cheaper to survive in this area during the difficult times. Simultaneously, the social structure and composition of the society was changing with more and more men having to travel to nearby areas for work and women taking up the role of primary breadwinners for their families.

Technological change from rails and coal to autos and petroleum caused a change in the pace of life, structure, and settlement patterns. Culture also responded to this technological challenge. The failure of the coal industry and the private sector encouraged the public sector to step in and save the day. The meaning of "progress" was changing from selfish pursuits of private interests to a more holistic development of the community, their educational standards, health, and nutrition. The public sector helped by funding new industries in the anthracite coal region through local development boards. Few members of the government were quick to realize that extended periods of unemployment would disintegrate the structure of the community. By 1955, with anthracite no longer economical to use, the community had to become involved in looking for alternatives to sustain themselves. At the onset, location and accessibility proved to be a deterrent to many groups interested in setting up industries within the watershed. Problems were many but they still had the most coveted asset –labor.

The period following World War II was dotted with uncertainty and turbulence. The diminishing need for anthracite coal and rapid technological changes forced many people working within the watershed into unemployment. But the willingness and enthusiasm to improve their life and surroundings was still alive within the community. Prominent and willing community members formed groups such as the Greater Hazleton Veterans Association with the aim of gathering people who had the means to provide jobs for the community. The Chamber of Commerce contributed by sponsoring the Hazleton Industrial Development Corporation (HIDC) to mobilize the economy. All the efforts of HIDC to entice businessmen or corporations to set up their operations within the Hazleton area proved futile, due to inadequate planning and delay of projects that forced the new entrants into bankruptcy. A community struggling to make ends meet was pushed further into economic decline, during the period 1949-1955, when textile industries were taking over from coal and employing females. The final blow came in 1955 when Hurricane Diane struck, inundating deep mines, destroying homes and equipment and overnight causing the loss of thousands of jobs. Left in despair people started looking elsewhere for opportunities.

The people of the community tried their best to keep their spirit of hope alive through small drives backed by the Chamber of Commerce. These were like a drop in the ocean but were successful in raising the self-confidence of people and stressing the importance of people power. The CAN DO was born out of this vision of broad based community effort.

In the effort to change peoples negative attitudes towards collective effort and progress, Dr. Edgar L Dessen, coined the name "CAN DO" which shortly afterwards became the acronym for "Community-Area New Development Organization".
CAN DO was successful in creating full-time employment for the community in Hazleton as well as the surrounding areas. This spurred development of small communities throughout the rural watershed. Attracting small companies to its newly developed Valmont Industrial Park was not enough; they had to facilitate transportation of goods. The people at CAN DO lobbied hard to acquire an Interstate highway interchange near Hazleton. (Rose 1981)
The chemical industry formed a major industrial segment followed by metal fabrication and textiles. Thus continued a period of dynamic change within the community as well as the landscape. Industries stepped in, settled for a while and then moved on. This pattern was replicated in the members of the community who were drawn into the area in search of jobs and moved on once the jobs were gone. This frequent movement left gaping holes in the structure of the community from time to time.
Whereas, on one hand CAN DO has been applauded for promoting industrial development and providing jobs within the community, it has also

THE CAN DO STORY

"Its mission would be to involve the entire community to raise money, to represent all facets of the public on the board of directors, to acquire land for development of an industrial park, to develop the land provide the infrastructure and to erect speculative industrial buildings. A huge order for any community!" (Source: "Upon the Shoulders of Giants" – THE CAN DO STORY).

faced criticism from various members of the community. Along with the much needed industries have come polluting ones too, making industrial waste disposal and recycling an issue in the watershed. With an increase in the level of awareness, the local community is stressing the need to bring in white-collar jobs into the region rather than polluting industries. This is a challenge that CAN DO has to address to keep alive their mission and aim of uplifting the community living within the area.

The development and spread of communities outside of Hazleton has decentralized the downtown and has been responsible for the segregation of the communities. This segregation is evident right down to the present day and even now resurfaces at various levels of the social and economic structure. Strong local affiliations are missing. The movement of the affluent people to Conyngham Valley has affected the settlement pattern within this primarily agricultural belt.

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Economics

1900s

Anthracite mining in the U.S. reached its peak in 1917, with 100 million tons produced. Anthracite production was vital during WWII to feed the Allies' war machine. Over 20,000 miners were working in the watershed at this time.

Mining jobs decreased from 20,000 in the 1940s to 2,300 by 1957. Almost 70% of all employed people in Freeland and White Haven Boroughs and Foster Township worked in the textile or apparel industry. In general, though, there were few jobs available in this region. Between 1930 and 1960, up to a third of the people had left due to a lack of work. The mining industry also had an affect on the physical landscape. Mines, quarries, and gravel pits have stripped between four and seven percent of the land area (Dolence 1998).

Current Economic Condition

In 1999, the Luzerne County coal mining industry employed less than 200 people (Fig. 1.6). Nine companies were listed in anthracite mining, each employing less than 20 people. There were two bituminous coal companies, each employing less than 20 people. Total payroll for the mining sector was $5,392,000 in 1999. Fifty to 70% of the coal resources in Luzerne County have been mined. Production of anthracite in Pennsylvania is extremely low compared to what it once was. Despite these low numbers, anthracite mining remains an important economic activity. Nationwide, 11.6 million tons of anthracite were mined in 1996 alone. Many homes, industries, and governmental buildings still burn anthracite as a source of heat. New cogeneration power plants also burn anthracite. Titanium manufacturers also burn this type of coal for its high heat and clean burning qualities. The cogeneration industry

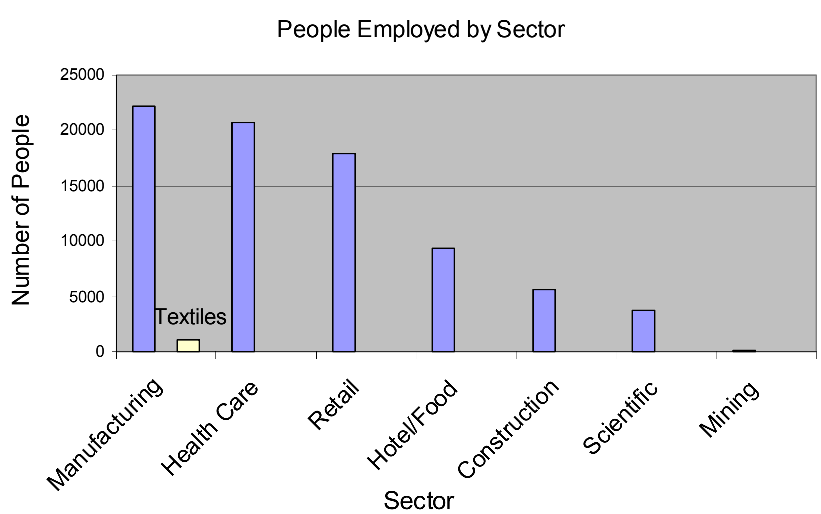

Figure 1.6 Luzerne County Employment by Sector (Source: Census 2000).

in particular often makes use of culm banks and alkaline coal ash, thus reclaiming abandoned mine sites.
In Luzerne County the manufacturing sector employs the highest number of people with 22,159 in 397 companies. They also generate the highest annual payroll. In 1999, it was $671,754,000. The next greatest sector is health care/social assistance with 20,674 employees among 877 companies. Annual payroll expenditures for this sector were $554,172,000 in 1999. Professional/scientific/technical jobs make up a small portion of the economy in terms of numbers, with 3,806 people employed in 543 companies, generating $118,593,000 in annual payroll (Census 2000) (Figure 1.7).

The current economic trends will favor technical and business related jobs, such as finance and research and development. Fewer workers are generally needed in manufacturing as processes are automated, methods are increasingly efficient, and raw material handling is improved. Also, technical and business related jobs usually pay higher wages and are less susceptible to swings in the economy. One concern for many downtown retail businesses is the increase in large regional shopping centers. These centers outside the watershed draw customers away from the downtown businesses. Companies

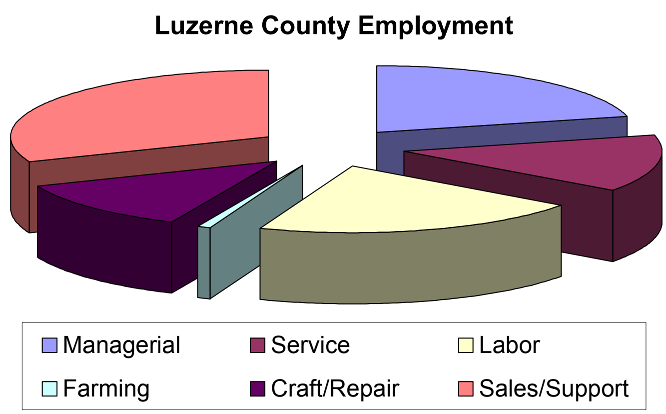

Figure 1.7 Employment in Luzerne County (Source: Census 2000).

Economic Incentive Zones

Keystone Opportunity Zones, or KOZs, are present in much of the Nescopeck Creek watershed. KOZs exempt certain industries from paying local and state taxes from one to twelve years. There were 1,285 acres originally designated as KOZ sites around Hazleton. The Greater Hazleton area now contains 20% of the KOZ zones in Pennsylvania. Also present are Keystone Opportunity Expansion Zones, or KOEZs. These economic zones grant tax exemptions until 2014.

sometimes find it cheaper to clear land and build a whole new store that meets their current corporate image than to renovate an abandoned building or lot closer to downtown. Another concern is the sprawl created by the interstates and interchanges near new businesses on the outskirts of town. While the road systems are and always were a boon to development, they promote freight and warehousing jobs over other, generally higher paying work.

Local Government
Like most watersheds, the Nescopeck Creek watershed crosses numerous local government jurisdictions. In fact, the watershed spans three counties, one city, 13 townships and five boroughs. Most of the watershed is in Luzerne County, with small portions extending into Schuylkill County and Columbia County in the southwest corner (Figure 1.8).

Township areas within the watershed range between 31 sq. mile (Butler Township) to 1 sq.mile (Bear Creek Township). Townships that compose a majority of the land area include Dennison, Black Creek, and Sugarloaf (Figure 1.9). Hazleton is the only city, while boroughs include Freeland, Jeddo, West Hazleton, Conyngham and Nescopeck.

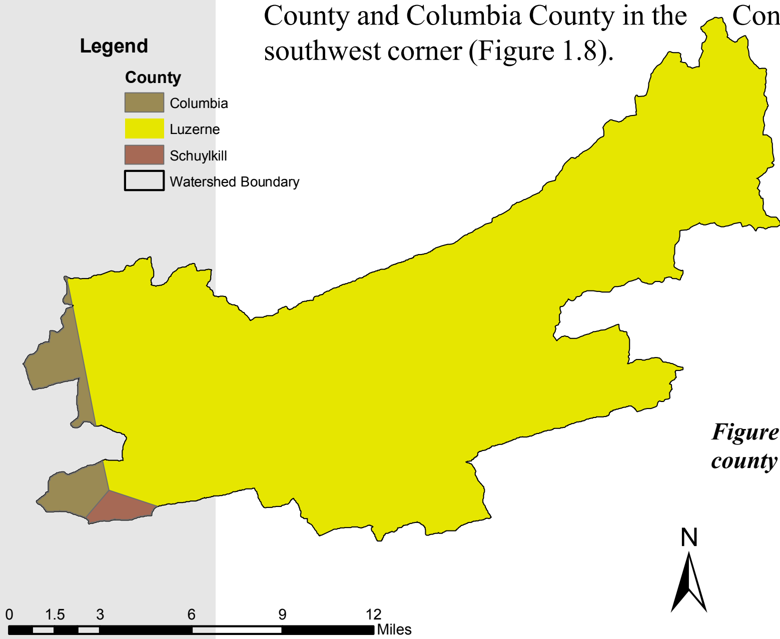

Figure 1.8 Proportion of land from each county found in Nescopeck Creek watershed.

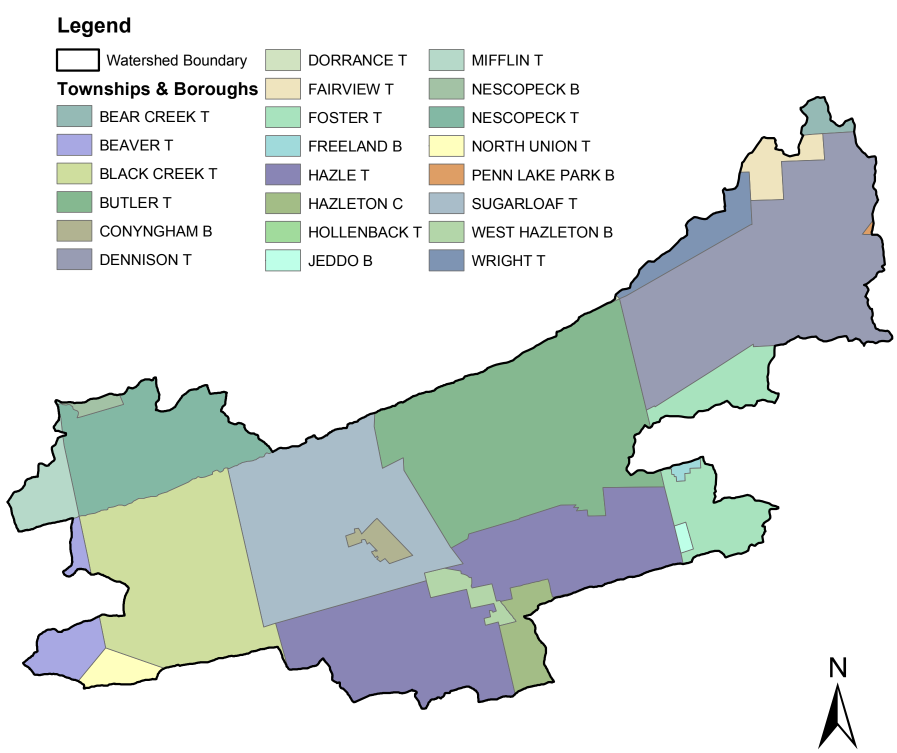

Figure 1.9 Municipalities with jurisdictions located in the Nescopeck Creek watershed.

Infrastructure

Transportation

Several major transportation routes pass through the Nescopeck Creek watershed. These important routes transport goods and people on a local and regional level. Interstate 80 connects Michigan and Ohio to east coast cities. Interstate 81 connects Scranton and Wilkes-Barre to Harrisburg and beyond. State Route 93 connects Berwick to White Haven along the Lehigh River. Route 309 connects the northern part of Luzerne County to the southern part. (Figure-1.10)

The Nescopeck Creek watershed has approximately 910 miles of total road length, including interstates, state and local roads. The Nescopeck Creek sub-watershed contains the highest percentage roads present in the watershed (31% or approximately 286 miles) followed by the Black Creek sub-watershed (28% or around 253 miles). The Little Nescopeck Creek sub-watershed contains 13% of the roads (122 miles) and Long Run has 12% (113 miles) of the total road length.(Figures 1.11 and 1.12)

Roads have implications on the health of the entire watershed if pollutants from the road surfaces discharge into streams. A large proportion (87 %) of the total stream length in the Nescopeck Creek watershed (218 miles) lies within 332 feet of roads. In addition, approximately 40% of total stream length lies within 100 feet of roads. (Source: Project Team) Thus any increased pollution on roads can affect large stream lengths within sub-watersheds.

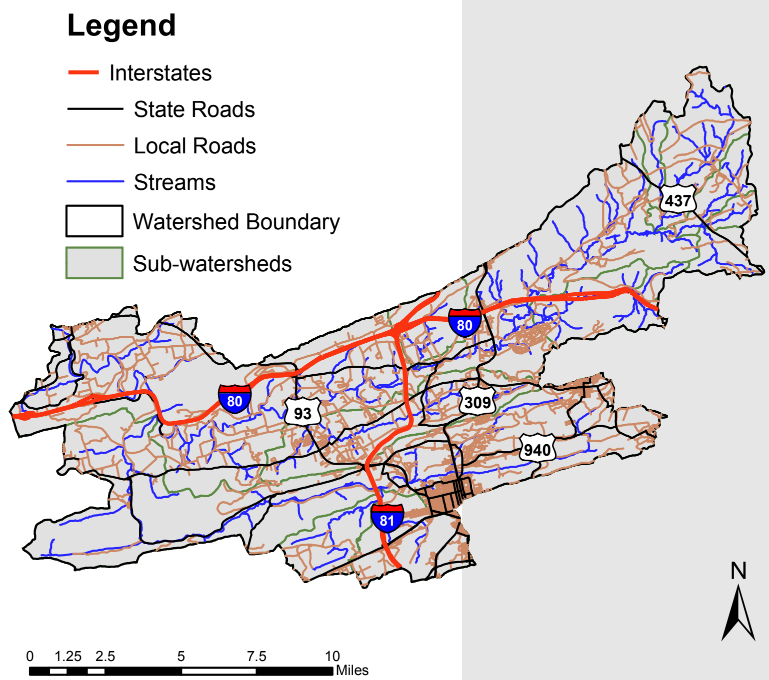

Figure 1.10 Road network within the watershed.

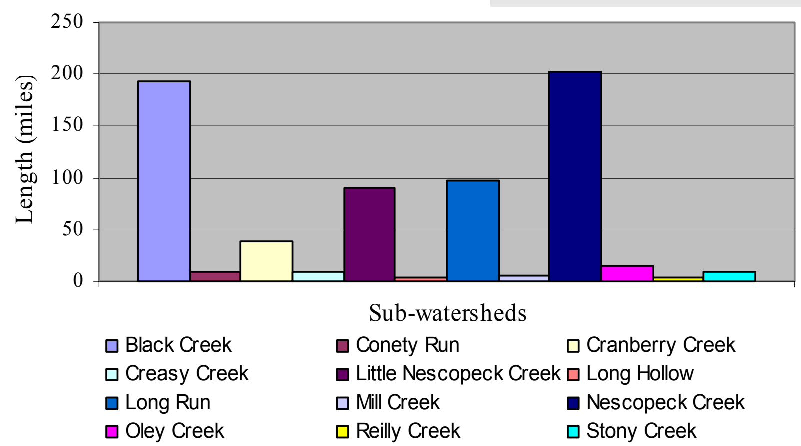

Figure 1.11 Chart showing the length of local roads in each sub-watershed.

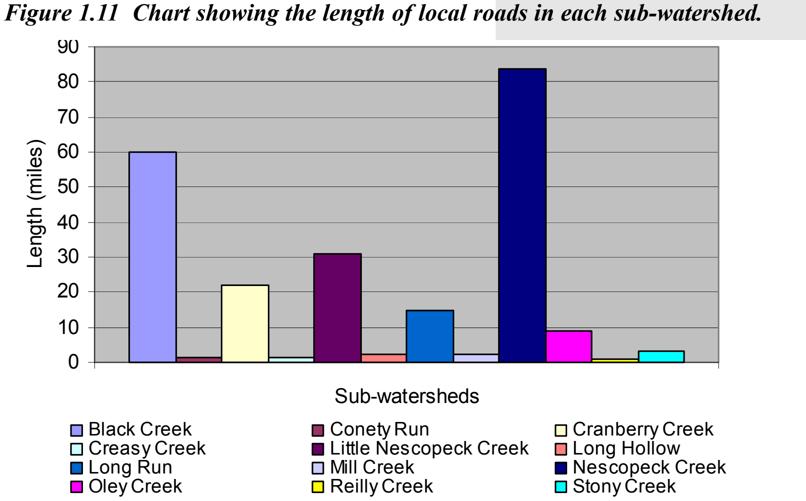

Figure 1.12 Chart showing the length of state roads in each sub-watershed.

CatHoles

"Cat Holes" are holes 4"-6" deep, dug in the top organic layer of the soil for the disposal of human waste. They are later covered with the soil that was removed from the site and are mainly constructed in camping sites that lack toilet facilities. Cat holes should be located at an appropriate distance (320-640 ft) from water bodies to avoid risk of contamination (Source: www.yournet.com/notrace.html).

Stormwater Management

During a rain event, water that flows over the surface into nearby streams and lakes is called surface run-off or stormwater. It is a vital link in maintaining the hydrological balance of the earth. A portion of this water infiltrates into the ground through the soils and recharges the aquifers. Increase in urbanization causes an increase in impervious surface, causing this water to flow quickly over the surface and by reducing infiltration into the ground. Stormwater management entails bringing surface runoff, caused by precipitation events, under control. Proper stormwater management principles can be incorporated to reduce the amount of storm run-off and improve the water quality within the watershed.
Combined Sewer Overflows (CSOs) refers to overflows into water bodies from sewage treatment plants when they exceed their capacity. This usually happens during periods of heavy rainfall, snowmelt or leakage from sewer lines. These overflows not only contain stormwater but also untreated human and industrial waste, toxic materials, and debris. They are a major water pollution concern for cities with combined sewer systems (Source: http://cfpub.epa.gov).

Sewer Systems
Within the Nescopeck Creek watershed, individual townships and boroughs control sewer systems. Townships own sewer treatment plants or make use of the neighboring treatment plants. Some boroughs pump their sewage out of the watershed to nearby plants. The Greater Hazleton Joint Sewer Authority operates one of the major treatment facilities for Hazleton, West Hazleton and approximately 10% of Hazle Township. Approximately 45% of Hazle Township is served by individual septic tanks. Some of the sewage is also disposed in "cat holes" and mine shafts.

According to the Hazle Township Planning Commission, the remaining areas within the township will be connected to a sewer system within the next three years and served by the Greater Hazleton Joint Sewer Authority (Image 1.29). Another treatment plant is located in the town of St. Johns in Butler Township and serves the area east of Interstate 81. The remaining area of Butler Township has on-site septic systems. A sewer line running along SR 2040 in Dennison Township serves around 117 homes and carries the sewage to the White Haven borough treatment plant while the rest of the township has septic systems. Within Black Creek Township 20% of the area is served by the Eagle Rock Sewage Treatment plant. The rest of the township has on-site septic systems. The Conyngham Borough Treatment Plant serves only 10% of Sugarloaf Township. The Dipple Manor area transports sewage to the Greater Hazleton Joint Sewer Authority Sewer Treatment Plant. Most lots in the Nescopeck Creek watershed have on-lot septic systems.

Stormwater Systems
The Luzerne County subdivision and land development ordinance requires the townships to provide protection from 10 to 100 year storm events. Although the county has adopted Stormwater Management Act 167, stormwater management systems do not exist for most of the townships within the Nescopeck Creek watershed. Stormwater from the urban areas of Hazleton and West Hazleton is diverted to Black Creek. Inspection of the conveyance facility at Black Creek showed traces of Combined Sewer Overflows (CSOs) (Wnuk et al. 1999). This may affect the quality of water in Black Creek. Within Hazle Township, 10% of the area has storm sewers that convey the stormwater into Black Creek, Hazle Creek and partly into Tomhicken creek. The majority of stormwater in Hazle Township is allowed to flow naturally into the nearby creeks, ponds, and wetlands, or into existing right of ways owned by agencies like Penn DOT.

Image 1.29 Greater Hazleton Joint Sewer Authority Sewage Treatment Plant (Source: Project Team).

Recreation

Outdoor recreation plays a major role in the mental and physical well being of a community. Many existing facilities within a watershed contribute in providing recreational opportunities for the people of a watershed. Recreation opportunities within the Nescopeck Creek watershed are diverse, ranging from fall foliage driving tours, golf courses, Nescopeck State park, Eckley Miner's Village, and water related activities. Most opportunities are located on privately owned lands and are well distributed within the watershed for easy access. Outdoor activities include backpacking, biking, camping, fishing, hiking, hunting, boating, Kayaking, rafting and various winter sports. All these activities make the Nescopeck Creek area an exciting place, offering recreation opportunities to various age groups. (Figure 1.13)

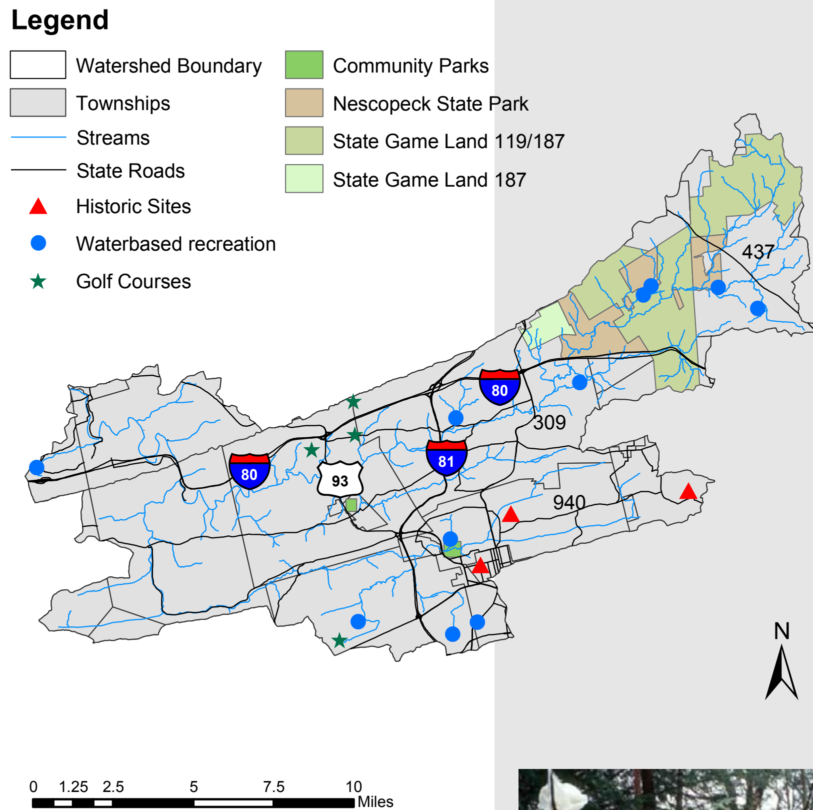

Figure 1.13 Recreation areas within the watershed.

Nescopeck State Park

Nescopeck State Park, encompassing approximately 3,550 acres, is located in the northeastern part of the watershed. Undeveloped natural areas surround the park, with its picturesque stream valleys and mountainous landscape. The park was established on October 3, 1968. It is conveniently accessible to the residents of the Nescopeck Creek watershed as well as surrounding areas due to its proximity to Interstates 80 & 81, the Northeast Extension of the Pennsylvania Turnpike and State Routes 11 and 309.

Lake Francis forms the focal point of the Nescopeck State Park and offers water-related recreational opportunities. Nescopeck Creek runs through the center of the park and provides opportunities for trout fishing. The park provides both day-use and overnight camping. A major portion of the recreation area provides passive recreation through undeveloped forests and wetlands and a small portion provides active recreation through a network of trails, an environmental education center, and picnic areas. With future plans of linking it to Lehigh Gorge and Hickory Run State Parks, the Nescopeck State Park is vitally important to the survival of many rare species and critical habitats. Additional information about the park can be obtained from www.dcnr.state.pa.us/stateparks/parks/nes.htm

Image 1.30 Nescopeck State Park Volunteers (Source:Diane Madl).

Image 1.31 Unidentified fern, Nescopeck State Park (Source:Diane Madl).

Image 1.32 Nescopeck State Park (Source:Diane Madl).

Image 1.33 Oley Creek near Beech Mountain Lake in Butler Township (Source: Project Team).

Image 1.34 Beech Mountain Lake in Butler Township (Source: Project Team).

Image 1.35 Beech Mountain Lake in Butler Township (Source: Project Team).

Community Parks

The parks within the urban areas, like the Community Park in West Hazleton and the Whispering Willows Community Park in Conyngham, provide respite in the form of community open spaces within densely populated neighborhoods. As evidenced by the children using these parks, these serve as convenient areas for enjoying the outdoors.

State Game Lands (no.187 & no. 119)

State Game Lands in the headwaters of the Nescopeck Creek watershed are a source of outdoor recreation like hunting, fishing, and hiking.

Golf Courses

Golf clubs in the watershed are owned by private resort companies, like the Eagle Rock Golf & Ski Resort in Hazleton, Sand Springs Golf Course and Edgewood in the Pines in Butler Township, and the Sugarloaf Golf Club in Sugarloaf Township. The Eagle Rock Resort in Hazleton also offers facilities for skiing, snowboarding, and snow tubing.

Water related activities

Reservoirs, lakes, and ponds provide water sport recreation opportunities. Knecht Dam (Mifflin Township), Olympus Lake and Ray T. Mantz (Dennison Township), Lake Irena and Beech Mountain Lake (Butler Township) are used for recreation and Humboldt reservoir (Hazle Township) is used to supply drinking water.

Cultural events

Various recreational and cultural events take place in and around the Nescopeck Creek watershed. Important among these events are the Fun Fest in downtown Hazleton during September (Image 1.37) and Valley Day in Conyngham Valley. The Bloomsburg Fair (September) is the largest country fair in Pennsylvania and it honors the regions agricultural history.

Image 1.36 Children using the community park in West Hazleton (Source: Project Team).

Eckley Miner's Village

The Eckley Miner's Village is an 1854 "patch town" museum located in Eckley. It replicates a typical coal miner's village of 58 buildings – miner's houses, churches, doctor's

Image 1.37 Fun Fest on Broad Street in downtown Hazleton (Source: Project Team).

office, and general store. The miners' village is located on 82 acres in the heart of the anthracite coal region. It is a National Historic Register site and is administered by the Pennsylvania Historic and Museum Commission. It is a popular tourist destination for people interested in the typical community structure of a "company town".

Tourist programs include an Anthracite Lecture Series, Patchtown Days, Family Sundays, Civil War Encampment, and Christmas in Eckley. Visitor services include guided tours,

Image 1.38 Eckley Miner's Village (Source: Project Team).

orientation films, exhibits, and a museum store. Eckley's stark landscape was originally preserved for filming of "The Molly Maguire's " in 1968. Volunteer support for running the museum is provided by members of the Eckley Miners' Village Associates.

Lattimer Massacre Memorial

The Lattimer Massacre Memorial is dedicated to the coal miners shot down while marching in protest of a local coal company, in Lattimer, PA. On Friday, September 10, 1897, an event occurred just north of Hazleton, which shocked and angered the nation. At the end of that day at least 55 unarmed, immigrant-miners were shot; 19 dead and 36 wounded. The text of the marker reads: "It was not a battle because they were not aggressive. Nor were they on the defense because they had no weapons of any kind and were simply shot down like so many worthless objects, each of the licensed life takers trying to outdo the others in butchery." (Source: http://www.icontech.com/baldeagle/lattimer.html#links)

Future Recreation Opportunities

Existing and Proposed Rails to Trails

The Greater Hazleton Area Civic Partnership (GHACP), a grassroots community organization, began the Rails-to-Trails Project in the Nescopeck Creek watershed in the late 1990s. This project seeks to improve the quality of life in the Greater Hazleton Area. These actions mirror interrelated programs occurring across the state of Pennsylvania as communities are beginning to perceive abandoned rail lines as valuable opportunities and resources for recreational activities. The GHACP's website lists the following elements that converted trails provide:

· Nature experiences,
· Economic benefits; including increased property values,
· Community pride,
· The promotion of good health, fitness, and recreation,
· Community meeting places
· The preservation and representation of local history,
· Incentives for industrial relocation and expansion, and
· Protection of wild habitat and biodiversity, while concurrently allowing people to view wildlife in their natural habitats.

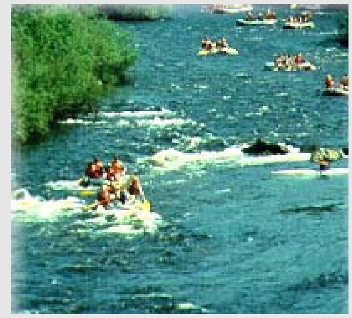

Image 1.39 River rafting at the Lehigh George State Park (Source: www.dcnr.state.pa.us/stateparks/parks/l-gov.htm).

Recreation Opportunities around the Nescopeck Watershed

A number of recreation opportunities within convenient driving distance from the watershed. These include both privately owned as well as state owned venues:

Lehigh Gorge State Park

Hickory Run State Park

Pennsylvania State Game lands nos. 40, 119, 149

Numerous ponds and lakes

The GHACP is currently working on a rails-to-trails project that establishes a link between the Greater Hazleton Area and the Delaware and Lehigh National Heritage Corridor. The GHACP welcomes any and all residents to join with them as volunteers to address the many challenges of the area and bring more opportunities to this beautiful and historic region.

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Land Resources

Land is used for a variety of different reasons such as recreation, development, open space, resource extraction, agriculture, and silviculture. The Nescopeck Creek watershed is exposed to a variety of different land uses. This section discusses major geologic formations, soil associations, slopes, and vegetative cover within the watershed. It also addresses the origin of land use authority for municipalities, the Municipalities Planning Code, the land use policies for various townships exhibited in municipal comprehensive plans, the implementation of such policies embodied in zoning ordinances, opportunities for implementing land preservation, and ownership of lands within the watershed boundaries.

Geology

There are several underlying rock formations that dominate the watershed. These geologic formations, created by eons of time, tectonic forces, and the plants and animals that once lived upon the crust, influenced the history, economy, and culture, of the watershed. The terminal moraine of the Wisconsin Glaciers, which once covered even the highest present-day peak in the watershed, runs over Hell Kitchen mountain, across Conyngham Valley, and over Nescopeck Mountain (Figure 2.1).

Mauch Chunk

The Mauch Chunk formation consists of 3,000 plus feet of shale, sandstone, and silt. This stratum underlies the valley of Hazleton, as it is softer than the rocks of the Pottsville and Pocono formations that make up the surrounding ridges and hills. The Mauch Chunk yields high quality groundwater in the southern and western anthracite fields. This water has been generally unaffected by mining activities. The reddish rocks of the Mauch Chunk may be viewed from Interstate 81 between mile 145 and the interchange with I-80, or around Interstate 380 near Exit 1. Sugarloaf Mountain was carved from the Mauch Chunk formation and this cone shaped hill may be viewed from the I-81 rest stop at mile 147. For more information on roadside geology of this area, consider Van Diver's "Roadside Geology of Pennsylvania".

Llewellyn

The Llewellyn formation is about 1,500 feet thick, composed of grayish-brown sandstone, siltstone, and shale. It is the greatest coal bearing formation in this area. Major coal seams include the Buck Mountain, Mammoth, and Gamma. The remaining rocks and coal resources of this formation are a small fraction of what was here before millions of years of erosion wore it away.

Pottsville

This formation forms the ridges that surround the valleys of Nescopeck Creek watershed. It is generally grey, 250 to 300 feet thick, and composed mostly of conglomerate and sandstone. It contains some coal, though no anthracite. The Alpha coal seam at around three feet thick runs through the Pottsville formation. Groundwater from this stratum, while low in dissolved solids, is often high in iron, manganese, and acidity. Iron and manganese are not harmful to humans but can cause bad tastes or orange-brown to black stains. High acidity may cause an unpleasant taste. This high degree of mineralization makes it a poor choice for well water. The Pottsville rock may be viewed at the road cut near Exit 1 of I-380. It is the whitish rock sitting atop the reddish Mauch Chunk. Another good location for viewing the Pottsville formation is mile 138 on I-81. Notice the whitish Pennsylvanian age Pottsville sandstones lying over Mauch Chunk sandstones.

Pocono

Composed mostly of conglomerates and sandstones, the Pocono formation forms the outer rim of the Pottsville ridges. Groundwater from this formation gives low yields of water, with an average of 15 to 20 gallons per minute.

Minor formations

Spechty Kopf: A little understood transition between the Catskill and the overlying Pocono formation.

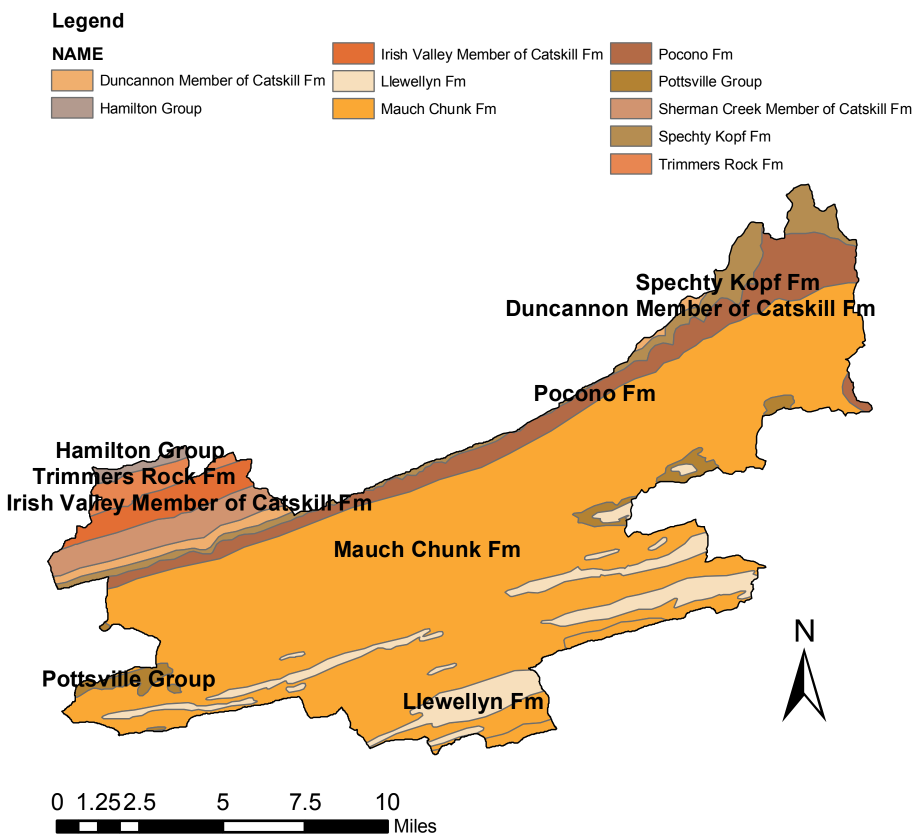

Figure 2.1 Geological formations within the Nescopeck Creek watershed.

Catskill

A combination of grayish-red sandstone, siltstone, and shale. It was most likely formed from an ancient river. For such a small area of the watershed, it contains a large proportion of the sensitive areas.

Hamilton Group

This rock formation is second to the Sherman Creek member of the Catskill formation in percent of area that is susceptible to ground water pollution. This rock formation is found in the Northwest corner of the watershed.

Anthracite

The coal of this region was deposited about 300 million years ago during the Pennsylvanian Period. Due to extreme pressures from overlying sediment and rock, igneous activities, and by the actions of tectonic plate movement, moisture and volatiles in the dead vegetation were driven off. These peat beds were transformed into the harder, cleaner burning form of coal, anthracite. Pure anthracite is over 92% fixed carbon and only 8% or less of volatiles. The Eastern Middle Anthracite Field lies almost entirely within the Nescopeck Creek watershed. The Llewellyn formation contains all of the major anthracite coal in the Eastern Middle Field (Figure 2.2). Thickness of the coal beds can range from around 3 feet in the Tracy bed, to 114 feet (or 50 feet, as per source) of the Mammoth bed.

Soil Associations

A general soils map indicates the soil associations found in the area of study. A soil association is formed when the soils are distributed in a distinctive proportional pattern. It generally consists of one or more major soils and at least one minor soil, and is named for the major soils. A soil associations map gives a general idea of the county- wide distribution of soils.
The following soil associations are found in the Nescopeck Watershed

1. Oquaga-Wellsboro-Lackawanna association:
Gently sloping to very steep, moderately deep and deep, well drained and moderately well drained soils on dissected plateaus.

2. Oquaga-Lordstown-Arnot association:
Moderately steep, moderately deep and shallow, well drained soils on mountain ridges and mountainsides.

3. Stripmine-Minedump association:
Nearly level to very steep, deep and very shallow soil and rock material on mountain tops and valleys.

4. Chenago-Pope-Wyoming association:
Nearly level to very steep, deep and moderately deep, well-drained soils on mountaintops and ridges.

5. Pocono-Dekalb association:
Gently sloping to very steep, deep and moderately deep, well-drained soils on mountaintops and ridges.

6. Mekesville-Kedron-Leck Kill association:
Gently sloping to moderately steep, deep well drained and moderately well drained soils in upland valleys.

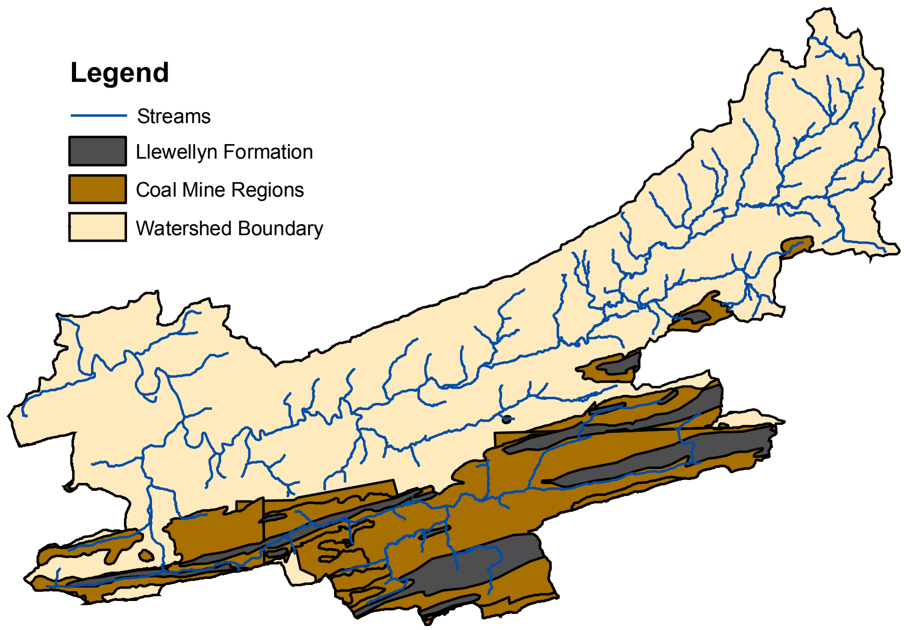

Figure 2.2 Location of anthracite coal within the geological rock formations of the Nescopeck Creek watershed.

Soils

Soil is a complex medium that supports and sustains life on the earth. Shape of the land surface, its slope, and position of the water table are factors that greatly influence the formation of soils. For the entire country, soils are classified and named according to uniform procedures. The following series occur in the Nescopeck Watershed (Figure 2.3):

Wellsboro-Oquaga-Morris Series
This series is found throughout the upper portion of the Nescopeck Creek watershed,where the topography is hilly and complex. It makes up about 24% of the watershed. Oquaga soils are on the higher ridges, knolls, and the steep valley sides formed by streams while the Wellsboro soils, occupying plateaus and intermountain basins, are associated with a fragipan. Minor in the association are Morris soils in upland depressions, which consist of deep, somewhat poorly drained, nearly level to sloping soils. These soils are acidic with slow permeability, moderate to low water capacity and contain stone fragments.

Lackawanna-Arnot-Morris Series
This series covers a portion of the state game lands within the watershed and consists of moderately steep to very steep soils on the sides and tops of ridges of the major northeast-southwest tending mountain. This association makes up about 9% of the watershed. The moderately steep, to very steep, Arnot soils, commonly occupying the upper one-third of mountainsides and the highest knolls on rounded ridge tops, are shallow and well drained. The soils on mountainsides are moderately steep to very steep,

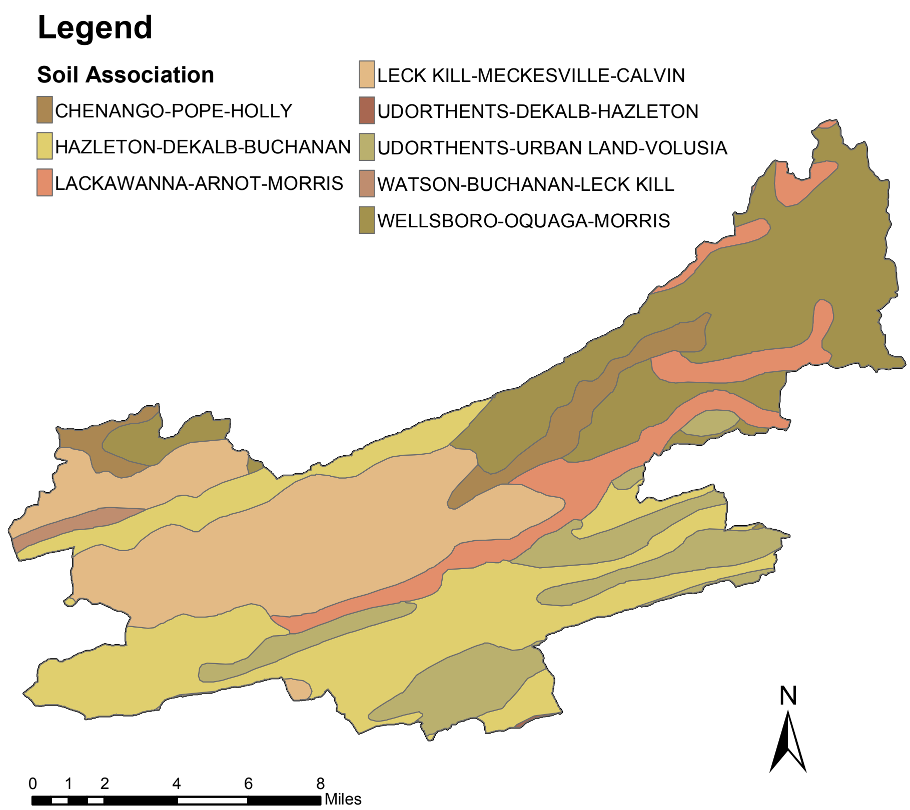

Figure 2.3 Soil associations within the Nescopeck Creek watershed.

and those on ridge tops are gently sloping. Minor in the association are Lackawanna soils on the lower foot slopes and Morris soils that are associated with a fragipan.

Hazleton-Dekalb-Buchanan Series
These soils occur mainly around Hazleton, West Hazleton, and the Black Creek and Stony Creek sub-watersheds. They make up about 26% of the watershed, in areas where exposed bedrock, soil, and rock material were removed for mining. Minor in the association are Dekalb soils in undisturbed areas and Urban Land soils in disturbed areas. Many streams in this series have been polluted by acid mine drainage and sediment from unprotected areas. These soils have a high degree of permeability and hence any pollution entering the streams from these areas can affect water quality.

Chenango-Pope-Holly Series
This association makes up about 4% of the watershed. Chenago and Pope soils are deep and well drained soils. Minor in this series are Holly soils found on the floodplains. Some areas are used for building sites and other development purposes. The flood hazard, slope, low available water capacity, and the hazard of groundwater contamination are major issues in this association.

Udorthents-Urban Land-Volusia Series
This series makes up about 11% of the watershed and consist of gently sloping to moderately steep soils on broad mountaintops and moderately steep to very steep soils on mountainsides and ridge-tops. Some

Fragipan

Fragipan is a loamy, brittle subsurface horizon low in porosity and content of organic matter and low or moderate in clay but high in silt or very fine sand. A fragipan appears cemented and restricts roots. When dry, it is hard or very hard and has a higher bulk density than the horizon or horizons above. When moist, it tends to rupture suddenly under pressure rather than to deform slowly (Source: Soil Survey of Luzerne County, Pennsylvania).

Available Water Capacity

Also known as available moisture capacity, it is the capacity of soils to hold water that is available for use by most plants. It is commonly expressed as inches of water per inch of soil. The capacity in inches, in a 60-inch profile is expressed as;

Very low, 0"-3"
Low, 3"-6"
Moderate, 6"-9"
High, more than 9"

areas are in urban use while others have been surface-mined. The depth to bedrock and the stony surface layer presents a major limitation for growth of vegetation in this association.

Leck Kill-Meckesville-Calvin Series
This series makes up about 24 % of the watershed and are found mainly in the Nescopeck Creek and Little Nescopeck Creek sub-watersheds. They consist of gently sloping to sloping soils on uplands and some moderately steep soils on hillsides adjacent to stream channels. Meckesville soils are deep, well-drained, loamy soils that have a fragipan while Leck Kill soils, on the broad upland plateaus and hillsides are deep and well drained. Minor in the association are Calvin soils. Many areas in this series are being used for building sites and other development purposes. The restricted permeability and seasonal high water table are the major limitations for development in this series.

The three most widespread soils in the watershed are the Hazleton-Dekalb- Buchanan followed by Leck Kill-Meckesville-Calvin and Wellsboro-Oquaga-Morris. (Figure 2.4 Chart showing the percentages of soils distribution) Large portions of the Hazleton-Dekalb-Buchanan and Udorthents-Urban Land-Volusia associations have been mined for coal (Figure 2.2). Twenty six percent of the total stream length (218.4 miles) within the watershed flows through these associations. (Figure 2.5) Since the Hazleton-Dekalb-Buchanan series has good permeability, acid drainage from strip mines can leach into the groundwater and surface water. development.

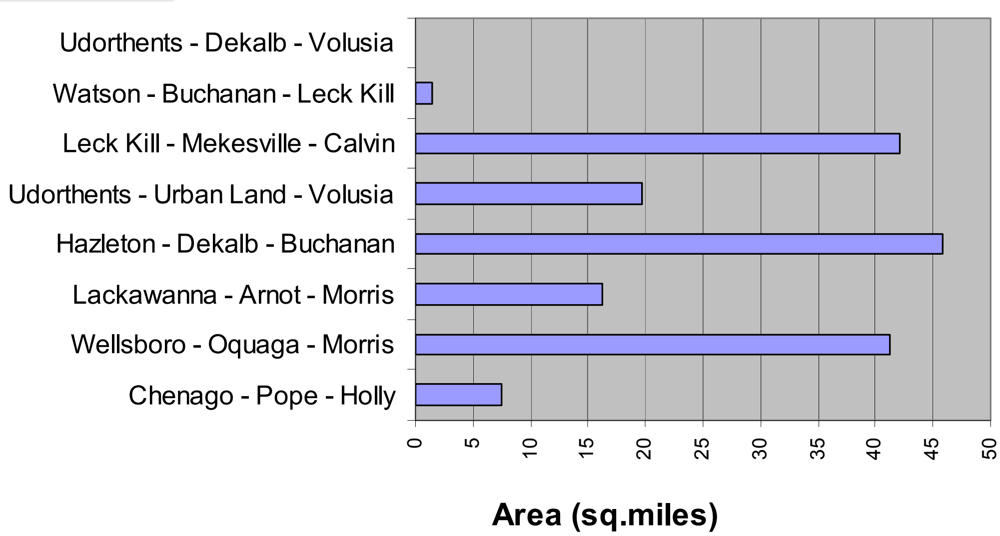

Figure 2.4 Percentage of soil associations within the Nescopeck Creek watershed.

Slopes

A large proportion of the watershed has slopes ranging from 0-3% (Figure 2.6) These slopes correspond to the valleys around the creeks. Higher slopes occur on low hills, ridge tops, and in coal-mined areas. The Digital Elevation Model (DEM) indicated that the urban areas of Hazleton, Conyngham, Freeland, Jeddo, West Hazleton, and areas covering parts of Hazle, Black Creek, and Foster Townships are higher in elevation than the valley of Nescopeck Creek in the Sugarloaf, Butler, Black Creek and Nescopeck Townships (Figure 2.7).

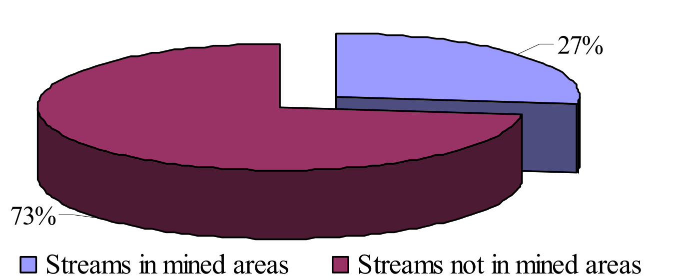

Figure 2.5 Percentage of streams running through surface mined areas in the Nescopeck Creek watershed.

The aspect map of the watershed (constructed from 100m DEM) shows that most of the watershed is flat followed by west, south, and north facing slopes (Figure 2.8). East facing slopes are least frequent. Aspect can be related to land cover within the watershed to highlight areas that have been altered by

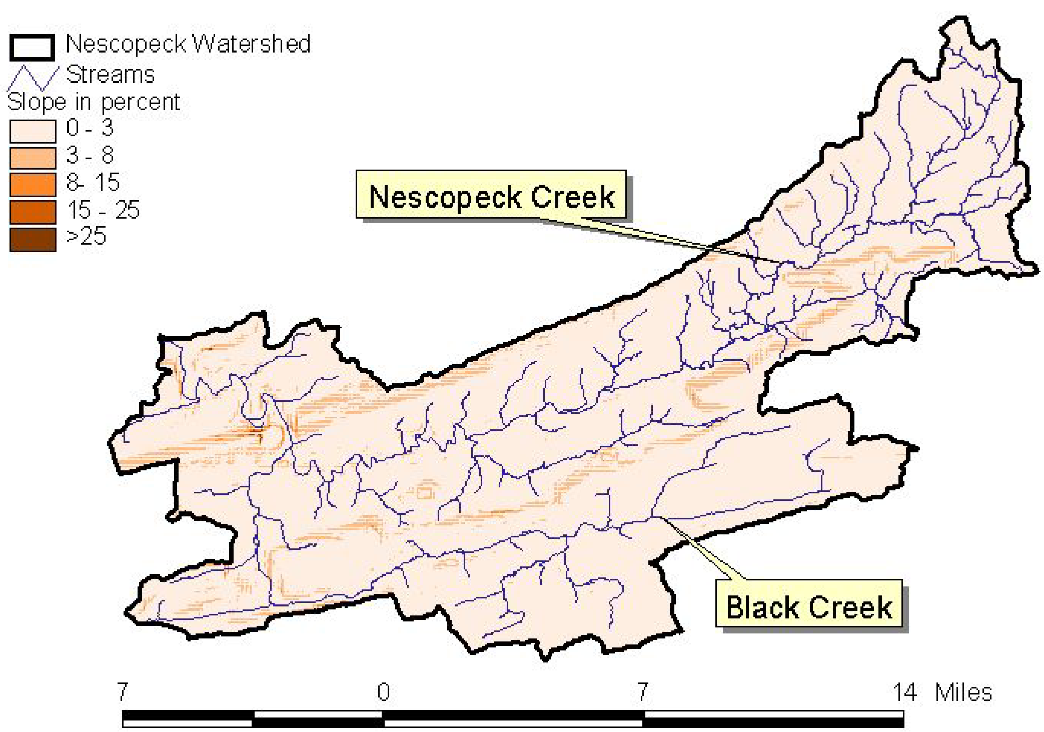

Figure 2.6 Slopes within the Nescopeck Creek watershed.

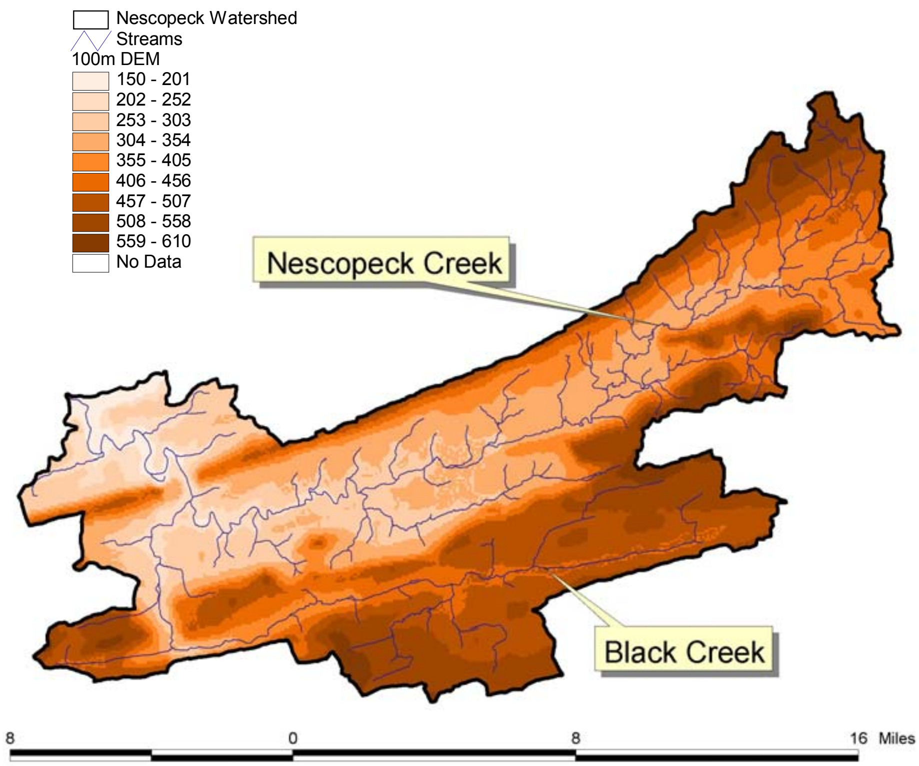

Figure 2.7 Digital Elevation Model (100m) of the Nescopeck Creek watershed.

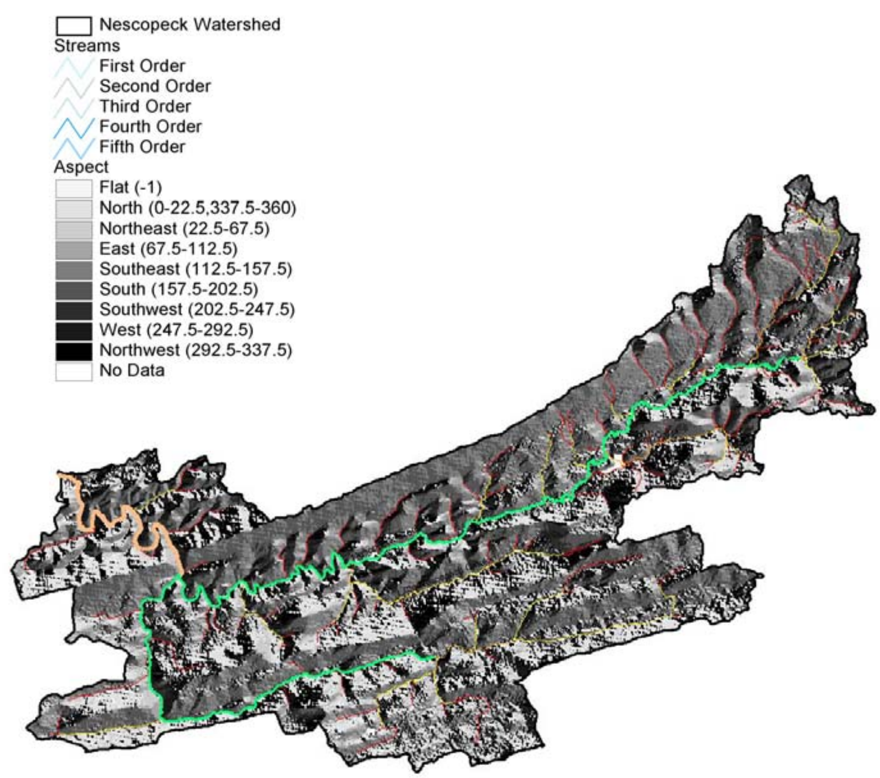

Figure 2.8 Aspect map of the Nescopeck Creek watershed constructed from 100m DEMs.

Land Cover

Land cover refers to the predominant vegetative composition of a particular landscape and provides information about the land use in that area. The Nescopeck Creek watershed contains a variety of predominant vegetative cover, including barren ground, open water, perennial herbaceous, annual herbaceous, mixed forest, deciduous forest, woody transitional, and evergreen forest (Table 2.1). These categories were developed from the Pennsylvania Gap Analysis Project (1999). Land cover categories were also divided by the percent composition and area covered in urban, suburban, and rural areas.

Approximately 95.5% of the Nescopeck Creek watershed is characterized as rural. The remaining 4.5% of the land in the watershed is urban or suburban (Table 2.2).

The primary land coverage within the watershed is deciduous forests (e.g. oak, maple), comprising almost 57% of the watershed. Mixed forest and perennial herbaceous areas comprise approximately 11% each of the watershed. Evergreen forests, woody transitional, and annual herbaceous coverages make up small areas of the watershed. Barren land consists of 6.7% of the land cover and is concentrated in the urban areas of Hazleton, West Hazleton, Freeland, the I-80 and Highway 309 corridors, and strip mines.

Land Cover in Sub-watersheds
Each sub-watershed in the Nescopeck Creek watershed was assessed for the percent coverage of forest, agriculture, and urban or barren land. The land use within each subwatershed can provide insight into the potential sources of polluted runoff from developed lands, the integrity of natural systems, and the interconnection of important wildlife habitats. Once decision-makers know the

Category	Definition
Open Water	Open water or wetlands with standing water
Evergreen Forest	Not more than 30% of tree canopy cover composed of deciduous trees
Mixed Forest	Deciduous and evergreen trees both greater than 30% of tree canopy cover
Deciduous Forests	Not more than 30% of tree canopy cover composed of evergreen trees
Mixed Vegetation	Coverage of woody plant foliage greater than 5% but less than 40%, including shrubland or forest regeneration
Perennial Herbaceous	Includes grasslands, pasture, forage, and oldfields less than 5% shrubs
Annual Herbaceous	Includes row crops, grain crops, and exposed mineral soils
Barren	Barren land, hard-surface, rubble or gravel

Table 2.1 Definitions of land coverage categories.

Land Cover	Rural		Suburban		Urban		Total	
	% Coverage	Area (mi.^{2})	% Coverage	Area (mi.^{2})	% Coverage	Area (mi.^{2})	% Coverage	Area (mi.^{2})
Open Water	0.4	0.6	0.0	0.0	0.0	0.0	0.4	0.6
Evergreeen	5.0	8.8	0.3	0.5	0.0	0.1	5.4	9.3
Mixed Forest	10.3	18.0	0.5	0.9	0.0	0.0	10.9	18.9
Deciduous Forest	56.3	98.1	0.6	1.0	0.0	0.0	56.9	99.1
Mixed Vegetation	3.0	5.3	0.1	0.3	0.0	0.0	3.2	5.5
Perennial Herbaceous	10.4	18.2	0.7	1.3	0.1	0.2	11.3	19.6
Annual Herbaceous	5.1	8.9	0.2	0.3	0.0	0.0	5.3	9.2
Barren	4.8	8.3	1.0	1.8	0.9	1.6	6.7	11.7
Total	95.4	166.2	3.4	6.0	1.1	1.9	100.0	174.1

Table 2.2 Percent coverage and area of predominant vegetative cover in the Nescopeck Creek watershed.

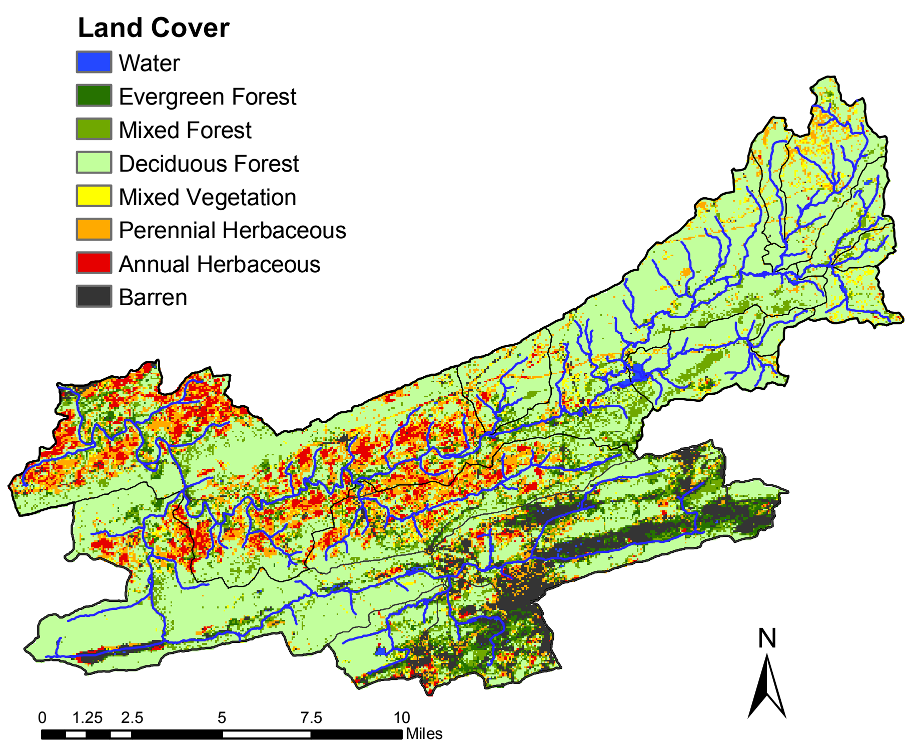

Figure 2.9 Land cover within the Nescopeck Creek watershed.

composition of a watershed's land coverage, they can use this information to encourage development in areas previously disturbed.

All subwatersheds in the Nescopeck Creek drainage contained over 50% of forest coverage. Long Hollow, Reilly Creek, Conety Run, Stony Creek, Creasy Creek, and Oley Creek, all located in the upper watershed, contained well over 80% forest coverage. Miller Creek, Little Nescopeck Creek[B], and the main stem Nescopeck Creek all have less than 80% forest coverage. Black Creek encompasses only 55% forest coverage.

Most subwatersheds had little barren land coverage. Cranberry Creek and Stony Creek, tributaries of Black Creek, and Black Creek contained 6.5%, 30% and 14% barren land coverage respectively. Not surprisingly, these subwatersheds also encompass part of Hazleton and a large portion of strip mines.

Most of the agricultural land in the Nescopeck Creek watershed is present in the lower end of the watershed. Little Nescopeck Creek[B] and Nescopeck Creek contained 30% and 24% agricultural land respectively. Agricultural land coverage for the remaining subwatersheds ranged from 2% (Long Hollow) to 13% (Long Run).

As indicated in other sections of this assessment, most of the developed lands (barren and agricultural land) are located in the lower portion of the watershed. In addition, there are extensive undeveloped forest lands along the ridges and some mainstem areas of Nescopeck Creek. With the presence of state game lands and the state park in the upper watershed, most of these undeveloped lands should remain intact. This has important implications for wildlife habitat, migration corridors, and gene flow among populations (discussed in the biological resources section).

Land Use

Land use and re-use are important issues in the urban, rural, and mining-influenced landscapes of the watershed. A number of the existing townships and boroughs are wrestling with the goals of attracting industrial and commercial development, and their resultant employment opportunities, while attempting to minimize the types of environmental and cultural effects such land use changes could produce.

Pennsylvania Municipalities Planning Code

The Pennsylvania Municipalities Planning Code (MPC) affords legislative support and procedural outlines for the implementation and planning of future development and land use evidenced in municipalities' comprehensive plans. The MPC also provides provisions for municipalities to govern and regulate such development through the enactment of zoning ordinances, subdivision and land development ordinances, planned residential development ordinances, and official plan ordinances. In addition, the MPC also requires that a comprehensive plan, or amendments to existing plans, consider the factors that influence the character and development of a community.

While comprehensive plans offer solid, and at times, progressive visions and goals in regards to the conservation and preservation of natural resources and sensitive areas,

The Pennsylvania MPC and natural resources

Specific elements required by the MPC that respond to community development and the protection and conservation of natural resources include:

· A Statement of Community Development Goals:
States the goals and objectives to chart the location, character, and timing of future development.

· A Community Facilities Plan and Inventory:
Evaluates existing facilities and their locations in relation to future growth expectations while considering the adequacy of these facilities. Such facilities include sewer availability, water quality and quantity, recreational needs, playgrounds, parks, public meeting places, fire protection, solid waste management and recycling, and floodplain management.

· A Sustainable Growth and Development Potential:
Determines the limits of potential growth and development density based on a physical feature analysis, and identifies items that need to be expanded, developed, or improved. Sustainability is based on such issues as the availability of aquifer yields, sewage treatment plant discharges, impact of development on water resources, point and non-point pollution sources, groundwater quality impacts of development, traffic impacts, and woodland preservation (Butler Township Draft Comprehensive Plan, 1999).

they are not legal documents such as land use, subdivision, or zoning ordinances.
Rather, if adopted by a municipality, they serve as guides for the development and implementation of goals and objectives in critical land use decisions, or in creating or amending ordinances. For instance, the MPC authorization of township or borough supervisors, as subject to various restrictions and regulation, include the following specific actions:
· Widening and deepening of watercourses,
· Planning for the development of the township through zoning, subdivision, and land development regulations,
· Make ordinances respecting the installation of individual or community sewage treatment facilities,
· Acquire and maintain historical landmarks,
· Acquire and hold tracts of land covered with forest or tree growth, and
· Establish and maintain roads, sewers, water supply systems, and storm water management facilities (Butler Township Draft Comprehensive Plan 1999).

Amendments to the MPC
The effectiveness of municipal comprehensive plans was strengthened by an amendment to the MPC in June of 2000, Act 67. The reformed statute provides counties and municipalities additional power by promoting cooperative, regional long-term planning and agreements in a multi-municipal framework, as well as funding for the development or amendment of comprehensive plans. These partnerships affect the development and conservation of natural resources by adopting or altering land use plans and ordinances as supportive and consistent forms of control. In addition to considering issues on a regional scale, it also allows municipalities to retain local control over implementation and local issues, so long as implementation is consistent with the multi-municipal framework plan. The amended plan also advances the sharing of significant costs of sound land use plans, along with the ability to use the technical assistance and expertise of county planning departments, state, regional, and local agencies, and the sharing of planning tasks among participating municipalities (10,000 Friends of Pennsylvania 2000).

Many factors contributed to the amended form of the MPC, including the need for regional approaches to growth and conservation issues, the need for land use reform, and the lack of support in applications or ordinances. These concerns are reflected in the decline of urban cores, the escalating social and economic segregation of communities, the loss of agricultural lands, and the encroachment of development on dwindling areas of open space (see note on Article XI).

The amendment additionally affords a number of incentives to entice counties or municipalities to adopt the overall plan. These incentives include:
· Direct the courts to consider zoning ordinances of all participating municipalities when addressing zoning challanges;
· Authorize state agencies to provide funding priority for multi-municipal planning and implementation;
· Require state agencies to consider and rely on multi-municipal plan in

making funding and permitting decisions;

· Authorize the adoption of a transfer of development rights program for the region of the plan;

· Authorize agreements for the sharing of tax revenues and fees within the region of the plan; and

· Authorize the multi-municipal plan to include planning for conservation and enhancement of natural, scenic, historic and aesthetic resources within the area of the plan. (Denworth 2000).

Land use decisions, or how and where human beings influence the landscape, are fundamental to the economic and social health of cities and towns. The conservation of rural character and agricultural heritage, the preservation of natural, historic, and cultural resources, and a community's inherent quality of life are among the factors directly influenced by these decisions.

Comprehensive Plans

Comprehensive plans attempt to crystallize problems, needs, and programs to fulfill community requirements. In order to do this, they plan for, and provide, capital physical improvements and address quality of life issues. Comprehensive plans also guide municipal governing bodies and boards when making land use decisions, or when considering altering existing policies or regulations. A number of existing comprehensive plans in the watershed, in accordance with an overall intent to provide responsible growth and environmental sustainability, attach significance to the preservation of environmentally sensitive areas. These areas include prime agricultural lands, wetlands, fragile soils, selected woodlands, riparian corridors, and scenic areas.

A number of plans list objectives that include the discouragement of intensive development in sensitive areas. Such areas may exhibit great ecological diversity or rare and endangered species or habitats, but they may also cover areas that contain steep slopes, high water tables, floodplains, stream corridors, woods, and aesthetic views. Many plans also view strip-mined areas as sites of possible landscape reclamation that could be used for residential development, recreation areas, or commercial and industrial uses. Additionally, reclamation of culm bank materials may provide opportunities for new technologies. In these varied applications, coal-scarred landscapes may be perceived as landscapes of opportunity, as their creative re-use lessens the pressure to develop pristine or agricultural land. Responsive to these complex issues, there now exist a number of federal, state, and local incentives for strip-mined landscape reclamation, stream and habitat restoration and preservation, historic and cultural heritage preservation,

Image 2.1 Agricultural landscape with cooling towers of the power plant near Nescopeck, PA (Source: Project Team).

MPC Ammendment, Article XI

Article XI of the Amendment, authorizes, among other things:

· Municipalities, including counties, to develop and implement a plan for an entire county or any area of contiguous municipalities using intergovernmental cooperative agreements;

· Designation of growth areas in multi-municipal plans where development is planned for residential mixed use, commercial, and institutional uses, and public infrastructure;

· Designation of rural resource areas where rural resource uses and densities are planned, and public infrastructure is not provided except in villages;

· Targeting public infrastructure services to growth areas;

· Planning for the conservation and enhancement of natural, scenic, historic and aesthetic resources (Denworth 2000).

Image 2.2 Lake Francis at the Nescopeck State Park (Source: Project Team).

community redevelopment, stormwater planning and management, greenway partnerships, and farmland preservation or the purchase of conservation easements.

Landscape Ecologcial Principles

Butler Township's Draft Comprehensive Plan of 1999 recognizes and encourages the development of patterns or regions of landscape buffering. In this way, residential, commercial, or industrial growth is channeled into areas most conducive to development, while sensitive areas are insulated, or buffered by other types of land use. Thus, the provision of local and regional parks, recreation areas, conserved agricultural land, and forms of community open space are planned in accordance with, and in proximity to urban areas, state gamelands, high-quality habitat areas, and the state park. This approach assures a consistent and overriding intent to design responsive growth patterns that are beneficial to both the residents and their quality of life, and that of the environment at large (Butler Township Draft Comprehensive Plan 1999).

Zoning

Most municipalities in the watershed have exercised authority to prepare comprehensive plans and zoning ordinances. A subset of municipality zoning ordinances was evaluated for provisions containing progressive requirements for land development practices that promote environmentally sound development or help preserve traditional agriculture areas (Table 2.3). Township ordinances analyzed were from Nescopeck, Dennison, Sugarloaf, Butler, Foster, and Fairview, as well as the Luzerne County zoning ordinance. These townships make up approximately 62% of the land area in the Nescopeck Creek watershed. Dennison Township and Butler Township were selected primarily because of their position in the upper watershed where good to high quality streams remain largely unaffected by past mining.

The Importance of Buffers in Landscape Planning

The basic concept of buffering is reflective of the primary principles of landscape ecological theory and planning. In terms of land use decisions, these principles include the establishment of contiguous patches and corridors for the benefit of, among other things:

- ***Interior and edge habitat***
- ***Species movement and migration***
- ***Increased biodiversity, and landscape ecological integrity.***

Township zoning ordinances within the Nescopeck Creek watershed were enacted for a variety of goals but were usually designed to promote and protect the public health, safety, morals, and general welfare of the particular municipality. For example, the Butler Township Zoning Ordinance § 103 states "This Chapter is enacted as part of the overall plan for orderly growth and development of Butler Township. As such, this Chapter is based upon the expressed or implied community development objectives as contained in the Township Comprehensive Plan." Depending upon the goals of a community, a zoning ordinance may help to extensively develop an area or it may seek to promote and sustain the rural character of the municipality. Whatever the growth priorities for a municipality, zoning ordinances provide a powerful tool for guiding development in desired areas.

Various communities in the Commonwealth have implemented effective techniques that help preserve naturally sensitive areas. Examples of these techniques are stream setback/buffering requirements, overlay districts, performance zoning, community growth boundaries, and quality development regulations.

Stream setback/buffering requirements are a simple, yet effective method to protect natural areas. Developers are simply required to limit land development some distance from streams, wetlands, and wildlife habitat. A vegetated buffer area provides the opportunity for plant nutrient uptake, storm water retention, and sediment retention. Distances can range from a few feet to more than 100 feet; however any buffer is better than no buffer.
Overlay districts impose additional protective regulations on sensitive areas already included in the underlying zoning districts. Many zoning ordinances already contain such districts with respect to floodplain protection ordinances and steep slope development restrictions.

Performance zoning regulates development based upon factors unique to each specific development site and proposal. Effects commonly targeted include required open space, pollutant emissions, chemical storage prohibitions, and traffic generation. Multiple townships within the Nescopeck Creek watershed already employ such initiatives.

Another method for limiting development in environmentally sensitive areas utilizes community growth boundaries. Such boundaries control the extension of public services to areas targeted for development.

Quality development regulations concern the quality and appearance of new development plans. Such regulations can include view protection, vegetation and tree protection, open space requirements, wildlife habitat protection, and planned residential developments. View protection simply promotes the development of aesthetically pleasing developments. Like stream setback requirements, vegetation and tree protection are not only aesthetically pleasing but also offer practical water quality and flood protection solutions. Planned residential developments help encourage efficient use of land, creative site design, and open spaces.
A limited survey of township zoning ordinances revealed the presence and

Ordinance	Municipality					
	Luzerne County	Fairview Twp.	Sugarloaf Twp.	Foster Twp.	Dennison Twp.	Nescopeck Twp.
Stream Setbacks	NO	NO	NO	NO	NO	NO
Overlay Districts	NO	YES	YES	YES	YES	YES
Performance Zoning	YES	YES	YES	YES	YES	YES
Community Growth Boundaries	NO	NO	NO	NO	NO	NO
Quality Development Regulations	YES	YES	YES	YES	YES	YES

Table 2.3 Summary of township zoning ordinances.

absence of land-use ordinances seeking to protect local water resources. No township zoning ordinance or the Luzerne County zoning ordinance contained provisions that required stream setbacks from development (Table 2.3).

All of the township ordinances employ overlay districts to control or limit development within the 100-year floodplain. These provisions primarily impose additional restrictions on developments in order to help prevent an additional financial burden upon the community caused by flooding. Floodplain overlay districts also prohibit certain activities in the 100-year floodplain such as building hospitals, jails, and nursing homes, and producing or storing certain chemicals and radioactive materials.

Butler Township employs a planned development overlay district that promotes "innovations in residential development for greater variety, efficient use of open space, and conservation of natural features." §316(1)(B). Although called a residential development, this provision allows commercial developments provided that they are specifically designed to serve the residents in the residential development.§316(3)(B). Common open space must also be designated. Natural features must include "woodland areas, large trees, natural watercourses and bodies of water, rock outcroppings, and scenic views." §316(5)(C)(3).

All townships establish performance zoning for at least industrial districts. Foster Township extended performance zoning to all districts. All township ordinances utilize quality control zoning such as varying open space requirements and special provisions for planned residential developments. Open space requirements varied among townships and among zoning districts. For example, required open space in Butler Township ranged between 50% lot coverage in a restricted industrial district to 90% open area in a rural conservation

The State of Agricultural Preservation

Development of agricultural lands is presently occurring within a number of townships and municipalities in the watershed due to people migrating from urban cores to outlaying rural districts. This process has been ongoing for five decades in the Hazleton area, and the increase in the population of Butler Township is testimony to the process (Butler Comprehensive Plan Draft, 1999). Agricultural lands are resources that, once lost due to development cannot be regained. Therefore, the policy intent advanced in a number of comprehensive plans designates agricultural lands as historical and physical resources. Yet, piece-meal or intensive development of prime agricultural lands is encouraged by many ordinance revisions, infrastructure extensions, and re-zoning.

district. Nescopeck Township designates areas as "Open Space Districts" with maximum lot coverage of 3% and total impervious surface coverage of 5%. Maximum lot coverage in Nescopeck Township industrial districts is 25% by buildings and 65% by impervious surfaces. No township ordinances employed community growth boundaries as a means to limiting development in undesirable areas. All of these differences exhibit the variation in land-use policies within the watershed.

Farmland Preservation

The loss of agricultural land is a major concern in Pennsylvania. Although the Commonwealth has over 1000 urban municipalities, it remains a predominantly rural state with the largest rural population in the nation. Agricultural land loss is evident in the ratio of a statewide 30-year population growth of just over 1% in contrast to one of the highest rates of land consumption per capita in the country (Denworth 2000).

Agriculture Security Areas

A number of townships in the Commonwealth of Pennsylvania have adopted and designated areas as Agriculture Security Areas (ASA). The designation of ASA's as special districts within a municipality are outlined under State Act 43 of 1981, with subsequent amendments, and supported by voluntary plan participation with landowners within those districts. The ASA designation protects the historical use of agricultural lands from zoning challenges,nuisance complaints, and condemnation for public purposes. However, this designation is not in perpetuity, for while additional lands can be added at any time, an ASA must be renewed every seven years. An additional tool in the conservation of agricultural lands is the Pennsylvania Purchase of Development Rights (PDR) program. PDR transactions compensate farmers for maintaining the agricultural nature of historical operations, thereby not developing that property. This program is not meant as an open space acquisition program, and prior to easement eligibility status in agricultural conservation, land tracts must meet a number of basic requirements.

Luzerne County Agricultural Preservation Program

Luzerne County, in July of 1999, established the Luzerne County Agricultural Preservation Program, which impliments the above referrenced state program. The Luzerne County Agricultural Preservation Board oversees the program, and is supported by the Luzerne County Board of Commissioners, the Luzerne County Planning Commis-

Image 2.3 Agricultural Landscape within the Nescopeck Creek watershed (Source: Wildlands Conservancy).

Luzerne County Agricultural Preservation Program Criteria:

The Agricultural Preservation Program, as defined by the Commonwealth of Pennsylvania, includes the following criteria for the preservation of individual farms:

· The farm must be within an Agricultural Security Area (ASA);

· It must have a viable Conservation Plan;

· The operation must be capable of generating $25,000 in gross receipts annually (1994);

· The Yield per acre must equal County average for harvested cropland;

· It must cover a total of 50 or more contiguous acres;

· At least half of that acreage must be harvested cropland, pasture, or grazing land; and

· Fifty percent of the subject soils must be in Soil Conservation Service classes I through IV.

sion, and the State Agricultural Land Preservation Board. The county supports the program administratively, with state funds. The impetus for the program, and the focus of the Commonwealth's concern, lies with a 46% loss of the state's farmland to development and the concerted efforts advanced by local farmers and conservation groups. Farming is still a major industry in the county, valued at $20.3 million in 1995/96 by the Department of Agriculture in farming and farming-related industries.

According to the director of the country program, as of the end of 2001 three farms have conservation easements in Luzerne County (Snee personal communication). Two farms that lie within the watershed are in Butler Township, whle the third is in Union Township, and together they total 290 acres.
The farms in Butler Township are:
· The Richard and Betty Thomas farm, 76.066 acres; and
· The Clyde and JoAnn Young farm, 103.976 acres.

Agricultural Zoning Ordinances
In addition to agriculture preservations discussed above, municipalities can enact pro-agriculture zoning ordinances that limit land-uses to those attuned to farming. Two strategies available to meet such goals include limiting uses incompatible with farming and limiting non-farming land-uses or developments. Various approaches can help lead to successful implementation of a farmland preservation program. Examples discussed in this assessment include large minimum lot size, fixed area based, transfer of development rights options, and agricultural nuisance disclaimers.

Large minimum lot size prohibits subdividing a tract of agricultural land below a specified size. For example, no parcel in an agricultural area can be subdivided into parcels less than 50 acres. Therefore, a 100-acre parcel could not be divided into 100 1-acre parcels, only two 50-acre parcels.

In addition to large minimum lot size, local zoning authorities can implement a maximum non-agricultural use area per unit of agricultural use. For example, for every 50 acres of agricultural land a fixed percentage of land can be developed for a non-agricultural purpose. This method is comparable to minimum lot size ordinances discussed above. The advantage of this method is that local planning officials can prescribe the percentage of non-agricultural land use permitted but not specifically delineate where the non-agricultural development actually occurs.

Current landowners who seek to maintain the agriculture use of land can also transfer the development rights for specific real property. All real property owners are figuratively considered to own a "bundle of sticks" that composes the property. For example, they own the right to sell the property, a right to exclude others, to conduct business on their property, and to dig on their property. Included within this bundle of sticks is a right to develop the property. If the landowner seeks to preserve the agricultural use of the land, he or she may sell the right of development to a third party and restrict the types of land development, if any, for future landowners.
Right to farm laws and nuisance notices provide protection for agricul-

tural lands. The Commonwealth of Pennsylvania enacted the Right to Farm Law in 1982 that protected farmers from nuisance complaints from neighboring landowners. This law recognized that landowners moving to an agricultural area might not be accustomed to some by-products of farming. In addition, local ordinances can notify potential buyers or developers of current agricultural practices and the possibilities of inconvenience caused by purchasing land in such an area.

Image 2.4 Nescopeck Creek (Source: Wildlands Conservancy).

Land Preservation Initiatives

North Branch Land Trust

In addition to municipal and county opportunities for conservation and preservation, the North Branch Land Trust is actively garnering support for such activities in the watershed and its adjacent regions. The Trust, one of many non-profit organizations in the country, is dedicated to helping individuals and families preserve unique or sensitive landscapes. Organized as a publicly-supported charity for educational purposes and the preservation of historic sites, natural areas, open space, wildlife habitat and water resources, the Trust relies on the donation of easements and restrictions of land use in perpetuity. The owner of the land covered by a conservation easement retains all rights and privileges of ownership not expressly given to the Trust. Public and private benefits arise from these types of conservation easements. It affords owners and families emotional and psychological benefits in the knowledge that the landscapes they loved and nurtured will retain the heritage of agriculture, and that the health and welfare of the community at large will be enhanced and preserved. Additional benefits may include the reduction of taxable income based on appraisals before and after the easement is placed on the property, along with a reduction in estate taxes (North Branch Land Trust 2001).

In a conversation with Alene Case, the director of the Trust, in November 2001, Ms. Case stated that the Trust's long-range plan stresses the importance of gaining access to specific conservation easements or property donations based on the principles of landscape ecological planning (Case, personal communication). Yet, realistically, they will accept any properties that become available. Ms. Case also reiterated that the principle focus of the Trust was not solely in the preservation of agricultural land, but rather in the conservation, protection, and preservation of a wide typology of landscapes. Furthermore, she noted that the concept of private, non-profit involvement in the realm of landscape protection has proven to be an incentive for those individual landowners who chose not to work with agencies or groups directly involved with any level of local, state, or federal governments. Such was the case with the Robert C. Houck farm, the only farm in the watershed covered by a conservation easement with the Trust. Mr. Houck's farm is located on the Berwick-Hazleton Highway, outside of Nescopeck, in Nescopeck Township. An example of points from Mr. Houck's Grant of Conservation Easement and Declaration of Restrictive Covenants, include the following and aptly illustrate the mission of the Trust:

· Mr. Houck, as Grantor, is the sole owner in fee simple;

· Property possesses significant natural, wooded, scenic, agricultural, water resources, and open space values (collectively "conservation values") worthy of protection;

· Conservation values are of great importance to Owner and of value to the people of Luzerne County and the Commonwealth of Pennsylvania;

· Property consists of open space available for its scenic beauty and educational value to members of the general public;

· Actions pursuant to these purposes are for the public health, safety, and general welfare of the citizens of the Commonwealth and for the promotion of sound land development by preserving suitable open spaces;

· Conservation and protection of agricultural lands as valued natural and ecological resources provide needed open space for clean air as well as for aesthetic purposes, and public benefits result from the conservation, protection, development and improvement of agricultural lands for the production of food and other agricultural products;

· Vital to the public interest of the County, the region, and the nation through its economic, environmental, cultural, and productive benefits;

· Significant portion is included in the Conservation Reserve Program administered by the USDA and Farm Service Agency FSA;

· Portion of the Property (5.1 acres) is included in a wetlands easement administered by the USDA and the NCRS;

· Property is within the Susquehanna River Drainage Basin, which has been identified by the Commonwealth of Pennsylvania as an area of significant environmental concern.

Ownership

The Nescopeck Creek watershed is composed of a wide variety of private and public landowners. While the headwaters of the Nescopeck are primarily public, the downstream portion of the watershed is almost entirely private (Figure 2.9). Whether land is publicly or privately owned helps determine its future uses.

The Pennsylvania Game Commission owns approximately 49.1 km^2 of state game lands in the headwaters of Nescopeck Creek and Little Nescopeck Creek[A]. The two state game lands are SGL 119 and 187. The Department of Conservation and Natural Resources also owns approximately 14.6 km^2 in Nescopeck State Park. State owned land sums to just over 13% of the land within the entire Nescopeck Creek watershed. Other publicly owned lands consist of township and municipal parkland. The rest of the watershed is almost entirely owned by private landowners.

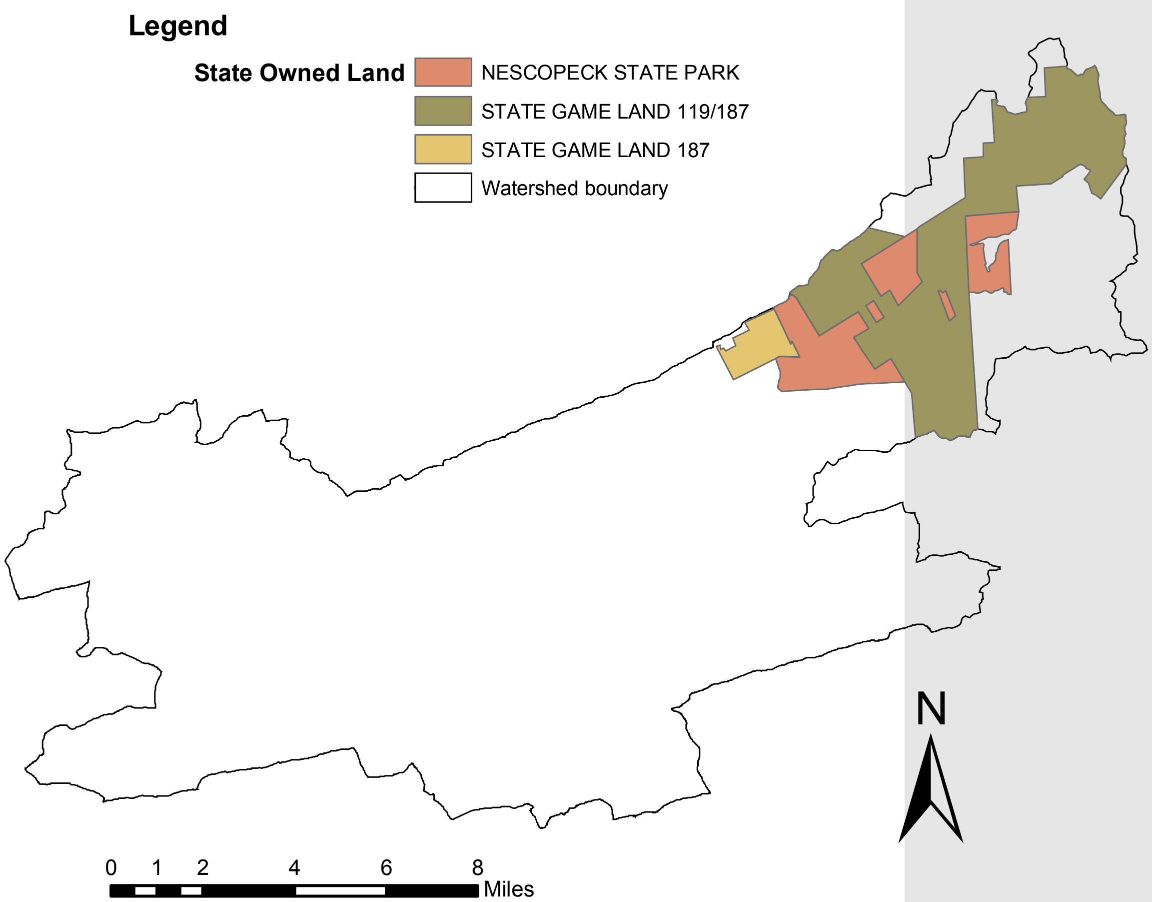

Figure 2.10 Public lands within the Nescopeck Creek watershed.

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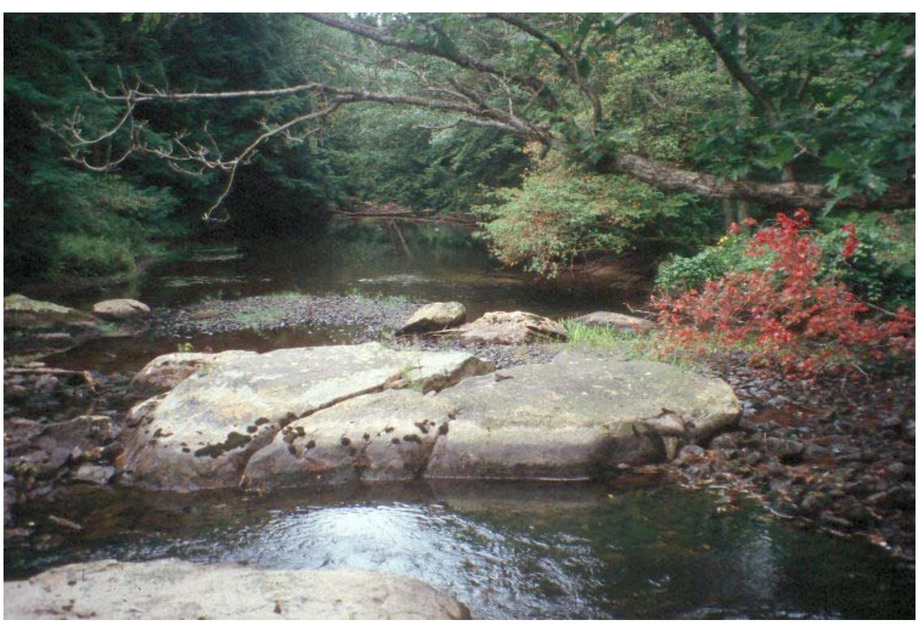
Water Resources

Precipitation falls as rain or snow and finds its way into lakes, rivers, streams, and wetlands. This can occur via direct runoff or through infiltration and subsequent groundwater seepage. Once water flows to a lake, river, or stream it is referred to as surface water. Surface water is simply standing water above the earth's surface or water that flows exclusively across land surface and includes all perennial and ephemeral water bodies.



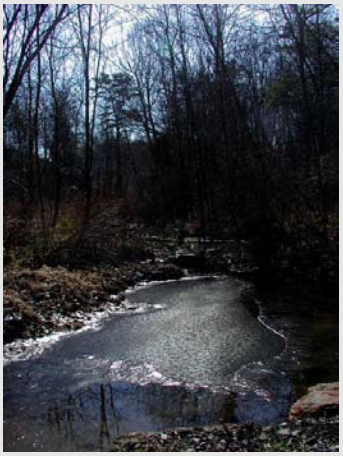


Image 3.1 Tributary to Black Creek in Hazle Township (Source: Project Team).

Stream Network Characteristics

Horton (1945) first introduced the concept of stream order. Strahler (1954) modified it slightly to its presently accepted use. Assuming the map being used contains all intermittent and permanently flowing streams in the basin, the smallest fingertip tributaries are designated Order 1. Where two first-order channels converge, a channel of Order 2 is formed; where two second-order channels meet, a segment of Order 3 is formed; and so on. The main stream channel through which all water passes is therefore the stream segment of highest order.

Horton's (1945) law of stream numbers states that the number of stream segments of each order form an inverse geometric sequence with order number. This is known as the *Horton's bifurcation ratio*. In general it has been shown that the Horton's bifurcation ratio averages about 3.5 (Strahler 1957). This means that on average there are three and one-half times as many streams of one order as of the next higher order. Surprisingly, this number is highly stable and shows a small range of variation from region to region.

The main stem of Nescopeck Creek, at the mouth, is a fifth order stream. Although Nescopeck Creek is a fifth order stream by the time it reaches its confluence with the North Branch of the Susquehanna River only about 8.7 miles of stream are actually fifth order. By far the largest number of stream segments (Figure 3.1) and stream miles in the Nescopeck Creek drainage are first order streams (Table 3.1).

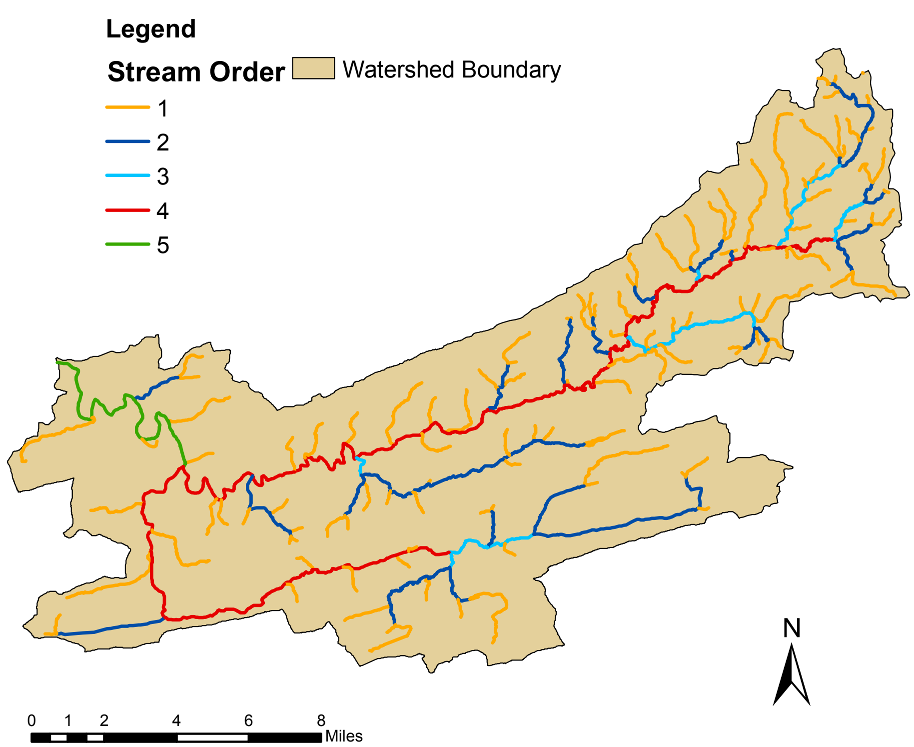


Figure 3.1 Stream order classifications.

Order Number	Number of Streams	Number of Miles
1	113	104.7
2	25	47.4
3	8	14.5
4	2	43.2
5	1	8.7

Table 3.1 Strahler (1954) stream order characteristics for the Nescopeck Creek watershed.

Major Tributaries

The Nescopeck Creek watershed contains 13 named streams (Figure 3.2). Curiously, the watershed contains two streams named Little Nescopeck Creek, both of which are tributaries to the main stem of Nescopeck Creek. For the purpose of this assessment, the two tributaries will be referred to as Little Nescopeck Creek[A] and Little Nescopeck Creek[B]. Little Nescopeck Creek[A] enters Nescopeck Creek just downstream of Lake Olympus and Little Nescopeck Creek[B] enters Nescopeck Creek near Sybertsville.

There are over 111 miles of named streams and over 106 miles of unnamed streams in the Nescopeck Creek watershed. Of the named streams, Nescopeck Creek is the longest stream followed by Black Creek (Table 3.2). At two miles, Reilly Creek is the shortest named stream in the watershed.

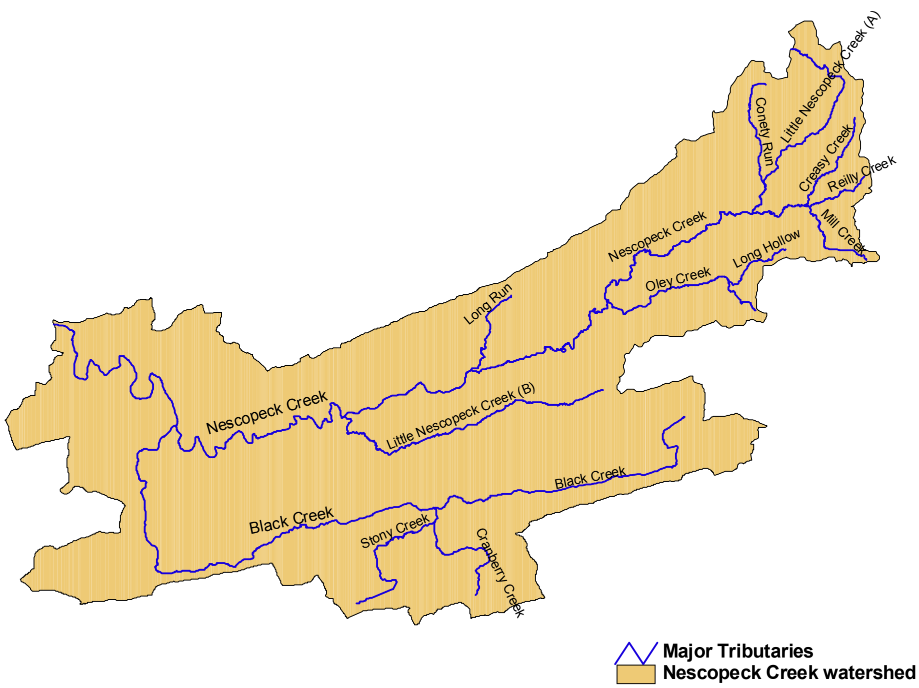


Figure 3.2 Major tributaries in the Nescopeck Creek watershed.

Sub-watersheds

Each of the named streams in the watershed drains a given area of land known as a sub-watershed (Figure 3.3). A sub-watershed is simply a smaller region or area drained by surface and groundwater flow in streams that is wholly contained within the larger watershed. Breaking the watershed into sub-watersheds allows for identification of problem areas in each sub-watershed at a scale more amenable to focusing attention and solutions to protect or restore watersheds. The sub-watersheds in the Nescopeck Creek drainage range in size from 1.1 square miles (Long Hollow) to 67.3 square miles (Nescopeck Creek) (Table 3.2). The size of the sub-watersheds in the Nescopeck Creek drainage does not follow exactly with the stream miles. Nescopeck Creek and Black Creek are the two largest sub-watersheds respectively; Long Hollow is the smallest sub-watershed.

Flow Characteristics

Land use in a watershed can greatly affect stream flow characteristics. Urbanization, mining, and agriculture can all have dramatic effects on stream hydrology. Increased urbanization creates more impervious surfaces. Impervious surfaces can lead to higher peaks in discharge during storm events than would normally occur. This can be seen when comparing the hydrograph of an urbanized stream to the hydrograph of a similar sized rural stream (Figure 3.4).

Mining, both surface and deep, can affect stream hydrology. Surface mining can speed surface runoff during storm events. Deep mining may rob surface water at one point due to subsidence and seepage. This water may emerge at another point in the watershed where it normally would not occur.

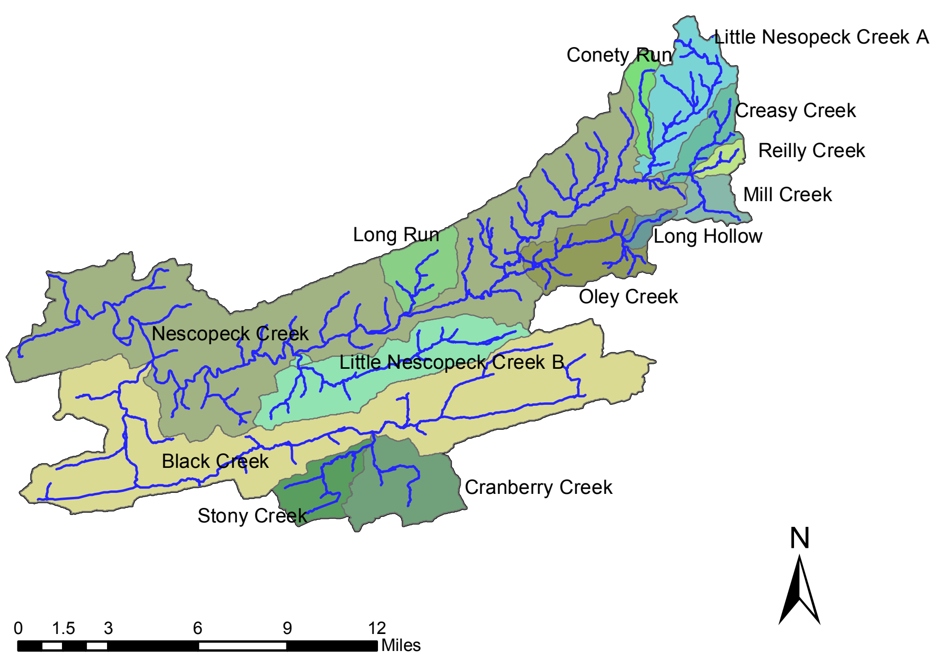


Figure 3.3 Named sub-watersheds in the Nescopeck Creek watershed.

Name	Stream Length (Miles)	Sub-watershed Area ($Mile^2$)
Reilly Creek	2.0	1.3
Long Hollow	2.3	1.1
Long Run	3.0	4.8
Mill Creek	3.1	2.7
Conety Run	3.6	2.3
Cranberry Creek	4.5	8.4
Stony Creek	5.2	4.8
Creasy Creek	5.5	3.3
Oley Creek	5.9	7.2
Little Nescopeck CreekA	7.7	14.0
Little Nescopeck CreekB	9.5	8.4
Black Creek	24.1	48.6
Nescopeck Creek	35.4	67.3

Table 3.2 Length of streams and sub-watershed area in the Nescopeck Creek watershed.

The United States Geological Survey (USGS) is in charge of measuring all surface water discharge in the United States. Unfortunately, flow characteristics of the Nescopeck Creek watershed are not well documented. From late 1919 to late 1926 there was a USGS continuous recording station on Nescopeck Creek at St. Johns, PA. The drainage area above this station is roughly 49 square miles and is entirely upstream of Little Nescopeck Creek[B]. Data from this station provides good historical information about flow characteristics for the upper portion of the drainage (Table 3.3). This data should also provide comparable current information for the site since most of the upper watershed has changed little since the mid 1920's.

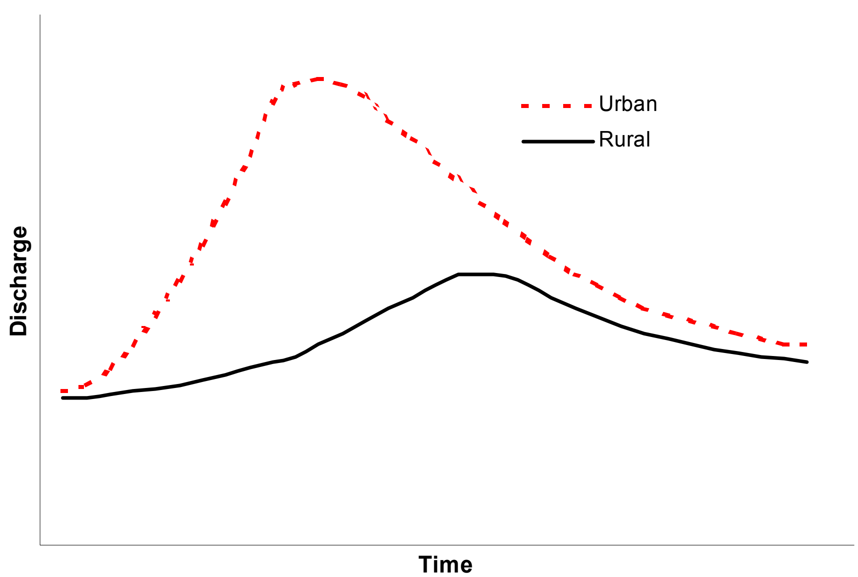


Figure 3.4 `Hypothetical comparison of an urban and rural hydrograph following a rain event.

Hydrograph

A graph that illustrates the relation of stream discharge or stream stage with time.

YEAR	Monthly mean streamflow, in ft^3/s											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1919										31.2	199	151
1920	32.9	25.1	479	188	97.2	131	32.4	19.3	19.6	63.9	136	184
1921	59.5	71	271	114	133	48.8	47	57.2	22.1	28.7	122	155
1922	40.4	156	254	235	104	221	43.8	17.6	12.9	16.5	13	17.6
1923	64.7	37.9	244	66.6	132	52.5	75.2	50.9	15.2	63.7	32.4	138
1924	214	40.9	96.4	193	181	60	65.8	21.6	62.9	92.4	34.7	26.5
1925	16.9	168	71.8	77.4	166	27.2	41.1	50.5	13.1	33.6	171	139
1926	83.1	156	174	119	45.2	62.6	28.4	49.1	76.9			
Mean of monthly streamflows	73.1	93.6	227	142	123	86.2	47.7	38	31.8	47.1	101	116

Table 3.3 USGS average monthly streamflow for Nescopeck Creek near St. Johns, PA. Lat. 41°01'15" Long. 76°00'40" (Source: www.usgs.gov).

There are two other USGS monitoring sites in the Nescopeck Creek drainage, both of which provide minimal data. Eight measurements were taken on Little Nescopeck Creek[B] between 1970 and 1973. This site is located approximately 0.6 miles upstream from the mouth. These measurements were used to estimate the average minimum annual discharge for seven consecutive days (Q7L) (Appendix C). The other site is located at the railroad bridge in Nescopeck Borough on the main stem Nescopeck Creek. Three measurements were taken at this site between July 1949 and September 1950 (Appendix C).

Image 3.2 Little Nescopeck Creek[B] downstream of Jeddo Tunnel outfall (Source: Wildlands Conservancy).

Jeddo Tunnel

A comprehensive watershed assessment completed by the Wildlands Conservancy (Kocher et al. 2000) documents discharge from the Jeddo Tunnel. Discharge from the Jeddo Tunnel is comprised of: direct infiltration of precipitation through mined land, seepage from streams, stream flow directly entering the mines through cave-ins or sinks, un-channeled overland flow, and natural groundwater discharge from aquifers (Kocher et al. 2000). Base flow for the Jeddo Tunnel averaged 72.3 cubic feet per second (cfs) annually between 1996 and 1998 (Table 3.4). Total discharge for these years averaged 79.4 cfs (Table 3.4).

Location and Characteristics of Lakes and Reservoirs

The Pennsylvania Department of Envrionmental Protection (DEP) monitors ten dams and their impoundments in the Nescopeck Creek watershed. The impoundments have a normal surface area ranging from three to 154 acres (Appendix C). The normal storage capacity of the impoundments in the Nescopeck Creek watershed ranges from 12 to 1546 acre-feet. All but one of the dams in the watershed is constructed of earthen-fill material; the exception is a small-unnamed dam constructed of stone masonry.

Water Year	Total Discharge	Direct Runoff	Mean Base Flow
1996	89.6	8.2	81.4
1997	78.8	8.6	70.2
1998	69.9	4.7	65.2
Average	79.4	7.2	72.3

Table 3.4 Base flow separations of the Jeddo tunnel discharge (cfs) (Kocher et al. 2000).

Floodplains

Floodplains are areas adjoining a water body that become inundated during periods of overbank flooding. This is often defined as the area immediately adjacent to streams that correspond to the highest level of a known recorded 100-year flood event.

Floodplains provide temporary storage space for floodwaters and sediment carried by this water. Through the storage of water they help to delay the runoff peak and decrease the severity of the peak. For these reasons it is very important that floodplains be protected from development.

In the Nescopeck Creek watershed, like in many other watersheds, the floodplains are very narrow or nonexistent in the headwaters. As you progress downstream the floodplain spreads out in areas of lower gradient and slower water. When the gradient picks up again the floodplains narrow (Figure 3.5).

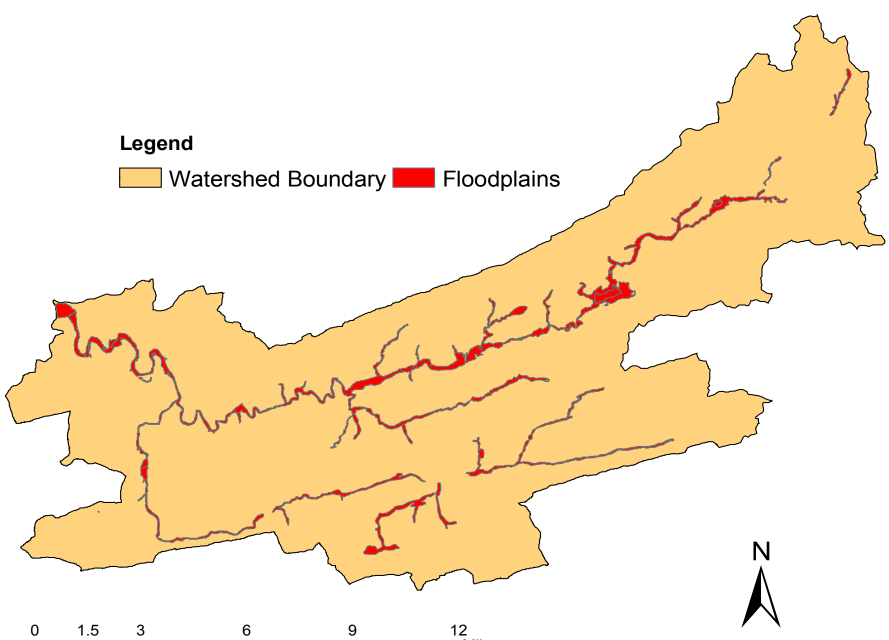


Figure 3.5 Floodplain regions in the Nescopeck Creek watershed.

Acre-foot:
the volume of water that would cover one acre to a depth of one foot.

Cubic feet per second (cfs):
the volume of water flowing at a fixed point per second of time.
1 cfs = 7.18 gallons.

Pollution

The Clean Water Act, Sec. 502-19 (U.S. Congress 1987) defines pollution as "man-made or man-induced alteration of chemical, physical, biological, and radiological integrity of water."

pH

pH is an important water quality variable to aquatic animals. Aquatic animals are sensitive to changes in pH, especially when these changes are sudden or large. In addition, aquatic life may be sensitive to other chemical changes that are caused by altered pH, such as an increase in the concentration of dissolved metals.

Surface Water Quality

Water dissolves almost every substance that it comes into contact with. Water, contains a wide variety of ions or charged molecules, including minerals from the earths' crust and atmosphere. These ions include calcium, sodium, chloride, sulfates, and nitrates, to name a few. Pollution occurs when human activities alter the quantities of these substances within water (as well as add a few man-made substances). The term "water quality" refers to the composition of substances within water and is meant to describe the extent to which a body of water is polluted. High quality water has very little pollution while low quality water contains larger quantities of pollutants.

This section of the assessment attempts to characterize the various creeks and sub-watersheds of the Nescopeck Creek watershed by their water quality. In order to understand what we mean when we describe the quality of a body of water it helps to review the fundamental chemical parameters related to this subject.

Water Quality Parameters

Water quality parameters are important to understand for two reasons (1) to describe their effects on the overall health of the watershed and (2) to understand the sources of different pollutants.

pH

pH measures the amount of free hydrogen ions (H^+) in water. The pH of water ranges from 0 to 14, with a pH of 7 being neutral and indicating water that is neither acidic nor basic (Figure 3.6). The most common natural control of water pH is the bicarbonate buffering system, which depends on the amount of calcium carbonate dissolved in the water. Typical pH measurements for natural streams range from slightly acidic to slightly basic or about pH 6.5 to pH 8.5. Pennsylvania state water quality standards set pH limits from 6.0 to 9.0.

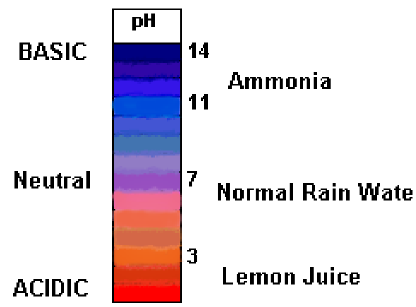


Figure 3.6 pH Scale.

Alkalinity

Alkalinity is often defined as the capacity of a solution to neutralize acidity. The important property of alkalinity is that it acts as a buffer. In a sense, alkalinity neutralizes acidity and can prevent water from changing pH when strong acids are added. The normal range of alkalinity for freshwater streams and lakes is 20-200 mg/L calcium carbonate ($CaCO_3$). Streams with high concentrations of calcium carbonate have a pH from about 6.5 to 8.0. Streams with alkalinity values below 10 mg/L $CaCO_3$ are described as poorly buffered and are susceptible to becoming acidic. It is usually desirable to have high alkalinity water, particularly when there is a likelihood of mixing with more acidic water at some point downstream.

Acidity

A similar concept to alkalinity is acidity. Acidity measures the capacity of water to neutralize alkalinity. Acidity is often measured for acid-impacted streams and is defined as the equivalent concentration of $CaCO_3$ necessary to neutralize the acidity present. Acidity is defined in this way to allow for the direct calculation of the amount of base necessary to neutralize the acid present. For example, an acid mine drainage (AMD) stream that has an acidity of 100 mg/L $CaCO_3$ would require that much carbonate to neutralize the acid. A stream can be both acidic and contain some alkalinity; therefore it is important to measure both values in conjunction with pH.

Metals

Some common metals in acid mine drainage include iron (Fe), manganese (Mn), and aluminum (Al). The concentration of these metals must be known to successfully treat acid water since they can change pH. Within the normal range of water pH, metals become more soluble, or dissolve more easily, as pH decreases. The opposite occurs when pH is raised. For example, if the pH of water containing aluminum is increased above 5.5, Al will combine with other ions to form an insoluble precipitate that settles to the stream bottom as a white substance. Iron will also precipitate as the familiar "yellow boy" at higher pH.

Metals are also important to understand because some are toxic to aquatic animals. Toxicity refers to the potential adverse effect, such as death or disease, of a substance on biological organisms. Some of the most commonly found toxic heavy metals include nickel (Ni), copper (Cu), zinc (Zn), lead (Pb), mercury (Hg), manganese, and aluminum among others. While all of these metals naturally occur in the environment, man's activities have introduced them at higher rates and levels. Of special concern for this assessment is aluminum. Excessive amounts of aluminum can be found in streams due to AMD and acid rain. Aluminum is especially detrimental to fish and may interfere with their survival and reproductive capabilities.

Nutrients: Phosphorous and Nitrogen

Phosphorous (P) and nitrogen (N) are two nutrients that are essential to plant and animal life. As such they are very important components to the basic functions of our environment. However, human activities have altered the balance of these two nutrients within the environment creating excess quantities of nitrogen and phosphorus in surface waters. Excessive amounts of these nutrients can cause eutrophication of the water, especially in lakes and estuaries. Eutrophication refers to water bodies that are excessively effected by nutrients. Eutrophication is one of the problems of the Chesapeake Bay, of which the Nescopeck Creek watershed is a part.

The major sources of nitrogen as a pollutant are direct discharge from sewage treatment plants and non-point source runoff. Some major non-point sources include acid rain, agricultural activities, and fertilization of residential areas, golf courses or other turf grounds. In Pennsylvania, 88% of the non-point source nitrogen load to surface water comes from atmospheric deposition and agricultural activities (Nizeyimana et al. 1996, Evans 1999). Nitrogen is fairly mobile (travels easily) in soils and is removed from soils mainly by surface run-off.

Definitions

Acidity: equivalent mg/L $CaCO_3$ Measures the capacity of a solution to consume alkalinity.

Alkalinity: equivalent mg/L $CaCO_3$, Measures the capacity of a solution to neutralize acidity.

Buffer: Type of substance that is capable of neutralizing both acids and bases. It is important to increase the buffer capacity of acidic streams in order to prevent pH from changing due to increased acid input.

$pH = -log_{base10} (H^+)$
pH is a scale from zero to fourteen that measures the hydrogen concentration in substances. For example, pH 6 is ten times more acidic than pH 7, and pH 5 is 100 times more acidic.

Nutrients to Measure

Nitrogen is usually measured as nitrate (NO_3), nitrite (NO_2), and ammonia (NH_3).

Phosphorus is usually measured as phosphate (PO_4).

Nitrogen and Phosporus Pollution

Nitrogen and phosphorus enter waterbodies by two means, through point sources such as industrial or municipal wastewater, and by surface runoff from land areas like farms and urban zones. Surface runoff is the movement of water over the ground's surface and generally occurs during rain events or snowmelts. Pollution that enters waterbodies via surface run-off is referred to as either "non-point" source pollution, or "diffuse" pollution.

Nitrogen and phosphorus can be controlled by treating the source of the pollutant or by changing or implementing different land use practices to minimize the amount of nutrient runoff over land. For example, a sewage treatment plant, which is a point source, can improve its treatment system, or a non-point source area like a farm can follow erosion control practices to limit the amount of nutrients that are lost from the land into streams or lakes.

The major source of phosphorus, especially in rural areas, is livestock grazing and agricultural activities; but other sources include land application of biosolids (sludge from wastewater treatment plants), on-lot septic systems, and fertilization. Phosphorus is not as mobile in soils as nitrogen and travels into surface water mainly through soil erosion, although over-land flow is also a factor. Historically, efforts to reduce loss of phosphorus from agricultural areas focused on changing fertilizer and manure appli cations. However, current research has highlighted the importance of reducing soil erosion.

Polluted Runoff from Point and Non-point Sources:

Polluted runoff is surface water that is polluted from both point or non-point sources. The term "diffuse source" shouldn't be confused with the terms "point" and "non-point" sources. The terms "point" and "non-point" source pollution are defined by the U.S. Congress and apply to specific categories of activities like those listed below. (Water Quality Act, Sec. 502-514, U.S. Congress, 1987).

· Some point sources include municipal and industrial wastewater, runoff from industrial sites not connected to storm sewers, runoff and drainage from active mines (surface and underground), etc.

· Some non-point sources include: agricultural runoff and infiltration from sources other than confined animal feeding operations, urban runoff, atmospheric deposition over a water surface, and abandoned acid mine drainage.

Both the point sources and the non-point sources described above include some "diffuse" pollutant sources, meaning the pollutant source is difficult to locate. The main reason point and non-point are defined separately by federal law has to do with whether they are regulated by a federal agency. The

Image 3.3 Stormwater overflow into Black Creek in Hazle Township (Source: Project Team).

federal government regulates all point sources, while only some non-point sources are regulated by either federal or local agencies. For the purposes of the assessment, we will use these terms in the regulatory meaning.

Assessment of Surface Water Quality

The Nescopeck Creek watershed has been the subject of a number of studies; most have focused on Little Nescopeck Creek[B], and the lower half of the watershed (Figure 3.7). The United States Geological Survey (USGS) was the first to collect water quality data at a few sampling stations across the watershed, collecting once in the 1930's and then sporadically through the 1970's. The Pennsylvania Department of Environmental Protection (DEP) has collected water quality at a sampling station near the mouth of the Nescopeck Creek since 1962, which is available on the Internet through EPA's STORET program. More recently, the Friends of the Nescopeck (FON), the DEP, the Susquehanna River Basin Commission (SRBC), and the Pennsylvania Fish and Boat Commission (PFBC) have all collected water quality data. However all of these surveys, except for those by the FON, are one-time samples.

The FON have conducted the most comprehensive water quality monitoring over a three-year period. Data from this monitoring effort are included in a report published by the Wildlands Conservancy (Kocher et al. 2000). The latest SRBC survey was conducted in August and September

Treating Diffuse Pollution

Communities interested in controlling or abating pollution in their watershed will most likely be confronted with "diffuse source" pollution. "Diffuse source" pollution is a category of pollutants that are difficult to pinpoint to one source. The methods available to control diffuse source pollutants are land and runoff management practices. This is different from point source pollution, which can be treated at its source, like a sewage treatment plant.

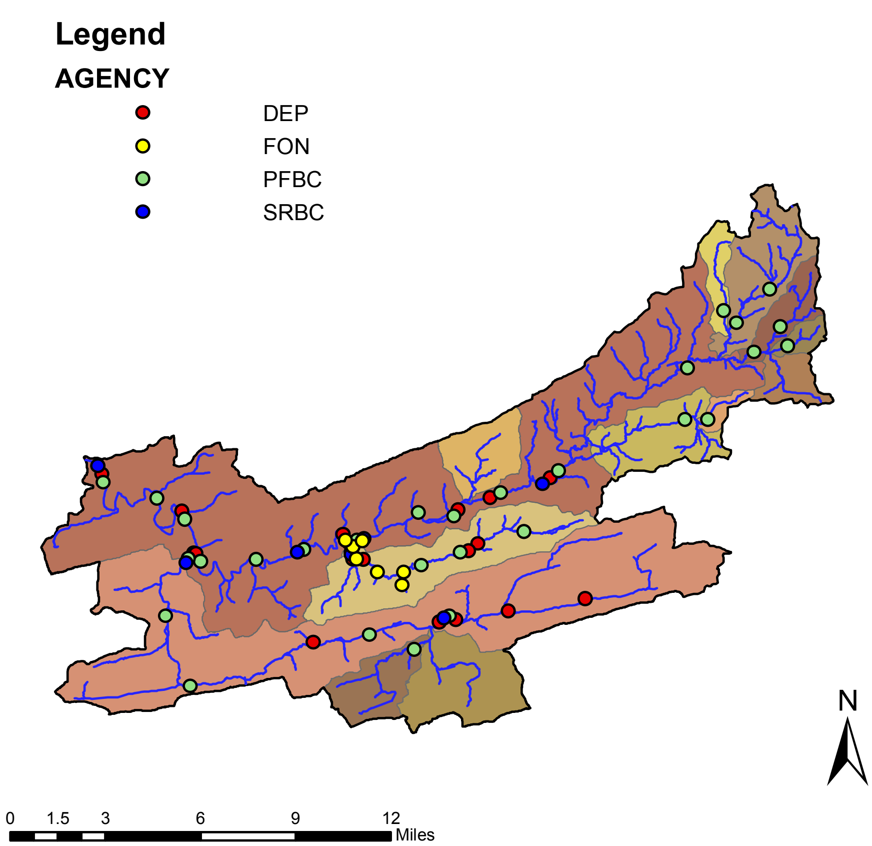


Figure 3.7 Water quality sampling locations in the Nescopeck Creek Watershed.

2001. This information is currently tentative until such time as it is formally released. Both of these survey efforts are limited to the lower half of the watershed. The DEP investigation is also limited to the lower watershed but contributed additional knowledge concerning possible pollutants from sources other than AMD. The DEP measured habitat quality and macroinvertebrate and fish community health to supplement their water quality findings. The PFBC report is the only source of water quality data for the headwaters (Wnuk et al. 1999), although again, these are limited to one-time samples (Figure 3.7 and Table 3.5).

While all of these reports contribute valuable information they are not comparable for a variety of reasons including: different chemical parameters, different time periods, and variable sampling locations. The one-time agency sample data is summarized in the following tables for Nescopeck Creek, Little Nescopeck Creek[B] and Black Creek (Table 3.6 - 3.8). Data from these reports and the FON are included on the CD in the back of this report.

Creek Name	Agency	Sampling Period	# Sampling Sites	# Times Site was Sampled
Black Creek	USGS	1973 - 1976	2	5
	DEP	July-98	6	1
	PFBC	July-99	5	1
	SRBC	September-02	2	1
Nescopeck Creek	USGS	1971-1976	2	7
	DEP	July-98	8	1
	PFBC	July-99	12	1
	SRBC	September-02	3	1
	FON	1995-1998	5	+100
Little Nescopeck Creek[B]	USGS	1971-1975	1	5
	DEP	July-98	4	1
	PFBC	July-99	4	1
	SRBC	September-02	1	1
	FON	1995-1998	2	+100

Table 3.5 Number of stations and sampling period for water quality samples collected by various state agencies and the Friends of the Nescopeck.

Nescopeck Creek Sampling locations	pH	Total Alkalinity (mg/l)	Total Acidity (Hot)	Total Hardness (mg/l)	Specific Conductance (umhos)	NO3-N (Nitrate)	Total Phos
PFBC	6.8	10		18	46		
PFBC	6.6	13		18	73		
PFBC	7	13		24	82		
PFBC	7.1	14		27	106		
DEP - NC1	6.3		0.8	13	49.8	0.06	0.02
DEP - NC2	6.4	7.8	0	12	51.5	0.07	<0.02
St. John's STP*	7.1	100	0	56	493	0.04	2.77
DEP - NC3	6.5	10.4	0	13	69.2	0.11	0.03
PFBC	7.1	13		25	116		
PFBC	7	14		28	112		
DEP - NC4	6.5	10	0	17	77.3	0.48	0.02
Cofluence with Little Nescopeck Creek B							
Days Inn STP* - unamed tributary to Nescopeck	7.8	156	0	69	539	<0.04	-
PFBC	4.7	0		>100	591		
PFBC	4.7	0		>100	581		
PFBC	4.7	0		>100	575		
DEP - NC5	4.9	2.6	22	137	365	0.45	0.02
DEP - NC6	4.9	2.8	16	113	329	0.75	0.02
Confluence with Black Creek							
PFBC	4.7	0		>100	486		
PFBC	4.8	0		>100	505		
PFBC	4.7	0		>100	481		
DEP-NC7	4.9	2.8	15.4	101	300	1.07	0.04
DEP - NC8	4.9	2.6	15.8	96	311	1.26	0.03

Table 3.6 One-time water quality data collected by DEP and PFBC in Nescopeck Creek.

Little Nescopeck Creek[B] Sampling locations	pH	Total Alkalinity (mg/l)	Total Acidity (Hot)	Total Hardness (mg/l)	Specific Conductance (umhos)	NO3-N (Nitrate)	Total Phosphorous
PFBC 1	7.1	66		96	631		
DEP - LN9	6.2		0	33	178.3	1.51	<0.02
Jeddo Tunnel*	4.4	0	64	79	729	0.17	<0.02
DEP - LN10	4.4	0	60	266	704	0.31	<0.02
PFBC 2	4.7	0			878		
Drums STP*	6.7	114	0	86	597	0.77	4.46
PFBC 3	4.7	0			861		
DEP - LN11	4.6	1.6	52	280	668	0.43	0.02
Conyngham STP*	7.1	156	0	69	539	<0.04	2.23
DEP - LN12	4.6	1.8		270	663	0.43	0.43
PFBC 4	4.7	0		>200	841		

Table 3.7 One-time water quality data collected by DEP and PFBC in Little Nescopeck Creek B.

Black Creek Sampling locations	pH	Total Alkalinity (mg/l)	Total Acidity (Hot)	Total Hardness (mg/l)	Specific Conductance (umhos)	NO3-N (Nitrate)	Total Phosphorous
DEP - BC14	4.2	0	22	47	269	0.07	<0.02
DEP - BC15	6.2	9.8	0.4	47	133	0.33	0.03
PFBC1	6.2	12		20	164		
Hazleton STP*	6.9	64	0	28	429	0.17	2.31
DEP - BC16	6.2	9.8	0.4	24	132.6	0.37	<0.01
DEP - BC17	6.3	22	0	14	237	1.38	0.028
PFBC2	6.6	12		32	246		
PFBC3	6	<1		24	209		
DEP - BC18	4.7	1.6	0	34	186.5	1.82	0.02
Rock Glen AMD*	4.2	0	68	213	497	<0.04	<0.02
PFBC4	4.6	0		60	261		
PFBC5	4.9	0		>100	252		
DEP - BC19	4.7	1.8	14	50	211	1.82	0.05

Table 3.8 One-time water quality data collected by DEP and PFBC in Black Creek.

pH and Acidity

The PFBC collected one-time water samples in the summer of 1999, during a drought period. Their measured pH values for the headwaters were generally high (6.5 to 7), however drought conditions are known to elevate pH in surface water. Moving downstream, the SRBC, DEP, and PFBC investigations all found a significant decline in pH after Little Nescopeck Creek[B] entered Nescopeck Creek. The recent SRBC survey found that Nescopeck Creek had a low acidity of 8 mg/L and pH of 7 upstream of the confluence with Little Nescopeck Creek[B]. Down-

Stream	pH	Total Alk. (mg/l)	Total Hardness (mg/l)	Specific Conductance (umhos)
Creasy Creek				
	6.9	12	15	49
	7.2	24	24	74
Reilly Creek				
	6.4	22	28	97
Little Nescopeck Creek A				
	5.8	2	3	19
	7	5	8	24
Conety Run				
	6.2	2	5	22
Long Hollow				
	6.4	14	16	32
Oley Creek				
	6.4	6	7	63
Long Run				
	6.6	4	21	192
Stony Creek				
	5.3	2	>100	27

Table 3.9 pH, alkalinity, total hardness, and specific conductance of headwater streams in the Nescopeck Creek watershed taken in July 1999.

stream of the confluence acidity increased to 54 mg/L and pH decreased to 4. The DEP study found a pH of 6.5 and 77 mg/l of acidity upstream and a pH of 4.7 and acidity of 591 mg/l downstream of the Little Nescopeck[B] confluence. At the mouth of Nescopeck Creek pH had risen to around 5 and acidity dropped to around 300 mg/l. Little Nescopeck Creek[B] and Black Creek were major contributors of acidity to Nescopeck Creek due to AMD.

Alkalinity

The headwater data collected by PFBC indicated fairly low alkalinity values (<10 mg/L) for most of these streams. Oley Creek, Long Hollow Run, and Conety Run were characterized as infertile and are classified as Class A Wild Brook Trout fishery (Table 3.9). Oley Creek has some AMD but the other streams have no such problems. Such low alkalinity values can leave these headwater streams susceptible to acidification from acid deposition, a common problem in Pennsylvania. Alkalinity values increased in the mainstem of Nescopeck Creek until the confluence with Little Nescopeck Creek[B], where alkalinity decreased from 12 mg/L to 0 mg/L (SRBC unpublished data, 2001). It is interesting to note that the headwaters of Black Creek and Little Nescopeck Creek[B] are of good water quality until AMD intersects the stream flow. At the mouth of the Nescopeck alkalinity values average around 3 mg/l (Kupsky, 1999).

Metals

Specific conductivity

Specific conductivity is often measured on AMD impacted streams as it measures the total ion concentrations present in water. High specific conductivity is a good indicator of AMD. In the headwaters, PFBC measured specific conductivity and found low specific conductance at all sampling locations. However, specific conductivity was around 250-300 µmhos in Little Nescopeck Creek[B] and 20-60 µmhos in Black Creek. The influ-

Stream	pH	Total Alk. (mg/l)	Total Hardness (mg/l)	Specific Conductance (umhos)
Creasy Creek				
	6.9	12	15	49
	7.2	24	24	74
Reilly Creek				
	6.4	22	28	97
Little Nescopeck Creek[A]				
	5.8	2	3	19
	7.0	5	8	24
Conety Run				
	6.2	2	5	22
Long Hollow				
	6.4	14	16	32
Oley Creek				
	6.4	6	7	63
Long Run				
	6.6	4	21	192
Stony Creek				
	5.3	2	>100	27

Table 3.10 DEP sampling stations that exceeded toxicity criteria.* Concentration exceeds CCC (Criteria Continuous Concentration for fish and aquatic life); ** Concentration exceeds CCC and CMC (Criteria Maximum Concentration for fish and wildlife) (Kupsky et al. 1998).

Water Quality Reports for the Nescopeck Creek

Stream Investigations of Nescopeck, Little Nescopeck and Black Creeks, Luzerne County.
by Kupsky, E.P.. Pennsylvania Department of Environmental Quality 570-826-2330. 1999.

Assessment of Conditions Contributing Acid Mine Drainage to the Little Nescopeck Creek Watershed, Luzerne County Pennsylvania, and an Abatement Plan to Mitigate Impaired Water Quality in the Watershed.
by Ballaron P.B., C.K. Kocher, and J.R. Hollowell. Susquehanna River Basin Commission, Pub. No. 204. 1999.

Little Nescopeck Creek Watershed Conservation Management Plan
by Kocher, C.M., A.M. Pattishall, B.J. Vedino, G.L. Woodruff. Wildlands Conservancy. 2000.

Nescopeck Creek Basin (405D) Fisheries Management Report.
by Knuk, R., R. Moase, and L. Benzie. Pennsylvania Fish and Boat Commission, Bureau of Fisheries, Fisheries Management Division. 1999.

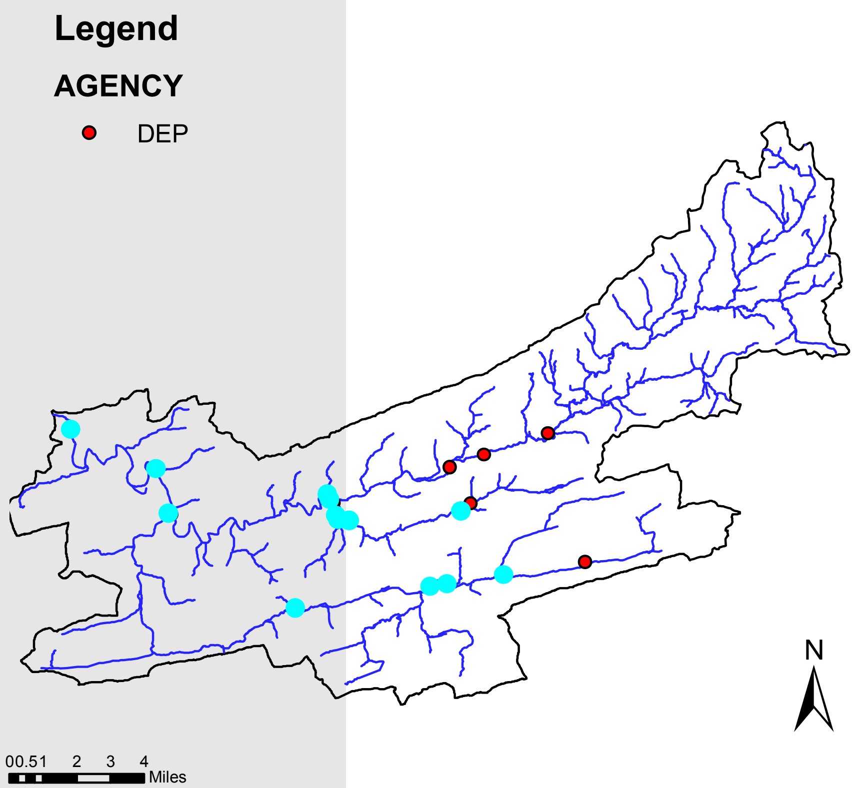


Figure 3.8 DEP water quality sampling locations, light blue sampling sites are those exceeding toxicity concentrations for copper, lead, or zinc (Kupsky et al. 1998).

ence of these two streams raised specific conductivity to around 100 µmhos in the mainstem of Nescopeck Creek.

Toxicity

DEP also analyzed copper (Cu), lead (Pb) and zinc (Zn) for toxic concentrations throughout their study area. They determined that the Jeddo outfall contributed toxic concentrations of copper, zinc, and lead. Black Creek also showed toxic concentrations of lead and copper from an unknown mine drainage source and toxic concentrations of copper, lead, and zinc from the Rock Glen outfall. At the mouth of Nescopeck Creek, the DEP detected toxic levels of copper and zinc (Figure 3.8 and Table 3.10). For concentrations please see Appendix C).

Iron (Fe) and Aluminum (Al)

Iron and aluminum concentrations in Nescopeck Creek increased from 0.11 mg/L to 1.26 mg/L and from 0.04 mg/L to 7.45 mg/L respectively after Little Nescopeck Creek[B] input (SRBC unpublished data, 2001). These changes and concentrations are similar in magnitude to the water quality data collected by the Friends of the Nescopeck and the DEP.

Nutrients

Data concerning nitrogen (N) and phosphorus (P) concentrations were limited to the lower half of the watershed. Both DEP and Friends of the Nescopeck collected data concerning N and P from 1996 to 1998. Nitrogen concentrations were measured in various forms including total nitrogen, total nitrate nitrogen, dissolved nitrate nitrogen, nitrite nitrogen, and total nitrogen ammonia. Phosphorus concentrations were recorded as total phosphorous and ortho-phosphate.

The DEP study measured nutrient concentrations downstream of effluent loadings of sewage treatment plants and downstream of combined sewer overflow areas. They found the regulated sewage treatment plants in compliance with their NPDES permits on the day they took the samples. However, they noted two areas of concern. The macroinvertebrate community index, downstream of the St. John's sewage treatment plant (STP) in Nescopeck Creek, indicated an environment that was moderately organically enriched. Downstream of the Hazleton STP bypass (combined sewer overflow area) along Black Creek, DEP noted visual evidence of organic loading although their water quality data did

not indicate a problem. This is most likely because the overflow was not flowing on the sampling day. The macroinvertebrate studies on Black Creek showed organic enrichment as well.
There are no sources of nutrient data for the headwaters of the Nescopeck Creek watershed. We used a watershed model (AVGWLF version 3.2) to estimate the phosphorus and nitrogen loads in the headwaters. AVGWLF is a GIS-based modeling tool founded upon the GWLF (Generalized Watershed Loading Function) model developed by Haith and Shoemaker (1987). This modeling tool allows the user to simulate runoff, sediment, and nutrient loadings from a watershed in a GIS interface. The model estimates the total amount of erosion, sediment, nitrogen, and phosphorus exiting a watershed. It can also estimate the amount coming from varying land use sources within the watershed.

We analyzed the entire watershed from the past ten years to estimate nutrient loads by sub-watershed and by varying land uses. The model gives us information where historical data are lacking and allows comparison of sub-watersheds and their different land use attributes to determine major diffuse sources of nutrients and sediment. As discussed previously, it is useful to determine where and how much nutrient pollution comes from diffuse sources in order to recommend the appropriate management strategy.
The estimated amount of erosion and total amount of sediment exiting the Nescopeck Creek watershed and its sub-watersheds can be found in Table Table 3.11. Note that the total amount of sediment is always less than the total amount of erosion. Erosion represents a gross or potential erosion figure while sediment represents the actual amount of material that actually reaches the receiving body of water. Some parts of the landscape, like riparian forest buffers, recapture some of the sediment released during erosion processes elsewhere in the landscape before it enters a water body.

Managing Phosphorous for Agriculture and the Environment. Sharpley, A.(2001). Penn State University, College of Agricultural Sciences, Agricultural Research and Cooperative Extension (Source: http://www.cas.psu.edu).

Watershed	Erosion (1000 kg)	Sediment (1000 kg)	Total Nitrogen (kg)	Percent contribution of N by subwatershed	Total Phosphorous (kg)	Percentage contribution of P by subwatershed
Mainstem Nescopeck Creek	74,365		143028	44.8	98	0.7
Black Creek	123,825	12,258	103,494	32.5	8,830	54.3
Headwaters	3,528	508	6,131	2.0	483	3.0
Little Nescopeck Creek B	44,876	6,911	60,215	19.0	6,361	39.0
Oley Creek	48,99	837	5,453	1.7	487	3.0
Total: Nescopeck Creek Watershed	**246,594**	**18,001**	**318,321**	**100.0**	**16,259**	**100.0**

Table 3.11 Estimated erosion and sediment exiting each subwatershed and the Nescopeck Creek watershed (AVGWLF).

The estimated average yearly amount of nitrogen discharging from the Nescopeck Creek watershed is about 318,000 kg (Table 3.12). Close to half of that amount comes from the land areas surrounding the main-stem of Nescopeck Creek. The headwaters and Oley Creek together represent about 4% of the total. The three major sources of nitrogen were land sources (33%), groundwater (60%), and septic systems (6%). Of the land sources agriculture was the dominant source type (49%) followed by deciduous forest (12%) and quarries (9%). The majority of the phosphorus runoff from the Nescopeck Creek watershed is from land sources (Table 3.13). Croplands, quarries, deciduous forest areas, coalmines, and areas of high intensity development represent the major contributors. Phosphorus comes mostly from the sub-watersheds of the Nescopeck Creek watershed and very little is contributed by the land areas surrounding the mainstem of Nescopeck Creek.

N Source	Hectares	% Area	Total N (kg)	% Contribution
Hay/Pasture	2,044	5	7,693.6	6.8
Cropland	5,383	12	55,479.4	48.9
Coniferous Forest	2,186	5	492.6	0.4
Mixed Forest	2,002	5	454.8	0.4
Deciduous Forest	28,116	65	13,444.8	11.9
Unpaved Road	10	0	111.6	0.0
Quarry	973	2	10,573.4	9.3
Coal Mines	631	1	6,628.8	5.8
Transition Lands	107	0	3,109.1	2.7
Low Intensity Development	853	2	782.8	0.7
High Intensity Development	1,119	3	14,922.3	13.1
Sub-Total: Land Sources	**43,424**	**100**	**113,693.2**	**100.0**
Groundwater Contribution			184,192.6	
Septic Contribution			20,435.9	
Total: All sources			**318,321.0**	

Table 3.12 Estimated nitrogen contribution by land use sources in the Nescopeck Creek watershed (AVGWLF).

P Source	Hectares	% Area	P	% Contribution of Land Sources
Hay/Pasture	2,044	5	462.6	3.2
Cropland	5,383	12	6,226.6	43.6
Coniferous Forest	2,186	5	30.1	0.2
Mixed Forest	2,002	5	28.3	0.2
Deciduous Forest	28,116	65	1,806.6	12.7
Unpaved Road	10	0	11.8	0.1
Quarry	973	2	2,109.6	14.8
Coal Mines	631	1	1,322.7	9.3
Transition	107	0	508.7	3.6
Low Intensity Development	853	2	104.4	0.7
High Intensity Development	1,119	3	1,654.7	11.6
Sub-Total: Land Sources			**14,266.1**	**100.0**
Groundwater			1,858.3	
Point Source			0.0	
Septic Systems			135.1	
Total: All Sources			**16,259.5**	

Table 3.13 Estimated phosphorous contribution by land use sources in the Nescopeck Creek watershed (AVGWLF).

Aquatic Macroinvertebrates as an Indicator of Water Quality

Owing to their varying tolerances to pollution, aquatic macroinvertebrates are good indicators of water quality status (Rosenburg 1996). Different groups of aquatic macroinvertebrates exhibit varying tolerances for types of pollution. For example, the Orders Epheroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) (commonly referred to as EPT) are generally *pollution sensitive* taxa. *Moderately tolerant* taxa include hellgrammites, dragonflies, damselflies, and sow bugs. *Pollution tolerant* taxa include flatworms, leeches, water striders, snails, and true flies. For example, a pristine stream would likely contain most or all taxa listed above. If this stream experienced increased pollution discharge, populations of pollution sensitive taxa will likely decrease or disappear first, followed by the moderately pollution tolerant taxa. The stream might also experience increased numbers of pollution tolerant species.

Noting the variable sensitivity of aquatic macroinvertebrates to pollution, aquatic scientists developed a variety of different biotic indexes that measure stream pollution. Macroinvertebrates were sampled by DEP as reported by Krupsky (1999) at 13 different stations in the Nescopeck Creek watershed in 1999 (Figure 3.9). The Hilsenhoff Biotic Index (HBI) was computed with these samples to assess the degree of pollution at the sampling stations (Table 3.13). Greater HBI indicates higher water quality. Greater numbers of EPT genera generally indicate higher water

Image 3.4 Trichoptera (caddisfly) larvae. This order is generally pollution sensitive (Source: NYS DEC, www.dec.state.ny.us).

Image 3.5 Plecoptera (stonefly) larvae. Typically found in high gradient, headwater streams. Generally pollution sensitive (Source: Illinois Natural History Survey, Natural Systematics Resource Center),

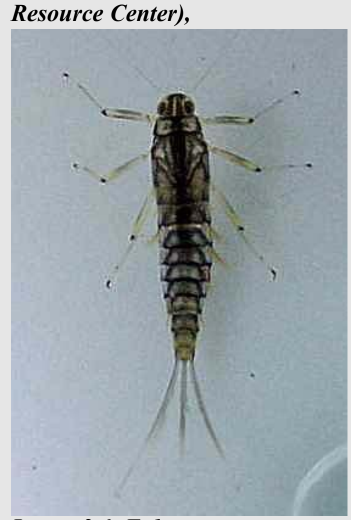


Image 3.6 Ephemeroptera (Mayfly) larvae. Along with trichoptera and plecoptera make up the EPT species. Generally pollution sensitive (Angie Conklin)

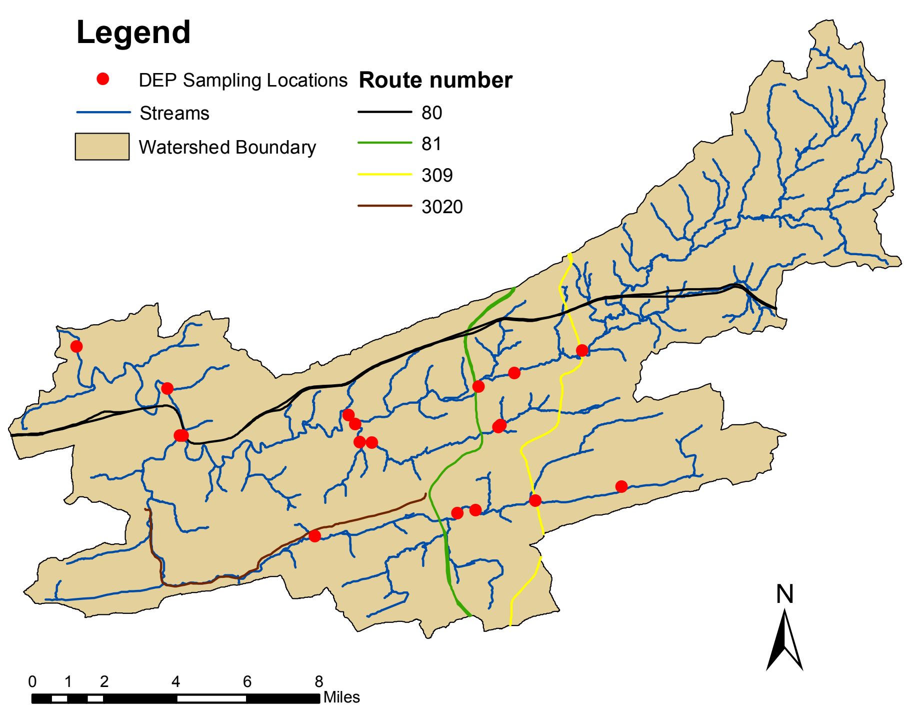


Figure 3.9 Location of DEP macroinvertebrate sampling stations in the Nescopeck Creek watershed.

Image 3.7 Chironomidae (true fly) larvae. Common in stream reaches that are highly sedimented. Generally a pollution tolerant taxa (Source: www.runtel.fr/ore/html/sommaire/fauflo/chiro.htm).

Image 3.8 Odonata (Dragonfly) larvae. Generally, moderately sensitive to pollution (Source: NYS Dept. of Environmental Conservation, www.dec.state.ny.us).

quality (Rosenburg and Resh 1996). Total taxa sampled, HBI, and number of EPT genera found in each sample indicated different levels of pollution at each station.

Little Nescopeck Creek[B] exhibited high HBI and total number of taxa immediately upstream from the Jeddo Tunnel. Immediately downstream from the Jeddo Tunnel, the number of taxa, HBI, and EPT genera dropped drastically. In fact, only three individuals of one taxon were sampled at this station.

Upstream sections of Black Creek contained very few total taxa or EPT genera. Sections just upstream from the confluence of Black Creek with Nescopeck Creek contained higher numbers of total taxa but few EPT genera.

Sample stations on Nescopeck Creek exhibited high total taxa, moderate HBI, and high numbers of EPT genera. Although the HBI actually increased, total taxa and EPT genera decreased just downstream from the St. John's Sewage Treatment Plant. These criteria increased substantially at the Nescopeck Creek 4 sampling station. Nescopeck Creek 6, downstream from the confluence of Nescopeck Creek and Little Nescopeck Creek[B], exhibited only 5 taxa and EPT genera were represented by a single genus. This reflects the low pH discharged from the Jeddo Tunnel into Little Nescopeck Creek[B].
Macroinvetebrate total taxa and EPT genera increased while the HBI decreased just upstream from the confluence of Nescopeck Creek with the Susquehanna River. Although macroinvertebrate diversity increased near the mouth of Nescopeck Creek, the diversity did not reach pre-Jeddo Tunnel levels.

				Nescopeck Creek						L. Nescopeck					Black Creek		
Station	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	17	19
Total Taxa Sampled	15	24	9	26	NA	5	5	16	18	1	NA	NA	NA	0	4	11	9
Hilsenhoff Biotic Index	4.5	4.3	5.4	3	NA	4.9	3.5	1.7	4.2	0	NA	NA	NA	0	6.6	5.5	5.6
EPT Genera Sampled	10	15	3	16	NA	1	1	8	9	0	NA	NA	NA	0	0	1	4

Table 3.14 Summary of aquatic macroinvertebrate data for stations sampled in the Nescopeck Creek watershed.

Groundwater

Wells

Unconfined aquifers supply most of the well water in this watershed. A water well must connect with at least one aquifer. Connecting with more than one water-bearing zone will increase the amount of water available to the well, as will drilling into a fracture, or crack in the rock. Confined aquifers, also known as artesian aquifers, are under pressure from confining layers of rock. These layers of rock squeeze the aquifer, so when a well is drilled into this system the natural water pressure can force the water up, sometimes even above surface level. Recharge may occur by slow leakage through the confining layer, or where the aquifer is exposed to the surface. Unconfined aquifers are layers of high permeability from the surface all the way to the bottom of the aquifer. They are more open to the surrounding environment and can be affected more easily by pollution, as recharge can occur from many different avenues. Most of the aquifers in this region are sandstone and shale.

Wells supply most of the irrigation and drinking water for rural residents of the Nescopeck Creek watershed. There are 80 public water supply well systems in the watershed, most of which are owned by local businesses. Each well system may have more then one well. For instance, Conyngham

Aquifer

"An aquifer is a geologic unit that can store and transmit water at rates fast enough to supply reasonable amounts to wells" (Fetter 1998).

Pumping Rate

Pumping rate can be calculated as:

Q=V/T

where Q is the pumping rate, expressed as ft³/day, gallons/minute, or meters³/day.

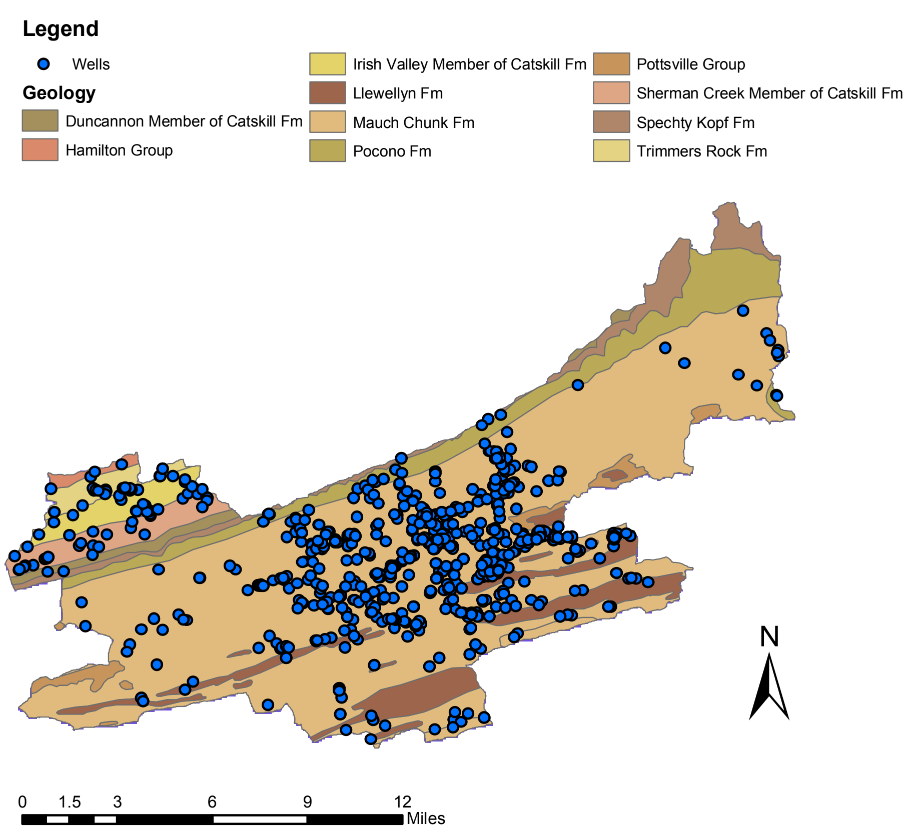


Figure 3.10 Location of wells and geological formation of the source water in the Nescopeck Creek watershed.

Total Dissolved Solids (TDS)

TDS is the sum of dissolved ions. High TDS can cause bad odor or taste. Water hardness is a measure of calcium carbonate in the water. It is not harmful to health, though very hard water can damage water heater elements or make it difficult to clean clothes or get good soap lather. Some hardness is beneficial as it can prevent plumbing corrosion.

Iron (Fe) and Manganese (Mn)

Iron and manganese are not harmful, but can cause bad tastes or orange-brown to black stains.

Sulfate

Sulfate may cause some stomach upset in high enough quantities.

Groundwater Quality

Groundwater quality is affected by the chemical makeup of the precipitation that recharges the system, the types of soils, rocks, and minerals this water passes through and settles in, as well as the amount of time the water contacts these soils, rocks, and minerals (Figure 3.11). Human activities also influence groundwater quality.

For more information see: Merideth, R., J.Jessen, C. Abdalla, E.Stevens, and J.Drohan. 1997. Groundwater Protection and Management in Pennsylvania: An Introductory Guide For Citizens and Local Officials, The Pennsylvania Groundwater Policy Education Project.

Borough maintains ten wells, while Hazleton possesses eleven. One of these supplemental wells for Hazleton averaged over 2 million gallons of water per week. The Mauch Chunk and Pottsville formations contain the major aquifers in this region, with the Mauch Chunk being the most popular and productive. Most of the wells tap into this formation (Fig. 3.10). This water has a wide range of total dissolved solids (TDS) and hardness. Of the wells in the Mauch Chunk, 73% are domestic water supply wells. These wells yield an average of 22 gallons per minute, with a maximum of 150 gallons per minute. Water from the Mauch Chunk is usually very high quality and has remained unaffected by mining activities, in general. The highest recorded yield from the Mauch Chunk formation in this area is from a public supply well for Freeland that achieves 427 gallons per minute.

The Pottsville is the next most common formation, which draws water for 17% of wells. The top two uses for this water are domestic supply (61 wells) and public supply (32 wells). While the Pottsville formation may yield greater quantities of water than the Mauch Chunk formation, it is more likely to contain high amounts of iron and manganese. Since the Pottsville formation also contains some coal and coal mines, its groundwater may contain 3 to 40 times the concentrations of iron, manganese, sulfate, and dissolved solids. Water that mildly exceeds EPA standards for concentrations of iron, manganese, or other elements may be used for public water supply if diluted with water of better quality. Groundwater recharge areas are most likely found in the Pottsville formation, which forms the ridges in the Nescopeck Creek watershed.

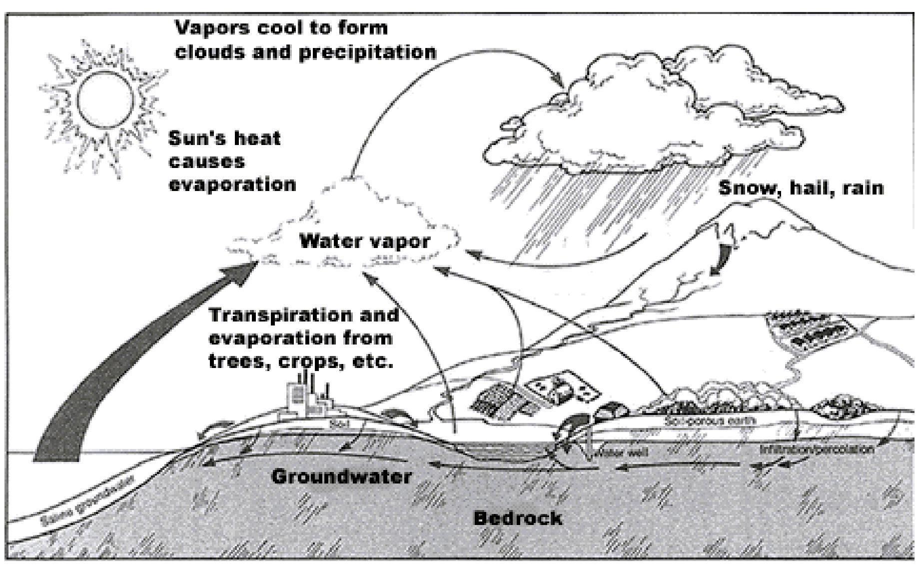


Figure 3.11 Depiction of the hydrocycle (Merideth et al., 1997).

Public Water
The City of Hazleton's water comes from five surface water sources. This water is located above mine tunnel discharges or industrial pollution sources. The Hazleton Sewer Authority owns about 9,000 acres of land around the surface water and ground water recharge areas to protect its water supply from pollution and development. Since surface water supplies most of Hazleton's drinking water, wells are generally for backup purposes. Most of the Hazleton water wells are located in Mt. Pleasant and Barne's Run, though some of these wells are left dormant until there is a need for extra water. Two wells near the Valmont Industrial Complex were shut down in 1987 due to a trichloroethylene (TCE) spill at the Industrial Park. A federal grant was used to extend the water authority's pipes to supply the homes whose wells were affected by this leak.

A gasoline leak at 17th and 22nd street in Hazleton discovered in the early 1990s has caused concern for the safety of drinking water in that area. Local citizens have reported vapors entering their homes and sewers and blame the gasoline from the Tranguch tanks for some cancer and tumor occurrences. The Pennsylvania State House passed H.R. 149 in April, 2001, declaring the area a disaster area. It will now be passed on to the Governor and federal authorities for approval. For an extensive list of articles on this incident, visit the Group Against Gas's website.

A wellhead protection program is required to protect the public water system from contamination. A wellhead protection area is defined as: "The surface and subsurface area surrounding a water well, well field, spring or infiltration gallery supplying a public water system, through which contaminants are reasonably likely to move toward and reach the water source." There are three zones of protection in a wellhead protection program. These are:

Zone 1: 100 to 400 foot radius, depending on aquifer and site characteristics, around a well or spring.

Zone II: ½ mile radius around the water source. This zone contains the area of the aquifer where water is diverted to the well, spring, or infiltration gallery.

Zone III: This area goes beyond Zones I and II and contains the land that affects groundwater quality for the wells and spring. (Pennsylvania Code, Chapter 109 Safe Drinking Water)

Hazleton has no wellhead protection area program.

Pollution Vulnerability
To determine groundwater pollution potential, we used a system called DRASTIC. This model was developed by the U.S. Environmental Protection Agency to classify and measure the vulnerability of groundwater to pollution using a combination of many factors. These factors can be seen in the acronym DRASTIC, which stands for: **d**epth to water, **r**echarge, **a**quifer media, **s**oil media, **t**opography (or slope), **i**mpact of the vadose zone, and **c**onductivity of the aquifer. The higher the rating on the DRASTIC scale, the greater the risk of pollution to the groundwater. The numbers are relative and do not represent a rating against a fixed scale.

TCE

TCE is an industrial solvent and can cause liver, kidney, and nervous system damage.

Groups Against Gas

http://www.groupagainstgas.com/frame5.html

DRASTIC ratings for the Nescopeck Creek watershed are relatively low in the headwaters, and increase in the southern and central regions (Figure 3.12). The lighter colors around the headwaters of Nescopeck Creek in the northeast corner indicate there is low risk of contaminants getting to the groundwater in this area. This rating does not take into account the land use on the surface, however. With state forest covering much of the headwaters, there is even less chance of pollution. In contrast, the population centers of Hazleton and Freeland cover highly vulnerable groundwater areas and would therefore warrant special attention regarding land use and waste disposal (Figure 3.13).

There are 396 wells, or almost 55%, listed within areas that are more vulnerable to ground water pollution relative to the rest of the wells in the watershed. 75% of these (296 wells) are domestic wells, while 7% (29 wells) are public supply. Butler Township contains most of these high-risk wells, with Sugarloaf Township second (Figure 3.14). The Llewellyn formation coincides with high sensitivity to ground water pollution, with a mean DRASTIC rating of 119 (Figure 3.15). This indicates particularly high risk considering the amount of coal mining within these rocks. The mine tunnel system in these areas can channel and concentrate groundwater, preventing natural mitigation of contaminants by the soil or by dilution with other groundwater.

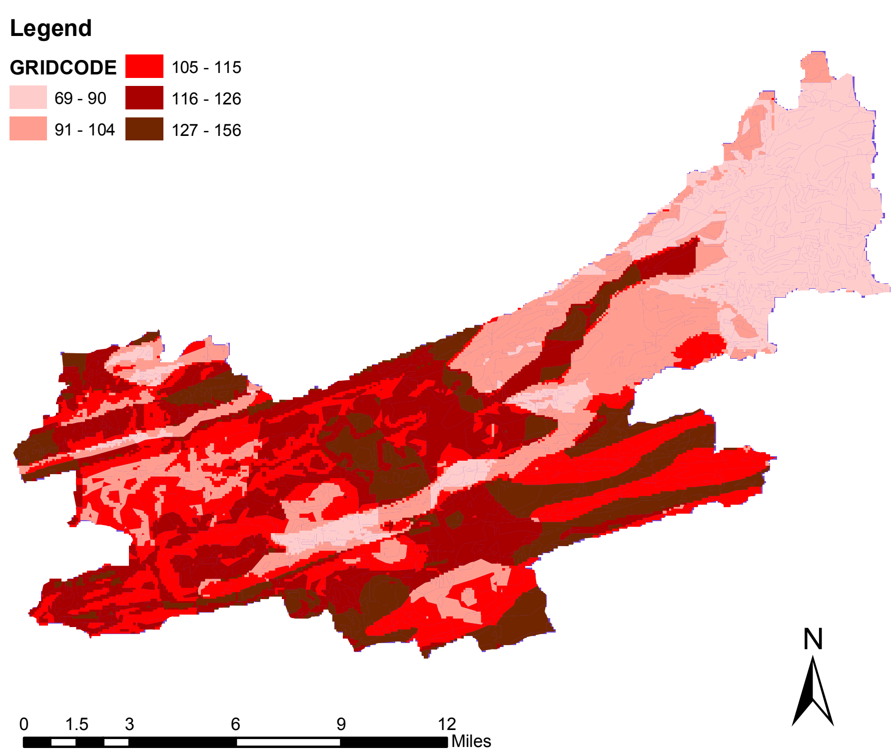


Figure 3.12 DRASTIC scores for the Nescopeck Creek watershed. The darker the color, the greater the risk for water pollution.

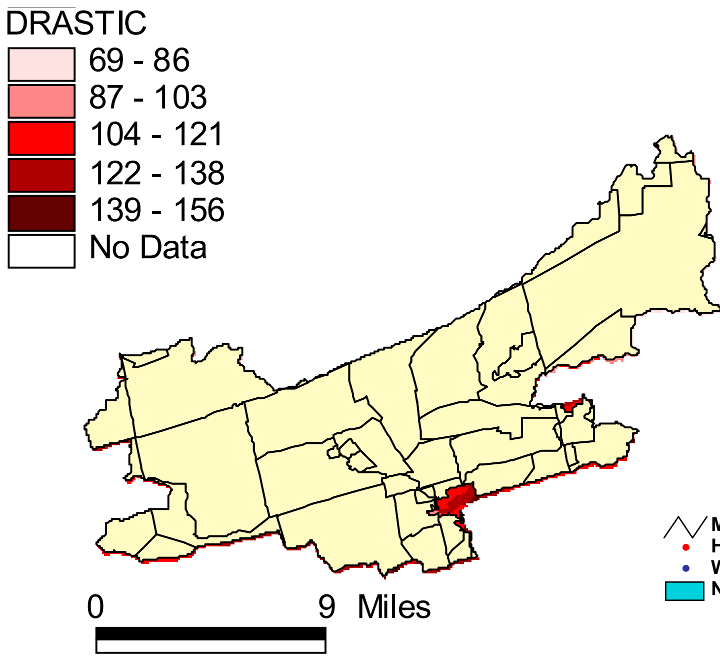


Figure 3.13 DRASTIC scores for Hazleton and Freeland.

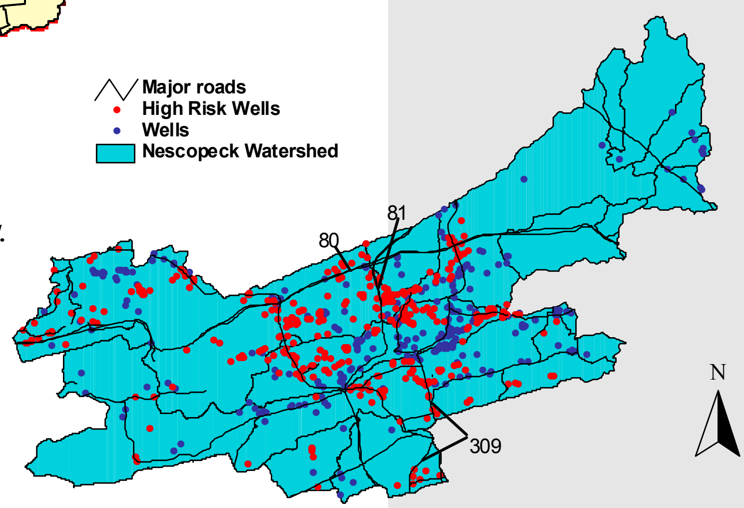


Figure 3.14 Location of wells in the Nescopeck Creek watershed.

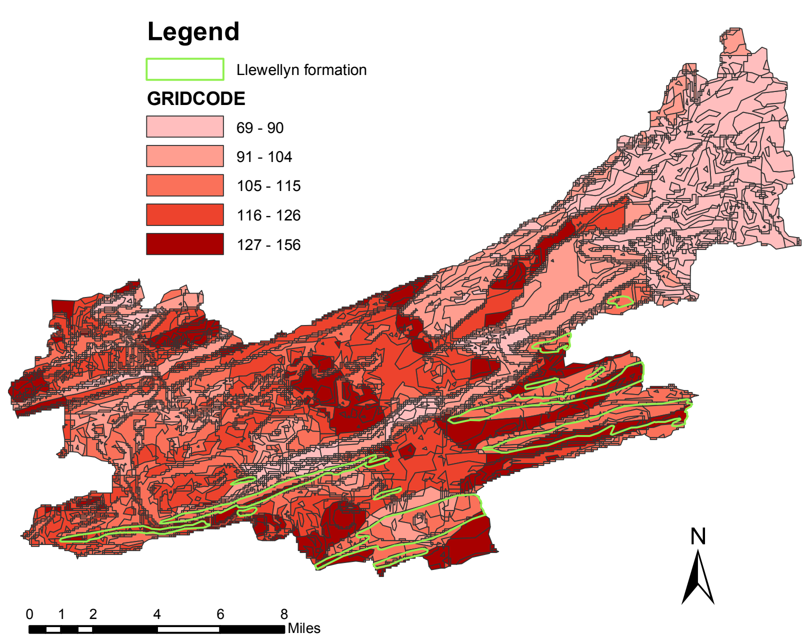


Figure 3.15 Location of Llewellyn formation in areas of high risk for groundwater contamination.

SRBC Reports on the Jeddo Mine Tunnel

Ballaron, P.B., C.K. Kocher, and J.R. Hollowell. 1999. Assessment of conditions contributing to the Little Nescopeck Creek watershed, Luzerne County, PA, and an abatement plan to mitigate impaired water quality in the watershed. Susquehanna River Basin Commission, Publication No. 204.

Hollowell, J.R. 1999. Surface overflows of abandoned mines in the Eastern Middle Anthracite field. Susquehanna River Basin Commission, Publication No. 207.

Ballaron, P.B. 1999. Water balance for the Jeddo Tunnel Basin, Luzerne County, Pennsylvania. Susquehanna River Basin Commission, Publication No. 208.

Mining Effects

Surface pits and deep mine tunnels can disrupt natural surface and groundwater flow systems. The open pits allow water to settle and drain into the ground, while the extensive network of mine tunnels shuttles water to drainage tunnels. The largest of these in the watershed is the Jeddo, which drains mine water from the Big Black Creek, Little Black Creek, Cross Creek, and Hazleton Coal Basins. The Jeddo Tunnel System consists of four main tunnels, the first being started in 1891. The last extension to the system was completed in 1932. This extraordinary engineering feat drains about 13 square miles of coal basins, with a total surface drainage area of over 32 square miles. After deep mines are abandoned and pumping of mine water ceases, the water fills to the level of the gravity drainage system. Water from nine major mine pools mixes with percolating surface water and overflows into the Jeddo, eventually draining into the streams. This water is highly acidic and has had a major influence on water quality. There have already been several mitigation studies on the Jeddo Tunnel by the Susquehanna River Basin Commission.

Image 3.9 Jeddo tunnel outfall (Source: Project Team).

Regulations

By enacting the Federal Water Pollution Control Act of 1972, commonly referred to as the Clean Water Act (CWA), 33 U.S.C. § 1251, the U.S. Congress sought to "restore and maintain the chemical, physical, and biological integrity of the Nation's water." National goals included achieving water quality which "provides for the protection and propagation of fish, shellfish, and wildlife" and for "recreation in and on the water." As a primary policy, Congress prohibited all discharges of pollutants into the waters of the United States without compliance with a required permit. 33 U.S.C. §§ 1342(a) and 1311(a).

Enforcement authority of the CWA was granted to the U.S. Environmental Protection Agency (EPA). 33 U.S.C. § 1251(d). Congress also recognized the rights and responsibilities of the state's primary authority for reducing and restoring the nation's waters. 33 U.S.C. § 1251(b). If desired, a state can step in and implement the CWA requirements for those waters in states jurisdiction. 33 U.S.C. § 1342(b). Such state enforcement authority is subject to the approval of the EPA. The Commonwealth of Pennsylvania has established a water quality regulatory system and the Department of Environmental Protection has primary authority over water quality regulation in the Commonwealth.

The National Pollutant Discharge Elimination System (NPDES) created by the CWA differentiates between point source and non-point source discharges. 33 U.S.C. §§ 1342(a) and 1362(12). Section 405(d) only regulates point source discharges of pollutants under the NPDES scheme. To be considered a point source, a discharge of pollutants must be traceable to one particular source such as a pipe, ditch, tunnel, channel, or conduit. 33 U.S.C. § 1362(14). Non-point sources include those discharges that cannot be traced to a particular source such as agricultural runoff, silvicultural runoff, and other categorical exclusions under the CWA.

If a discharge is considered a point source, requesting and receiving a NPDES permit is a quasi-judicial process. That is, the enforcement agency must provide a hearing before granting the permit that provides the opportunity for public comment. 33 U.S.C. § 1342(a).

In addition, a compliance permit establishes numerous technology and effluent limitations, as well as reporting requirements for the permittee. The technology-based limits are industry-specific requirements based upon technological and economic ability to treat the effluent. In this manner, the permittee can treat the effluent with any technology, as long as it meets effluent limits. Effluent limitations serve a backup function to the technology-based requirements by seeking to set water quality goals and imposing treatment controls beyond the technology requirements when those goals are not met. Finally, a permit holder must also comply with monitoring and reporting requirements. Although primarily site specific, a NPDES permit imposes duties such as minimizing permit violations, properly operating and maintaining the treatment operations, and allowing authorities to enter the premises for inspection, among others.

In the Nescopeck Creek watershed, certain permit holders are allowed to discharge pollutants under NPDES permits issued by the DEP. The DEP makes decisions on granting permits based upon the "use" of a waterbody. Uses of a waterbody can be "existing uses" or "designated uses." An existing use is "Those uses actually attained in the water body on or after November 28, 1975, whether or not they are included in the water quality standards". A designated use is defined in 25 Pa. Code 93.1 as a use specified in §§93.9a-93.9z for each waterbody. Based upon these criteria, existing or designated use, the DEP makes decisions regarding NPDES permit applications. There are no existing use designations for any streams in the Nescopeck Creek watershed. Most of the designated uses for Nescopeck Creek and tributaries are either high quality cold-water fishery (HQ-CWF) or cold water fishery (CWF) (Figure 4.2).

Although primarily concerned with point source discharges, the CWA also recognizes water quality problems caused by non-point sources of water pollution. The CWA does not directly regulate these sources but provisions have been enacted which seek to address the non-point source pollution problem. Congress also requires states with enforcement authority to report on the status of water resources within their boundaries and make a list of those waters that, despite point source controls, are still impaired. 33 U.S.C. § 1315(b). States are also required to identify waters that will not meet water quality standards without additional non-point source pollution controls and to identify the sources of such non-point source pollution. 33 U.S.C. § 1329. In response to this mandate, the DEP implemented the Un-assessed Waters Program that sought to conduct statewide stream assessments within 10 years, document continued point and non-point source impairments, and identify the causes and sources of these impairments. The Nescopeck Creek assessment by DEP is in progress but not yet completed.

Section 303(d) of the CWA also required states to list those impaired waters that do not meet a designated water quality use even after the application of water pollution control technology (NPDES permit compliance). 33 U.S.C. §1313(d). In this list, the state must include reasons for further impairment and also develop a Total Maximum Daily Load (TMDL) for specified pollutants. A TMDL seeks to designate the "greatest amount of loading that a water can receive without violating water quality standards." A TMDL includes four components: point source contributions, non-point source contributions, natural background concentrations, and a margin of safety. In essence, a TMDL, once formulated, can act as a tool to help guide DEP's decisions for granting future NPDES permit applications. The DEP has listed Little Nescopeck Creek[B] and Black Creek on the 303(d) list but a TMDL has not been formulated for either stream.

Section 404(d) of the CWA prohibited the dredging and filling of waters of the United States without first obtaining a permit from the Army Corps of Engineers. 33 U.S.C. §1344. This section includes the dredging and filling of wetlands. To apply, the conversion activities must include dredging or filling of waters of the United States, considered "jurisdictional wetlands." Primarily, this includes any water used in interstate commerce, any water adjacent to waters used in interstate commerce, or waters that could affect interstate commerce. Until recently, jurisdictional waters also included those isolated waters that were used by migratory birds. A recent U.S. Supreme Court decision this asserted jurisdiction (Solid Waste Agency of Northern Cook County v. U.S. Army Corps of Engineers, 121 S.Ct. 675 (2001)). The Commonwealth of Pennsylvania also has jurisdiction over the dredging and filling of wetlands that are not within the jurisdiction of the Corps. Wetlands present in the Nescopeck Creek watershed are subject the Corp's or DEP's jurisdiction. Any individual seeking to significantly alter these landscapes must first obtain a permit.

Water Quality Areas of Concern

Surface water

The acid mine drainage (AMD) in the Nescopeck Creek watershed is collectively the single largest contributor of water pollution. All of the written studies within the watershed to date have been concerned with assessing and abating AMD in Nescopeck Creek, Black Creek, and Little Nescopeck CreekB. In addition, the problem is currently being addressed by the Eastern Middle Anthracite Recovery Region Project. We feel that we cannot contribute additional information to the large body of knowledge and list of potential actions that are available to treat this problem. However, there a number of other water quality concerns in the Nescopeck Creek watershed that need to be addressed. In this assessment we will concentrate on polluted runoff from the following areas in our recommendations to the Nescopeck watershed:

a. Non-point sources due to various land practices
b. Agricultural runoff
c. Combined sewer overflows

Groundwater

Coal mining in this region accounts for most of the human effects on ground water quality. Water and oxygen are introduced through mine tunnels and interact with pyrite, forming AMD. Non-point source pollution from storm water runoff has been flowing into Black Creek and finally down through abandoned mine tunnels, to come out the mine drainage tunnels such as the Jeddo, or into the underground aquifers. There was little ground water quality data available aside from the public supply systems, all of which showed contaminant levels well within regulations.

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Wnuk, R., R.E. Moase, L. Benzie. 1999. Nescopeck Creek Basin (405D) Fisheries Management Report. Pennsylvania Fish and Boat Commission Files, 450 Robinson Lane, Bellefonte, PA.

Biological Resources

The Nescopeck Creek watershed contains a variety of aquatic and terrestrial communities. This section discusses the various flora and fauna found in the Nescopeck Creek watershed. In addition, there are many habitat types including wetlands, streams, forests, and unique natural areas that are present in the watershed. These areas are important given their relation to regional biological diversity. A Bird Community Index was used to quantify the integrity of surrounding landscape ecosystems. In addition, fish communities and the integrity of aquatic habitat in Nescopeck Creek and tributaries are addressed. This section demonstrates the abundant biological resources that are present in the watershed.

Biological Diversity

It is estimated that scientists have identified only 20 percent of all species on earth. While scientists are striving to learn as much as they can about species biodiversity, there is still a long way to go. Learning about biodiversity does not require a classroom or laboratory. The only prerequisite is one's interest in the subject. Biodiversity is found not only in state parks and wildlife refuges, but also in backyards and urban areas. People can enjoy learning about the natural resources around them and reflect on how to sustain these assets that are the support systems for life on earth (Kim 2001).

Endangered species *means a class of species that are in imminent danger of extinction or disappearance throughout most or all of their natural range within Pennsylvania, if critical habitat is not maintained or if the species is greatly exploited by humans. An example of an endangered species is the Bog Turtle (Clemmys muhlenbergii), which has lost great areas of its natural habitat due to human encroachment (DCNR 2001).*

Extirpated *is a term meaning believed to be extinct in Pennsylvania. The species may or may not exist outside of the state. If the species were found to exist in Pennsylvania, then the classification would be changed to endangered (DCNR 2001).*

Fauna and Flora of the Nescopeck Creek Watershed

Fishes

The Nescopeck Creek watershed falls under the jurisdiction of the Area 4 fisheries management office of the Pennsylvania Fish and Boat Commission (PFBC) located in Sweet Valley, Pennsylvania. Area 4 is located in northeast Pennsylvania and serves Bradford, Carbon, Columbia, Lackawanna, Luzerne, Monroe, Pike, Sullivan, Susquehanna, Wayne, and Wyoming counties.

In the summer of 1999 the PFBC conducted an extensive fish survey of the entire Nescopeck Creek watershed (Wnuk et al. 1999). The PFBC conducted the survey to update information on previously surveyed streams and to collect baseline inventory information for formerly unassessed streams. In total, 13 named streams and 19 unnamed tributaries were assessed during the survey. The PFBC did not conduct electrofishing surveys on streams that had insufficient flow, water quality parameters inhospitable to fish, or had no public access points. For the purpose of this document, streams not surveyed via electofishing will be classified as unassessed for fish populations (Figure 4.1).

The PFBC survey documented the presence of 20 fish species in the Nescopeck Creek watershed (Table 4.1). Fifteen of the species had been captured during previous PFBC surveys, while five species were documented for the first time in the watershed. The five new species captured were the golden shiner (*Notemigonus crysoleucas*), fathead minnow (*Pimephales promelas*), bluespotted sunfish (*Enneacanthus gloriosus*), green sunfish (*Lepomis cyanellus*), and the American eel (*Anguilla rostrata*). The capture of the American eel marked the first time the species had been captured in the Area 4 fisheries management region since 1983. Two species that had been captured previously in the watershed were absent from the

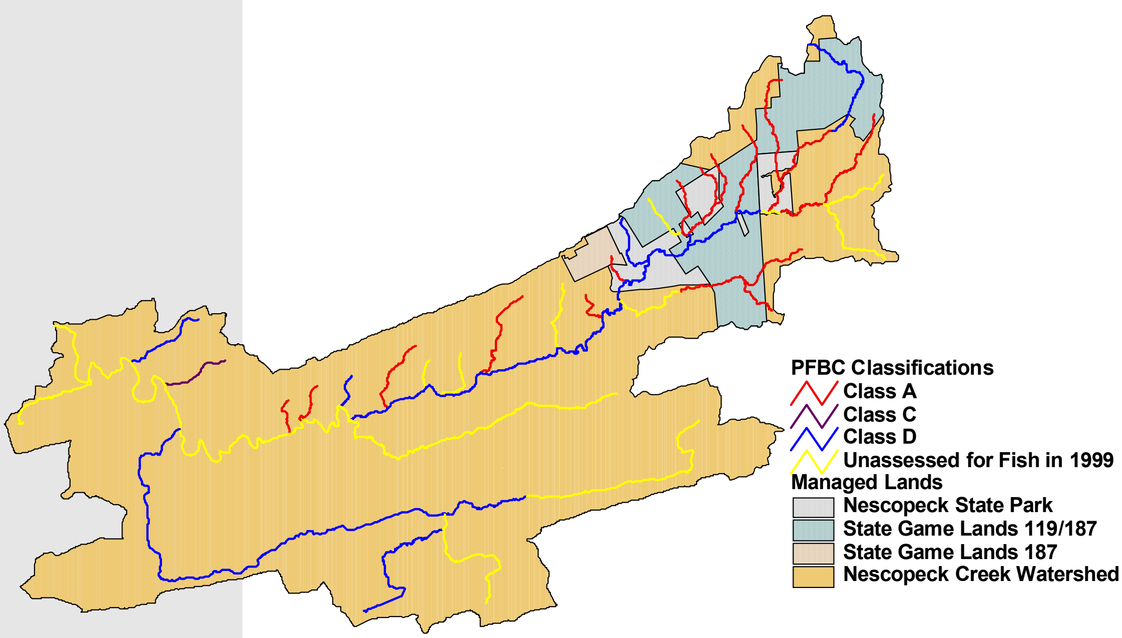


Figure 4.1 PFBC biomass/abundance classes of streams in the Nescopeck Creek watershed.

Scientific name	Common Name	1999	Historic
Salmo trutta	Brown trout	X	X
Salvelinus fontinalis	Brook trout	X	X
Esox niger	Chain pickerel	X	X
Exoglossum maxillingua	Cutlips minnow	X	X
Notemigonus crysoleucas	Golden shiner	X	
Luxilus cornutus	Common shiner	X	X
Pimephales promelas	Fathead minnow	X	
Rhinichthys atratulus	Blacknose dace	X	X
Rhinichthys cataractae	Longnose dace	X	X
Semotilus atromaculatus	Creek chub	X	X
Semotilus corporalis	Fallfish	X	X
Catostomus commersoni	White sucker	X	X
Noturus insignis	Margined madtom	X	X
Ameiurus nebulosus	Brown bullhead		X
Anguilla rostrata	American eel	X	
Enneacanthus gloriosus	Bluespotted sunfish	X	
Lepomis cyanellus	Green sunfish	X	
Lepomis gibbosus	Pumpkinseed	X	X
Lepomis macrochirus	Bluegill		X
Micropterus salmoides	Largemouth bass	X	X
Etheostoma olmstedi	Tessellated darter	X	X
Cottus spp.	Sculpins	X	X
Total species:		20	17

Table 4.1 Scientific and common names of fish species captured in the Nescopeck Creek watershed during the 1999 and historic surveys (Wnuk et al. 2000).

1999 survey. The two species were the brown bullhead (*Ameiurus nebulosus*) and the bluegill (*Lepomis macrochirus*).

A number of the smaller streams in the Nescopeck Creek watershed maintain a substantial wild brook trout (*Salvelinus fontinalis*) population. The larger streams in the drainage were found to be either polluted by acid mine drainage or warmed too much during the summer to support wild trout. Streams in the Nescopeck Creek watershed ranged from Class A to Class D status for wild trout based on PFBC criteria (Table 4.2). The 1999 PFBC survey documented 15 stream sections in the basin where brook trout populations met the criteria to qualify for Class A status (Figure 4.1). The goal of the Class A wild trout waters option is to provide recreational trout angling opportunities in waters where wild trout populations are capable of supporting an attractive fishery without stocking (Pennsylvania Fish and Boat Commission 1997). Brown trout (*Salmo trutta*) were relatively scarce due to the basin's acidic nature.

The DEP designates a protected water use for each stream in Pennsylvania (25 Pa. Code §93.3). DEP classifies the majority of the streams surveyed during the 1999 PFBC survey coldwater fishes (CWF) (Table 4.2). The upper portion of the Nescopeck

Rare species *are species that are uncommon within Pennsylvania. All species classified as "Disjunct," "Endemic," "Limit of Range," and "Restricted," are included in the "PA Rare classification." An example of a rare species in Pennsylvania is the northern goshawk, which is known to breed in few places in the state (DCNR 2001).*

Threatened *refers to a classification of species that may become endangered within the foreseeable future throughout most or all of their natural range within Pennsylvania if critical habitat is not maintained to prevent their further decline, or if the species is greatly exploited by humans (DCNR 2001).*

Vulnerable *is a classification of species that are in danger of population decline within Pennsylvania because of their beauty, economic value, use as a cultivar, or other factors that indicate that persons may seek to remove these species from their native habitats.*

Subprogram	Class	Criteria
1. Wild brook trout fisheries	A	Total brook trout biomass of at least 30 kg/ha (26.7 lbs/acre)
	B	Total biomass of brook trout less than 15 cm (5.9 in.) total length of at least 0.1 kg/ha
	C	Brook trout biomass must comprise at least 75% of total trout biomass
2. Wild brown trout fisheries	A	Total brown trout biomass of at least 40 kg/ha (35.6 lbs/acre)
	B	Total biomass of brown trout less than 15 cm (5.9 in.) total length of at least 0.1 kg/ha
	C	Total brown trout biomass must comprise at least 75% of total trout biomass
3. Mixed wild brook / brown fisheries	A	Combined brook and brown fisheries trout biomass of at least 40 kg/ha (35.6 lbs/acre)
	B	Brook trout biomass must comprise less than 75% of total trout biomass
	C	Brown trout population must comprise less than 75% of total trout biomass
	D	Total biomass of brook trout less than 15 cm (5.9 in.) total length of at least 0.1 kg/ha
	E	Total biomass of brown trout less than 15 cm (5.9 in.) total length of at least 0.1 kg/ha

Table 4.2 PFBC wild trout population / abundance classes (Pennsylvania Fish and Boat Commission 1987).

Blacknose dace (Rhinichthys atratulus)

Brown bullhead (Ameiurus nebulosus)

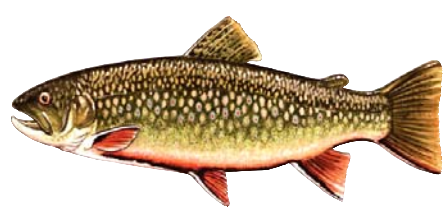
All drawings by Ted Walke, "Pennsylvania Fishes," PFBC.

Creek watershed (with the exception of Creasy Creek and Little Nescopeck Creek[A]) and the upper portion of the Oley Creek sub-watershed are classified high quality-coldwater fishes (HQ-CWF), while the lower portion of the mainstem of Nescopeck Creek is classified trout stocked fishes (TSF) (Figure 4.2).

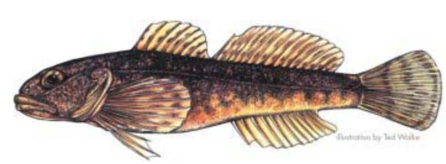
Aquatic Macro-invertebrates

The Pennsylvania DEP conducted a stream investigation of Nescopeck Creek, Little Nescopeck Creek, and Black Creek over the summer of 1998. The macroinvertebrate data from this survey are listed in Appendix A.1. For a complete discussion of the results of the macroinvertebrate and water quality information obtained in this survey refer to the Water chapter of this assessment.

Brown trout (Salmo trutta)



Brook trout (Salvelinus fontinalis)



Slimy sculpin (Cottus sp.)

Plants

The Department of Conservation and Natural Resources has commissioned a study of the natural and historic resources of the Pennsylvania state parks to assist in its planning for the 21st century. As part of this assessment, Drs. Ann Rhoads and Tim Block of the Morris Arboretum of the University of Pennsylvania and the Academy of Natural Sciences are engaged in a three-year survey of the plant diversity of the Nescopeck State Park. Although Rhoads and Block will complete the assessment in the summer of 2002, they have recorded more than 600 plant species. A full list of plant species identified to date can be found in Appendix A.

Other Species

Recent studies of the terrestrial biological diversity of the Nescopeck Creek watershed illuminate the state or condition of its wildlife. The Wildlands Conservancy's Rivers Department documented the presence of diverse array of amphibians, reptiles, and birds in its year 2000 assessment of the Little Nescopeck Creek watershed, a sub-basin in the Nescopeck Creek drainage area. Another invaluable study conducted by the Department of Conservation and Natural Resources in 2001 provided extensive data on bird and mammal species richness of the Nescopeck State Park. The project team utilized these data sources to understand the current status of biological resources in the Nescopeck Creek watershed. Please refer to Appendix A for species lists.

Image 4.1 Wood turtle (Clemmys insculpta) (Source: Diane Madl).

Image 4.2 Blue vervain (Verbena hastata) (Source: Diane Madl).

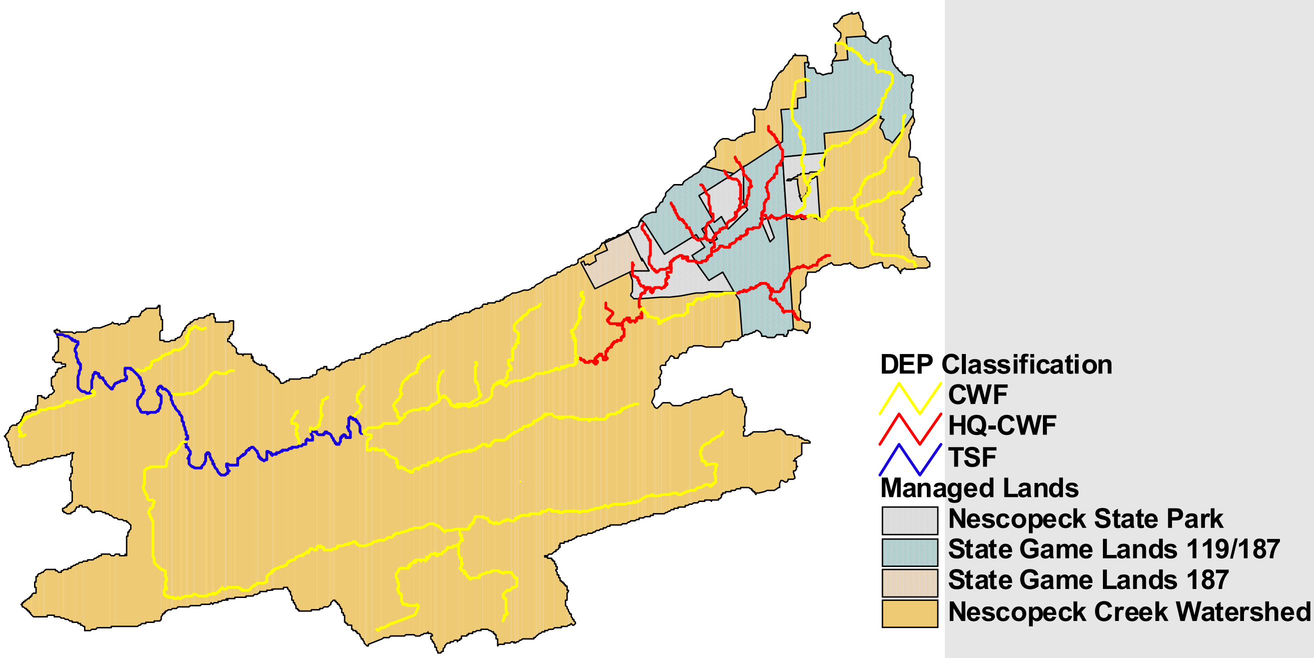


Figure 4.2 DEP protected uses classification for the Nescopeck Creek watershed.

Wetland Restoration Programs

· Partners for Wildlife –A Cooperative effort of the U.S. Fish and Wildlife Service and the Natural Resource Conservation Service. This is a voluntary landowner assistance program that has contributed more than 3,000 acres of wetlands to Pennsylvania.

· Section 319 and Growing Greener Grants – These programs target wetland restoration within a watershed context to help address and control non-point source pollution.

Habitat Areas

Dominant Forests Types

The Dry Oak-Mixed Forest

The dry oak-mixed hardwood forest is the most common forest assemblage in the watershed today. The dominant species include mast-producing trees such as northern red oak (*Quercus rubra*), white oak (*Q. alba*), and chestnut oak (*Q. prinus*). Other trees in this forest type include red maple (*Acer rubrum*), gray and black birch (*Betula populifolia* and *B.lenta*), eastern white pine (*Pinus strobus*), and eastern hemlock (*Tsuga canadensis*). On ridgetops and severe slopes with little soil, chestnut oak combines with scarlet oak (*Q. coccinea*), and black oak (*Q. velutina*) (Stauffer 2001). Penobscot Mountain, near the northwest boundary of the watershed, is an example of this forest type.

Understory trees, shrubs, and wildflowers that prefer these dry conditions include serviceberry (*Amelanchier spp.*), hawthorn (*Crataegus coccinea*), maple-leaved viburnum (*Viburnum acerifolium*), blueberry (*Vaccinium* sp.), huckleberry (*Gaylussacia* sp.), and teaberry (*Gaulteria procumbens*). Dense stands of rhododendron (*R. catawbiense*, or *R. carolinianum*), and mountain laurel (*Kalmia latifolia*) also thrive on the wooded slopes, along with purple-flowering raspberry (*Rubus odoratus*), and New Jersey tea (*Ceanothus americanus*).

Image 4.3 Maple (Source: Project Team).

Perennial wildflowers here include trout lily (*Erythronium americanum*), wild strawberry (*Fragaria virginiana*), wild onion (*Allium canadense*), wood geraniums (*Geranium maculatum*), and other spring ephemerals that supply pollen and nectar to bees. Blue wood aster (*Aster cordifolius*), white wood aster (*A. divaricatus*), and goldenrods (*Solidago spp.*) brighten the fall forest scene and its edges.

The dry oak-mixed hardwood forest supplies food, cover, and nest sites for birds, butterflies, moths, reptiles, and amphibians (Stauffer 2001).

Pitch pine-scrub oak forest

This forest type is found on Arbutus Peak, in the Stockton Mountain Barrens near the southern edge of the watershed, in the Nescopeck Mountain Barrens, and in the Humboldt Barrens. Here, pitch pine (*Pinus rigida*) is found growing in association with dense stands of scrub oak (*Quercus ilicifolia*), and black and chestnut oaks. Both pine seeds and oak acorns are of major importance as wildlife foods because they are usually abundantly available. Many species are dependent on pine trees and oak leaves for cover, nest sites and materials (Martin et al. 1961). Bracken fern

(*Pteridium aquilinum*) grows readily in the acidic soil of these barrens thickets. Fruiting shrubs and ground covers potentially found here are huckleberry, black chokeberry (*Aronia melanocarpa*), low bush blueberry, and teaberry.

Wetlands

Wetlands are defined as areas of the land that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support (and that under normal circumstances do support) a prevalence of vegetation typically adapted for life in saturated soil conditions, including swamps, marshes, bogs, and similar areas (33 CFR 328.3(b) 1984). In their intact condition, wetlands supply many benefits to humans and wildlife, including habitat, aquatic productivity, water quality enhancement, carbon sequestering, erosion prevention, flood damage protection, and opportunities for recreation and aesthetic appreciation. Many sport fishes spawn in the aquatic areas of wetlands (Tiner 1987).

Approximately 50% of the original wetlands in North American have disappeared because of human activities. Between 1956 and 1979, Pennsylvania lost almost 28,000 acres of vegetated wetlands. Within the Chesapeake Bay watershed, freshwater-forested wetlands are the most common type of freshwater wetland. The predominant causes of freshwater-forested wetland loss in the Bay watershed are reservoir creation (45%), development (23%), pond creation (18%), and agricultural practices (14%) (U.S. EPA Chesapeake Bay Program Office, 2002). Pennsylvania was one of the Chesapeake Bay Program partners to agree to no-net loss of wetlands in 1988. In 2000, they further agreed to a 25,000-acre restoration goal within the Chesapeake Bay watershed. In order to meet this agreement by 2010, Pennsylvania will restore approximately 400 acres of non-tidal wetlands a year.

Image 4.4 Emergent wetland in Nescopeck State Park (Source: D. Madl).

Wetland Types

Wetlands encompass a wide range of wet environments, and occur in the transitional zones between bodies of water and uplands (Cole 1996).

Freshwater wetlands ***can include a network of basins formed by glaciers as in the area of Edgewood, where they fill with water for a few months in spring.***

Forest swamps ***occur in the wide valley of Nescopeck Creek. The ground in these sites can be saturated to the surface with water, or covered with standing water.***

Seeps***, as in the Valmont Industrial Park, are places where the aquifer is close to the land surface, and an opening allows water to trickle out slowly. Groundwater seeps seldom freeze.***

Cattail marshes ***are wetland types dominated by soft-stemmed plants such as cattails and pickerelweed. Emergent and floating marsh plants easily establish themselves in wetlands on a river or major creek floodplain. The Nescopeck State Park is the site of a number of marshes that harbor diverse flora and fauna (Niering 1997).***

Natural Areas Inventory

Inventory teams conduct PNDI surveys in three stages. 1) PNDI database files, local experts, topographic maps, and existing aerial photographs supply essential information about each study area. 2) Teams of biologists conduct new surveys on the ground and by air to determine the present condition of the areas. 3) The teams map and analyze the information compiled, and hold a public meeting to air the report (Stauffer 2001).

Natural Areas

Intact natural zones adjacent to Nescopeck Creek and its tributaries include forested ridges, stream banks, woodland buffers, and wetlands. Abandoned strip mine lands are also discussed here because of the potential for restoration or development instead of disturbing intact natural ecosystems.

Information used in this section includes sources such as the the Pennsylvania Science Office (PSO) of The Nature Conservancy, Natural Areas Inventory report of Luzerne County (Stauffer 2001), the Pennsylvania Gap Analysis Project of the U.S. Geological Survey (Myers 1998), the Resource Management Manual for Nescopeck State Park (2001), and the recently developed Bird Community Index, an instrument used to predict ecological conditions of an area based on the presence of its types of bird communities (O'Connell et al. 2000).

The Luzerne County Office of Community Development sponsors the periodic assessment that utilizes the Pennsylvania Natural Diversity Inventory (PNDI) database to determine the county site biological values. The PNDI database, established in 1982, is a cooperative project of The Nature Conservancy, the Pennsylvania Department of Conservation and Natural Resources (DCNR), and the Western Pennsylvania Conservancy. The PSO published its findings in a public document called *A Natural Areas Inventory (NAI) of Luzerne County, Pennsylvania* (Stauffer 2001).

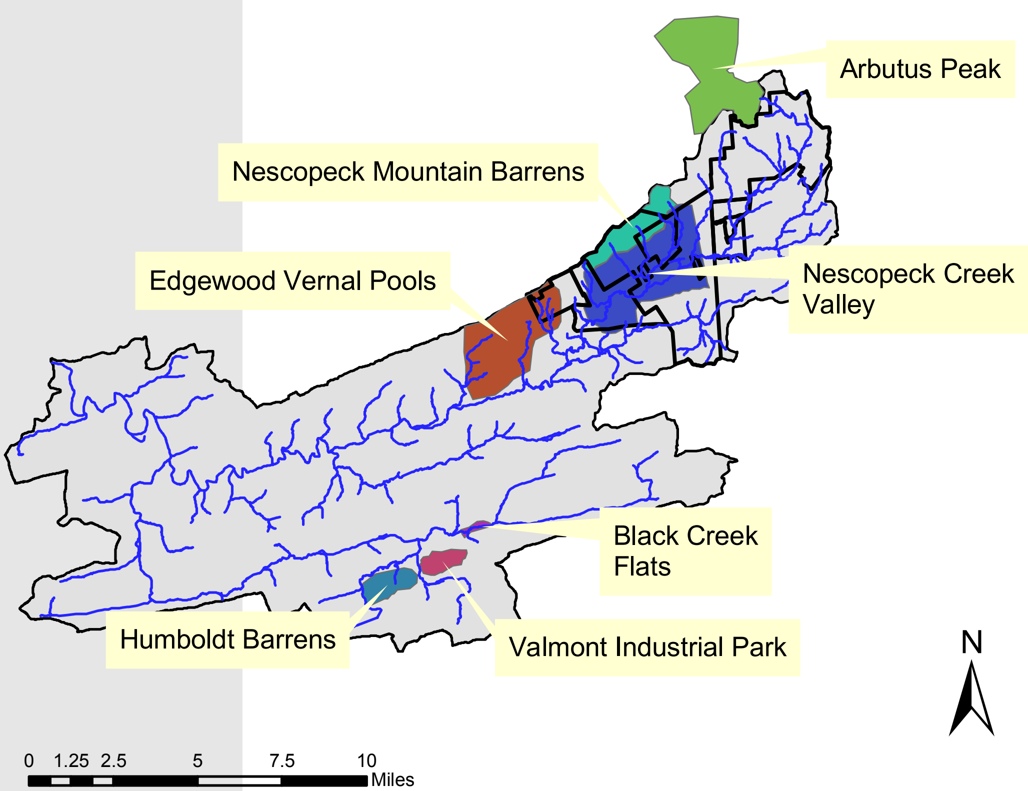


Figure 4.3 Important natural areas within the Nescopeck Creek watershed identified by Pennsylvania Science Office of The Nature Conservancy (Stauffer 2001).

According to a report recently completed by the PSO, the Nescopeck Creek watershed is brimming with biodiversity. The PSO determined from its assessment of Luzerne County that among four sites in the county containing the highest natural integrity, three lie within or near the Nescopeck Creek watershed. They are Arbutus Peak, Edgewood vernal pools, and Nescopeck Creek Valley (Figure 4.3). The PSO describes these living tapestries of plants and animals as critically important to sustain endangered and threatened species in the county, state, and region (Stauffer 2001).

Arbutus Peak: is part of an oak-barrens complex of 5,000 to 6,000 acres occurring southeast of Wilkes-Barre. The sub-area of the barrens in which Arbutus Peak is found lies southwest of Crystal Lake along the ridge tops at the edge of the Nescopeck Creek watershed. Fifteen rare animal and plant species are found within the barrens. Four plant species of concern are also found there. Although barrens are often dry sites, the Arbutus Peak complex encompasses a number of wetlands. Its top priority ranking stems from the presence of uncommon habitats and its distinction as one of the richest barrens for butterfly and moth groups in the northeastern United State (Appendix A).

Edgewood vernal pool complex: is located in Butler Township and is identified as the second most important site in the county to preserve for the protection of biological diversity. Glaciers created this extensive vernal pool network around 12,000 years ago. During winter and spring, precipitation and runoff flood these basins, creating essential breeding areas for frogs and salamanders. By mid-summer when the water dries up, the amphibians are mature and move to upland areas to hide from predators and escape the heat. A mosaic of such depressions is considered "the lifeline of many woodland amphibians in northeastern deciduous forests" (Cassell 1996). The pools supply high quality breeding habitat for wood frogs (*Rana sylvatica*), spotted salamanders (*Ambystoma maculatum*), and Jefferson salamanders (*Ambystomata jeffersonianum*) (Stauffer 2001).

Human disturbances near the fragile Edgewood vernal pool areas have destroyed some of the forestlands and depressions south of I-80. Nearby roadways fragment the living space for amphibians and reptiles, and are hazardous to migrating species in the spring. Pressures of ATV traffic and development in the area are additional concerns.

Image 4.5 Forested wetland along Black Creek, Hazle Township (Source: Project Team).

Barren Areas

Barrens are dry sites of low fertility usually found in remote areas. These sites are usually important habitats for a variety of rare plants and animals requiring uncommon habitat conditions. Naturally occurring disturbances such as fire and flooding may be essential for maintenance of the biodiversity present.

Wetland Networks

It is not uncommon for a network of wetlands types to be interconnected, and to form natural travel corridors for migrating species (Cole 1996).

Image 4.6 Spotted salamander (***Ambystoma maculatum***) **(Source: Diane Madl).**

The Nescopeck Creek Valley: is a large, forested area in the upper Nescopeck Creek watershed (Figure 4.3). It includes portions of Nescopeck State Park and State Game Lands 187. The trees and dense under-story vegetation along the creek and tributaries can effectively trap sediment and remove nutrients from water. Rare animal and plant species have been found in wetlands in this area. The continued existence of these species in the park depends upon efforts to protect the valley from undue human disturbances, especially by preserving or restoring the forests along tributaries.

Nescopeck State Park, one of the newest state park lands managed by DCNR spreads across 3,550 acres of the broad, glaciated creek valley between Nescopeck Mountain to the north, and the steep slopes of Mount Yeager to the south (DCNR 2001) (Figure 4.4). Although the park is buffered from the effects of human settlement by ridges and game lands to the north and south, it may be less protected from human disturbance on its east and west boundaries (DCNR 2001). In the headwaters areas, unlimited development could alter stream conditions that protect groundwater sources, a high wildlife and vegetation species diversity, and cold-water fisheries.

The park encompasses a diversity of habitats, including old fields, bottomland and upland forests, hemlock ravines, open cattail marshes, ponds, alder marshes, and swampy woods (Ford 1995). As of July 2000, there is one species of special concern and two species under consideration for special concern designation in the state park. The northern goshawk (*Accipiter gentilis*) is a Pennsylvania candidate rare species that nests in a remote area of the park. Nest areas are protected from timbering and other human interferences. The flypoison borer moth (*Papaipema sp.)* has no PNDI status, but is a Pennsylvania biological survey species of special concern, and is protected by the Bureau of State Parks (DCNR 2001). The eastern hognose snake (*Heterodon platyrhinos*) is classified as rare and uncommon in the state. Based upon observations in recent years the eastern hognose snake may be more secure, at least in the park (K. Fazzini personal communication). The snake prefers dry, sandy terrain in open, sparsely wooded uplands or

Image 4.7 Eastern Hognose Snake; J. ***LeClere (Source: http://herpnet.net/ Minnesota-Herpetology/).***

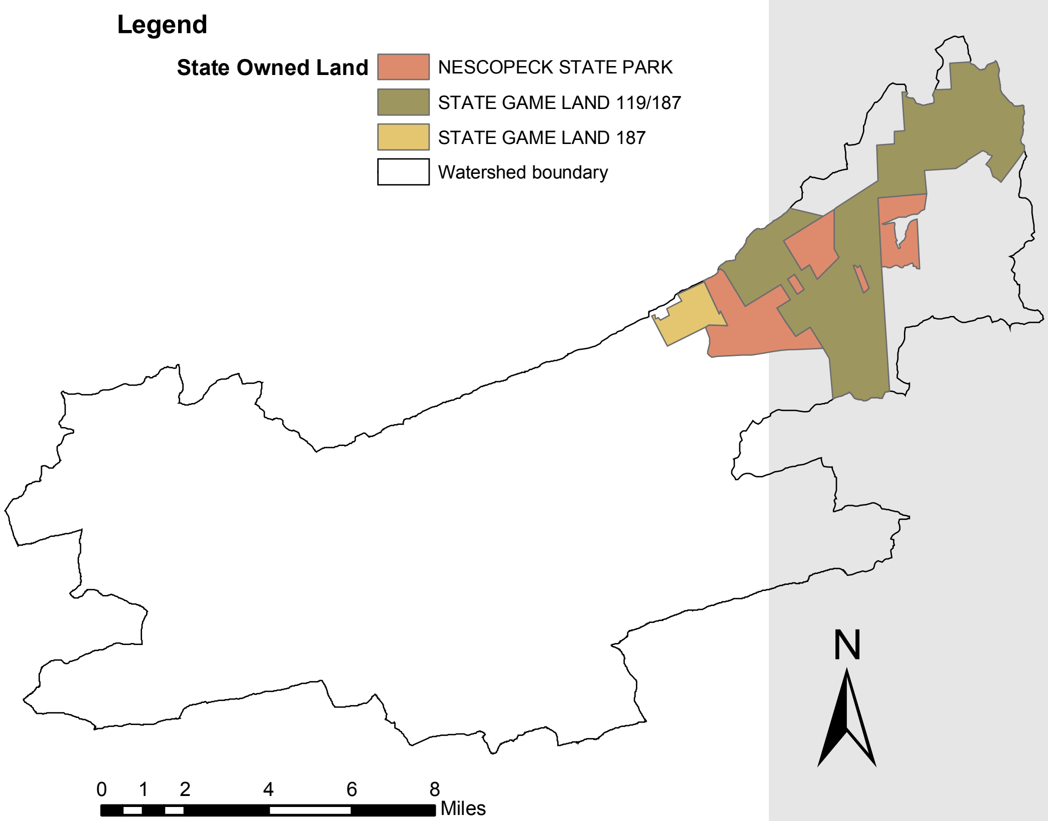


Figure 4.4 State owned lands within the Nescopeck Creek watershed.

rocky slopes (DCNR 2001).
Area naturalist Alan Gregory recently conducted a survey of bird species for the Pennsylvania Society for Ornithology Special Areas Project (SAP), and reported 130 species. Gregory has logged 142 species in all of his Nescopeck State Park observations (A. Gregory, personal communication).

The Pennsylvania Game Commission staff conducts management activities to support wild turkey and deer in Game lands 187 near the park. The game managers clear tracts of invasive multiflora rose and establish a grass/legume browse cover to attract game species. The staff erects bluebird boxes, and limes and fertilizes the fields. Within the park, Game Commission, park personnel, and the local chapter of the National Wild Turkey Federation cooperate in habitat improvement projects involving re-seeding and tree planting (Zindell 2001).

One of the unusual plant species of the park is lupine (*Lupinus perenis*), a late spring-blooming wildflower found in dry sandy woods and banks. This plant is designated Pennsylvania rare. The climbing fern (*Lygodium palmatum*), also Pennsylvania rare, is found in swamps and peaty woods in acid soil. The variable sedge (*Carex polymorpha*) is classified as critically imperiled in the state, either because of rarity (few remaining individuals), or because of some condition or factor that increases its vulnerability. In Nescopeck State Park, the variable sedge grows in clumps along roadway drainages, and its population here currently appears to be stable (Rhoads 2001).

Image 4.8 Common milkweed (Asclepias syriacea) (Source: Diane Madl).

Image 4.9 Wetlands area found in extreme eastern area of Black Creek Flats (Source: Project Team).

Humboldt Barrens: is the site of a Ridgetop Dwarf-tree Forest Natural Community comprised of pitch pine (*Pinus rigida*) and scrub oak (*Quercus ilicifolia*). Important snake habitat is found among the large rock slabs and boulders in openings of the forest stands. The NAI (Stauffer 2001) noted potential threats to the site from the large utility line, gravel road fire-breaks, and mine tailings at the edges of the community. Fire suppression, herbicide use in the power line right of way, pulpwood logging, and ATV trails could potentially undermine this uncommon natural community (Figure 4.3).

Nescopeck Mountain Barrens: is another occurrence of the Ridgetop Dwarf-Tree Forest Natural Community where primarily scrub oak woods cover the sandy peaks of adjacent ridges. These barrens are located in Dennison and Wright Townships (Figure 4.3).

Image 4.10 Spoilage banks of abandoned coal surface mine area within the Black Creek drainage; gray birch dominates the site (Source: Project Team).

Valmont Industrial Park: is habitat for seven rare plant species and one rare animal species. This unique site is a high-elevation naturally acidic seep incorporating open areas from human disturbances (Figure 4.3). Chief potential threats stem from intensive ATV trail use, herbicide spraying in the power line right of way, encroaching development, and possible hydrologic changes.

Black Creek Flats: is an open floodplain along Black Creek in Hazleton. There is evidence of extensive mining and other disturbances occurring in the past. However, the altered conditions do not seem to hinder a good-quality population of a PA-Rare plant species from growing in the area (Figure 4.3).

Abandoned Surface Mines: are located on broad mountaintops, mountainsides, and valleys in the watershed the Nescopeck Creek watershed. They are primarily located in the southern portion of the watershed. The dominant tree species is often the gray birch. Because these areas have lost most of their original biodiversity, they may be better candidates for commercial and industrial sites than undisturbed plots. Some of the abandoned strip mines in the watershed may have potential for restoration to wildlife habitat or use as industrial or commercial sites. Please refer to Figure 2.2 for a map of coal bearing areas.

Habitat Analysis

Riparian Buffers

The Pennsylvania Science Office (PSO) describes the Susquehanna River and Lehigh River as exceptional natural features and major corridor ecosystems for the movements of animals found there. The soundness of smaller natural communities in adjacent watersheds depends upon these two large-scale systems and their tributaries. Development of comprehensive conservation plans for important natural areas in the river floodplains is critical to preserving the integrity of the river systems (Stauffer 2001).

Riparian buffers serve an important function along stream banks of rivers and their tributaries. Vegetation holds the soil in place, preventing erosion, and filtering out or fixing excess nutrients and contaminants. Organic litter such as leaves, bark, and fallen tree trunks become detritus, benefiting a widening web of stream life. Overhanging vegetation cools the water in hot weather so that it is more oxygenated.

Birds and small mammals are among a streambank's most prevalent residents. A wide vegetated streamside buffer or corridor that contains a diversity of native plant types such as grasses, shrubs, and trees will attract the greatest abundance and variety of wildlife (Davis and Brittingham 1991).

We analyzed the percent composition of forested, agricultural, and barren land cover within riparian buffers along Nescopeck Creek and major tributaries. While any riparian buffer is better than nothing, we calculated the percent area of forest, agricultural, and barren land within 100 feet of the stream (Figure 4.5).

All of the subwatersheds analyzed for riparian stream buffers possessed greater than or equal to 80% of forested cover. Some subwatersheds, such as Little Nescopeck Creek[B],

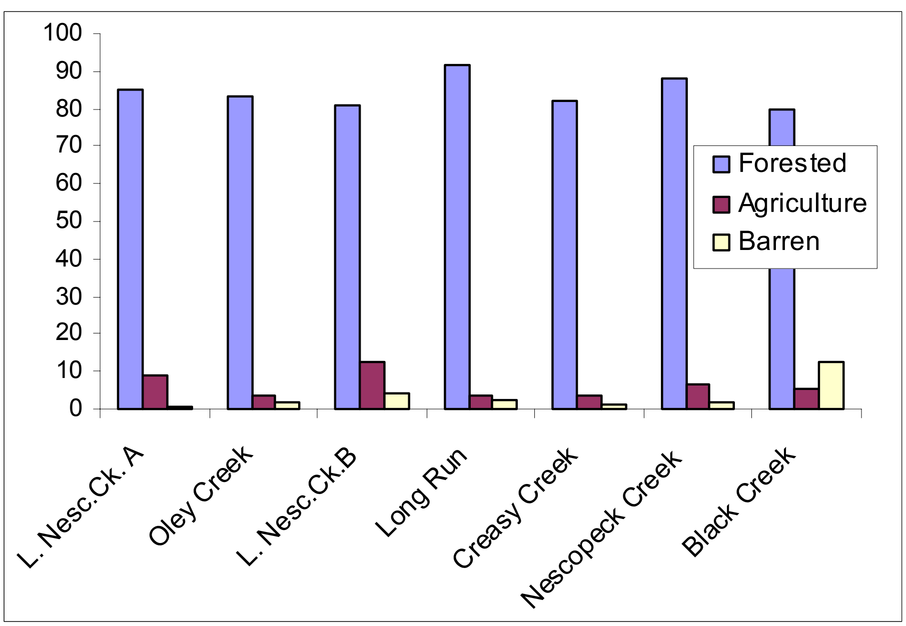


Figure 4.5 Percent of three land cover types within 100 feet of stream in each subwatershed within the Nescopeck Creek watershed.

Long Run, and Nescopeck Creek, showed a decrease in the percent coverage of forested riparian buffer as the distance from the stream increased from 100 to 500 ft. Other streams percent coverage of forested riparian buffer increased as the distance from the stream increased. Examples of these subwatersheds include Creasy Creek and Oley Creek.

We divided the range of percent cover for forest, perennial and annual vegetation, and barren categories into quartiles, or from one to four for each subwatershed (Table 4.3). A rating of one indicates the lowest percent cover for that vegetation type while a rating a four indicates the highest percentage of cover. This type of rating system can help compare subwatersheds. For example, Black Creek has the lowest rating for forest cover and highest rating for agriculture and barren cover compared to the other subwatersheds. This indicates the potential for riparian forest buffer restoration activities on Black Creek.

	Quartile rank		
Watershed	**Forest**	**Agriculture**	**Barren**
Little Nescopeck Creek A	2.0	4.0	1.0
Oley Creek	1.0	2.0	1.0
Little Nescopeck Creek B	1.0	4.0	2.0
Long Run	3.0	2.0	1.0
Creasy Creek	1.0	2.0	1.0
Nescopeck Creek	2.0	3.0	1.0
Black Creek	1.0	3.0	4.0

Table 4.3 Relative rank of each subwatershed for percent forest, agriculture, or barren land cover type.

Image 4.11 Main channel of Black Creek, the view beyond is of wetlands within a disturbed post-mining landscape. (Source: Project Team)

Bird Community Index

The Bird Community Index (BCI) is a songbird-based indicator of the overall ecological condition of a land area. Rather than sensitivity to point source pollution or other environmental stressors, the BCI is calibrated to the landscape matrix, i.e., the majority land cover in an area. Since the particular type of songbird community present is generally correlated with the predominant type of ecosystem, the BCI uses these communities as a barometer of overall ecological integrity. In general, the shift from medium to poor ecological condition as defined by the bird community present may coincide with land use changes from forested to urban. However, the progression from forest to urban for the BCI is not absolute, and is a general relationship only.

Bird species seek land cover types where they can find preferred food, nest sites, and other necessities. For example, many warblers breed in moist interior Pennsylvania forests where there are abundant insects. An absence of warblers in a habitat may mean insufficient forested area to support them. Studies by the Environmental Protection Agency indicate that as humans reduce forest cover, the type of birds present can indicate the level of stress for both wildlife and humans, because forests perform important functions to make the environment healthy for all (Jones et al. 1997, O'Connell et al. 2000).

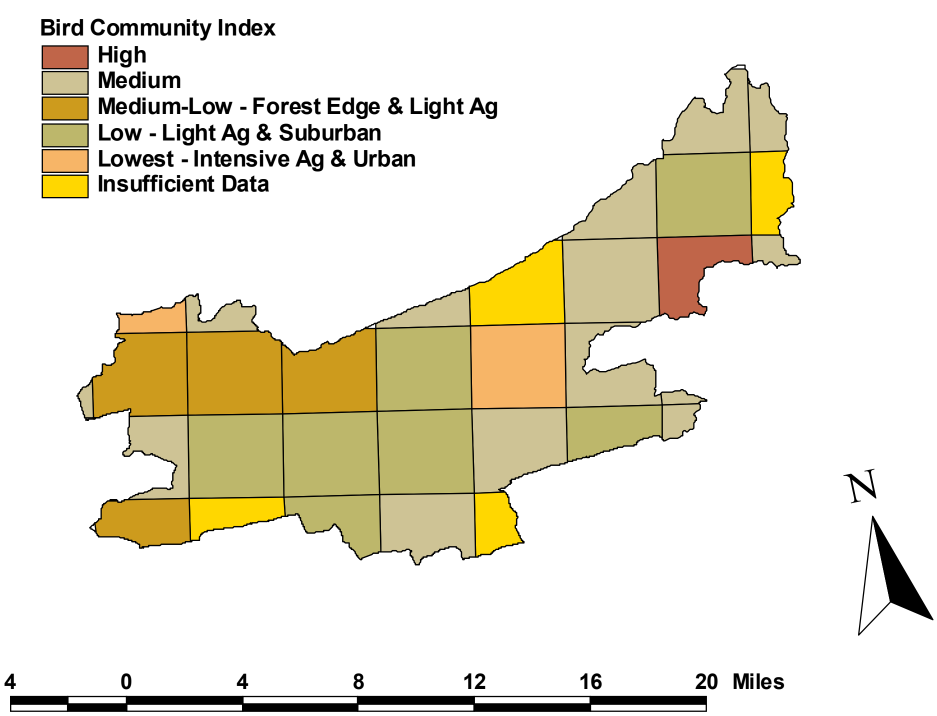


Figure 4.6 Bird community index scores for the Nescopeck Creek watershed. (Analyis by J. Bishop & T. O'Connell 2002)

BCI scores range from 20-77 and occupy four major categories of ecological integrity: ~20-40 is "low," ~ 41-52 is "medium," ~ 53-60 is "high," and 61-77 is the "highest," or "best attainable." The Nescopeck Creek watershed is dominated by medium and low ecological integrity based upon BCI scores (Figure 4.6). The watershed is broken into Breeding Bird Atlas blocks (Brauning 1992) of approximately 200 acres each. Some squares only include a small piece of the watershed, although for interest' sake, the landscape covering the entire block is scored.

The map key assigns a color to each possible category of land cover. Decreasing bird community integrity mirrors the landscape change from forest (medium green), to woody shrubs (dark green), and waterways (blue), to agricultural/herbaceous (tan), to barren (brown), or to residential/commercial (red). Yellow blocks are areas where insufficient data were collected to accurately determine the songbird community. For a detailed description of methods refer to O'Connell (1999).

Planners in the watershed can use this BCI information as baseline data to monitor the percentage of blocks that achieve scores in each category. If through time, more blocks fall out on the left hand side than the right, then it may be time to do some large-scale restoration in the watershed. Applying the BCI on a routine basis can help township planners prevent loss of irreplaceable biotic integrity.

Another way that BCI analysis can be utilized is to focus on watershed areas in good condition as resources valuable to the community's health and enjoyment of life. Mindful of this, managers might strive to maintain current land cover in those specific places. Permitting mature forests in good condition to stand undisturbed for longer periods could potentially create the "best attainable" conditions for songbird communities (O'Connell 1999).

For agricultural and/or urban landscapes in poor ecological status, it may not be important to strive for an improvement of the BCI scores. Community planners might instead try to guide development to maintain current land cover in fair-condition areas rather than allow it to deteriorate

Aquatic Habitat

The integrity of physical habitat in and around bodies of water helps determine the suitability of a stream for sustaining aquatic life. In essence, stream habitat directly affects the fish and macroinvertebrate communities by providing required rearing, feeding, and reproductive space. The Pennsylvania Department of Environmental Protection (DEP) and the Pennsylvania Fish and Boat Commission have each developed a habitat assessment protocol for examining the condition of stream habitats. In the Nescopeck Creek watershed, DEP conducted habitat assessments in Little Nescopeck Creek[B], Black Creek, and mainstem Nescopeck Creek drainages (Figure 4.7) (Kupsky 1999).

For each sampling section, habitat categories assessed include: instream cover for fish, epifaunal substrate, embeddedness, velcocity/depth regime, degree of channel alteration, sediment deposition, riffle

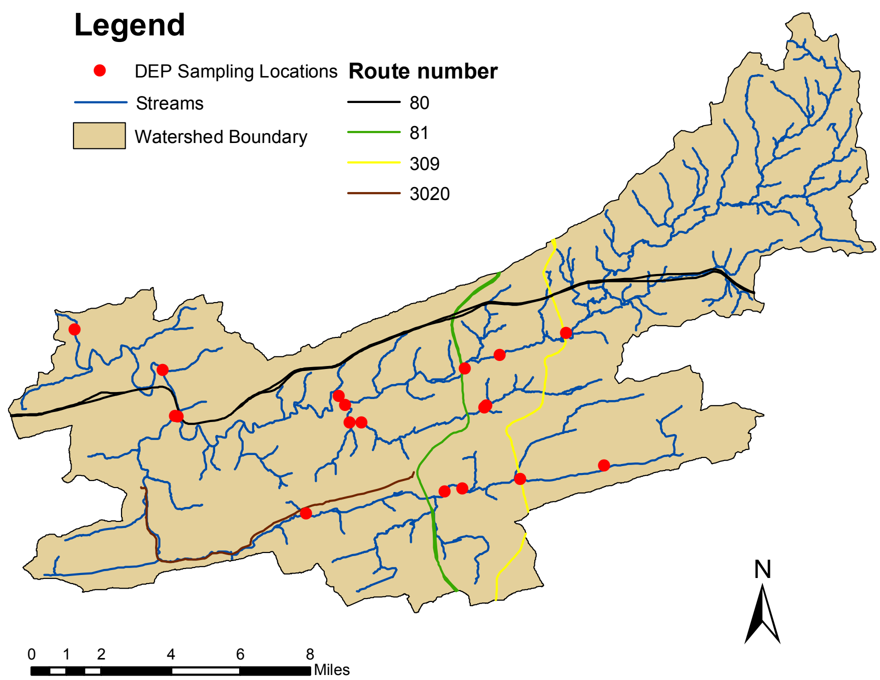


Figure 4.7 DEP habitat sampling stations in the Nescopeck Creek watershed.

	Habitat Criteria and Score													
Station Number	Instream cover	Epifaunal Substrate	Embed-dedness	Velocity/ Depth Regime	Channel Alteration	Sediment Deposition	Frequency of Riffles	Channel Flow Status	Condition of Banks	Bank Vegetative Protection	Grazing or Other Disruptive Pressure	Riparian Vegetative Zone Width	Total	Condition
Nescopeck Creek 1	13	9	13	12	15	14	10	16	13	16	16	16	163	Suboptimal
Nescopeck Creek 2	17	15	13	16	15	13	16	16	12	14	13	10	170	Suboptimal
Nescopeck Creek 3	16	18	15	16	15	14	15	16	14	14	16	15	184	Suboptimal
Nescopeck Creek 4	16	13	16	16	17	17	11	15	16	18	16	12	183	Suboptimal
Nescopeck Creek 5	18	13	6	17	17	13	11	16	14	17	17	15	174	Suboptimal
Nescopeck Creek 7	14	13	15	16	16	13	15	17	15	14	16	15	179	Suboptimal
Nescopeck Creek 8	15	15	12	16	15	13	13	16	14	14	15	15	173	Suboptimal
Little Nescopeck Creek 9	16	17	13	15	16	14	15	17	13	15	16	14	181	Suboptimal
Little Nescopeck Creek 11	16	13	9	14	17	14	14	18	12	18	16	11	173	Suboptimal
Little Nescopeck Creek 12	16	16	12	17	17	8	15	18	14	17	14	12	176	Suboptimal
Black Creek 13	2	1	1	6	7	0	2	15	6	9	5	2	56	Poor
Black Creek 15	6	5	2	3	16	2	5	14	9	10	15	10	96	Marginal
Black Creek 17	17	12	8	16	16	10	15	18	18	16	17	17	180	Suboptimal
Black Creek 19	15	13	12	16	15	15	16	16	15	16	15	11	175	Suboptimal

Table 4.4 DEP habitat assessment scores for sampling stations in the Nescopeck Creek watershed.

frequency, channel flow status, condition of streambanks, bank vegetative protection, disruptive pressure, and riparian buffer width (Table 4.4). For each category, a score from 1 - 20 is assigned. Each score is divided between four condition categories: 20 - 16 is optimal, 15 - 11 is suboptimal, 10 - 6 is marginal, and 5 - 0 is poor. The score for each category is summed to compute a total station score. Total score between 240 and 192 is considered optimal, 191 to 132 is suboptimal, 131 to 72 is marginal, and 71 to 0 is poor.

Within the Nescopeck Creek watershed, 12 of 14 sections received suboptimal total habitat scores (Table 4.4). Black Creek stations 13 and 15 received poor and marginal habitat scores, respectively. This indicates that most stations assessed in the watershed, although not pristine, still attain good aquatic habitat conditions.

Instream cover refers to the amount of available overhead cover for stream dwelling fish, such as logs, undercut banks, and boulders. Instream cover scores were primarily high for most of the sampling stations (Table 4.4). Scores ranged from 2 - 18 at Black Creek 13 and Nescopeck Creek 5, respectively. Black Creek 15 also received a low instream cover score of six. Instream cover at 13 of the 15 sampling stations indicated either optimal or suboptimal conditions for instream cover. Accordingly, there is sufficient cover to support fish and aquatic macroinvertebrate populations in these sections.

Epifaunal substrate refers to the presence of well-developed riffles and runs. Higher ratings for epifaunal substrate indicate a heterogeneous stream environment. Epifaunal substrate scores ranged from one at the Black Creek 13 station to 18 at the Nescopeck Creek 18 station. The majority of stations received scores between 11 and 15, a suboptimal score. Although not optimal, this indicates that epifaunal substrate is not a seriously limiting factor for aquatic populations.

Degree of embeddedness addresses the amount of fine sediment collected around gravel, cobble, and boulder substrate. Embeddedness is particularly important for substrate spawning fish such as brook trout and brown trout; significantly embedded spawning gravels directly limit young trout survival. When gravel is embedded, the fine sediments act as a concrete that limits the ability of spawning trout to form spawning areas and also impedes the survival and emergence of young trout from the gravel. One sampling station received an optimal embeddedness score. Most other stations received scores between 11 and 15. Black Creek 13 and 15 received scores of one and two respectively indicating the presence of substrate that is 75 to 100% embedded with fine sediment.

Velocity/depth regime determines whether a variety of depths and water velocities are present in order to support more diverse stream communities. All but five stations received optimal scores for velocity/depth regime. Only Black Creek 13 and 15 received marginal and poor scores, respectively. Predominantly optimal or suboptimal scores at all sampling stations indicate the presence of variable stream to depth ratios within the sampling station. In essence, the streams in these sections maintain a variety of streamflow conditions that are suited to a variety of fish and macroinvertebrate communities.

Degree of channel alteration addresses any human induced changes in the stream channel morphology. Only one sampling station received a marginal stream alteration score, Black Creek 13. A majority of stations obtained an optimal rating. For at least these locations, there has been little if any detectable alteration of the stream channel.

Sediment deposition characterizes the presence of sediment bars in a stream that may limit fish and invertebrate habitat. Riffle frequency refers to the extent of stream habitat composed of riffles. Sediment deposition for most of the stations was low. Nescopeck Creek 4 received the highest rating at 17. Most other stations scored between 10 and 15. Black Creek 13 and 15 both received poor scores. Scores for the embeddeness variable and the sediment deposition variable were similar for each section. Both embeddedness and sediment deposition are related to sediment discharge from the surrounding landscape. Lower scores in these categories indicate that sediment discharge may deleteriously affect stream habitat within the watershed.

Condition of streambank, bank vegetative protection, disruptive pressure, and riparian buffer width all refer to the integrity of terrestrial environments adjacent to the stream channel. High ratings in these categories are particularly important when considering sediment, nutrient, and other pollutant runoff from lands adjacent to a stream. Condition of streambanks, bank vegetation protection, grazing, and riparian vegetation zone protection scores were primarily optimal or suboptimal among the sampling stations. Black Creek 13 and 15 received the lowest scores in these categories. Predominantly optimal or suboptimal scores in these categories indicate that streambanks and the riparian corridor, at least at the sampling sites, are primarily intact.

GAP

The Pennsylvania Gap Analysis Project (GAP), established in 1993, is a state-level application of the National Gap Analysis Program. The project provides environmental planners critical geographic information for the protection of biological diversity across regional landscapes by evaluating the conservation status of land cover types and habitat areas for vertebrate classes of amphibians, reptiles, fish and birds. The primary purpose of Pennsylvania GAP is to identify unprotected habitat areas that have a high potential for vertebrate species across landscapes. In other words, “gaps” within the protection net for vertebrate species across landscapes.

GAP analysis allows planners to prioritize areas for vertebrate conservation by using geographic information technology to develop a series of overlay maps. First, areas that serve long-term conservation purposes, such as state forestlands, are identified and mapped. Next, GAP uses information about species and their habitat preferences to identify potential areas of good habitat. Due to the network of state game lands and parklands as well as the land use make-up of the watershed, very few gaps within the conservation net were identified within the Nescopeck Creek watershed. However, the Nescopeck Creek

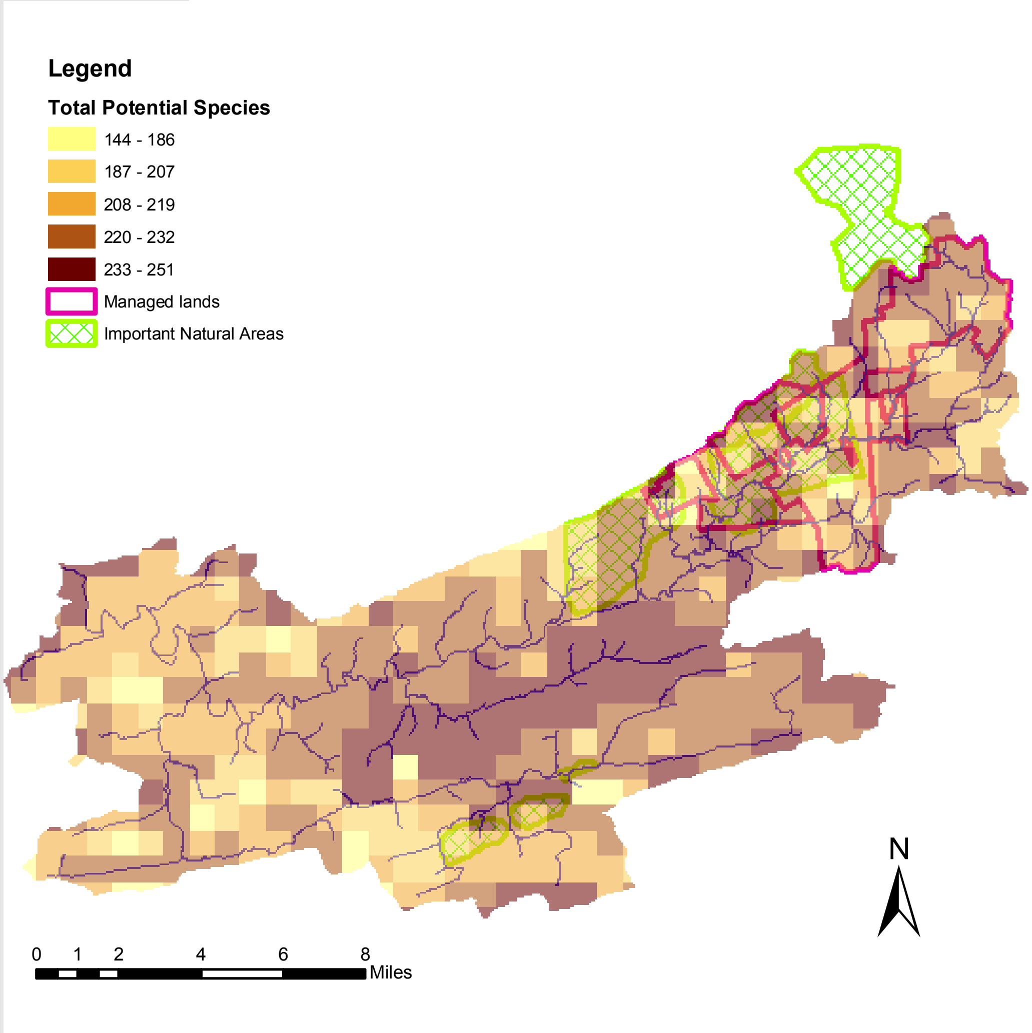


Figure 4.8 Potential number of all species (amphibians, reptiles, birds and mammals) within the Nescopeck Creek watershed (GAP).

watershed is potentially rich in terms of numbers of species that could reside here (Figure 4.8).

A secondary application of GAP is to determine areas of potentially good habitat for a variety of species and document the total number of species occurence. GAP determines the potential number of species within one kilometer squared units across the landscape. The results are projected in terms of total number of species in one-square kilometer cells, which roughly estimate the location of habitat, not definite boundaries. These individual species maps do not reflect the actual occurrence of species, only the possible number of species based upon the land cover data. However, the maps can indicate areas that can be restored or protected for those species types, such as birds or amphibians (Figures 4.9 – 4.12). They also demonstrate the veritable richness of the Nescopeck Creek watershed in terms of species occurrence.
The overlay maps are drawn directly from databases such as long-term species checklists and single-year survey records for research sites.

Amphibians

A GAP Analysis map of amphibian species richness for the Nescopeck Creek watershed is presented in Figure 4.9. The Nescopeck Creek drainages are strong attractants for amphibians, whereas the headwaters region with its faster-flowing stream habitats draws fewer amphibians.

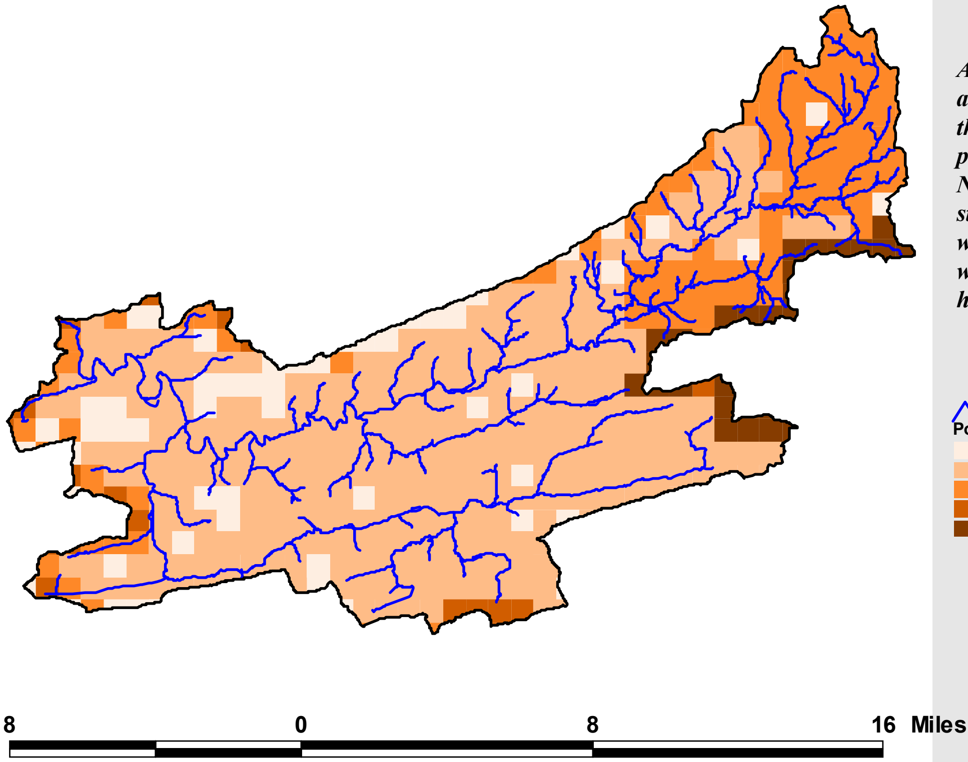


Figure 4.9 Potential amphibian species richness.

Reptiles

Across Pennsylvania, 34 species of reptiles, including 10 turtle species, are predicted based upon available habitat. GAP Analysis maps of turtles and of snakes and lizards in the Nescopeck Creek Watershed are shown in Figure 4.10. Heavily forested ridges are more likely habitats for snakes and lizards, whereas the valleys in the Nescopeck Creek drainage are more favorable for turtles.

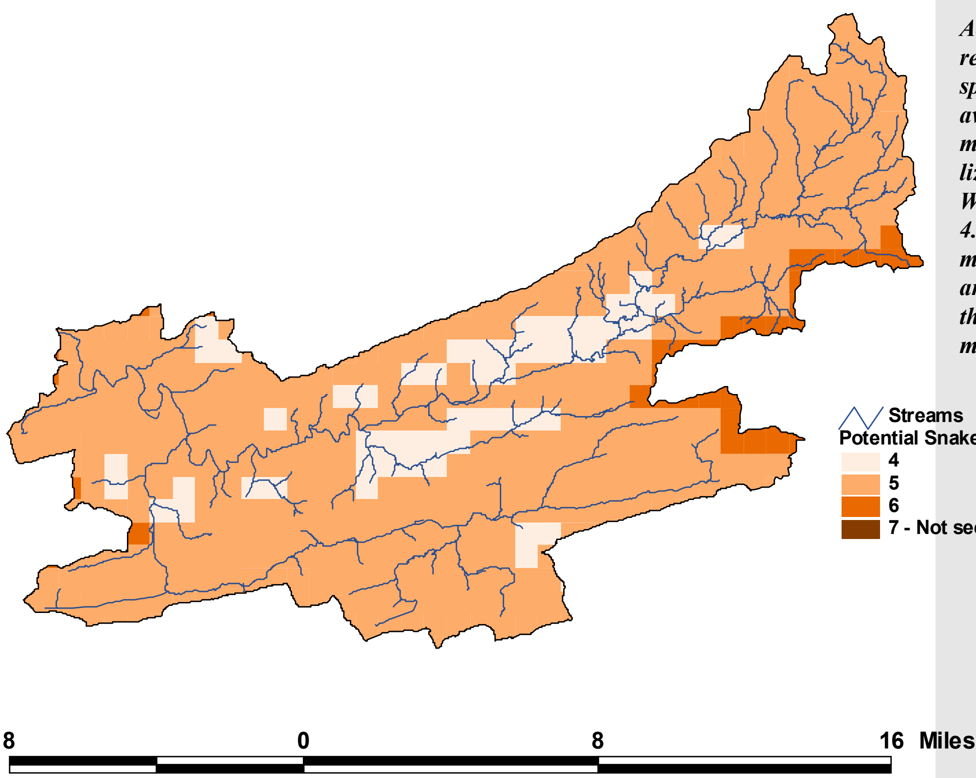


Figure 4.10 Potential snake and lizard species richness.

Birds

The GAP Analysis map depicting potential bird species richness in the Nescopeck Creek watershed is based upon the Breeding Bird Atlas (Brauning 1992) blocks of approximately 200 acres each (Figure 4.11). Areas in the map of lower species richness reflect land uses such as urbanization, or agriculture, that provide fewer elements necessary to avian survival.

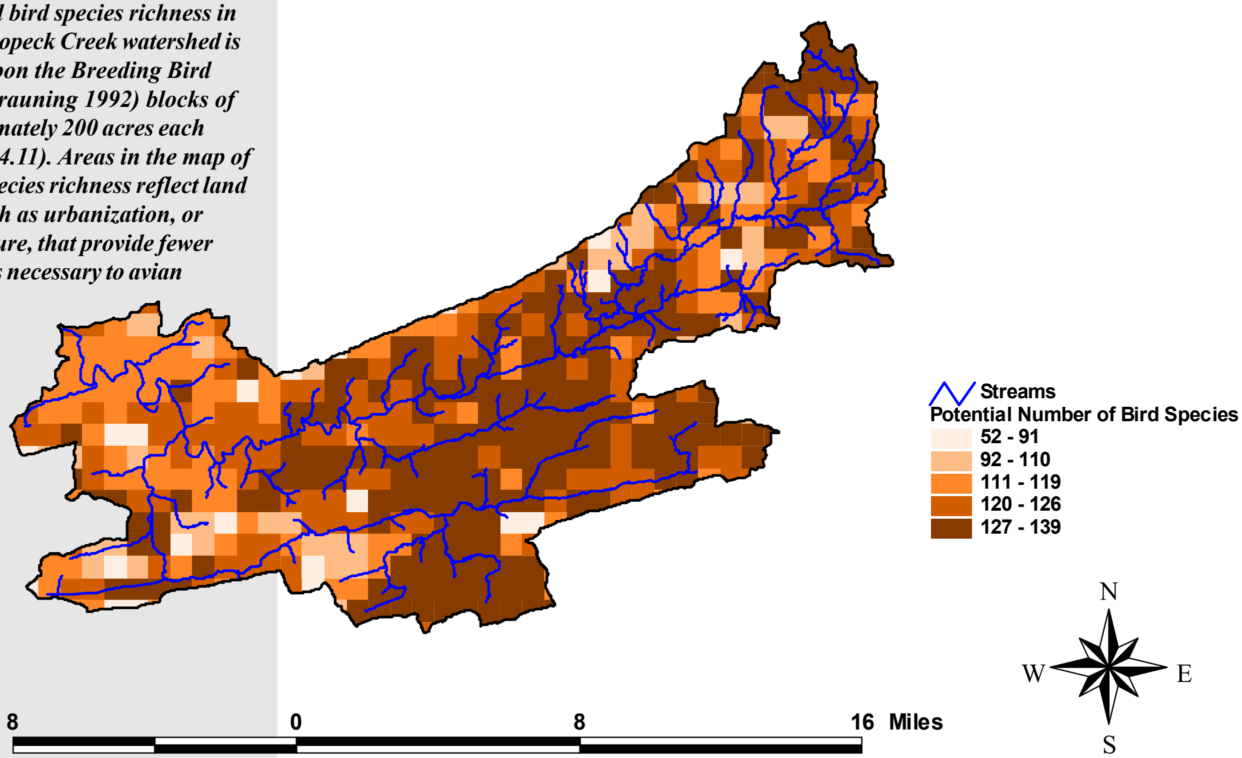


Figure 4.11 Potential bird species richness.

Mammals

The prediction of mammal species diversity in the Nescopeck Creek watershed is reflected in the GAP Analysis map in Figure 4.12.

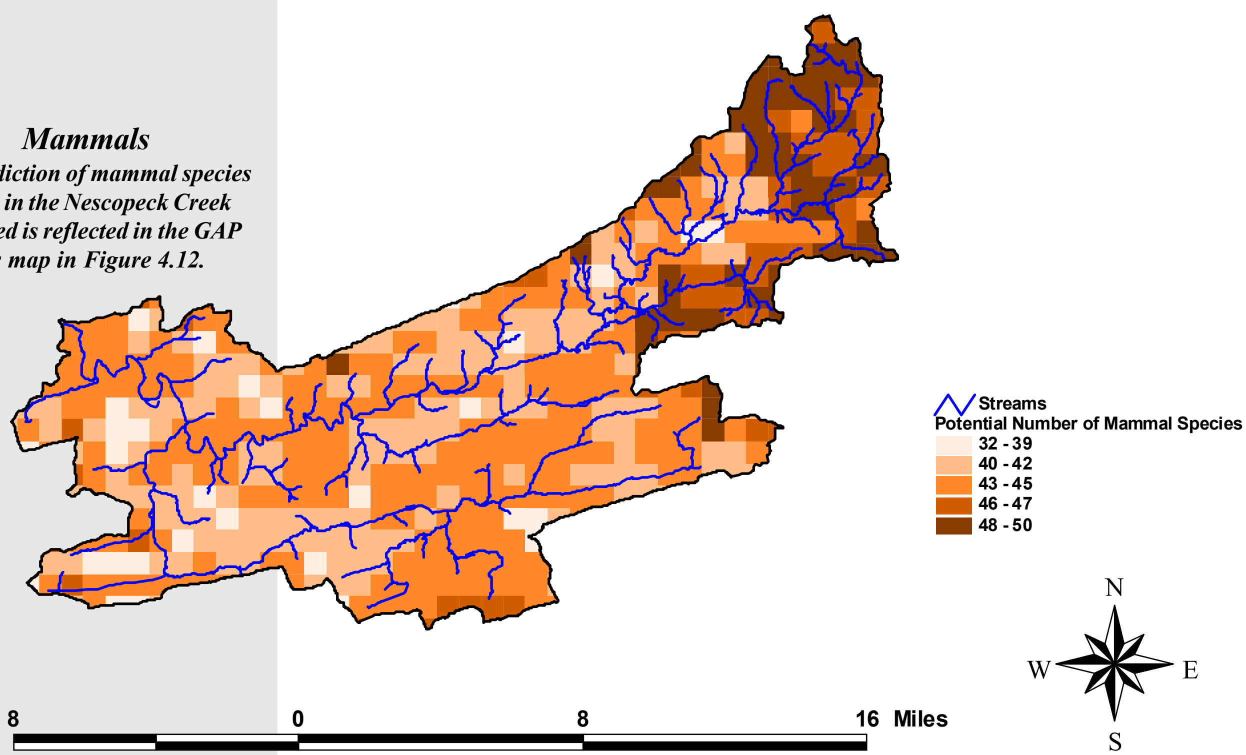


Figure 4.12 Potential mammal species richness.

Areas within the Nescopeck watershed that serve long-term conservation purposes, such as the Nescopeck Creek State Park are considered protected. Appendix B includes transparency maps of species richness, land cover types, critical natural areas, and conservation lands. One may overlay these maps to help develop conservation strategies for species or critical natural areas.

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Recommendations

This section describes the recommendations to address some of the major environmental issues within the Nescopeck Creek watershed. They were developed by our multi-disciplinary watershed team in cooperation with a panel of experts in hydrology, organization, water monitoring, or other related fields. These suggestions detail practical implementation techniques, as well as sources of funding and further information. Note that the first part focuses on watershed coalition organization, as we believe this is a crucial step before further actions are taken.

Organization

Issues	Goals	Recommendations
Need for community-based Nescopeck Creek watershed coalition	Form a watershed management framework	Formalize a watershed coalition
	Develop stakeholder involvement and promote watershed awareness	Provide opportunities for environmental education

Planning

Issues	Goals	Recommendations
Lack of ecologically based regional planning and support	Development of political and community support for eco-regional planning	Promote opportunities for cooperative, regional long-term planning and a multi-municipal framework.
	Protect, conserve, and restore riparian buffer areas	Develop program to target riparian areas for conservation/protection; restoration, or enhancement. educate landowners about conservation programs and techniques.
Environmental degradation from development	Promote "green" industry	Strategic Environmental Management

Water

Issues	Goals	Recommendations
Polluted runoff from agricultural, urban, and suburban landscapes	Local decision makers play key role in reducing polluted runoff	Plan for polluted runoff at the municipal level and educate the public
	Control on-lot septic pollution to ground water and surface water	Educate and promote better management of on-lot septic systems and planning for communities
	Control nutrient pollution from agricultural areas	Encourage inclusion of best management practices in farmland conservation plans
	Prevent combine sewer overflows into Black Creek	Implement controls and formulate a plan to decrease the number of overflows into the creek
	Implement a stormwater management plan across the Nescopeck Creek watershed community	Form a partnership among townships within the watershed to implement a watershed based stormwater management plan
Lack of water quality monitoring program	Establish water quality monitoring program	Develop a community-based effort to track water quality
Lack of water quantity monitoring program	Develop water quantity monitoring program	Develop a community-based effort to track water quantity
Well water contamination	Prevent well water contamination	Establish wellhead protection areas

Need for community-based Nescopeck Creek watershed coalition
Form a watershed management framework
Formalize a coalition

Introduction

A key concept in watershed management and planning is the involvement of residents in natural resources issues within their own communities. This participation and empowerment of an organized citizenry is also the focus of a number of state and federal policies and legislative acts concerning natural resource issues. These assorted actions require that responsibility be shifted away from external entities to residents who have an intimate relationship and personal stake in the health and viability of their environment. Typically, this requires a formalized group of individuals, agencies, and governments, such as a coalition or advisory council.

In the Nescopeck Creek watershed, this prospect has not yet reached its full potential. However, a number of entities do exist that could advance the prospect of a coalition or advisory council. Individuals from the various agencies, organizations, and government entities that have an ad-hoc coalition currently in place include:

- City of Hazleton
- Luzerne County Community College
- Pennsylvania State University, Hazleton
- Luzerne County Planning Commission
- Greater Hazleton Chamber of Commerce
- Office of Congressman Paul Kanjorski
- Friends of the Nescopeck
- Department of Conservation and Natural Resources
- Pennsylvania House of Representatives
- Luzerne County Conservation District
- Eastern Pennsylvania Coalition for Abandoned Mine Reclamation
- Office of Senator Ray Musto
- Wildlands Conservancy
- Earth Conservancy
- Pennsylvania Environmental Council.

This ad-hoc coalition has expressed interest in watershed management and planning for the Nescopeck Creek watershed. However, in order to continue to facilitate watershed planning and implementation, this coalition must become some type of defined and agreed-upon entity. While developing a formal watershed oriented group or coalition may be a difficult task, it is a requirement for long-term success.

Need for community-based Nescopeck Creek watershed coalition
Form a watershed management framework
Formalize a coalition

Techniques
Develop a Management Framework
Scenario:
The key point to develop in a watershed management framework, is the ability to communicate within and among the following three defined bodies; Municipal Governments, Citizens/Community, Natural Resource and Agricultural Agencies. One potential way to do this is to formalize the aforementioned coalition into a formal Nescopeck Creek Watershed Coalition/Advisory Council, with members from all three bodies (Figure 5.1).

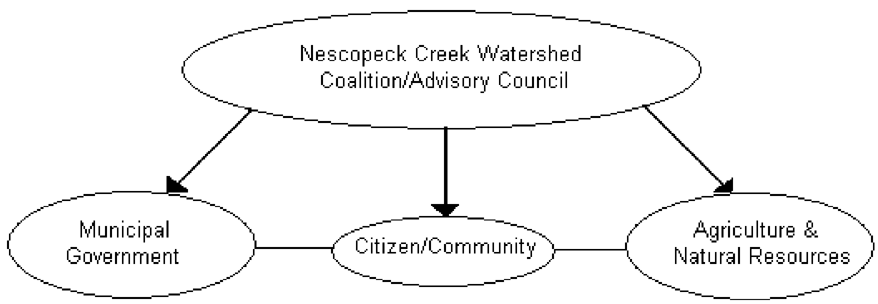

Figure 5.1 Coalition/Advisory Council Structure

- **Municipal Governments** – This body includes representation of all municipal bodies within the Nescopeck Creek watershed, including representatives from Luzerne County. The intent is to develop multi-municipal support for watershed-based management and planning. (See Planning Recommendations for multi-municipal planning tools.)
- **Citizens/Community** – This body includes representation of any and all interested citizens or community-based groups, such as the Friends of the Nescopeck. The intent is to grow and develop the Friends of the Nescopeck organization.

Need for community-based Nescopeck Creek watershed coalition
Form a watershed management framework
Formalize a coalition

- **Agriculture and Natural Resources Group** – A number of state and local agencies have expressed interest in the Nescopeck Creek watershed. This body would include the Luzerne County Conserva tion District, Luzerne County Cooperative Extension, the Susquehanna River Basin Commission, Eastern Pennsylvania Coali tion of Abandoned Mine Reclamation (EPCAMR), and the Depart ment of Environmental Protection Watershed Coordinator, among others. The intent is to develop a formal technical advisory commit-tee hat could provide assistance to the process.

The following framework represents how the process described above could coalesce into integrated watershed management.

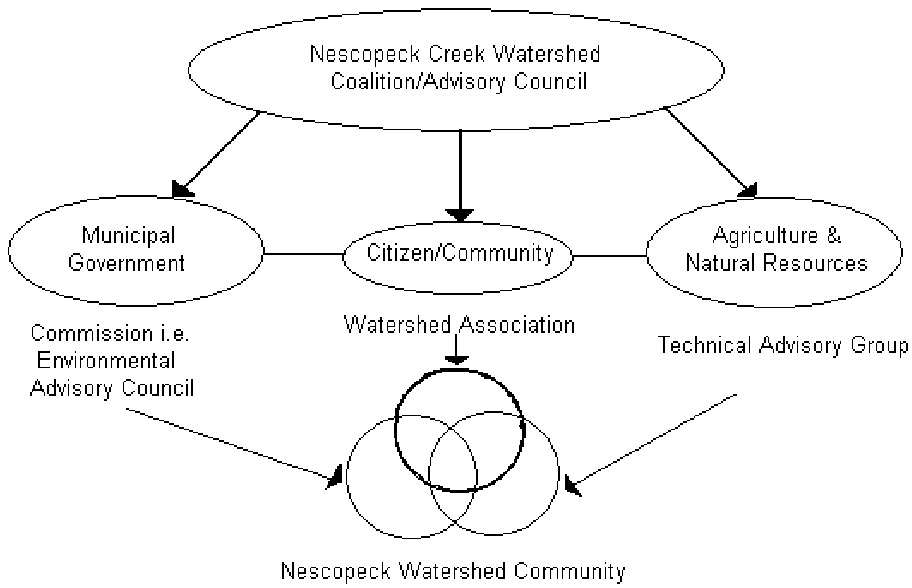

Figure 5.2 Coalition/Advisory Structure Completion

The framework depicted in Figure 5.2 almost exists today, but it lacks an identified lead person or agency coordinating its official formation. Ellen Alaimo, of the Pennsylvania Environmental Council, indicated that the North-east office could help support this effort, given that funding were made available for one person to lead the effort at least part time (Alaimo, personal communication). This type of staff resource could help the council eventually stand on its own with a full-time staff person, office space, and funding. To start, the existing coalition could sign a memorandum of agreement (MOA) that can set forth their vision. The existence of an MOA would demonstrate commitment to this process and have greater potential to bring in a volunteer coordinator like the Pennsylvania Environmental Council to help with the development of the coalition.

Need for community-based Nescopeck Creek watershed coalition
Form a watershed management framework
Formalize a coalition

Develop a community watershed vision

Visioning forums are widely used to address community and regional environmental challenges in order to effect strategic responses and solutions. The process is composed of a group dialogue with a trained leader or committee that identifies the watershed's strengths, challenges, and opportunities as well as areas for potential regional collaboration. The process can help a new organization coalesce and form a strong group identity. The vision can be reviewed periodically to refresh group unity, creativity, and problem-solving skills. A shared vision is essential to the formation of the Nescopeck Watershed Community outlined above.

Help & Information Sources

- **Pennsylvania Environmental Council** –http://www.pecpa.org
  "The Council promotes sustainable use of our land and natural resources, protection of watersheds, and innovative solutions to long-standing environmental problems."
- **POWR – Pennsylvania Organization for Watersheds and Rivers**-http://www.pawatersheds.org
  "POWR is dedicated to the protection, sound management and enhancement of the Commonwealth's rivers and watersheds and to the empowerment of local organizations with the same commitment."
- **The Institute for Conservation Leadership** –_http://www.icl.org
- **Electronic newsletters** such as http://www.boardcafe.org

Funding Sources

- **The Eastern Pennsylvania Coalition of Abandoned Mine Reclamation** (EPCAMR) Regional Watershed Support Initiative is a small matching grant opportunity for new or forming watershed groups and organizations
- **The Pennsylvania Community Development (PACD)** organization can contribute between $5,000 and $10,000 to discrete projects such as a watershed monitoring station.
  The website www.greenprojectbank.org_is an excellent source of state matching funds that can be used in watershed projects.
- **The Chesapeake Bay Program** is the unique regional partnership that's been directing and conducting the restoration of the Chesapeake Bay since the signing of the historic Chesapeake Bay Agreement of 1983. The website http://www.chesapeakebay.net provides information about grants available for projects within the Chesapeake Bay watershed.

Nescopeck State Park:

Diane Madl
c/o Hickory Run State Park
R.R. 1, Box 81
White Haven, PA 18661-9712
570-443-0400
email: hickoryrunsp@state.pa.us
website:
http://www.dcnr.state.pa.us/stateparks/parks/nes.htm

EPCAMR, Luzerne Conservation District

485 Smith Pond Road
Shavertown, Pa. 18708
website:
http://www.dep.state.pa.us/dep/deputate/minres/bamr/bamr.htm

Robert Hughes, Regional Coordinator
(570) 674-7993
email: epcamr@ptd.net

Need for community-based Nescopeck Creek watershed coalition
Develop stakeholder involvement and promote watershed awareness
Provide opportunities for environmental education

Introduction

There are a number of objectives concerning the need for environmental education within the watershed and beyond its boundaries. Among these one of the most relevant to the watershed residents is the promotion of environmental education as a tool to enhance watershed health, and the empowerment of its residents to individually and collectively promote and practice environmental stewardship. As awareness and appreciation of their natural and built environment is cultivated, residents can gain a more holistic understanding of the watershed's natural processes and thereby discern areas of ecological concern. In this way, a more environmentally literate and involved citizenry can affect layers of change in the ecological, cultural, and political climate of the watershed.

The promotion of environmental education within the watershed is closely aligned with the second objective concerning private partnerships. Creating and facilitating both public and private partnerships increases access to resources and services, enhances problem identification, and boosts existing environmental programs. Equally, or perhaps even more importantly, is the coordinated, integrated education of local, county, and regional government officials about watershed issues such as nonpoint source pollution, land use practices, and stormwater best management practices.

The Nescopeck State Park Environmental Education Center, headed by Diane Madl, provides opportunities for enhancing and expanding existing programs dealing with environmental education. Ms. Madl has been supportive of the watershed assessment, has participated in each phase of the process, and has provided valuable data, information, suggestions, and insight. Ms. Madl is a key source that should not be overlooked, but rather encouraged.

Robert Hughes, the Regional Coordinator for the Eastern Pennsylvania Coalition for Abandoned Mine Reclamation (EPCAMR) is also a key source for environmental education concerning an elemental issue in the watershed, that of the impacts associated with disused mining landscapes and acid mine drainage. Mr. Hughes has actively supported the watershed assessment by providing data and information to the team, and by attending the community meetings. The mission of EPCAMR is to reclaim post-mining landscapes and improve water quality by coordinating the efforts of County Conservation Districts and local organizations. Examples of EPCAMR's activities include providing educational outreach to increase community understanding about mining practices and effects, promoting

Need for community-based Nescopeck Creek watershed coalition
Develop stakeholder involvement and promote watershed awareness
Provide opportunities for environmental education

awareness of environmental stewardship through an active and empowered citizen base, cultivating cooperation and partnerships with diverse groups, and fostering public education.

At the statewide scale, The Pennsylvania Center for Environmental Education promotes environmental education as a tool to sustain environmental quality and empower citizens to exercise environmental stewardship. The National Environmental Education Advancement Project assists states and communities with the incorporation of environmental education into K – 12 schools, while the establishment of Environmental Advisory Councils (EACs) can promote different applications at the local and regional scale. The role of EACs will be further discussed in our recommendations for regional and municipal landscape and ecological planning.

Pennsylvania Center for Environmental Education:
http://www.sru.edu/Depts/pcee/index.htm

National Environmental Education Center:
http://www.uwsp.edu/cnr/neeap/

Techniques
A number of techniques were suggested and discussed at a project group workshop, the foremost among these were the establishment and expansion of partnership opportunities. As noted above, the Nescopeck State Park Environmental Education Center, as it is currently established and actively working toward the focus goals of environmental education, would be a key partner in the dissemination of environmental education information and materials. In this way, the center increases the watershed resident's access to environmental education information and materials and serves as a translator for specialized or technical environmental and ecological information.

There are a number of ways to supplement the Nescopeck Creek State Park Environmental Education Center's current programs, these include:
- Workshops
- Training
- Informal cultural and social programs
- Conferences
- Symposia
- Retreats
- Watershed tours
- Tour groups can include school children, community organizations, church members, and municipal officials
- Community Days for stream and watershed clean-ups
- Availability of meeting spaces for different community groups
- Support of the existing Environmental Forum project

Need for community-based Nescopeck Creek watershed coalition
Develop stakeholder involvement and promote watershed awareness
Provide opportunities for environmental education

North Branch Land Trust:
http://www.nblt.org/

Wildlands Conservancy:
http://www.wildlandspa.org/

Clean and Green Program, aka Act 319, the Farmland and Forestland Assessment Act, 1974:
http://luzerne.extension.psu.edu/Agriculture/retention.htm

Pennsylvania Audubon Society:
http://pa.audubon.org/

Techniques
The establishment and expansion of partnership opportunities is foremost among techniques to bring alive the watershed identity and its significance in the quality of community life. The Nescopeck State Park Environmental Education Center can be a key partner and a wonderful source of environmental education information and materials. The Center can enhance the watershed residents' access to education information and serve as a conduit of specialized or technical environmental and ecological information.

EPCAMR is actively involved with the organization and rejuvenation of watershed and watershed restoration associations, and with the fostering of environmental education outreach programs and activities, which include:

- Mine tours
- Visitor centers
- Community awareness days
- Career days
- Personal volunteerism in the schools
- Maintaining adopt-a-school programs
- Education partnerships
- Innovative initiatives approved by their awards committee

Moreover, EPCAMRs direct involvement and interaction with communities extends to support for abandoned mine reclamation and watershed planning. Further, and of great importance to the Nescopeck Creek watershed community, is the assistance available for the formation of watershed organizations and groups to address AMD/AML problems, and for grant-writing actions for funding support.

In addition to the Nescopeck Creek State Park Environmental Education Center and EPCAMR, a number of other partnerships may be formed among diverse organizations, which include:

- The North Branch Land Trust
- The Wildlands Conservancy
- The "Clean and Green" Program
- The Pennsylvania Audubon Office
- Local and regional businesses and industries
- Local and regional education facilities
- Universities, colleges, K-12 schools
  - * Promotion of environmental education to both students and educators

Need for community-based Nescopeck Creek watershed coalition
Develop stakeholder involvement and promote watershed awareness
Provide opportunities for environmental education

Resources

Diane Madl, Environmental Educator
Nescopeck State Park Environmental Education Center

Robert Hughes, Regional Coordinator
(570) 674-7993 email: epcamr@ptd.net
EPCAMR, Luzerne Conservation District
485 Smith Pond Road
Shavertown, PA. 18708

· **Networking**
- Environmental Education and the Media Toolkit –
  * Web based tutorial on using the media to effectively communi cate information about environmental education to the public
- A Statewide Survey of Community Advisory Panels and Environ mental Advisory Councils
  * A listserve for higher education and environmental eductation professionals
- The Pennsylvania Environmental Education Events Calendar Network
  http://www.eelink.net/cgi-bin/risee/pcee/calendar
  * Internet-based information sharing community for organizations and agencies throughout the state

· **Publications**
- Promoting Environmental Education: An Action Handbook for Strengthening Environmental Education in Your State and Commu nity, by Abby Ruskey and Dr. Richard Wilke. This handbook provides state and local leaders with models and suggestions to enhance environmental education programs. It can be ordered from the National Association of Conservation Districts for $22.50 plus $5.00 shipping and handling:
  NACD Service Center
  P.O. Box 855
  League City, TX 77574-0855
  (713) 332-3402

Need for community-based Nescopeck Creek watershed coalition
Develop stakeholder involvement and promote watershed awareness
Provide opportunities for environmental education

- "Environmental Education Advocacy: Everyone's Responsibility" is a 45-minute motivational video on the need for and elements of a successful environmental education program. It can be ordered from:
  NEEAP
  College of Natural Resources
  University of Wisconsin-Stevens Point Stevens Point, WI 54481
  (715) 346-4179

Funding

·A number of grants are available through the partnering services of EPCAMR with such agencies as:

- Bureau of Abandoned Mine Reclamation, BAMR (see below DEP)

- Bureau of Watershed Conservation, BWC
  Stuart Gansell, Director
  Phone: (717) 787-5267
  Website: http://www.dep.state.pa.us/dep/deputate/watermgt/WC/wc.htm

- Department of Conservation and Natural Resources, DCNR
  Website: http://www.dcnr.state.pa.us/financialpartnershipsgw.html

- Rivers Conservation Plan Program
  Department of Conservation and Natural Resources
  Division of Conservation Partnerships
  PO Box 8475
  Harrisburg, PA 17105-8475
  Phone: (717) 787-2316
  Website: http://www.dcnr.state.pa.us/rivers/riverfact.htm

- Environmental Protection Agency, EPA
  Website: http://www.epa.gov/ogd/

- Alliance for the Chesapeake Bay Foundation
  600 N. Second Street
  Suite 300B
  Harrisburg, PA 17101
  (717) 236-8825
  Fax (717) 236-9019
  Email: acbpa@acb-online.org
  Website: http://www.acb-online.org/aboutacb.htm

Need for community-based Nescopeck Creek watershed coalition
Develop stakeholder involvement and promote watershed awareness
Provide opportunities for environmental education

- Department of Environmental Protection (DEP)
  Pennsylvania Department of Environmental Protection
  Environmental Education Grants Program
  P.O. Box 2063
  Harrisburg, PA 17105-2063
  (717) 772-1828
  Contact: Sandy Titel
  Email: learning.center@a1.dep.state.pa.us
  Website: http://www.dep.state.pa.us/dep/subject/grants/grants.htm

- National Fish and Wildlife Foundation – Chesapeake Bay Small Watershed Grants Program.
  Website: http://www.nfwf.org/programs/Chspke_rfp2002.htm

- Aufzien Foundation grants
  Contact: Alan Aufzien, Treasurer
  Aufzien Foundation
  P.O. Box 2369
  Secaucus, NJ 07094

- Water Resource Education Network (WREN) Grant Funding for 2001-2002 (The League of Women Voters of Pennsylvania Citizen Education Fund (LWVPA-CEF) has funds available through the WREN Project)
  Sherene Hess, (724) 465-4978
  Email: sherenehess@yourinter.net
  Website: http://pa.lwv.org/wren
  LWVPA-CEF invites coalitions of local or regional organizations (such as civic groups, governmental groups, and other public interest organizations) to submit proposals for either a drinking water source water protection project or a watershed protection project.

- Department of Environmental Protection, DEP
  Through the AMD Regional Watershed Support Initiative, small grants of $5000 are given to groups and organizations that promote environmental education about issues surrounding ADM/AML.
  Mr. Robert Hughes, Regional Coordinator
  Eastern Pa. Coalition for Abandoned Mine Reclamation
  485 Smith Pond Rd.
  Shavertown, PA 18708
  Phone: (570) 674-7993
  Website: http://www.dep.state.pa.us/dep/DEPUTATE/MINRES/BAMR/guidlines.htm

Lack of ecologically based regional planning and support
Development of political and community support
Promote opportunities for regional long-term planning and a multi-municipal framework

Introduction

Local governments are the primary decision-makers concerning land use issues in communities. As such, they can either react to situations in their communities, or develop plans that allow them to be proactive towards issues like suburban sprawl, polluted runoff, and other land use pressures. There are many mechanisms available that local governments can follow, including the establishment of Environmental Advisory Councils (EACs) described below.

In addition, as noted in the assessment section, the Pennsylvania Municipalities Planning Code (MPC) provides counties and municipalities with the power to promote cooperative, regional long-term planning and agreements in a multi-municipal framework, as well as funding for the development or amendment of comprehensive plans. These partnerships affect the development and conservation of natural resources by adopting or altering land use plans and ordinances as consistent forms of control. In addition to considering issues on a regional scale, it also allows municipalities to retain local control over implementation and local issues, so long as implementation is consistent with the multi-municipal framework plan. The amended plan also advances the sharing of significant cost of sound land use plans, along with the ability to use the technical assistance and expertise of county planning departments, state, regional, and local agencies, and the sharing of planning tasks among participating municipalities.

Environmental Advisory Councils

Within the complex environmental arena of contemporary municipal operations, a number of townships are gaining insight and assistance from citizen-based EACs. EACs, a project of the Pennsylvania Environmental Council, act to provide a forum for select community residents to interact, in an advisory role, with municipal officials on the protection, conservation, management, promotion, and use of environmental resources within its territorial limits. They additionally serve to promote community involvement and awareness by undertaking specific environmental actions and education projects. In this way, EACs, when established throughout the numerous townships and boroughs within the watershed, can advise elected officials, planning commissions, park and recreation boards, and the general public on the environmental consequences of their decisions. Furthermore, in their role with individual municipalities or in partnerships with neighboring municipalities, EACs can encourage officials to think regionally and act locally.

Lack of ecologically based regional planning and support
Development of political and community support
Promote opportunities for regional long-term planning and a multi-municipal framework

Although federal and state action is often necessary to achieve comprehensive environmental protection, many decisions about the use of natural resources reside in local government. In their role within this structure, EACs affect municipal processes in environmental issues by:

- Identifying environmental problems and recommending plans and programs aimed at the protection and improvement of environmental quality;
- Making recommendations regarding open land use;
- Promoting community environmental programs;
- Indexing open space for the determination of proper use of such areas;
- Advising local governments concerning property acquisition;
- Acting as a repository for local and regional environmental information;
- Increase municipal environmental protection and improvement projects through leadership, grant writing, and volunteer recruitment;
- Facilitate environmental protection on a multi-municipal level, encom passing projects within the watershed boundary;
- Utilize specialists or key individuals from within the watershed community, including residents, professionals, and municipal officials, who have expertise and concern for the environmental aspects of the watershed;
- Role of the watershed association
  * Sit on the EAC board and council to represent the association

Authorization for the municipal establishment of EACs comes through Act 177 of 1996 (originally Act 148 of 1973). Due to the flexibility of this legislation, EAC projects are granted the ability to reflect the needs of individual municipalities. Luzerne County currently has five EACs operating within its boundaries:

- Dorrance Township EAC, Linda Kent, Chair
- Hanover Township EAC, Anthony Aigeldinger, Chair
- Harveys Lake EAC, Michael Daley, Chair
- Nanticoke EAC, Frank Shaulis, Chair
- Pittston Township, William Williams, Chair

Publications:

HANDBOOK FOR MUNICIPAL ENVIRONMENTAL ADVISORY COUNCILS
(PA Environmental Council, 70 pp, 1996)
This publication explains the role and responsibilities of EACs, provides details on the many projects they can take, and includes model EAC ordinances and bylaws.
It is available free from PEC, 1-800-322-9214

The EAC Handbook: A Guide for Pennsylvania's Municipal Environmental Advisory Councils Andrew W. Johnson, Joanne R. Denworth, Esq., and Daniel R. Trotzer.
This 74-page Handbook is designed to give Pennsylvania's municipal environmental advisory councils (EACs), and those interested in establishing them, an understanding of their responsibilities and opportunities for action. It is also intended to provide a framework for more practical subjects, such as the effective organization and operation of EACs.
Cost (including postage and handling): $5.00.

PROTECTING WETLANDS: TOOLS FOR LOCAL GOVERNMENTS IN THE CHESAPEAKE BAY REGION.
Prepared for the U.S. Environmental Protection Agency Chesapeake Bay Program Office by the Environmental Law Institute.
Call 1-800-YOURBAY
Cost: Free

Lack of ecologically based regional planning and support
Development of political and community support
Promote opportunities for regional long-term planning and a multi-municipal framework

Techniques

Establishment of an EAC:

- Contact the EAC Network for case studies and sample ordinances describing the activities and responsibilities of working EACs;
- Attend municipal meetings to gain experience on meeting structure and local issues;
- Introduce concerned community members to municipal representa tives to promote familiarity on both sides;
- Promote the EAC concept to community residents and elicit support and interest for participating in the program;
- Discuss the EAC program with municipal officials, suggest projects an EAC might undertake, and request their suggestions on promot ing the idea of establishing an EAC in the community.
- Emphasize that EAC members are appointed by and advisory to the governing body. They are charged only with advising and informing the people who appoint them on environmental issues;
- Be prepared to submit written proposals outlining the necessity for an EAC, and the references for the residents interested in sitting on the council. Additionally, include a list of projects an EAC should under take that would support the needs of the municipality

Other Planning Tools

- Floodplain, Watershed, Riparian Zone, Wetlands, and Greenway Plans
  - * individual plans specific to the locality where they are developed and implemented. Focus can be on different areas including floodplains, watersheds, riparian zones, wetlands, and greenways.

- Public Infrastructure Plans – Infrastructure planning is an important component of determining where growth and development activities can take place. In Pennsylvania the Sewage Facilities Act (Act 537) requires municipalities to develop a ten-year plan for sewage facilities. These plans must be consistent with the comprehensive plan, if it is in place.

Lack of ecologically based regional planning and support
Development of political and community support
Promote opportunities for regional long-term planning and a multi-municipal framework

Funding
In a DEP update of April 2000, watershed-based EACs received growing greener grants of $64,902.

- **Pennsylvania Environmental Council**
  EAC Network
  117 S. 17th Street, Suite 2300
  Philadelphia, PA 19103
  (215) 563-0250

- **Growing Greener Grants**: established in 1999, will give $650 million over five years to restore and clean up watersheds and mines, preserve open space, and create or upgrade sewer systems. Website: http://www.dep.state.pa.us/growgreen/

- **Luzerne County Conservation District**:
  485 Smith Pond Road, Shavertown, PA 18708
  Phone: (570) 674-7991
  FAX: (570) 674-7989
  E-Mail: Info@LuzerneConservationDistrict.org
  Website: www.luzerneconservationdistrict.org

- **"Protecting Wetlands II: Technical and Financial Assistantce Programs for Local Governments in the Chesapeake Bay Region"**. Prepared for the U.S. Environmental Protection Agency Chesapeake Bay Program Office by the Environmental Law Institute. Call 1-800-YOURBAY

Final Community Meeting at the Conyngham Borough Municipal Building on April 17, 2002.

BMP = Best Management Practice

Continuous Conservation Reserve Program
http://www.fsa.usda.gov/dafp/cepd/crp.htm

Pennsylvania Department of Conservation and Natural Resources
http://www.dcnr.state.pa.us/

Natural Resource Conservation Service
http://www.nrcs.usda.gov/

Forestry Incentive Program
http://www.nrcs.usda.gov/programs/fip/

Farm Service Agency
http://www.fsa.usda.gov/pas/default.asp

United States Fish and Wildlife Service
http://www.fws.gov/

United States Department of Agriculture
http://www.usda.gov/

Wildlife Habitat Incentives Program
http://www.nrcs.usda.gov/programs/whip/

Lack of ecologically based regional planning and support
Protect, conserve, and restore riparian buffer areas
Develop program for riparian conservation/ restoration, and educate landowners about techniques

Introduction
Riparian, or streamside areas, are only one component of a watershed management plan. However, they are a good place to start in the Nescopeck Creek watershed. A comprehensive riparian and streamside buffer program could be implemented that would conserve or protect intact streamside areas, restore or enhance other areas, and educate landowners and citizens about the importance of streamside zones.

Techniques
- **Demonstration projects:** serve as a good technique to help inform, educate, and publicize the importance of protecting and conserving streamside areas. If possible, try to work with a private landowner who is well known and respected within the community. This can show goodwill towards landowner needs and allow other farmers or private landowners to learn about projects from their peers.
- **Habitat Analysis and Streamwalks**: A few people can target potential sites by conducting a simple streamwalk or streamside habitat analysis. As the organization grows, this can be expanded as a way for the general public to become involved. Obtain the Volunteer Monitoring Handbook from the Pennsylvania Department of Environmental Protection for specific guidelines.
- **Flyers/Printed Material**: Basic information about available programs, status of riparian buffer areas, etc. can be developed and distributed to potential private property owners and the general public.

Funding and Other Sources of Assistance
The following programs are geared towards conservation of riparian areas on private lands:
- **Partners for Fish and Wildlife Program**: The Fish and Wildlife Service, working through local conservation districts and the Natural Resources Conservation Service (NRCS), can provide free informal advice on the design and location of potential restoration projects or it may design and fund restoration projects under a voluntary cooperative agreement with a landowner. Projects include restoration of wetlands, plantings, removal of exotics, streambank fencing, and restoration of riparian areas. Signs are provided which identify the area as a habitat restoration project.

Lack of ecologically based regional planning and support
Protect, conserve, and restore riparian buffer areas
Develop program for riparian conservation/ restoration, and educate landowners about techniques

- **The U.S. Fish and Wildlife Service (FWS):** assists landowners in installing high tensile electric fence to exclude livestock from streams and wetlands. Although wide buffers are preferred, there are not set back distance requirements. The FWS can install the fence using their own equipment operators or they will use private contractors. In addition, depending on the project location and contractor rates, the FWS or its partners can pay up to 100% of the costs.

- **Ducks Unlimited, Habitat Stewardship Program:** Provides strong incentives for landowners to: create wooded stream buffers, create wider-than-minimum stream buffers, and fence cattle out of streams. Landowners can earn Best management Practice (BMP) credits by creating wider-than-minimum buffers (>15') and/or fencing wetlands that are currently grazed. BMP credits may be used for agricultural stream crossings or other approved BMPs. This program pays 100% of fencing and tree planting costs.

- **Continuous Conservation Reserve Program (Continuous CRP):** The Continuous CRP is administered through the Farm Service Agency (FSA) and the technical assistance is provided through the NRCS. Continuous CRP is a statewide cost-share program for creating buffers. Buffer widths are 35 feet to 180 feet per side of the stream. Cost-share is 50% for stream bank fencing, stabilized stream crossings, and any plantings. A 40% practice incentive payment is available as well as a $10 per acre steward ship incentive. Landowners also receive an annual payment for acreage included in the buffer zone. Contracts are for ten or fifteen years. Land must have been pasture or cropland to be eligible. For more information, contact your local Farm Service Agency office.

- **Wildlife Habitat Incentives Program (WHIP):** This program is administered through the FSA and the technical assistance is provided through the NRCS. Participants who own or control land agree to prepare and implement a wildlife habitat development plan in consultation with the local conservation disctrict. Cost share agreements cover up to 75% of the cost of installing wildlife habitat practices, while the owner agrees to maintain the WHIP practices. For more information, contact your local Farm Service Agency office.

United States Fish and Wildlife Service
http://www.fws.gov/

Ducks Unlimited:
David LeRoy
Eastern Regional Director
1753 James Ave.
State College, PA 16801
(814) 234-6893
dleroy@ducks.org

Continuous Conservation Reserve Program:
http://www.fsa.usda.gov/dafp/cepd/crp.htm

Local USDA/FSA office:
911 W MAIN ST
PLYMOUTH, PA 18651-2714
(570) 779-0645 ext 3
(570) 779-5714 fax

Wildlife Habitat Incentives Program
http://www.nrcs.usda.gov/programs/whip/

Forestry Incentives Program:
http://www.fs.fed.us/spf/coop/fip.htm

Other Forestry Programs for Private Landowners:
http://www.na.fs.fed.us/spfo/stewardship/financial.htm

Wetlands Reserve Program:
http://www.fb-net.org/wrp-afct.htm

Local USDA/FSA office:
911 W MAIN ST
PLYMOUTH, PA 18651-2714
(570) 779-0645 ext 3
(570) 779-5714 fax

Luzerne and Columbia County Service Forester:
RR#2 Box 47, Bloomsburg, 17815
Phone: (717) 387-4255

Schuylkill County Service Forester:
Box 99, Cressona, 17929
Phone: (717) 385-7800

Luzerne County Conservation District:
485 Smith Pond Road,
Shavertown, PA 18708
Phone: (570) 674-7991
FAX: (570) 674-7989
E-Mail:
Info@LuzerneConservationDistrict.org
Website:
www.luzerneconservationdistrict.org/

Lack of ecologically based regional planning and support
Protect, conserve, and restore riparian buffer areas
Develop program for riparian conservation/ restoration, and educate landowners about techniques

- **Forestry Incentives Program (FIP):** This program is administered through the NRCS and U.S. Forest Service. FIP shares up to 65% of the costs of tree planting, timber stand improve ments, and related practices on private forestlands. There is a limit of $10,000 per person per year that can be paid out. Available practices include tree planting, improving a stand of forest trees, and site preparation for natural regeneration. For more information, contact your local conservation district or your local U.S. Department of Agriculture (USDA) Service Center.

- **Wetlands Reserve Program:** This program is administered by the NRCS in consultation with the FSA. Landowners may sell a conservation easement or enter into a cost-share restoration agreement with USDA to protect and restore wetlands. The programs offers permanent easements, 30-year easements, and restoration cost-share agreements with a 10-year minimum. Permanent easements allow a payment for the land as well as 100% costs of restoring wetlands. Thirty-year easements allow a 75% payment for land and 75% cost-share of restoration. Restoration cost-shares are for 75% of restoration costs without easement. Land must be restorable and suitable for wildlife benefits. Additional information is available from USDA Service Centers.

- **DCNR—PA Forest Stewardship Streambank Fencing Program**: This program is through the Pennsylvania Bureau of Forestry and is available statewide. This program requires a 35’ wide buffer on each side of the stream. Fence is usually one or two strands of high-tensile fence with corners and ends. Fence is 75% cost-share. Stream crossings are also cost-shared at 75% up to a set maximum. Plantings and other practices are not required but can be completed. For more information contact your local service forester at the PA Bureau of Forestry.

- **AgriLink:** This is a low interest loan program established by the State Treasury to assist animal operations in implementing best management practices (BMP’s) that are components of an approved nutrient management plan, including conservation buffers. Animal operations in production prior to 10/1/97 are eligible for a loan on BMP’s called for in a nutrient management plan. Loans are offered by participating financial institutions for 100% of the cost of the design, construction and implementation of BMP’s up to $75,000. Contact local county conservation district.

Lack of ecologically based regional planning and support
Protect, conserve, and restore riparian buffer areas
Develop program for riparian conservation/ restoration, and educate landowners about techniques

Other programs are available to permanently preserve riparian areas:

- **Conservation Easements** – The North Branch Land Trust, described earlier in the assessment, is a private organization that engages in land protection activities such as conservation ease ments. A conservation easement is a method that protects land while leaving it in private ownership. The landowner donates the easement to the North Branch Land Trust who ensures that the conditions of the easement are met over time.

Nescopeck Creek joining the Susquehanna at Berwick (Source: Project Team).

North Branch Land Trust:
http://www.nblt.org/

Environmental degradation from development
Promote "green" industry
Strategic Environmental Management

Introduction

Strategic Environmental Management, or SEM, was developed by the Department of Environmental Protection as an innovative, effective, and business-friendly way of protecting the environment. SEM can lead to fewer emissions, cleaner and more environmentally-friendly products, better economic returns, and promote a greater understanding between business and the surrounding community than command-and-control systems can generally achieve. SEM is, basically, a way of keeping environmental costs and effects in mind and integrating this thinking into all aspects of the production cycle, from designing new products, obtaining raw materials, manufacturing, packaging, distributing, selling and finally disposing of waste. Done correctly, this method increases efficiency and profits by uncovering hidden costs. An economic benefit to the community is also realized. For example, by reducing influent to a water treatment plant, the plant's available capacity is increased and therefore the capacity of the community for economic development is increased.

Techniques

The goals of SEM include:

- Written policy from management committing the company to continuous environmental performance
- Accounting for all environmental inputs and outputs
- Complying with all legal requirements and company objectives
- Training, learning from, and communicating with employees
- Emergency response preparation
- Monitoring and auditing environmental performance
- Being aware of new pollution control or efficient manufacturing technologies

A good place to start implementing this environmental management is by opening a community dialogue. This discourse involves a diversity of viewpoints, geographic locations, and interests. These groups sit down with the business to discuss the company's manufacturing processes and products, and any environmental effects the system may cause. Keep in mind that the public is NOT asked for input about fiscal matters, private business information, or major business decisions. The purpose of these meetings is to foster trust between the business and community, air concerns about pollution the business may produce, and educate all parties about what is going on in the community. The information provided by the community is used by the business to improve its operations to limit or eliminate pollution or otherwise increase the efficiency of the manufacturing process in ways that are important to the community.

Environmental degradation from development
Promote "green" industry
Strategic Environmental Management

One of the key points of SEM is pollution prevention. This element includes substituting non-toxic substances for toxic ones, in-house recycling of materials, or other changes to protect the natural environment through conservation or reduction/elimination of materials, especially toxic ones. An important point here is the focus on pollution prevention, not cleanup. Focusing on prevention leads to greater economic benefits and fewer environmental risks than end-of-the-line cleanup measures.

Another key point is measuring performance. If you do not measure something, you do not know what you have got or how to improve it. Performance measures can include:

- Emissions of substances with significant environmental effects, and understanding those effects and risks
- Emissions in relation to government regulations
- Cost/Benefit analysis of all stages of the company's operations, uncovering hidden environmental costs that are often external ized on the public

Financial Analysis
If a company cannot show financial benefits to environmental management, there is little practical incentive to continue. This is where environmental accounting comes in, which touches on some of the points made earlier. This system identifies the 'true cost' of a product. Environmental accounting regards all costs, even those normally hidden or relegated to cleanup, and attaches them to the actual product or process that produces the environmental cost. These costs may include not only the purchase and maintenance of more efficient equipment, but also the costs of waste disposal, liability, loss/gain of market share, publicity, and employee/ community health and safety.

Integral to environmental accounting is Life Cycle Analysis, also known as product stewardship. Life Cycle Analysis tracks a product from design, production, packaging, marketing, use and finally disposal and quantifies the costs, including all the hidden environmental costs, into the respective stages of the product. This is a powerful tool that can lead to greater efficiency and reduction/elimination of pollutants, or at least promote a more environmentally-friendly product.

The Department of Environmental Protection's Office of Pollution Prevention and Compliance Assistance can assist private organizations in implementing all stages of SEM. Please contact them with any questions or requests for further information and assistance.

PA DEP
Regional Director:
William McDonnel
(570) 826-2511

For more information about Life Cycle Analysis:
http://www.gdrc.org/uem/lca/life-cycle.html

NEMO: Nonpoint Education for Municipal Officials
http://nemo.uconn.edu/

See NEMO Project Fact Sheet #2 for more information (Appendix D).

Polluted runoff from agricultural, urban, and suburban landscapes
Local decision makers play key role in reducing polluted runoff
Plan for polluted runoff at the municipal level and educate public

·Introduction
Polluted runoff is a consequence of the decisions we all make about the way we live on the landscape, including the types and locations of human activities. These decisions about our activities are made at the local level in terms of the way we develop, use and maintain our land. While federal and state regulations provide some control over polluted runoff generating practices, locally based plans and decisions can have the greatest effect.

Techniques
The University of Connecticut Cooperative Extension Service has developed a program known as NEMO, Non-Point Education for Municipal Officials to help educate and guide local officials in the planning and decision-making process. They recommend the combination of three practices to help control polluted runoff; natural resources planning, site design, and the use of best management practices. Using these three techniques, NEMO then recommends:

- **Plan**: for development based on your natural resources. This step attempts to prevent pollution by incorporating natural resources into the planning process.
- **Minimize**: pollutant effects by incorporating site design practices into development planning.
- **Mitigate**: for unavoidable effects by using Best Management Practices (BMP's). BMP's (as described in the agricultural runoff section of the goals) can prevent, reduce, or treat polluted runoff.

NEMO also provides some guidance for citizens to help them ask the right questions about proposed development from their local officials. These questions address the three-step process outline above. These questions are outlined in NEMO Project Fact Sheet # 6 (Appendix D).

Controlling polluted runoff is one of the most difficult components of a watershed management strategy. However, it is also one of the most important components of watershed planning. All the activities that take plan on the landscape from increasing impervious surface areas to farming to industry, affect our waterways. This is why localities must be proactive and determine the where and the how of these activities, before it is too late.

Polluted runoff from agricultural, urban, and suburban landscapes
Local decision makers play key role in reducing polluted runoff
Plan for polluted runoff at the municipal level and educate public

Funding and Sources of Assistance

- **NEMO (Non-point Education for Municipal Officials):**
  http://nemo.uconn.edu
  NEMO is an "educational program for local land use officials that addresses the relationship of land use to natural resource protection." Many of NEMO's project activities take place in Connecticut, however they have a publications database on-line that provide information and materials, mostly free of charge.

- **Center for Watershed Protection (CWP)**
  http://www.cwp.org
  CWP is a "non-profit 501(c)3 corporation that provides local govern ments, 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 provides publications, technical tools and assistance, and a free electronic newsletter.

Planning Workshop in progress at the Center for Watershed Stewardship on March 15, 2002 (Source: Project Team).

Polluted runoff from agricultural, urban, and suburban landscapes
Control on-lot septic polltion to ground water and surface water
Educate and promote better management of on-lot septic systems and planning for communities

Introduction

A recent survey of residential nutrient behavior in the Chesapeake Bay watershed and nutrient education programs found two disturbing trends related to on-lot septic systems (Swann 1999). Overall, a significant faction of septic owners did not understand the relationship between a properly maintained septic system and water quality. In addition, despite the existence of outreach materials providing maintenance recommendations, close to half of all septic owners had not followed them. This survey, which was performed by the Center for Watershed Protection, recommends that more educational programs need to focus on proper care and maintenance of septic systems.

Techniques

The majority of sewage disposal treatment systems within the Nescopeck Creek watershed are private on-lot septic systems. The maintenance and upkeep of these systems is primarily incumbent upon the homeowner. Local governments are required to administer a permitting system to install on-lot systems, which are evaluated by a sewage enforcement officer (SEO). Repair or maintenance of septic systems requires a permit from the SEO, while routine maintenance does not. However, some townships may pass ordinances requiring all residents to pump their systems within a certain time frame, typically every three years. Proper care and maintenance of septic systems is a must in order to prevent system failure. In addition, it is generally cheaper to maintain a system than it is to repair a system, \$100 - \$250 versus \$2,000 to \$8,000. The following techniques are a basic description of the steps necessary to care for septic systems. For more information see the "Country Living: A Homeowners Guide" reference listed below.

- **Planning** – can help prevent failure as well by allowing a home owner to evaluate water use and learning more about what their system can handle. Planning can help prevent design failures like hydraulic overload where too much water is forced through the system.
- **Repair and Maintenance** – Conducting appropriate maintenance procedures in a timely fashion and making small repairs can prevent more costly fixes. This includes pumping, replacing baffles within the tank, replacing damaged pipes, and removing tree roots from distribution lines and the absorption field.
- **System Expansion** – This includes increasing tank size or installing a second absorption field. These require approval and permits from the SEO.
- **System Replacement** – Eventually, a new system may have to be constructed if design failures are significant or the system has exceeded its life-span. This will also require approval and permit from the local SEO.

Polluted runoff from agricultural, urban, and suburban landscapes
Control on-lot septic polltion to ground water and surface water
Educate and promote better management of on-lot septic systems and planning for communities

The watershed community can also become involved by communicating with and among townships and educating homeowners. Look for opportunities to help by talking with each township and the sewage enforcement officer. You can also investigate using alternative or experimental on-lot sewage designs or multi-municipal planning efforts.

Funding and Other Sources of Assistance:

- **Luzerne County Cooperative Extension Office** – can connect you with information from Penn State University. A short list of publications are provided below.
- **National Small Flows Clearinghouse** – Based out of West Virginia University, NSFC helps small communities and homeowners solve their wastewater problems. They can help plan, finance, operate and manage new or existing systems for individual homeowners or communities of less than 10,000 people. They have a listserve, discussion groups, free publications, and other information you can access through their webpage, writing, or calling.
- **National On-Site Wastewater Recycling Association (NOWRA)** – is a national professional organization for the onsite wastewater industry. They provide information and assistance for governmental regulatory personnel, installers, field practitioners, suppliers, distribu tors, engineers, research professionals, designers, consultants, educators, soil scientists and manufacturers.
- **Local Government Environmental Assistance Network (LGEAN)** - provides environmental management, planning, funding, and regulatory information for local government elected and ap pointed officials, managers and staff. Check out www.lgean.org or call 1-877-865-4326 for more information.
- **Penn State Water Quality Extension Website** – http://wqext.psu.edu
  The Penn State Water Quality Extension Group developed this site to give the public access to resources and information concerning many aspects of water quality. They hope to educate the public on issues that are important to them such as on-lot septic systems, drinking, and well water protection.

References

Drohan, J.R., C.W. Abdalla, and T.W. Kelsey. 1997. Country Living: A Homeowners Guide. Penn State University.

Swann, C.P. 1999. A survey of residential nutrient behavior in the Chesapeake Bay. Prepared for the Chesapeake Research Consortium, Edgewater, MD by The Center for Watershed Protection, Ellicot City, MD.

For the following list of publications contact:

Publications Distribution Center
112 Agricultural Administration Building
University Park, PA 16802
(814) 865-6713
All single copies are free unless otherwise noted.

NRAES-48, **Home Water Treatment** ***($15.00)***

Extension Circular 302, **Two Remedies for Failing Septic Systems**

F-161, **Septic Tank Pumping**

F-162, **Preventing Septic System Failures**

F-163, **The Soil Media and the Percolation Test**

F-164, **Mound Systems for Wastewater Treatment**

F-165, **Septic Tank-Soil Absorption Systems**

F-167, **Use of Dyes and tracers to Confirm Septic System Failure**

Polluted runoff from agricultural, urban, and suburban areas
Control nutrient pollution from agricultural areas
Encourage inclusion of best management practices in farmland conservation plans

Introduction

Farmers in Pennsylvania recognize the importance of installing buffers to improve soil, air and water quality, enhance wildlife habitat, and restore biodiversity. Best management practices for agricultural lands, otherwise known as BMP's, are a suite of practices and actions that a farmer may voluntarily implement to protect water quality and natural resources while maintaining and supporting farmland goals. One of the best ways to determine which BMP's are most appropriate for a particular farm is to develop a farm conservation plan. Farm conservation planning allows farmers to integrate different changes on their farm into one process. In this way, farm planning is very similar to watershed planning. Landowners establish personal goals and objectives and then study their property. They can then make sound decisions about existing conservation practices and whether others will need to be implemented.

Techniques

A variety of BMP's can be implemented on agricultural lands and this information is available from the local conservation district office. It is up to the individual farmer as to which BMP's they may implement depending on their goals and objectives. Ideally, these practices are implemented as part of a whole farm plan that allows the farmer to make decisions for the good of their farm and for the community.

The following is a short list of BMP's taken from "A Conservation Catalog: Practices for the Conservation of Pennsylvania's Natural Resources" to help describe the type of benefits they can provide. For a more extensive list and description contact your Conservation District.

- **Crop Residue Management** – Planned use of crop residue to protect the soil surface.
  * Reduced water runoff (volume and velocity), increased water absorption, improved soil moisture
- **Contour Farming** – Conducting tillage, planting, and harvesting operations around a hill or slope as near to the contour as is practical to reduce erosion.
  * Reduced water runoff, increased water absorption, improved water quality, reduced soil erosion
- **Contour Stripcropping** – Growing crops in strips or bands on or near the contour to reduce soil erosion.
  * Reduced water runoff, reduced soil erosion, improved water quality, improved air quality.

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- **Conservation Buffers** – Areas or strips of land maintained in permanent vegetation to help control pollutants and manage other environmental problems.
  * Improved water quality, stable and productive soils, improved wildlife populations, improved recreational opportunities.
- **Crop Rotations** – Planned sequence of different crops on the same field.
  * Improved soil nutrient balance, improved soil quality, reduced soil erosion, reduced insect/disease threat, reduced pesticide use.
- **Cover Crops** – Reduce soil erosion and add organic matter to the soil.
  * Reduced soil erosion, reduced nutrient loss, improved water quality, increased soil organic matter and soil structure.
- **Permanent Vegetation Areas** – Soil in all areas can be protected from erosion by using vegetation.

To put BMP's in place farmers need information, money, and manpower. A watershed organization can help provide all of these items. Talk with the Luzerne Conservation District Office and the Luzerne Cooperative Extension Office to learn more about ways to help.

Funding and other Sources of Assistance

- **U.S. EPA Chesapeake Bay Program**: The Chesapeake Bay Program through the Luzerne Conservation District will cost share 80% of the cost (up to $30,000) to install BMP's on the farm. The Conservation District will work with Natural Resource Conservation Service (NRCS) to provide technical assistance.

- **NRCS Environmental Quality Incentives Programs** (EQIP): EQIP is a conservation program that offers technical, educational, and financial assistance to help install vegetative or structural prac tices on lands that face serious threats to soil, water, and related natural resources. EQIP works in priority areas identified by a locally led conservation process and can only be carried out on farms that have a conservation plan. Priority area proposals are carried out locally and submitted to the NRCS State Conservationist. Contact the Luzerne County Conservation District for more information.

U.S. EPA Chesapeake Bay Program

U. S. Environmental Protection AgencyRegion III
Mailcode: 3CB00
1650 Arch Street
Philadelphia, PA 19103
Phone: (215) 814-2200
Fax (215) 814-2201
1-800-YOURBAY
http://www.epa.gov/r3chespk/

Luzerne County Conservation District:

485 Smith Pond Road,
Shavertown, PA 18708
Phone: (570) 674-7991
FAX: (570) 674-7989
E-Mail:
Info@LuzerneConservationDistrict.org
Website:
www.luzerneconservationdistrict.org/

NRCS Environmental Quality Incentives Programs

Anthony Esser, National EQIP Program Manager, (202)720-1840
Edward Brzostek, Acting Program Manager, (202) 720-1834
http://www.nrcs.usda.gov/programs/eqip/

Polluted runoff from agricultural, urban, and suburban areas
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- **FSA Conservation Reserve Program (CRP)** – The Conservation Reserve Program is a voluntary program that offers annual rental payments, incentive payments for certain activities, and cost-share assistance to establish cover on eligible cropland. The program is administered through the Farm Service Agency (FSA) and obtains assistance from the NRCS, the Cooperative Extension Service, Pennsylvania Bureau of Forestry, and the Conservation Districts. For more information contact the Luzerne Conservation District and the Luzerne Cooperative Extension Service.

Polluted runoff from agricultural, urban, and suburban landscapes
Prevent combined sewer overflows in Black Creek
Implement controls and formulate a plan to decrease the number of overflows into the creek

Introduction

On the occasions that the team visited the watershed, the members of the community voiced numerous complaints regarding combined sewer overflows into the Black Creek. One of the major efforts in this regard should aim at forming a long-term plan to control the overflows based on the sensitivity of the receiving waters. Combined sewer overflows are generally the result of overflows from wastewater treatment facilities during heavy rainfall or snowmelt events. In such cases, the combined sewer system exceeds the capacity of both the sewer system and the treatment plant. During 'dry weather' the system transports the wastewater directly into the sewage treatment plant. Combined sewer overflows have become an issue within the Nescopeck Creek watershed. In addition to being harmful to the water quality of the creeks, they influence the quality of life and recreational opportunities within the watershed.

Technique

To successfully eliminate the impacts due to combined sewer overflows, it is important to first identify the sources. To effectively arrange for resources and grants it is required to prepare a prioritization plan based on the degree of impacts on the receiving waters. To take care of the excess quantities of overflow, new techniques that focus on source control would be beneficial. Adequate information for controlling stormwater at the source needs to be collected so that techniques appropriate for the watershed can be employed.

In many instances, failing and leaking sewer drains within the urban areas cause the contamination. Therefore, it is necessary to conduct checks for the sewer systems within the highly urbanized areas of Hazleton and West Hazleton, to determine the leaks and plug them. Since the infrastructure lies within the jurisdiction of a number of townships and boroughs it would be beneficial to involve all the concerned officials for an efficient implementation of the plan.

Upgrading the sewage treatment facility of the Greater Hazleton Joint Sewer Authority could be beneficial in preventing the overflows during 'wet weather discharges.' However, a watershed community responsibility lies with each member to help the officials identify, prioritize and implement the plans for abatement of overflows. Small communities can also create demonstration areas to highlight innovative treatment and prevention techniques.

Polluted runoff from agricultural, urban, and suburban landscapes
Prevent combined sewer overflows in Black Creek
Implement controls and formulate a plan to decrease the number of overflows into the creek.

Funding and Resources
The Environmental Protection Agency, townships and municipalities, as well as watershed organizations have recognized combined sewer overflows as a problem. Communities that begin to assess their systems, implement controls, and develop plans for the future will benefit at the time of re-issuance of their permits. Grants and funding for such type of projects can be available can be available through the Pennsylvania Department of Environmental Protection, Bureau of Water Quality, PENNVEST, among others.

Polluted runoff from agricultural, urban, and suburban landscapes
Implement a stormwater management plan across Nescopeck Creek watershed community
Form a partnership between townships to implement a stormwater

Introduction

There is no comprehensive stormwater management plan for the Nescopeck Creek watershed. To prevent the water resources from further degradation it is imperative to develop and implement such a plan. For Luzerne county Act 167 requires the townships to regulate increased runoff due to increased development. While most townships have ordinances that necessitate control of post-development runoff rate, it does not necessarily solve the problems due to increased volumes downstream. Therefore a plan that takes care of the rate and volume in addition to frequency and duration would help in solving existing problems and prevent the creation of new ones.

Technique

The main aim of the stormwater management plan should be to solve the existing problems arising out of uncontrolled stormwater, prevent future damages, preserve the natural drainage system of the watershed in addition to enhancing the quality of runoff. A typical planning process would include assessing the current situation within the watershed, identify problem areas and assign them a priority, examine the possibility of using alternate or innovative methods with a cost analysis, looking for funding sources and culminating the process with an action plan ready to be implemented.

At the onset, to develop a sound stormwater management plan for the entire watershed, significant input from the community, active participation of participating municipalities and technical input from the involved fields is required. To be effective, the plan should form a part of the comprehensive plan and should be reflected in the ordinances of the involved townships and boroughs. It also important to integrate the efforts of numerous jurisdictions within the watershed to arrive at a plan that works best. While regulating the peak flows from the various sub-watersheds it is important to take a holistic view since controlled runoff from small watersheds may still contribute to peak flows further downstream where the basins combine. It has been seen in numerous studies conducted throughout the country that while it is important to design facilities for 10, 25, 50 and 100 year design storms, it is also important to consider the more frequent, high intensity storm that wash away the bulk of pollutants and sediments from the pervious and impervious surfaces into the water bodies.

Polluted runoff from agricultural, urban, and suburban landscapes
Implement a stormwater management plan across Nescopeck Creek watershed community
Form a partnership between townships to implement a stormwater management plan

While following the regulations and ordinances within a particular township or municipality, small demonstration sites using alternative technologies available for maintaining quality and quantity of stormwater could be incorporated in addition to the Best Management Practices for stormwater management. They could use the recommended structural as well as non-structural practices to control runoff from the sites. This would help in making more people interested in the new and alternate approaches. The municipalities and townships can amend their regulations to include such practices that require controlling the stormwater at the source rather than encouraging new developments to send their stormwater downstream.

Funding and Resources

Funding is available through state agencies that can fund any owner and/or operator of a municipal stormwater system with a project to construct a new system or improvements necessary to correct public health, environmental, compliance or safety deficiencies. Growing Greener funds can be applied through a single PENNVEST(Pennsylvania Infrastructure Investment Authority) application that makes the project eligible for grant funding. More information about the grants and funding is available through www.pennvest.state.pa.us/pennvest and www.dep.state.pa.us/growgreen.

For more information on stormwater management, see Appendix D, fact sheet #7.

Lack of water quality monitoring program
Establish water quality monitoring program
Develop a community-based effort to track water quality

Introduction
As indicated in the assessment, the Friends of the Nescopeck is the only group to have taken repeated water quality monitoring in the Nescopeck Creek. DEP, PFBC, and the SRBC have taken water quality measurements, but these were single points in time samples. Sampling in this way does not give a consistent, continuous picture of water quality and so is not very useful for tracking changes over time. With no water quality plan or program in place, it seems desirable to formulate such a plan.

Technique
The first question to address in water quality monitoring is what type of information is desired. If knowledge of pollutant loading from different land uses is desired, a program that measures contaminants during storm events is required. Alternatively, if pollutants contributed from groundwater are a concern, baseflow (i.e., groundwater contribution to surface water) measurements may be adequate. Storm event sampling is generally more expensive and time consuming than baseflow measurements.

The second question to answer is what parameters will be measured. There are different methods to measure nitrogen and phosphorous, as well as metals such as Al, Fe, and Zn. In addition, different parameters are appropriate for different types of contamination.

Regardless of what parameters are measured or whether baseflow or storm water is measured, samples must be taken at the same positions, with the same method, and with uniform time periods between sampling. Strategic placement of sampling positions can help address the questions asked. For example, if concern over a new residential development is at issue, monitoring water quality upstream and downstream of this position is necessary to measure changes in water quality from this site.

Once a plan is implemented, it is important to maintain uniform sampling over time. A citizens based organization can supplement agency monitoring programs, especially when agency monitoring is limited due to budget constraints. Organizations such as Wildlands Conservancy, DEP, water and sewer authorities, county planning agencies and citizens organizations can all coordinate to achieve an efficient monitoring program.

Lack of water quality monitoring program
Establish water quality monitoring program
Develop a community-based effort to track water quality

Funding and Resources

Copies of the Volunteer Monitoring Program Handbook are available online at http://www.pawatersheds.org/KWN/vol_mon_info/ or by contacting local DEP personnel. This handbook provides technical assistance in water quality sampling procedures.

The Environmental Alliance for Senior Involvement (EASI) seeks to expand citizen involvement in protecting and caring for the environment through different environmental programs. Once formed, individuals may provide assistance with monitoring programs.

DEP provides financial assistance with water quality monitoring programs through Growing Greener grants. Visit http://www.dep.state.pa.us/growgreen/defaultdep.htm for more information on Growing Greener grants.

Lack of water quantity monitoring
Develop water quantity monitoring program
Develop a community-based effort to track water quantity

Introduction

The assessment found that streamflow measurements were continuously recorded on Nescopeck Creek during the 1920's and on Little Nescopeck Creek between 1996 and 1998. However, there are no permanent streamflow monitoring stations that are part of a continuous, watershed-wide monitoring program. We recommend that a local watershed organization implement a streamflow measurement program to better understand the hydrologic characteristics of the watershed.

Technique

The first consideration for streamflow monitoring is to decide what data are desired. If only groundwater contributions to streams are needed, baseflow measurements may be sufficient. However, baseflow measurements provide little information about streamflow during periods of rain or snowmelt.

The number and position of monitoring station sites is also an important consideration. Generally, a stream stage water logger costs $3,000 – $4,000. If more than one station is not possible, a site located in the lower part of the watershed will provide information about the entire watershed. If additional stations are possible, placing the stations on Black Creek and Little Nescopeck Creek, just above the confluences with Nescopeck Creek, as well as a point on Nescopeck Creek near the confluence with the Susquehanna, would provide streamflow data for all three major tributaries.

The next consideration is installing, recording, and interpreting the data. At first glance, streamflow measurements seem daunting. With a little training and experience, they are straightforward. The basic elements needed include staff gauges, stream stage water loggers, flow-meters, construction of a rating curve, a computer to download the data, and most importantly, individuals to carry out the field measurements. The U.S.G.S. has published a series of documents outlining different methods to measure streamflow (Carter and Davidian 1968, Buchanan and Somers 1982).

baseflow = ground-water contribution to a stream.

streamflow = the volume of water passing through the channel.

stream stage = height of the surface of a stream above an established point.

A staff gauge is simply a large ruler placed in the stream that measures the height of the water surface above an established point. Staff gauges are inexpensive and easily installed.

USGS online publications, techniques of water resource inventory:
http://water.usgs.gov/pubs/twri/

United States Geologic Survey

PA Hydrologic Rep:

John Nantz:
(717) 730-6916
jmnantz@usgs.gov
www.usgs.gov

Literature

Buchanan T.J. and W.P. Somers. 1982. Stage Measurements at Gaging Stations. Techniques of Water-Resources Investigations of the United States Geological Survey. United States Printing Office, Denver, CO.

Carter, R.W. and J. Davidian. 1968. General procedure for gaging streams. Techniques of Water-Resources Investigations of the United States Geological Survey. United States Government Printing Office, Denver, CO.

Lack of water quantity monitoring
Develop water quantity monitoring program
Develop a community-based effort to track water quantity

Stream stage water loggers allow continuous measurement of stream stage. These instruments come in many forms but a common method employs a submersible pressure transducer. Based upon a mathematical equation, changes in stream stage are measured based upon the varying pressures experienced by the instrument.

To convert stream stage into streamflow, measuring streamflow at different stream stages is required. A detailed procedure for measuring and calculating streamflow is given in Carter and Davidian (1968). With stream stage measurements and corresponding streamflow measurements, a discharge rating curve and equation are developed that predict streamflow at a particular stream stage (Figure 5.3). Using the equation, stream stage measured by the water logger over time can calculate the streamflow at each point in time.

Funding

The USGS may be a source of funding, as they often partner up with communities to install water gauges. There are numerous agencies and municipal organizations that may be interested in such information, and could be a possible source of funds. Examples of such entities include PennDot and municipal planning commissions. If a plan is devised and marketed as a benefit to such agencies, they may provide some funding to conduct the monitoring.

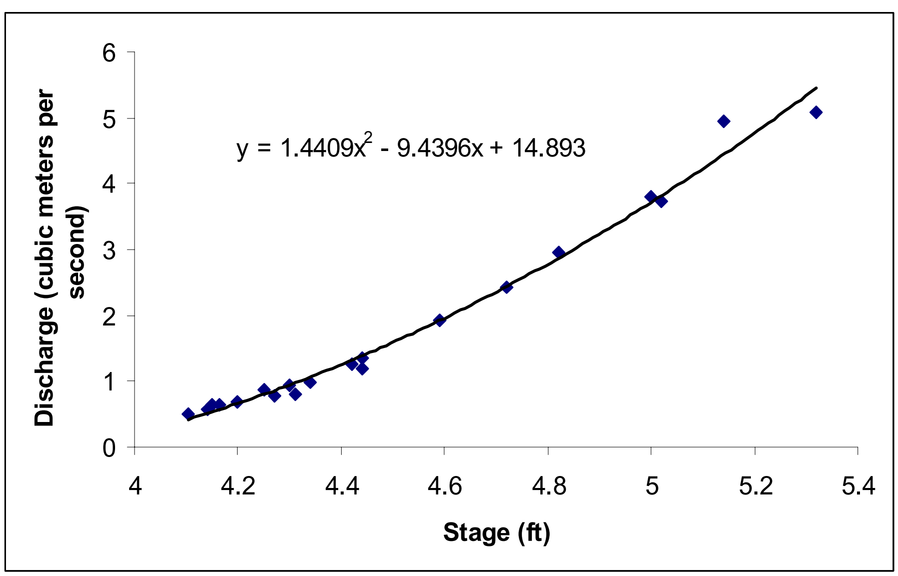

Figure 5.3 Hypothetical example of a stage-discharge rating curve.

Well water contamination
Prevent well water contamination
Establish wellhead protection areas

recharge area = land surface upon which precipitation or surface water seep into an aquifer.

Introduction

The high number of wells drawing groundwater from the Nescopeck Creek watershed necessitates the protection of groundwater from contamination. Numerous individuals at public meetings indicated unease about possible well water contamination caused by septic system leaks, industrial pollution, and resource extraction activities. The AVGWLF (i.e., nutrient loading model) used in the assessment indicated that groundwater likely contributed high levels of nitrogen to surface water. Preventing well water contamination first requires identifying the recharge areas of groundwater so planning officials can make informed decisions about land uses in sensitive areas. Identifying the recharge areas is accomplished by studying the hydrology and topography of the watershed, and then designating wellhead protection areas. Then, identifying contaminants that exist in the water and possible contaminant sources in the recharge areas is done. The Wellhead Protection Program designed by DEP applies only to public wells, however. A similar program would be very useful to the protection of the hundreds of private wells in the watershed.

Technique

DEP defines a wellhead protection area (WHPA) as *the surface and subsurface area encompassing a public well, wellfield, spring or recharge area in which contaminants are likely to enter the water source*. There are three zones of protection for wellhead protection areas (Figure 5.4).

Delineating a WHPA requires formulating a groundwater flow model based on general groundwater concepts and, if available, site-specific data. Methods available include fixed radii methods, simplified variable shapes, hydrogeologic mapping, numerical modeling, and analytical methods (listed in order of simple to most difficult).

Once a WHPA is delineated, the potential sources of contamination must be inventoried. This list includes all contaminant sources and land uses in the area. Identifying contaminant sources allows officials to see the number and location of the potential contaminant sources and make decisions regarding management options. Identifying land uses would highlight areas that pose a high risk of contamination, as well as what kind of contamination would be likely to occur. For example, a small organic farm in a recharge area would pose a low risk of nitrogen and phosphorous pollution, whereas a large furniture company could indicate a risk of TCE contamination. A source of high-risk contaminants should be located outside of the WHPA.

WHPA zones: Definition, Deliniation, and Implementation:
An excellent website that identifies steps in a wellhead protection area program can be found at: http://www.wrds.uwyo.edu/wrds/deq/whp/whpsect1.html

Well water contamination
Prevent well water contamination
Establish wellhead protection areas

Placing the compiled inventory information on the base map allows the team to see the number, location and type of potential contaminant sources that exist in the WHPA. Understanding the relationship of inventoried sources to the well or intake is important in deciding on the best management option. Some community planning teams have noted that the inventory step generates considerable paperwork. It is important, though, that all land uses within the WHPA are identified for the effort to be of value. Stakeholders would include not only hydrogeologists and other scientists, but also public water supply managers, affected landowners and industry.
Once the area is delineated and the potential contaminant sources are identified, managers can seek to protect the source water zone through numerous land use ordinances, site plan reviews, subdivision regulations, design standards, wellhead protection ordinances, and public education about the importance of protecting the WHPA. Butler Township and Sugarloaf Township should be given special attention due to their high DRASTIC scores and the high number of wells.

Funding
DEP offers one-time grants for single municipalities, groups of municipalities, or community water systems to help determine the source water protection areas. Up to $50,000 is available to such entities to conduct a source water protection plan. EPA may be another source of funds, depending on congressional funding.

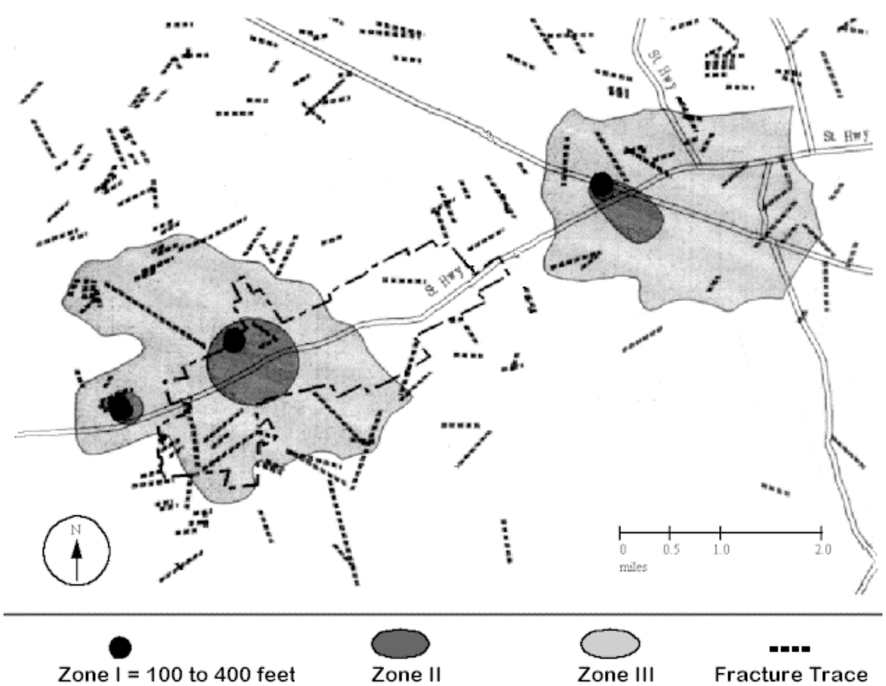

Figure 5.4 Wellhead protection areas (Source: http://www.dep.state.pa.us/dep/deputate/watermgt/Wc/Subjects/SrceProt/WHPOVR_Fig1.htm).

PA DEP

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