
CHAPTER 2. LAND RESOURCES

This chapter provides a comprehensive overview of the land resources within the Sinnemahoning Creek watershed, including physical characteristics, a description of present land uses, and a discussion of natural and manmade threats to the resources.

Geology

Geology is the science that deals with the study of the earth, its history, and its natural processes and products. Geology may also refer to the names and descriptions given to natural features on our planet. Geological investigations of an area can yield insight to the land's history, composition, structure, and natural resources.



Mountainous terrain typical within Sinnemahoning Creek watershed

Geology is an important component of a watershed, because it influences the region. Soils, plants, animals, groundwater, and topography in a region are dictated by the geology. Geology plays a role in determining quality and quantity of groundwater and surface water available within a region.

Today's landscapes reflect millions of years of natural events. Because forces acting on the land have had varying effects, vast arrays of landscapes exist throughout the earth. In order to categorize landscapes and landforms with similar features and help distinguish between them, geologists have divided the earth into various physiographic provinces. A physiographic province is a region containing similar terrain shaped by geologic history. Pennsylvania is divided into six physiographic provinces, each having a particular type of landscape and geology.

Appalachian Plateaus Province, the largest physiographic province in Pennsylvania, encompasses the region. Using elevation, relief, and geologic structure, physiographic provinces are subdivided into sections based on the distribution of patterns of rock formations, deformation, erosion, specific landforms, or other geologic features (Radford University, 2005). Divided into 10 sections, the Appalachian Plateaus Province is characterized as highland eroded by streams creating deep valleys and hilly topography. Two sections are prevalent within the Sinnemahoning Creek watershed, the Pittsburgh Low Plateau section and the Deep Valleys section.

Located in the Pittsburgh Low Plateau section, the Bennett Branch subwatershed is characterized by a smooth to irregular, undulating surface, narrow, relatively shallow valleys, surface mines, and reclaimed lands of shale, sandstone, siltstone, and coal. Local relief in the Pittsburgh Low Plateau section is low to moderate—ranging from 101 to 600 feet—with the elevation ranging from 660 to 2,340 feet. Underlying rock types include shale, siltstone, sandstone, limestone, and coal. Current and former surface mines have significantly altered a portion of the region's topography.

The remainder of the Sinnemahoning Creek watershed is located within the Deep Valleys section. Characterized by very deep, angular valleys with broad to narrow uplands, this section contains moderate amplitude—open folds that control valley orientation. Local relief in the Deep Valleys section is moderate to very high with elevations ranging from 560 to 2,550 feet. Underlying rock types include sandstone, siltstone, shale, and conglomerate.

The bedrock geology is from the Devonian, Pennsylvanian, and Mississippian periods that occurred during the Paleozoic Era approximately 290 to 405 million years ago. The Devonian period is named for the County of Devonian in southwest England where Devonian outcrops are common. The Devonian period occurred 365 to 405 million years ago. Red sandstone, gray shale, black shale, limestone, and chert are associated rock types (Devonian, 2007).



Outcrop of rocks along Route 120

Pennsylvanian and Mississippian periods are separated in order to distinguish the coal-bearing layer of the Pennsylvanian from the layers of the Mississippian. Estimations situate the Pennsylvanian period occurring 330 to 290 million years ago, and currently underlying 35 percent of Pennsylvania. Cyclic sequences of sandstone, red and gray shale, conglomerate, clay, coal, and limestone are associated rock types (Sevon and Barnes, 2007). The Mississippian period, occurring 365 to 330 million years ago, contained red and gray sandstone, shale, and limestone as associated rock types.

Beyond physiographic provinces, an area can also be categorized by geologic formations. Geologic formations of a region are continuous rock units with a distinctive set of characteristics that make it possible to recognize and map.

In addition to physiographical regions used in describing landforms of the region, ecoregions describe biophysical characteristics. An ecoregion is the name given to an area having a distinctive composition and pattern of plant and animal species distribution (Washington State Department of Natural Resources, 2003). Other features, such as climate, landform, soil, and hydrology are important in the development of an ecosystem, and thus help define ecoregions. Although both provinces and ecoregion delineations consider the geology of an area, the difference is that ecoregions also view the distribution of species and ecosystems across the landscape.

The project area is within the Northern Forest ecoregion, and more specifically, the Unglaciated Allegheny High Plateau section of the North Central Appalachians division of the Atlantic Highlands subregion. This subregion is a maturely dissected plateau with sharp ridge tops and narrow valleys. Characterized by extensive forest, short growing season, nutrient poor soils, and high local relief, the area is rugged with steep valley sides, entrenched streams, and high-gradient channels (Woods, Omernik, & Brown, 1999).

Geology has a huge impact on watershed attributes, especially on their location and presence. Different landform structures exist in different locations due to the geology. Physiographic provinces and ecological regions have related geology and most often overlap. The existence of plant species in a region relies on geology, climate, and soil type.

Soil Characteristics

Soil Associations

Soil associations are comprised of two or three major soil types and a few minor soil types. The names given to the soil association are based on the major soil types found within them. In the name they are listed in order by the percentage of each soil type. For example, the Hazleton-Buchanan-Cookport soil association has three major soil types—Hazleton, Buchanan, and Cookport—the Hazleton soils compose

the largest percentage of the association followed by the Buchanan and Cookport soils. There are 17 associations within the region. Identified in Table 2-1 are brief descriptions of each of the associations.

Table 2-1. Soil Associations

Soil Association	Description
Albrights-Buchanan	Very deep and moderately well drained and somewhat poorly drained soils that are nearly level to moderately steep. They are formed on uplands in materials weathered from sandstone and shale.
Atkins-Philo-Monongahela	Poorly drained to moderately well drained, deep, nearly level and gently sloping soils on flood plains and terraces. The Atkins and Philo soils were formed in recent alluvium from sandstone, siltstone, and shale while the Monongahela soils were formed in old alluvium weathered from acid shale and sandstone
Bath-Mardin	Yellow and brown, very acidic and deep, well/moderately well drained
Buchanan-Hartleton-Leck Kill	Very deep and deep with somewhat poorly drained and well drained soils that are moderately steep to very steep. Soils are formed on uplands in materials weathered from sandstone and shale
Clymer-Cookport-Dekalb	Deep to shallow yellowish/yellowish-brown residual accumulations derived from fine/textured sandstone. Clymer and Dekalb soils are extremely acidic and somewhat droughty, Cookport soils are moderately well to somewhat poorly drained
Cookport-Hazleton	Deep and very deep soils that are moderately well drained and well drained soils that are nearly level to moderately steep soils. They are formed on uplands in materials weathered from sandstone and shale
Cookport-Hazleton-Clymer	Moderately well drained and well drained, deep, nearly level to moderately steep soils on broad uplands, ridges, and hillsides on the Allegheny Plateau. They are formed in residuum weathered from fine-grained and coarse-grained sandstone.
Hartleton-Wharton-Buchanan	Very deep and deep with moderately well drained and well drained soils that are gently sloping to very steep. They are formed on uplands in materials weathered from siltstone and shale
Hartleton-Wharton-Udorthents	Very deep and deep with moderately well drained and well drained soils that are nearly level to very steep. They are formed on uplands in materials weathered from shale, sandstone, and siltstone
Hazleton-Cookport-Ernest	Moderately well drained with low permeability
Hazleton-Buchanan-Cookport	Very deep and deep with moderately well drained and well drained soils that are nearly level to steep. They are formed on uplands in materials weathered from sandstone and siltstone
Hazleton-Cookport-Buchanan	Very deep and deep with moderately well drained and well drained soils that are nearly level to very steep soils. They are formed on uplands in materials weathered from sandstone and siltstone
Hazleton-Dekalb	Well drained, deep and moderately deep with moderately steep to very steep soils on hillsides. They formed in residuum weathered from fine-grained and coars-grained sandstone
Hazleton-Dekalb-Buchanan	Characterized by highly permeable, well drained soils derived from the weathering of sandstone and shale

Table 2-1. Soil Associations (continued)

Soil Association	Description
Lackawanna-Wellsboro-Cattaraugus-Culvers	Deep, reddish glacial till and frost worked materials
Leck Kill-Hartleton Albrights	Very deep and deep with somewhat poorly drained to well drained soils that are nearly level to very steep. They are formed on uplands in materials weathered from shale, sandstone, and siltstone
Leetonia-Dekalb	Coarse and droughty soils, extremely acidic and sandy; they include many large stones and boulders of quartz conglomerate, except in small areas of medium-textured and less stony Dekalb soils
Rayne-Gilpin-Ernest	Well drained and moderately well drained with deep and moderately deep, gently sloping to very steep soils on hilltops, ridges, hillsides, and foot slopes. The Rayne and Gilpin soils are formed in residuum weathered from shale, siltstone, and fine-grained sandstone. The Earnest soils are formed in colluvium from shale, siltstone, and sandstone.
Wharton-Cavode-Chippewa	Moderately deep residual accumulations that come from dark-brown or gray shale and siltstone, sticky and plastic soils

(Sources: DEP, 2003b; Kopas, 1993; Goodman, et al., 1958; Eckenrode, 2007; Churchill, 1987; Pennsylvania; Soil survey of Clearfield County, Pennsylvania)

Prime Agricultural Soils

Soils that meet certain physical, chemical, and slope characteristics are prime agricultural soils or prime farmland (Farmland Protection Policy Act Annual Report FY 2000, 2001). These soils are important in meeting the country's short-term and long-term needs for food. Ultimately, these soils will produce the highest yields with minimal input of energy and economic resources. Based upon a predetermined set of criteria, they are designated by the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) in each county. The criteria typically include level to nearly level slopes, a well drained structure, deep horizons, an acceptable level of alkaline or acid components, and the capacity for producing food and crops. Figure 2-2 depicts areas that have prime agricultural soils or farmland of statewide importance. There are 80 prime agricultural soils. A listing of these soils by county is located in Appendix C.

In order for soils to be designated as prime soils they need to maintain soil qualities, growing seasons, and moisture supply to sustain high yields of food crops. Soils need an adequate and dependable supply of moisture from precipitation or irrigation. They cannot be excessively erodible or saturated for long periods. They need to have acceptable levels of acidity and alkalinity, few to no rocks, and be permeable to air and water. The length of the growing season and temperature also influence whether a soil is a prime agricultural soil. Slopes mainly range from zero to six percent.

Farmland of Statewide Importance

Important soils, distinguished for agricultural uses, not meeting the criteria for prime agricultural soils, may be designated as farmland of statewide importance. When managed properly, these soils produce high yields of crops, making farmland of statewide importance and prime agricultural soils essential to the region's agriculture production. Some of these areas may even produce yields as high as areas in prime farmland when conditions are favorable (Farmland Protection Policy Act Annual Report FY 2000, 2001). Farmland of statewide importance, designated by the State Rural Development Committee, may include tracts of land designated for agriculture by state law. Within the six counties that

comprise the project area, 95 soils are designated as farmland of statewide importance. They are listed by county in Appendix C.

Agricultural Land Preservation

Agricultural lands are under increasing pressure to convert to residential or commercial developments and other land uses. According to USDA's Natural Resources Inventory conducted between 1992 and 1997, more than 11 million rural acres in the country were converted to a developed use and over half of that acreage was agricultural land. That conversion translates into a loss of over one million acres of agricultural lands each year, or more than 3,250 acres every day (USDA, 2000).



Farm along West Creek

Pennsylvania's farmland, in farms participating and acreage, reached its pinnacle in 1900 when two-thirds of the state's land use was devoted to farming. Since that time, farmland and the number of farms has been steadily declining. As the percentage of farmland declines, the average farm size has increased, which is in line with national trends of fewer, larger farms and an overall reduction in farmland. Between 1982 and 1997, over 420,000 acres of farmland and 767,000 acres of pasture in Pennsylvania were lost to other land uses [Pennsylvania Game Commission (PGC), 2005a].

Pennsylvania has been aggressively pursuing farmland preservation since 1988, when the Farmland Protection Program was formed by state legislature. Since its inception, the program has preserved over 377,900 acres on 3,339 farms. With these impressive numbers, Pennsylvania leads the nation in both acres and numbers of farm preserved. To qualify for the Farmland Protection Program, farms must be designated in agricultural security areas. Only Clinton and Potter counties have agricultural preservation programs within the project area (PDA, 2007a).

Agricultural Security Areas

The Agricultural Security Area (ASA) program, created by Pennsylvania legislature, is administered at the township level. ASAs are rural, agricultural areas targeted for protection from urban development. They receive special consideration regarding local ordinances affecting normal farming practices, state agency rules and regulations, and in eminent domain condemnation proceedings. To be eligible for an ASA designation, at least 250 acres must be nominated. The 250 acres do not have to be contiguous, but individual parcels must be no less than 10 acres. Lands eligible for the program include pasture, hayland, woodland, or cropland (PDA, 2006).

Within the project area, this program is not highly utilized, partially because of the minimal of agricultural land use in the region. There are 6,120 acres (9.56 square miles) enrolled in ASA accounting for less than one percent of the land use. Figure 2-2 identifies the ASA. Additional agricultural lands should enroll in the ASA program to preserve the land for agricultural purposes.

The benefits to the landowner are: limited government ability to condemn land for roads, parks, and other infrastructure projects; municipal agreement not to create "nuisance laws" including odor and noise ordinances, which may limit agricultural practices; and eligibility of landowners to sell the development rights of their farm as a conservation easement to the Commonwealth of Pennsylvania (Farmland Preservation).

An easement is a deed restriction to protect its natural resources that landowners voluntarily place on their property with another entity that establishes a material interest in the property to protect its natural resources (American Farmland Trust, 1998). With an easement agreement, the owner authorizes the easement holder to monitor and enforce restrictions set forth in the agreement, and ensures that the property be protected indefinitely.

Clean and Green Program

Pennsylvania administers the Clean and Green program, which provides incentives to landowners for preservation of agricultural lands and forestlands. The program provides real estate tax benefits by taxing land based on its “use value,” rather than its market value. The program is available to landowners who own 10 or more acres of qualifying land or earn an annual gross income of more than \$2,000 from farming. More information about the Clean and Green Program is available on the Pennsylvania Department of Agriculture’s website at <http://www.agriculture.state.pa.us/agriculture/cwp/view.asp?a=3&q=129083>.

Conservation Reserve Enhancement Program (CREP)

CREP is a voluntary, federal program designed to reward landowners for implementing conservation practices on portions of their land. CREP is designed to improve water quality, benefit wildlife through habitat development and financially reward participating landowners. Administered by the USDA Farm Service Agency and implemented by the NRCS, CREP in Pennsylvania is supported by many conservation partners, such as Pennsylvania Department of Environmental Protection (DEP), PGC, Western Pennsylvania Conservancy, and Chesapeake Bay Foundation.

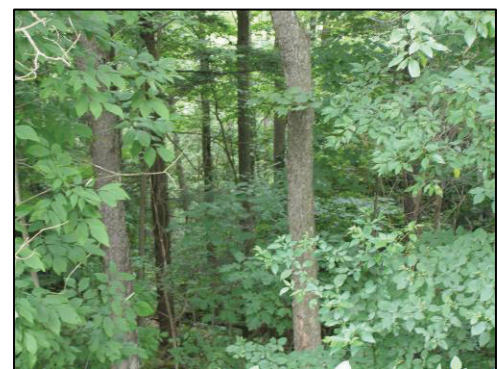
Landowners receive reimbursements for the installation of CREP practices, annual rental payments, and additional cash awards over a 10 or 15-year period. CREP practices include streambank fencing, livestock watering systems, and native tree and grass plantings. The environmental benefits of CREP are multiple and focus on improving water quality, strengthening and developing wildlife habitat, and encouraging landowners to be actively involved in conservation efforts (CREP, 2006).

More information about CREP is available on the Pennsylvania Game Commission’s website <http://www.pgc.state.pa.us/crep/site/default.asp> or by calling 1-800-941-CREP.

Land Use

Evaluating the land use of a specific region can reveal a significant amount about that region. Land uses can provide clues about the major economic catalysts in a region, and offer a glimpse into its past. Looking at a region’s land use can even identify trends not seen from everyday observation, such as insights into possible sources of environmental degradation. It is important to continually monitor land-use changes in a region in order to inform decision makers regarding planning and natural resources protection.

Open space dominates the landscape, with 89 percent of the landscape in forestlands, 5.4 percent in shrub and grasslands, and 3.1 percent in agricultural uses. Development accounts for 1.5 percent of the land area. Water and wetlands account for less than one percent of the land use. Barren lands, primarily comprised of mined areas, make up about 0.25 of a percent. Table 2-2 and Figure 2-3 depict the existing land use.



One of the numerous forestlands found through out the region

Forestry

Forests provide a variety of resources, including timber, wildlife habitat, water filtration, aesthetics, recreation, and employment. Over 90 percent of the nations' threatened and endangered species have some of their habitat on private forestlands (Koehn, 2005).

In 1630, an estimated 95 percent of Pennsylvania was forest. Harvesting timber to support a growing nation reduced the forest coverage of Pennsylvania to 30 percent by 1907. Over the past century, the number has rebounded; and today, Pennsylvania Department of Conservation and Natural Resources (DCNR) estimates the majority of Pennsylvania's land area is forested (2004).

Nationally, Pennsylvania ranks number one in hardwood production. Seventeen million of Pennsylvania's 28 million acres are covered by forest. Private landowners own the majority of forest in Pennsylvania, with 12.5 million acres—74 percent. State forest and state game lands make up 22 percent of Pennsylvania's forest, and three percent is national forestland (Bureau of Forestry). Within the project area, there are four state forests Elk, Moshannon, Sproul, and Susquehannock.

Throughout Pennsylvania, forestry is a key component to both the history and future of many communities. Before settlement in the region, the landscape was vast forestland, home to numerous species of large game animals including elk, bear, and panthers. Today, the region remains an immense forestland accounting for 89 percent of the landscape. The majority of the forestland—74 percent—is deciduous, while 20 percent is mixed, and six percent is coniferous.

The lumber industry, started in the region in the 1800s, is a major component of the local economy. Many livelihoods are based on the forest industry. Within Cameron, Clearfield, Clinton, Elk, McKean, and Potter counties, the forestry industry adds \$97.1 million to Pennsylvania's economy. Value-added industries, such as wood and paper products, add an additional \$279.4 million (Jacobson & Seyler, 2004).

The region's forestry history is recognized through its inclusion in the Pennsylvania Lumber Heritage Region (LHR). The LHR is one of 11 heritage regions covering much of the Pennsylvania landscape. The designation recognizes the forested landscapes that dominate the project area.

Forest Management

Forest management is the art and science of structuring a forest to promote a desired outcome. Skilled foresters use silviculture (the art and science of controlling the establishment, growth,

Table 2-2. Current Land Use

Land-Use Type	Square Miles	Percent of Land Area
Forest	934.744	89.00%
Deciduous Forest	692.502	65.93%
Evergreen Forest	54.495	5.19%
Mixed Forest	187.747	17.88%
Open Land	56.72	5.40%
Shrub/Scrub	45.73	4.35%
Grasslands/Herbaceous	10.99	1.05%
Agriculture	32.202	3.07%
Pasture/Hay	29.344	2.79%
Cultivated Crops	2.858	0.27%
Development	15.457	1.47%
Developed, Open Space	12.217	1.16%
Developed, Low Intensity	2.11	0.20%
Developed, Medium Intensity	0.912	0.09%
Developed, High Intensity	0.218	0.02%
Wetlands	7.226	0.69%
Woody Wetlands	4.861	0.46%
Emergent Herbaceous Wetlands	2.365	0.23%
Barren Land	2.572	0.24%
Water	1.395	0.13%

composition, health, and quality of forest and woodlands) to meet the diverse needs and values of landowners and society on a sustainable basis (Helms, 1998). The type of management used may differ depending on these goals. Common types used in Pennsylvania often fall under the categories of “even-aged” versus “uneven-aged” management.

Even-aged management methods harvest all trees in a stand at one time or in several cuttings over a short time to produce stands of all or nearly the same age. This management method is commonly applied to achieve a forest comprised of shade-intolerant trees, such as black walnut, cherry, poplar, oak, Virginia pine, and table mountain pine. Typical management practices include clear-cutting, seed tree, and shelterwood.

1. **Clear-cutting:** The removal of all trees and most, if not all, woody vegetation from an area, leaving maximum growing space and resources available for the next generation. If done in an appropriate area, it can allow for rapid seedling growth and recolonization
2. **Seed Tree:** A heavy removal of trees within a forest, leaving some remaining mature trees for seed dispersal and regeneration purposes
3. **Shelterwood:** A heavy removal of trees within a forest, leaving some trees uncut to provide a seed source for regeneration. Once regeneration is established, multiple cuttings may occur removing the remaining trees

Uneven-aged management is used to maintain a stand with trees of varying ages—from seedlings to mature. Trees are harvested selectively to maintain shaded conditions. It is most often used to promote stands comprised largely of shade-tolerant species, such as sugar maple, and beech (Penn State, 1995). Typical management practices include individual section cutting, group selection cutting, and high-grading.

1. **Individual Selection Cutting:** A cutting of individual trees (economically valuable and non-economically valuable) used to protect forests health and multi-dimensional forest structure
2. **Group Selection Cutting:** Similar to individual selection cutting, but involves cutting small groups of trees
3. **High-Grading:** Involves cutting the biggest, most profitable trees in a stand leaving smaller, weak trees remaining. Also referred to as selective cutting or diameter limit cutting, some foresters view this as an even-aged technique, but it is rarely recommend as a sustainable management technique

Though specific management practices may be favored, these practices may not be appropriate for all types of stands. Forest management needs to be specific for each individual forest. No one practice can be recommended as the best or worst practices because of the varying characteristics and factors that exist for each forest. However, it is recommended that forest landowners work with a professional forester to manage their land to its greatest potential.

Pennsylvania Bureau of Forestry, administered by DCNR, offers a cost-free Forest Stewardship Program. Landowners can receive forestry management advice and develop a Forestry Management Plan for their properties.

Agriculture

In Pennsylvania, the number of farms and amount of farmland has been steadily declining. In some areas, development pressures are to blame. It is more profitable for landowners to sell their properties as opposed to farming the property. In 1959, there were 100,051 farms in Pennsylvania covering 11.9 million acres. As of 2001, there were 59,000 farms remaining, covering 7.7 million acres. As technological advances in the agricultural industries are developed, productivity increases, decreasing the amount of land needed (Shields).

Within Cameron, Clearfield, Clinton, Elk, McKean, and Potter counties there were 468,826 acres in agricultural use in 1959. In 2001, that area decreased to 255,000 acres. There are 20,609 acres of agricultural land cover within the Sinnemahoning Creek watershed, of which 91 percent is used as pasture or hay land (Shields; PASDA).

Agriculture is still an important sector for employment and the local economy. Many livelihoods are based on the agricultural industry. Within the counties of the project area, the agricultural industry added approximately \$72.4 million to the Pennsylvania economy in 2002. The majority—\$49.6 million—was generated from livestock. This was a 20 percent increase from 1997 [USDA National Agricultural Statistic Service (NASS)].

Agricultural Management Practices

In managing agriculture, a series of sustainable principles and recommendations known as best management practices (BMPs) are utilized. Implementation of these practices minimizes the harmful impacts to the land and water, and can improve herd health and crop yields. Practices include techniques, such as streambank fencing, livestock fencing, manure storage facilities, remote watering systems, and nutrient management. For more information on these practices and others, you can contact your local cooperative extension or conservation district.

Oil and Gas Exploration

For over a century, oil and gas exploration has been a common fixture. Pennsylvania's history of oil and gas exploration dates back to 1859, when the world's first intentional and successful oil well was drilled in Venango County, near Titusville. Until oil fields were discovered in Texas during the 1900s, western Pennsylvania generated over half of the world's petroleum supply. Pennsylvania's annual contribution to the national petroleum supply since 2000 is less than one percent, but is still notable due to the distinguishing lubrication properties of Pennsylvania crude oil (Shultz, 1999).

As the demand for oil and natural gas grows around the world, exploration for these resources expands as well. Due to increased demand, and therefore, increased prices; oil and gas exploration in Pennsylvania has been expanding since the 1970s, and even more so in recent years (Table 2-3).

It is estimated that Pennsylvania has 2.8 trillion cubic feet of natural gas available for development. The U.S. produces 30 trillion cubic feet of natural gas annually. Since the detection of natural gas within the Marcellus Shale formation, the interest in natural gas well drilling in Pennsylvania has increased.

Table 2-3. Wells Drilled in Watershed Municipalities

County	2007	2006	2005	2000
Cameron County	2	0	0	0
Clearfield County	28	22	64	22
Clinton County	0	0	0	0
Elk County	41	33	10	11
McKean County	4	8	25	0

(Note: Only sites located within the municipalities of the Sinnemahoning Watershed are included. Other wells may have been drilled within other portions of the counties.)

(Source: DEP, 2008e)

the interest in natural gas well drilling in Pennsylvania

A good indicator of future drilling activities in the region is the number of new drilling permit applications issued. In 2007, the DEP issued 7,241 oil and gas well drilling permits, which represents a 19 percent increase from 2006. Within Cameron, Clinton, Elk, McKean, and Potter counties 1,801 oil and gas well permits were issued, of which only a portion are located within the project area (DEP, 2008e).

Sinnemahoning Creek watershed is located in the region of Pennsylvania likely to produce natural gas. Portions of Elk and Clearfield counties are already producing gas, while the Potter County portion has an underground gas storage area (Flaherty & Flaherty III, 2002). Figure 2-4 identifies active, inactive, and abandoned well sites.

Marcellus Shale

The Marcellus Shale is the second largest shale formation in the U.S. and is among the top natural gas shales in the world. In 2002, it was believed that 1.9 trillion cubic feet of natural gas was available for development within the Marcellus Shale formation in Pennsylvania. Since then, additional studies have been conducted, and now based on new techniques, the Marcellus Shale formation is believed to have the potential to produce 500 trillion cubic feet of natural gas. It is believed that the amount of natural gas produced from the Marcellus Shale formation could support the entire U.S. for two years.

Marcellus Shale

Black shale from the Devonian period that is slightly radioactive. It has a low density and is organically rich.

Found in the Appalachian Region, it extends 575 miles through West Virginia, Ohio, Pennsylvania, and New York.

Natural gas within the Marcellus Shale formation occurs within pore spaces, fractures, or breaks in the shale. It can also be absorbed in mineral grains and organic material. The majority of the gas is located within pore spaces, which are fine and poorly connected, making it difficult for the gas to escape. Gas that is discharged escapes very slowly. Utilizing hydrofracturing techniques—blasting large amounts of water, sand, and other chemicals at the shale causing it to fracture—can establish a network for the natural gas to easily flow through the created cracks and into wells.

When drilling for natural gas, a vertical well is bored into the ground. In order to increase permeability and recover the gas from the Marcellus formation, horizontal drilling and hydrofracturing are used. When horizontal drilling techniques are used, the cost can more than double, but productivity can increase by 15–20 times.

Hydrofracturing techniques work well in recovering the gas; however, it requires a large volume of water, which becomes contaminated during the process. This technique was used to recover gas in the Barnett Shale formation in Texas, which required an average of three million gallons of water to frac one well. The necessary use of this volume of water and the resulting contamination has caused drilling for gas in the Marcellus Shale to be met with resistance. The development of a method for fracturing the formation without contaminating millions of gallons of water is imperative. Presently, water should be treated to ensure that it meets the standards of the receiving waters where it will be discharged.

Mining

Early coal mining gave little thought to the long-term environmental impacts that would occur from the practices. However, as awareness of the environmental harm caused by mining increased, regulations to address the issue improved. In 1971, Pennsylvania enacted the Surface Mining Conservation and Reclamation Act, and followed in 1977 by the federal government passage of the Surface Mining Control and Reclamation Act, which closely modeled the Pennsylvania regulation. With the creation of these

regulations, mining activities had guidelines to follow and state and federal oversight of the projects (DEP, 2005c).

The southwestern portion of the watershed, particularly the Bennett Branch subwatershed, has a long history of coal mining, which continues today. The majority of the mining activities are concentrated in the Bennett Branch subwatershed due to the geological makeup of the region. Sterling Run, a subwatershed of Driftwood Branch Sinnemahoning Creek, has also experienced significant mining activities. Figure 2-4. identifies active and abandoned mining activities and active reclamation projects.



An active mining site within the Bennett Branch subwatershed

A number of mining operations are actively mining and numerous abandoned mine sites exist. As of March 2008, there were 30 active mining permits issued in the watershed. Some of these operations are revisiting previously mined areas, reclaiming impacts left by the initial mining operation. Through re-mining impacts caused by earlier mining practices can be corrected and treated while additional natural resources are obtained. This is a win-win situation; the mining companies make a profit while contaminated lands are reclaimed.

Current mining operations work under stricter regulations than those preceding them, but still raise concerns among area residents. Most resident concerns are related to protecting the quality of their water. Due to rural characteristics and wildness of the region area residents rely on groundwater supplies through private wells to provide their water. In some areas of Pennsylvania, mining activities have contaminated the water supply leaving home owners with polluted drinking water. More information about residents concerns is located within the Issues and Concerns chapter.

Abandoned Mines

Once all the economically recoverable coal is removed from a mine, the mine is shut down, and the mine operator moves on to the next site. The story of the coal mine, however, often lives on long past the closing of the mine. Abandoned coal mines are a significant hazard throughout western Pennsylvania. Abandoned mines have left behind a legacy of un-reclaimed land and water quality problems that many are striving to correct.

Some of the most potent legacies of abandoned mines are the discharges of polluted water that significantly degrade nearby waterways. The discharges may contain metals, sulfates, and/or acids. Abandoned mine discharges are usually located in close relationship to the inactive coal mining sites.

Pennsylvania Bureau of Abandoned Mine Reclamation (BAMR), a division of DEP, is working to remediate hazards and impacts of abandoned mine drainage in the Bennett Branch subwatershed. BAMR has invested more than \$11.5 million towards remediation and restoration of local abandoned mine lands. Table 2-4 identifies abandoned mine land reclamation efforts occurring in the Bennett Branch subwatershed as of 2007.



This settlement pond is one of many passive abandoned mine drainage treatment systems within the Bennett Branch subwatershed

Table 2-4. Abandoned Mine Land Reclamation Efforts

Site	Site Name	Status	Amount	Acreage
OSM 24(3895)101.1	Winslow Hill III	Completed	\$391,297	28.8
OSM 24(3894)101.1	Winslow Hill III	Completed	\$560,684	12.6
OSM 24(0519)101.1	Kersey	Construction	\$2,769,634	74.4
OSM 24(0525)101.1	Gray Hill	Construction	\$2,726,632	94
OSM 24(0521)101.1	Caledonia Northwest	Construction	\$550,605	18
OSM 24(0515)101.1	Weedville	Design	NA	NA
OSM 24(0504)101.1	Tyler Run	Design	NA	42.4
OSM 24(3898)101.1	Porcupine Hollow	Construction	\$1,156,042	49
COE Site 3895	Passive Treatment System	Construction	\$407,477	NA
OSM 24(Dents Run)	Pass through grant to Bennett Branch Watershed Association	Construction	\$3,028,000	NA
OSM 24(1934)	P&N Mine Site and Box Cut	Construction	\$328,000	NA
OSM 24(3890)101.1	Winslow Hill IV	Design	NA	38
OSM 24(3890)101.1	Dents Run	Bid	NA	50
COE Site 3888	Passive Treatment System	Completed	\$158,133	NA
COE Site 3893	Passive Treatment System	Completed	\$515,987	NA
COE Site 3893	Surface Mine Reclamation	Unknown	\$311,000	8
Discharge 17, Site 1934	Potential Lime Doser on Porcupine Run Hollywood Treatment Plant	NA	NA	NA

(Source: DEP, 2007)

Developmental Pressure

The rural address and rugged terrain keep this region primarily undeveloped. Large amounts of public lands already exist protecting the region's natural resources and communities from development. The steep slopes common throughout the area also hinder would be developers. Three Keystone Opportunity Zones are located in the region. Two—Barton Street and Catalano Property—are located in Emporium and one is located at the Saint Marys Airport Industrial Park. These locations, along with brownfield sites—identified later in this chapter—are primarily the areas capable of undergoing development.

Land Ownership

The majority of the Sinnemahoning Creek watershed—60 percent—is under public ownership by DCNR and PGC. DCNR operates six state parks and portions of four state forests in the region, while PGC oversees portions of seven state game lands. Figure 2-5 displays the public and managed lands within the Sinnemahoning watershed.

Critical Areas

Critical areas have constraints that limit development and various other activities. Critical natural areas contain rare, threatened, or endangered species; natural communities of concern; or significant ecological and geological landscapes worthy of protection. Steep slopes, ridgetops, floodplains, streambanks, and wetlands are examples of critical natural areas. Figure 2-6 displays the environmentally sensitive areas.

Landslides

A landslide is the movement of earth, rocks, or debris down a slope under the direct influence of gravity. Most landslides occur in areas with steep slopes where loose colluvial soils exist. They can occur gradually moving millimeters per year or rapidly as a mass. The speed at which it moves depends upon the angle of the slope, material type, and water content (USGS, 2005).

Typically, landslides occur as a secondary or reactionary event to a natural disaster—such as severe storms, hurricanes, earthquakes, and floods—that can cause more damage than the initial disaster. Activities and influences of people through sprawl are major factors for the increased damage caused by landfills. Factors, such as stream erosion, earth-moving activities, soil characteristics, weakened or fractured rock, mining debris, and weather, can determine the occurrence of a landslide (Delano & Wilshusen, 2001; USGS, 2005).

Landslides cause damage to transportation routes, utilities, and buildings. They can create travel delays and other side effects. The threat of landslides should always be assessed while planning any development project. Proactively avoiding a landslide is much cheaper as opposed to the clean up and repair that is required after a landslide. If development within landslide-prone areas is ultimately chosen, additional precautionary measures during development, such as additional drainage features and proper site planning, are essential to minimize the risk of a landslide (Delano & Wilshusen, 2001).

Landslide Hazards Program (LHP) was established as a part of the United States Geological Survey (USGS) in the mid 1970s. Their role is to reduce long-term losses from landslide hazards by improving the understanding of the causes of ground failure and to suggest strategies to mitigate these causes. Through information gathering, research, and responding to emergencies and disasters LHP is able to produce scientific reports to a variety of audiences. Within Landslide Hazards: A National Threat, the Sinnemahoning Creek watershed is identified as being located within a region of the U.S. that has a high to very high potential for the occurrence of a landslide (USGS, 2005).

Subsidence Areas

Subsidence is the downward movement of surface material involving little or no horizontal movement. Occurring naturally due to physical and chemical weathering of certain types of bedrock, subsidence usually occurs locally as a result of underground mining, excessive pumping of groundwater, or subsurface erosion due to the failure of existing utility lines. Subsidence usually occurs slowly over a long period, but also can happen rapidly. The development of a sinkhole, for example, occurs when the support of the land is gradually removed, causing the land surface to sag and finally collapse, leaving a hole or cavity. Although subsidence is not common in the watershed, the potential exists, especially in the southwestern portion where abandoned coal mines exist (Kochanov, 1999).

Sinkholes

A sinkhole is a subsidence feature that can form rapidly. It is characterized by distinct breaks in the land surface and the downward movement of the surface materials into the resulting hole or cavity. Sinkholes only occur in certain parts of Pennsylvania underlain by carbonate bedrock, typical in central and eastern parts of the Commonwealth. This region is generally not affected by sinkholes, unless mine subsidence causes them.

Mine Subsidence

Mine subsidence is the movement of ground surfaces because of the collapse or failure of underground mine workings. In active, underground mining operations using longwall mining or high extraction pillar recovery methods, subsidence usually occurs concurrently with the mining operation in a predictable manner.

In abandoned mines where rooms and unmined coal pillars are often left in various sizes and patterns, it may be impossible to predict if and when subsidence will occur. Mine subsidence resulting from abandoned room-and-pillar mines is generally classified as either sinkhole or trough subsidence.

Sinkhole subsidence occurs in areas overlying shallow room-and-pillar underground mines. The majority of sinkholes develop where the amount of cover is less than 50 feet. They are typically associated with abandoned mines. DEP will no longer authorize underground mining beneath structures where the depth of overburden is less than 100 feet, unless the subsidence control plan demonstrates the proposed mine will be stable and that overlying structures will not suffer irreparable damage. This type of subsidence is fairly localized and is recognized by an abrupt depression evident at the ground surface as overburden materials collapse into the mine void.

Subsidence troughs over abandoned mines usually occur when the overburden sags downward due to the failure of remnant mine pillars. The resultant surface effect is a large, shallow, broad depression in the ground, which is usually elliptical or circular in shape. The flow of streams may be altered or disrupted, and surface cracks may occur, particularly near the edge of the trough.

A need exists to research areas where mining occurred in the past to determine the risk of subsidence. Homeowners should check with DEP to determine if their property is susceptible to mine subsidence and secure insurance through the PA Mine Subsidence Insurance Fund, if necessary.

Erosion and Sedimentation

Erosion is the transfer of soil particles through air or water. The relocation of these particles is sedimentation. Erosion and sedimentation are natural earthmoving processes, but the extent of this movement can be greater than normal due to poor land-use practices. Erosion and sedimentation is a very serious issue, with the potential to cause significant degradation to an area's waterbodies.

Erosion is common along streambanks, steep slopes, and ridgetops. Streambank erosion occurs when the land adjacent to the waterway erodes and deposits sediment into the waterway. Typically, erosion is accelerated by improper land uses and a lack of vegetation along the streambank. Vegetation anchors soil in place, preventing it from washing away during high stream levels or heavy rains. However, if the vegetation is removed or inadequate, the soil is easily washed into the waterbody. A lack of vegetation also leaves soils vulnerable to high winds, which can induce erosion.



Siltation fences are used to control the loss of soil from a construction site. This particular siltation fence is termed a "super siltation fence" and is located at an AMD remediation project within the Bennett Branch subwatershed

An increase in sediment in the waterbody itself is a cause for concern, as it alters native aquatic habitats. Excessive sedimentation clouds the water, which reduces the amount of sunlight reaching aquatic plants. It covers fish spawning areas and food supplies, and may clog their gills. Other pollutants attached to soil particles are deposited in waterbodies with the sediment. Downstream, sediment settles out of the water and is deposited in a new location, which can significantly alter the channel and flow of the stream.

Erosion occurring throughout the terrestrial portion of a watershed also can have a negative impact on the region's waterbodies. Soil eroded off construction sites, timber operations, or agricultural operations eventually reaches nearby streams, further exacerbating sedimentation problems.

In an effort to combat this problem, DEP and Pennsylvania Code regulate the disturbance of earth materials leading to erosion and sedimentation. Disturbances include any earth moving activities, such as timber harvesting, construction activities, agricultural plowing and tilling, etc. Disturbances of less than 5,000 square feet are required to minimize the potential for accelerated erosion and sedimentation through the implementation and maintenance of best management practices. Disturbances over 5,000 square feet must have a soil and erosion control plan on site. It is critical that these plans are implemented and monitored to ensure their effectiveness (Pennsylvania Code, 2008).

Fish and Wildlife Habitat

Habitats are the natural environments upon which animals and plants depend. Healthy habitats are important to maintaining a diversity of biological resources. Interferences and changes to habitats affect the variety of plants and animals that depend on them. Habitats where rare, threatened, and endangered species reside are critical in nature. Important habitats in the watershed include forested and riparian areas, floodplains, and wetlands.

Riparian Corridors

Riparian corridors are lands located next to a body of water. When densely vegetated, they serve as a buffer against polluted runoff and provide habitat corridors for many species of wildlife. The Water Resources and Biological Resources chapters provide specific information about riparian corridors and their benefits.

Floodplains

A floodplain is the land adjacent to a waterway that dissipates floodwaters over the land surface thereby reducing the flow of flood waters. These scenic and valuable habitats are beneficial in reducing: streambank erosion and sedimentation, flooding downstream, loss of property, and the degradation of water quality. Some people even consider floodplains to be a natural sponge due to their ability to absorb and slowly release floodwaters recharging groundwater and decreasing the velocity and volume of flood waters. Floodplains also help improve water quality by trapping sediment and capturing pollutants similar to the role of wetlands.

Floodplains are delineated by the frequency of flooding events that cover them with water. The “100-year” flood is a flood that has a one percent chance of occurring in a given year, and thus a 25-year flood has a 25 percent chance of occurring in a given year.

Floodplains often contain rich sediments, as occasional flooding deposits nutrient rich soils from the floodwaters. Floodplains are also inhabited by unique plants and wildlife accustomed to the periodic inundation. Many species found within floodplains are seldom seen in other areas. More information about floodplains and the species that thrive in them is located in the Biological and Water Resource chapters.

Wetlands

Wetlands are “areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions” (U.S Army Corps of Engineers, 2002). Wetlands are delineated according to hydrology, soil type, and vegetation. Whether constructed or naturally occurring, wetlands have a variety of appearances. Standing water, inundated soils, or an apparently dry field can be a wetland.



Butterflies, like this Monarch butterfly, rely on the presence of flowers to survive

Wetlands are a vital component to a healthy watershed as they provide many unique and critical functions. More information about wetlands is discussed in the Water Resources chapter.

Wind Energy

In search for alternative energy, a variety of methods are being explored. One of the front-runners in Pennsylvania is wind energy. Wind energy is a sustainable, economical, and fast growing alternative energy source. It reduces some of the negative effects of fossil fuel electricity generation.

Although not identified within the top 25 sites for wind energy potential, Pennsylvania has moderate potential. DEP estimates there is a potential to generate 45 billion kilowatt-hours annually.

In order to establish a wind farm six components are needed and include (DEP, 2002):

- **Open land**—each turbine requires a 15-foot diameter area with no vegetation. Typically, one turbine is situated per every eight acres of land
- **Wind turbines**—supported by towers reaching over to 200 feet generate electricity at wind speeds between seven and 35 mph
- **Transmission lines**—proximity to transmission lines is an important factor in generating electricity to sell to a utility
- **Substation**—changes voltages to match voltage of transmission line
- **Weather station**—used to collect wind data in order to adjust turbines for maximum efficiency
- **Access roads**—needed to facilitate construction and maintenance at the site

Areas desired for wind energy coincide with areas of ecological significance. Forest ridges and other landscapes where high wind speeds are generated, often are also the most biologically rich forests and streams in the Commonwealth. For this region, site selection for establishing wind farms can be very controversial.

Issues about wind farms vary among nuisance, safety, and ecological concerns. Nuisance issues include spoiling views, noise, excessive lighting, and interference with communication signals, such as television. Impacts to wildlife include bird and bat mortality, habitat loss and fragmentation, and interfering with migration patterns (American Wind Energy Association).

A wind farm proposed within miles of Cherry Springs State Park would be the first in the Pennsylvania Wilds region. Opponents against the selection of the site worry that the lighting from the established turbines will degrade the only dark sky preserve east of the Mississippi. Proponents for the site feel the site's location 13 miles away from the Cherry Springs State Park will not affect stargazing, and would be an economic benefit to their community (Anonymous, 2007).

Additional information about wind farms and wind energy can be obtained from various websites identified in Appendix P: Useful Websites.

Hazardous Areas

Hazardous areas have or could have potentially hazardous materials or conditions. Hazardous areas include Superfund sites, hazardous waste haulers and storage facilities, illegal dumpsites, auto salvage yards, landfills, brownfield sites, and abandoned mines.

Comprehensive Environmental Response Compensation and Liability Act

The Comprehensive Environmental Response Compensation and Liability Act (CERCLA), commonly known as Superfund, enacted in 1980, provides broad federal authority to respond directly to

releases of hazardous substances that may endanger public health or the environment [U.S. Environmental Protection Agency (U.S. EPA), 2004]. By creating a tax on the chemical and petroleum industries, a trust fund was established to provide for cleanup when no responsible party can be identified. In 1986, the Superfund Amendment and Reauthorization Act (SARA) amended CERCLA.

Short-term and long-term action responses were identified in the law. Short-term actions require prompt response for releases or threatened releases. Long-term responses permanently and significantly reduce the dangers associated with releases or threats or releases of hazardous substances that are serious, but not immediately life threatening. These actions are conducted only at sites listed on U.S. EPA's National Priorities List (NPL).

Pennsylvania Pressed Metals is the only CERCLA site identified within the project area. Located in Emporium, Cameron County, the site is not included on the NPL.

Resource Conservation and Recovery Act

The Resource Conservation and Recovery Act (RCRA)—a federal statute—regulates the transportation, handling, storage, and disposal of solid and hazardous materials. Federal facilities may control regulatory responsibilities, including obtaining permits, identifying and listing hazardous waste, adhering to procedures when transporting or disposing of waste, developing risk management plans, and managing records (EPA, 2002). Requirements for underground storage tanks, including cover tank design, operation, cleanup and closure, are also contained in RCRA. There are 29 RCRA sites in the area; listed in Appendix E.

Illegal Dumpsites

Remote areas, streambeds, hillsides, back roads, and old coal mines are often inundated with old tires, appliances, and other items that people no longer want. These illegal dumps grow with continued use over time, and can cause a variety of environmental and health impacts. Dumpsites pose a direct threat the health and safety of humans, plants, and animals. They have the potential to attract disease-spreading pests, such as mosquitoes and rodents. Dumpsites have the potential to pollute the soil, surface and groundwater, and air quality depending on the materials that are disposed of at the site. They affect the esthetics of the area, property values, and landowner liability.

Currently, it is the responsibility of each municipality to identify and clean-up illegal dumpsites. Elk and McKean counties have had illegal dump surveys completed. These surveys access and document the location and size of illegal dumpsites. Illegal dumpsites were identified at 17 sites in Elk County through PA CleanWays' Illegal Dump Survey. Site 27 has been cleaned up by employees of Elk State Forest. Within the McKean County portion of the Sinnemahoning Creek watershed, no illegal dumpsites were documented during the Illegal Dump Survey. Surveys for Cameron, Clearfield, and Potter counties, have not been conducted as of 2008. Table 2-5 identifies dumpsites identified in the Illegal Dump Surveys.

PA CleanWays chapters and affiliates throughout the state work to clean up and prevent illegal dumping through action and education. Local businesses, organizations, or clubs often "adopt" rural roadways, trails, and/or waterways to help curtail illegal dumping. These volunteers pick up trash in their adopted areas two to three times per year, similar to the Adopt-A-Highway Program run by Pennsylvania Department of Transportation. County governments or volunteer groups organize chapters and affiliates of PA CleanWays.

Three associations of PA CleanWays operate within the watershed—Clinton County affiliate, Elk County chapter, and McKean County chapter. Cameron, Clearfield, and Potter counties currently have no chapter or affiliate of PA CleanWays.

Table 2-5. Illegal Dumpsites

Site #	Municipality	Site Name	Calculated Tons	Distance From Waterway	Visibility From Roadway	Road Type	Terrain
16	Jones Township	Glen Hazel Rd Site 2	0.5	Within 50 ft	No	State Road	Medium Slope
18	Jones Township	Stony Hill Road	0.25	More than 100 ft	Yes	Municipal Road	Medium Slope
27	Benezette Township	Gray Hill Road	1	No Waterways	Partial	State Forest	Steep Slope
28	Benezette Township	Sumerson Road	1.5	Within 50 ft	Partial	County Road	Medium Slope
61	St Marys Borough	West Creek Road	0.5	50-100 Feet	Partial	Municipal Road	Medium Slope
62	Jay Township	Hill Road Site 1	2	No Waterways	Partial	Municipal Road	Steep Slope
63	Jay Township	Hill Road Site 2	0.25	No Waterways	Yes	Municipal Road	Flat
64	Jay Township	Gardner Hill Rd Site 3	0.75	No Waterways	No	Municipal Road	Flat
65	Jay Township	Washington Street	1	Within 50 ft	Yes	Municipal Road	Flat
66	Jay Township	Old Byrndaale Rd Site 1	0.25	No Waterways	Yes	Municipal Road	Flat
67	Jay Township	Old Byrndaale Rd Site 2	0.5	No Waterways	Yes	Municipal Road	Medium Slope
68	Jay Township	Apple Road	2.5	Waterway/Wetlands	Partial	Municipal Road	Steep Slope
69	Jay Township	Rt. 255	0.5	No Waterways	Yes	State Road	Flat
70	Jay Township	McClintocks Road	1	Within 50 ft	Yes	County Road	Medium Slope
71	Benezette Township	Rock Hill Road	0.5	Waterway/Wetlands	Yes	County Road	Flat
72	Jay Township	Smith Hill Rd Site 1	2.5	Within 50 ft	Yes	County Road	Flat
73	Jay Township	Smith Hill Rd Site 2	3	More than 100 ft	Partial	County Road	Extremely Steep
74	Jay Township	Grey Hill Rd	0.5	No Waterways	No	County Road	Gently sloped
76	Fox Township	Bennett Rd	0.5	No waterways	Yes	County Road	Flat

(Source: PA CleanWays, 2007).

Auto Salvage Yards

Auto salvage yards, commonly referred to as junkyards or wrecking yards, serve as locations for decommissioned and wrecked vehicles that are usable for parts and materials. Environmental impacts of auto salvage yards are related to fluids that result from salvage yard operations, including crank case oil, hydraulic oil, brake fluid, oil recovered from steam cleaning, gasoline, antifreeze, transmission fluid,

window cleaner, and wastewater recovered from steam cleaning. In addition, tires and lead acid batteries must be properly stored or disposed. All generated wastes and associated products must be managed in compliance with municipal ordinances, DEP and EPA regulations.

Landfills

Landfills continue to be the chief method of solid waste disposal in Pennsylvania. A landfill is simply a disposal site for various types of waste, which are discarded into or onto the land. In the past, landfills were situated for convenience, and did not utilize any measures to control leachate, which is the liquid formed when water infiltrates into the waste and draws out chemicals, metals, and other materials. Without proper and now federally mandated measures, leachate can easily infiltrate and contaminate groundwater resources.

Federal regulations for municipal solid waste landfills (MSWLFs) mandated by EPA falls under Subtitle D (Part 258) of RCRA, which was last revised in 1991. The eight main components of the regulations are listed below (EPA, 2008).

- **Location restrictions** ensure that landfills are built in suitable geological areas away from faults, wetlands, floodplains, or other restricted areas
- **Composite liners requirements** include a flexible membrane (geomembrane) overlaying two feet of compacted clay soil lining the bottom and sides of the landfill; protect groundwater and the underlying soil from leachate releases
- **Leachate collection and removal system** sit on top of the composite liner and removes leachate from the landfill for treatment and disposal
- **Operating practices** include compacting and covering waste frequently with several inches of soils to reduce odor; control litter, insects, and rodents; and protect public health
- **Groundwater monitoring** requires testing groundwater wells to determine whether waste materials have escaped from the landfill
- **Closure and post-closure care requirements** include covering landfills and providing long-term care of closed landfills
- **Corrective action provisions** control and clean-up landfill release, and achieve groundwater protection standards
- **Financial assurance** provides funding for environmental protection during and after landfill closure (i.e., closure and post-closure care)

Landfills and landfill regulations are of particular importance in Pennsylvania due to the fact that, since 1992, the state has been the nation's lead importer of waste (Action PA, 2005). Pennsylvania can attribute this title to its geographical proximity to Megalopolis—the dense urban band that stretches from Washington D.C. to Boston—and that it has large amounts of inexpensive, rural lands.

No active landfills are located in the project area. The closest active landfill is located in Kersey, Elk County. There are 11 abandoned and two inactive landfill sites, which may be of concern, as they may have been built before federal and state regulations, and could be a source of groundwater contamination (DEP⁴).

Recycling

Recycling starts with community collection of approved materials, which generally includes glass, plastic, paper, and metal materials. Community collection may be done through curbside collection, drop-off centers, buy-back centers, and/or



Recycling receptacles located at Thunder Mountain Park in Benzette

deposit/refund programs. After sorting, recyclable materials are sold and purchased in the same manner as any other commodity. Materials recovery facilities buy the materials and remanufacture the recyclables into new products.

The benefits from recycling are numerous and can have a positive impact on a community. Recycling materials keeps them out of municipal landfills, and therefore reduces the need for such facilities. Recycling also limits the amount of raw materials required to produce products, which reduces the need for resource extraction activities, reduces emissions, and saves a significant amount of energy in the process. Recycling programs also create numerous jobs. In Pennsylvania alone, 81,322 jobs are the result of recycling programs (DEP, 2006b).

Pennsylvania Act 101, the Municipal Waste Planning, Recycling, and Waste Reduction Act of 1988, mandates curbside recycling for municipalities with populations of at least 5,000 or a population density of a least 300 persons per square mile, by September 1991. Additionally, each county is responsible for developing its own municipal waste management plan (DEP, 2006b).

The rural characteristic of the Sinnemahoning Creek watershed limits curbside recycling opportunities due to economic feasibility. Only one municipality, City of Saint Marys, meets Act 101 requirements mandating curbside recycling. Most areas are limited to the 29 drop-off recycling centers in the region. There is a need for additional drop-off sites, especially outside of Emporium and Saint Marys areas. Establishing drop-off locations in additional areas will increase recycling efforts throughout the region (DEP⁸).

Brownfields

According to U.S. EPA, “brownfields are real estate property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant.” Cleaning up and reinvesting in these properties takes development pressure off undeveloped, open land, while improving and protecting the environment (EPA, 2006a).

To address brownfields issues in Pennsylvania, DEP has created a Brownfields Action Team (BAT). BAT formed to streamline the revitalization of Brownfield sites and enhance the interaction between the local community and DEP. Responsibilities of the team include expediting permits, coordinating funding, and obtaining liability protection for sites. One approved BAT site, Driftwood Pellet/Molding Plant, is located within the project area

DEP also developed a joint program with U.S. EPA called the “One Cleanup Program” in 2004. The purpose of the program is to ensure that brownfields recovered under Pennsylvania Brownfields Program also satisfy requirements under federal regulations. Listed in Table 2-6 and Figure 2-7 are the 21-brownfield sites located within the region (DEP²).

Table 2-6. Brownfield Sites

Brownfield Site	Address	City	Status
10 East Fourth Street	10 East Fourth Street	Emporium	Unknown
Borough of Emporium Former Waste Disposal Area	Taylor Street and Barton Street	Emporium	Unknown
Carey's Store	10268 Main Street	Sinnemahoning	Unknown
Driftwood Pellet/Molding Plant		Driftwood	BAT Site

Table 2-6. Brownfield Sites (continued)

Brownfield Site	Address	City	Status
East Allegheny Ave Lot	241 West Fourth Street	Emporium	Unknown
Emporium Borough Taylor Street Property	Taylor Street and South Mountain Road	Emporium	Unknown
Former Auto Dealership	209 Sizerville Road	Emporium	Unknown
Former Auto Parts Store	37 East Fourth Street	Emporium	Unknown
Former Brown Co. Building	116 West Second Street	Emporium	Unknown
Former Machine Shop and Laundry	170 East Second Street	Emporium	Unknown
Former Tri-Fac Property	East Second Street	Emporium	Unknown
GE Transportation System-Motor Coils	55 Pike Street	Emporium	Site Specific
Huston Township Water Authority Building	Bennetts Valley Road	Penfield	Unknown
IDA Multi Tenant Facility	140 West Second Street	Emporium	Unknown
Jeffrey Madinger Prop Cleanup	RR 1 Box 12	Penfield	Statewide Health
Metal Wire Driftwood M&M Pipeline	Route 255	Driftwood	Site Specific
Olivett Prop	401 4 th Street	Emporium	Statewide Health
Penfield Commercial Lot	Bennetts Valley Road	Penfield	Unknown
PPL Avery Hollow Check HG Meter Sites	2 nd Ninth Street	Allentown	Statewide Health
Pro-America	Second Street	Emporium	Unknown
Pro-America 2	East Second Street	Emporium	Unknown

(Source: Geospatial Data Center, 2004; DEP; DEP, 2008e)