CHAPTER 2. LAND RESOURCES

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

A scenic overlook of the Connoquenessing Creek watershed

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 insights to the land's history, composition, structure, and natural resources.

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. In order to categorize landscapes and land forms with similar features and help distinguish between them, geologists have divided the earth into various physiographic provinces. Pennsylvania is divided into six physiographic provinces, each with a particular type of landscape and geology. The project area is located completely within the Appalachian Plateaus Province, which stretches from Alabama to New York, and encompasses a significant amount of western Pennsylvania (Sevon and Barnes, 2002).

The Appalachian Plateaus Province is divided into ten physiographic sections. The project area is located within the Pittsburgh Low Plateau section. It is characterized by a smooth to irregular, undulating surface, with narrow and relatively shallow valleys (Sevon and Barnes, 2002). Local relief in the 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 strip mines have significantly altered a portion of the region's topography.

The bedrock geology is from the Carboniferous period that occurred during the Paleozoic Era approximately 290 to 354 million years ago. The Carboniferous period was named after the rich deposits of coal deposited throughout northern Europe, Asia, and midwestern and eastern North America (University of California Museum of Paleontology). The U.S. the Carboniferous period was divided into two sub-periods, the Pennsylvanian and Mississippian, in order to distinguish between the coal-bearing layers of the Pennsylvanian from the mostly limestone layers of the Mississippian.

The bedrock geology in the study area is that of the Pennsylvanian. It is estimated that the Pennsylvanian subperiod occurred 290-330 million years ago and currently underlies 35 percent of Pennsylvania, for which it is named. Cyclic sequences of sandstone, red and gray shale, conglomerate, clay, coal, and limestone are associated rock types (Sevon and Barnes, 2002).

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. Four geologic formations exist in the region including Allegheny, Casselman, Pottsville, and Glenshaw. Of these, the Glenshaw is the most dominant formation found throughout the project area. The Allegheny formation is primarily found along waterways and floodplains. The Casselman formation is located in the southern border of the project area and the

Pottsville formation is located in the western portion near the mouth of Connoquenessing Creek in Beaver and Lawrence counties.

Soil Characteristics

According to Soil Society of America, soil is, "The unconsolidated mineral or organic material on the immediate surface of the earth that serves as a natural medium for the growth of land plants." There are over 20,000 soils in the U.S. alone. Soils are named and classified on the basis of physical and chemical properties. The development of soil relies on several factors: climate, plant and animal organisms, parent material, time, and differences in elevation. The influence of each factor varies, creating the diversity of soil associations both locally and regionally. The type of soil should determine the use of land.

Soil Associations

Soil associations are comprised of two or three major soil types and a few minor soil types. There are 13 associations in the region. Descriptions of each of the associations are located in the text below (Smith et al., 1982; Smith et al., 1989: Newbury, et al., 1981).

1. **Canfield-Ravenna Loudonville** soil association occupies smooth to hilly uplands and associated drainage ways in northwestern Beaver County and in areas throughout Lawrence County. Many areas in the association are used for farming activities, including beef, grain, dairy, corn, hay, and pasture. The potential is good for farmland, woodland, and wildlife habitat. For non-farm uses, its potential is fair to poor. Major limitations are seasonal wetness, slow permeability, depth to bedrock, and slope.

2. **Cavode-Wharton-Gilpin** soil association occupies smooth to rolling uplands and associated drainage ways in all but the northwest part of Butler County. Most areas in the association are used for farmland and woodland. Dairy farming is the main farming enterprise, with corn, small grain, hay, and pasture being the major crops. Artificial drainage is usually required. This association's potential is fair for farmland, good for woodland and wildlife habitat, and fair to poor for urban uses. The major limitations are seasonal wetness, unstable soil material, slow permeability, depth to bedrock, and slope.

3. **Gilpin-Weikert Atkins** soil association is found on mainly steep and very steep sides of valleys, but also includes nearly level flood plains. This association is mostly wooded, and has severe limitations for other uses, due to the hazard of flooding on the flood plains and the steep slopes.

4. **Gilpin-Wharton-Upshur** soil association is located on undulating to hilly uplands and is highly dissected by small streams and drainage ways. Gently sloping ridgetops are generally long and narrow, and high rounded knobs are scattered throughout the area. Most of the association has been cleared and farmed, and is under continuing suburban development.

5. **Gilpin-Wharton-Weikert** soil association is located on undulating, broad and narrow ridgetops, side slopes, and hillsides of highly dissected uplands. It is found in the southeast corner of Lawrence County and in a majority of the northern two-thirds of Beaver County. Ridgetops in the association are primarily used for urban

and suburban development, farmland, and woodland. Hillsides and steep drainage ways are generally wooded. Beef, grain, and dairy farming comprise the major farm enterprises and corn, small grain, hay, and pastures comprise the major crops. The potential is good for farmland, woodland, and wildlife habitat. For non-farm uses, its potential is fair to poor. Major limitations are seasonal wetness, slow permeability, depth to bedrock, and slope.

6. **Hazelton-Buchanan-Gilpin** soil association occurs near the major streams and their tributaries in all but the northwest corner of Butler County. The association is located on ridges, hills, benches, foot slopes, and associated flood plains. The majority of areas in the unit are woodland and brushland, with a few areas of farmland on the ridgetops. In general, the association is too steep and stony for farmland, but has good potential for woodland and wildlife habitat. Its potential for urban uses is poor. The major limitations of the soil are slope, the presence of many large stones on the surface, seasonal wetness, and depth to bedrock.

7. **Hazelton-Cookport-Buchanan** soil association is found in all but the northwest part of Butler County. Most of the areas in the unit are used for farmland and woodland. The major farm enterprises are dairy, potato, and orchards. The major crops are corn, potatoes, small grains, apples, hay, and pasture. This association has good potential for farmland, woodland, and wildlife habitat. It has good to poor potential for urban uses. The major limitations of the soils are seasonal wetness, slow permeability, and slope.

8. **Hazelton-Gilpin-Wharton** soil association is located throughout all but the northwest part of Butler County. The unit is undulating to rolling on uplands, in depressions, and in drainage ways. The majority of land in the association is used for farmland and woodland. The major farm enterprises are raising beef, potatoes farming, and dairy. The major crops are corn, potatoes, small grains, hay, and pasture. The potential for farmland, woodland, and wildlife habitat is good. For urban uses, the potential is good to poor. The major limitations are seasonal wetness, slow permeability, depth to bedrock, and slope.

9. **Monongahela-Atkins-Caneadea** soil association is located on smooth to rolling terraces, flood plains, and small areas on adjacent uplands and foot slopes along Connoquenessing Creek and its tributaries including Brush Creek. The majority of areas in the unit are used for farmland and woodland. Near Zelienople, some areas are used as urban land. The unit has fair potential for farmland and good potential for woodland and wildlife habitat. Its potential for urban uses is fair to poor. The major limitations are seasonal wetness, slow permeability, slope, and frequent flooding.

10. **Ravenna-Canfield-Frenchtown** soil association occupies smooth to rolling uplands and associated drainage ways in Lawrence County. The majority of areas in the association are farmed for beef, dairy, corn, small grain, hay, and pasture. Generally, artificial drainage is required. The potential is fair to good for farmland, good for woodland and wildlife habitat, and fair to poor for most non-farm uses. The major limitations are seasonal wetness, slow permeability, and slope.

11. **Tilsit-Brinkerton-Gilpin** soil association is located throughout the southern half of Butler County. This association is smooth and undulating on uplands, in

depressions, and in drainage ways. The majority of areas in the unit are used for farmland. A few areas of woodland are on lowlands and on slopes near drainage ways. The potential for farmland is fair or good, good for woodland and wildlife habitat, and fair to poor for urban uses. The major limitations are seasonal wetness, slow permeability, depth to bedrock, and slope.

12. **Udorthents-Wharton-Hazelton** soil association is located throughout Butler County, but is mainly found in the northern half. Most areas are in native vegetation and woodland, with only small areas used for farming. The potential of the unit for farming is poor, for woodland and wildlife habitat it is fair to poor, and for urban uses, it is poor. The major limitations of the soils are low available water capacity, slope, many small stones on the surface, and seasonal wetness.

Green Turf Farm, located along Route 68 in Forward Township, is one of the many sod farms in the region

13. **Urban Land-Monongahela-Tyler** soil association occupies smooth to rolling terraces and flood plains and some adjacent uplands. Urban land is occupied by buildings and structures or is covered by asphalt, concrete, and other impervious surfaces. It is dominantly nearly level to moderately steep. This association is generally urban or industrial areas interspersed with woodland, cropland, pasture, and idle land. The potential is fair to poor for farmland, fair to good for woodland and wildlife habitat, and fair to poor for most non-farm uses. The major limitations are seasonal wetness, slow permeability, and flooding.

Prime Agricultural Soils

Soils that meet certain physical, chemical, and slope characteristics are identified as 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 U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) in each county. The criteria typically includes level to nearly level slopes, 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 31 prime agricultural soils. A listing of these by county is located in Appendix D (USDA, 2003).

Farmland of Statewide Importance

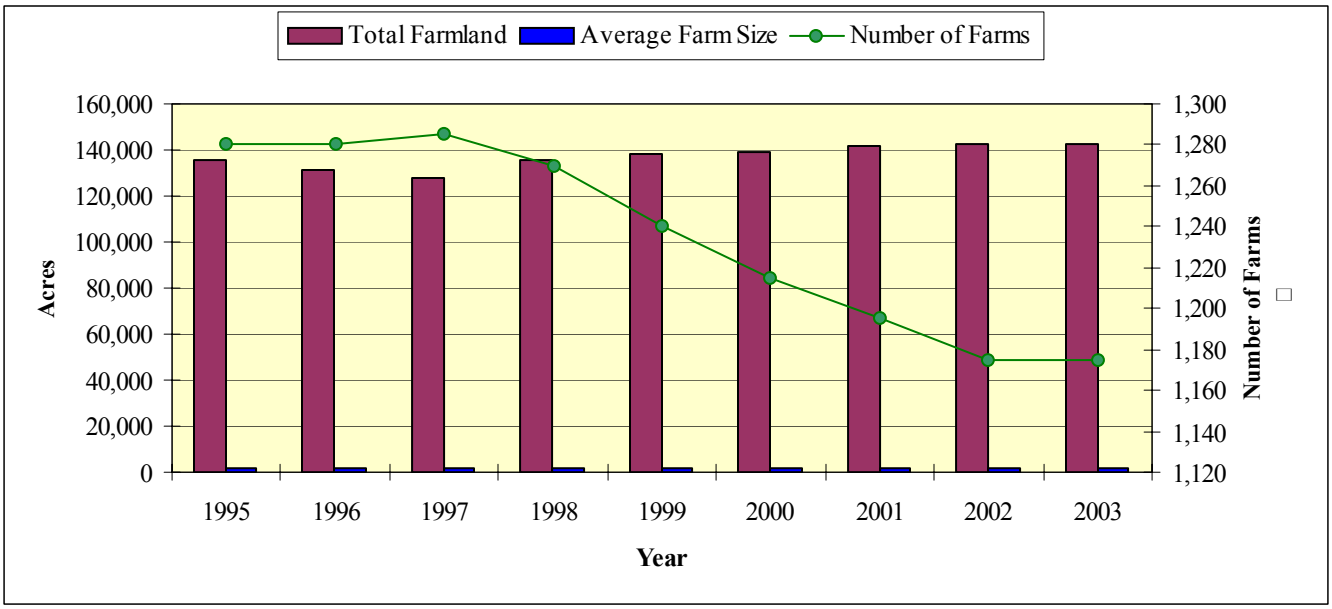
Important soils that are distinguished for agricultural uses, but that do not meet the criteria for prime agricultural soils, may be designated as "farmland of statewide importance." When managed properly, these soils produce high yields of crops, making farmland of statewide importance and prime agricultural 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 is designated by State Rural Development Committee and may include tracts of land that have been designated for agriculture by state law. Within the four counties that comprise the project area, 108 soils have been designated as farmland of statewide importance. They are listed by county in Appendix D.

Agricultural Land Preservation

Agriculture, along with forested lands, is the major land use and economic component in the region. But similar to many areas, agricultural uses are under increasing pressure to convert to residential development 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 (NRCS, 2006). That conversion translates into a loss of over one million acres of agricultural lands each year, or more than 3,250 acres every day.

Pennsylvania's farmland, in quantity and in land cover, 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 percent of farmland declines, the average farm size has increased, which is in line with national trends of fewer, larger farms, with an overall reduction in farmland. In the 17 years between 1982 and 1997, over 420,000 acres of farmland, and 767,000 acres of pasture in Pennsylvania, have been lost to development or other land uses (PA Game Commission, 2005a). In Butler County, recent statistics from 1997 to 2003 reveal that while the number of farms has decreased, and the average farm size has slightly increased, the overall amount of farmland has actually increased, as demonstrated in Figure 2-3 (USDA, 2006). However, the contemporary growth is modest and has only occurred in recent years. There is still a great need to protect farmland, especially in the wake of considerable growth and sprawl in areas like Cranberry Township, which experienced a 62 percent increase in population from 1990 to 2000 (U.S. Census Bureau, 2006).

Figure 2-3. Change in Number of Farms, Average Farm Size, and Total Farmland, Butler County.



Pennsylvania has been aggressively pursuing farmland preservation since 1988, when the Farmland Protection Program was formed by the state legislature. Since its inception, the program has preserved over 300,000 acres through more than 2,500 conservation easements. With these impressive numbers, Pennsylvania leads the nation in both acres and number of farms preserved. Through the passage of the Growing Greener II referendum in 2005, an additional $80 million will be available through the program. To qualify for the Farmland Protection Program, farms must first be designated in agriculture security areas (PDA, 2007a).

Agricultural Security Areas

The Agriculture Security Area (ASA) program was created by the Pennsylvania legislature, and is administered at the municipal level. ASAs are rural, agricultural areas that are 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 there are 252 parcels enrolled in agricultural security areas. These 49.8 square miles account for 11.6 percent of the land use. Figure 2-4 identifies the agricultural security areas.

The benefits to the landowner are: limited government ability to condemn land for roads, parks, and other infrastructure projects; a municipal agreement not to create "nuisance laws," including odor and noise ordinances that would 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).

A conservation easement is a deed restriction that landowners may 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 will be protected indefinitely.

Purchase Conservation Easement Program (PACE)

If a landowner enrolled in the ASA program purchases a conservation easement, it is done through the PACE program. This program authorizes the state to purchase conservation easements from willing farmers who are already within an ASA. This program allows agricultural operations to continue. Farmers who participate in this program receive economic benefits in return for the conservation easement. The PACE program has not been active in the Connoquenessing Creek watershed, or is mistakenly viewed as part of the ASA program.

Clean and Green Program

Pennsylvania administers the Clean and Green program, which provides incentives to landowners for the preservation of agricultural lands and forestland. 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 either own 10 or more acres of qualifying land or earn an annual gross income of more than $2,000 from farming.

Conservation Reserve Enhancement Program (CREP)

CREP is a voluntary, federal program designed to reward landowners for implementing conservation practices on portions of their land. PA Ohio River watershed CREP is administered by USDA Farm Service Agency and implemented by NRCS, and in Pennsylvania, is supported by many conservation partners, such as Pennsylvania Department of Environmental Protection, Pennsylvania Game Commission and Western Pennsylvania Conservancy.

Landowners receive reimbursement for the installation of CREP practices, annual rental payments, and additional cash awards over a 10 or 15-year period. CREP practices include funding for 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 (PA CREP, 2006).

Land Use

Analyzing land use within a specific region is an important tool that can reveal a significant amount about that area. Land uses can provide clues about major economic catalysts and offer a glimpse into how the past has created present-day conditions. Examining a region's land use can even identify future trends or explain existing conditions that are not recognized from casual 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 guide decision-making regarding planning and natural resource protection.

The predominant feature of the local landscape is open space. Urban development comprises only 10 percent, and is generally concentrated in a handful of population centers dispersed throughout the area, which includes Butler, Connoquenessing, Saxonburg, Evans City, Zelienople, Mars, Cranberry Township, and Ellwood City. Forestry and agriculture are the two major and dominant land uses, each with about 41 percent coverage. Barren lands, which are usually comprised of inactive and abandoned mine areas, and transitional areas together comprise slightly fewer than seven percent of land use. Wetlands are sparse, representing only one tenth of one percent of the project area.

Table 2-1. Current Land Use

Land-Use Type	Square Miles	% of Land Area
Agriculture	**177.40**	**41.29**
Pasture/Hay	79.62	18.53
Row Crops	97.78	22.76
Wetlands	**0.04**	**0.01**
Woody Wetlands	0.03	0.01
Emergent Herbaceous Wetlands	0.01	0.00
Barren	**26.47**	**6.16**
Transitional	26.47	6.16
Development	**44.31**	**10.31**
Low Density Urban	36.20	8.42
High Density Urban	8.11	1.89
Forest	**176.16**	**41.00**
Deciduous Forest	139.94	32.57
Coniferous Forest	19.58	4.56
Mixed Forest	16.64	3.87
Water	**2.29**	**0.53**
Open Water	2.29	0.53
Mining	**3.02**	**0.70**
Quarries	2.88	0.67
Coal Mines	0.14	0.03
Total	**429.69**	**100%**

Forestry

In 1630, an estimated 95 percent of Pennsylvania was covered with forest. Harvesting the timber to support a growing nation reduced the coverage of Pennsylvania to an amazing 30 percent by 1907. Over the past century, the number has rebounded, and today 58 percent of the land area in Pennsylvania is forested. Among the forests throughout the state, private interests hold 69 percent, while 31 percent are owned by public agencies (DCNR, 2004b).

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

Forests account for 41 percent of the land use

Nationally, Pennsylvania ranks number one in hardwood production (Bureau of Forestry). Seventeen million of Pennsylvania's 28 million acres are covered by forest (Bureau of Forestry). Private landowners own the majority of the forest in Pennsylvania, with 12.5 million acres or 71 percent. State forest and state game lands make up 22 percent of Pennsylvania's forests, and three percent is national forestland.

There are 176 square miles of forestland within the project area, with deciduous forests comprising the majority at 79 percent. Coniferous forests account for four and a half percent of forestlands. Mixed forests, which contain combinations of both deciduous and coniferous trees, comprise close to four percent of forestlands. No state forests exists, which helps to explain why the percentage of private landowners who own forestlands is significantly higher than the state's average, with 97 percent private landowners in Butler County (Jacobson and Seyler, 2004).

Many livelihoods are based on the forestry industry. Butler County has 24 forestry and wood product establishments, which employ 174 people. The value of Butler County's standing timber is valued at $159.34 million, while the annual economic contribution of the forestry sector is $16.9 million. The annual timber harvest's value is $8 million and an additional $7 million is generated by wood products and paper production (Jacobson and Seyler, 2004). More information about forests is available in Chapter 4, Biological Resources.

Forest Management

Forest management is the art and science of developing a forest to promote a desired outcome. Skilled foresters use silviculture (the art and science of controlling the establishment, growth, composition, health, and quality of forests and woodlands) to meet the diverse needs and values of landowners and society on 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 a forest where trees are left for regeneration purposes.

3. **Shelterwood:** A heavy removal in which some trees are left uncut to provide a seed source for regeneration. Once regeneration is established, multiple cuttings removing remaining trees may occur.

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 (DCNR, 2007b). Typical management practices include individual selection cutting, group selection cutting, and high-grading.

1. **Individual Selection Cutting:** Cutting of scattered individual trees, including both large, economically valuable trees and weak trees, in order to maintain the health of the forest 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 of only the biggest, most profitable trees in a stand; this is not a good forestry management practice because only smaller, weak trees remain. Some foresters also view this as an even-aged management technique, but rarely recommended it as a sustainable management technique. High-grading is also referred to as selective cutting or diameter limit cutting.

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 practice 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.

Forest Management Assistance

The Pennsylvania Bureau of Forestry, administered by Pennsylvania's Department of Conservation and Natural Resources, offers a cost-free Forest Stewardship Program. Landowners can receive forestry management advice and develop a Forestry Management Plan for their properties.

Agriculture

Along with forestry, agriculture is a dominant land use. However, the agricultural industry in all four counties has a greater annual economic contribution than the forestry industry (Jacobson and Seyler, 2004). Many livelihoods are based on the agricultural industry. There are two management types of farms—family farms and factory farms. As estimated by the Butler County Farm Service Agency, there are approximately 700 to 800 family farms within the study area (Fritz, personal communication, 2006).

There are a variety of local farms, including dairy, beef, horse, llama, sod, tree, and field crop

Family farms are typically smaller farms that have been in operation for several generations. For the most part, owners of family farms manage and work on their farms following sustainable agricultural practices.

Factory farms are larger, corporate-based industries. Many of these farms control production from animal breeding, processing, and to the market shelf. Factory farms emphasize high volume and profit. Several different types of farming operations are considered factory farms. They include Concentrated Animal Feeding Operation, Confined Animal Feeding

Operation, Conventional Farming, Industrial Agricultural Operation, and Industrial Livestock Operation. Although, currently no factory farms exist in the project area, the potential for their establishment exists.

Agricultural Management Practices

In managing agriculture, best management practices (BMP) are utilized. BMPs are a series of sustainable principles and recommendations. Implementation of these practices minimizes the impacts to the land and water, and can improve heard health and crop yields.

1. **High Residue Management** leaves at least 30 percent of the ground covered with crop residue, such as leaves and stalks, after crops are planted. This limits erosion by protecting and binding the soil.

2. A **Cropland Protection Cover**, or cover crop, is usually grown for a year or less. A crop of close-growing grasses, legumes, or small grains is not grown for harvest, but for many different functions in crop rotations, such as preventing erosion and improving soil fertility.

3. **Nutrient Management** is the management and crediting of nutrients from all sources, including legumes, manure, and soil reserves for the application of manure and commercial fertilizers. Management includes the rate, method, and timing for the application of all sources of nutrients to minimize the amount of nutrients entering surface or groundwater. This practice includes manure nutrient testing, routine soil testing, and residual nitrogen soil testing.

4. **Pesticide Management** is the management and handling, disposal, and application of pesticides, including the rate, method, and timing of application to minimize pesticides entering surface and groundwater. This practice includes integrated pest management scouting and planning.

5. **Rotational Grazing** is an intensive grazing management practice that divides pastures into multiple cells that receive a short but intensive grazing period followed by a period of recovery of the vegetative cover. Rotational grazing can correct existing pasturing practices that result in degradation. When the practice of summer dry-lots results in water quality degradation, it should be replaced by this practice.

6. **Livestock Fencing** encloses or divides an area of land with a suitable permanent structure that acts as a barrier to livestock or big game. The fencing excludes livestock from areas that should not be grazed, subdivides land to permit use of grazing systems, and protects new seeding and plantings from grazing.

7. **Channel Crossings** are stable surfaces installed on the bottom of streams to provide a crossing for equipment or livestock. They are typically used to coincide with streambank fencing.

8. A **Manure Storage Facility** is a structure used to store manure until it can be applied to the land. The facility is needed to properly store manure, so that it does not become a non-point source of pollution.

9. **Field Diversion** is a shallow channel constructed across the slope of the land to divert water from areas where it may cause flooding or erosion. The water is diverted to where it can be stored or safely transported.

10. **Terraces** are a system of ridges and channels with appropriate spacing and constructed on the contour with a suitable grade to prevent erosion in the channel.

11. **Grassed Waterways** are a natural or constructed channel shaped, graded, and established with suitable cover as needed to prevent erosion by runoff waters.

12. An **Agricultural Sediment Basin** is a structure designed to reduce the transport of sediment, agricultural waste, and other pollutants transported from agricultural fields and barnyards to surface waters, closed depressions, and wetlands.

13. **Shoreline and Streambank Protection** is the stabilization and protection of stream and lake banks against erosion, and the protection of fish habitat and water quality from impacts caused by livestock. Methods include fencing, shaping, and seeding of vegetation, rock, riprap, bioengineering, or structures to stabilize shorelines and/or provide fish habitat.

14. **Shaping and Seeding** is the planting of vegetation, such as trees, shrubs, vines, grasses, or legumes, on highly erodible or critically eroding areas. This vegetation stabilizes the soil, reduces damage from sediment and runoff, and improves wildlife habitat and visual resources.

15. **Streambank Fencing** excludes livestock from the near shore area to prevent trampling and grazing, protecting the riparian habitat.

16. A **Remote Watering System** is a system of portable tanks, pumps, and pipes designed to bring water to livestock in all grazing cells rather than allow the animals to have direct access streams where erosion can occur.

17. **Shoreline Buffers** are permanent vegetated areas immediately adjacent to lakes, streams, channels, and wetlands designed and constructed to manage critical non-point sources or to filter pollutants from non-point sources.

18. **Wetland Restoration** is the construction of berms or destruction of the function of tile lines or drainage ditches to create conditions suitable for wetland vegetation.

19. **Barnyard Runoff Management** includes the structural measures to redirect surface runoff around the barnyard and collect, convey, or temporarily store runoff from the barnyard. Management includes measures such as sediment basins, roof gutters, and clean water diversions.

20. **Animal Lot Relocation** involves moving an animal lot from a critical site, such as a floodway, to a suitable site to minimize the amount of pollutants from the lot to surface or groundwater.

Oil and Gas Exploration

Pennsylvania's history of oil and gas exploration dates back to 1859, when the world's first intentional and successful oil well was dug in Venango County, near Titusville. Until the 1900's when oil fields were discovered in Texas, western Pennsylvania generated over half of the world's petroleum supply. Today, Pennsylvania's annual contribution to the national petroleum production is less than one percent, but is still notable due to the distinguishing lubricating properties of Pennsylvania crude oil (Shultz, 1999).

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. In 2005, Pennsylvania Department of Environmental Protection (DEP) issued 6,046 oil and gas well-drilling permits, which represents a 32.4 percent increase over the record 4,567 permits that were issued in 2004 (DEP, 2004b). In contrast, the Connoquenessing Creek watershed region has seen a sharp decline in the amount of permits issued, as demonstrated in Table 2-2, with only 18 permits issued since 1990.

All of the wells are shallow wells—that is they do not infiltrate the boundary between the Middle and Upper Devonian Series and have an average depth range of 500 to 5,000 feet deep. Shallow oil and natural gas reserves in Pennsylvania are primarily found in the Western portion of the state, where it forms a scattered band that runs diagonally from Greene and Fayette Counties in the south to Warren, McKean and Potter Counties in the north (Shultz, 1999).

Table 2-2. Oil and Gas Well Permits by Decade

Decade	Number of Well Permits
Unknown	31
Prior to1909	1085
1910–1919	38
1920–1929	21
1930–1939	27
1940–1949	47
1950–1959	29
1960–1969	25
1970–1979	34
1980–1989	47
1990–1999	9
2000–2006	9

Since the late 1800s, 1,402 permits have been issued for wells in the watershed region. Oil wells, totaling 858, are by far the most dominant type permitted. Gas wells comprise a much smaller presence, with 217 permits issued. Additionally, there are 109 permits issued for wells that produce a combination of both oil and gas. A significant number of wells, 187, are considered "dry," meaning there is not enough gas or oil present to warrant extraction in an economically feasible manner. The remaining 31 wells fall into categories, such as junked, observation, storage, and unknown (DEP, 2004b).

Mining

As previously mentioned in the geology section of this chapter, there are significant reserves of coal found. Currently, there are 11 active coal mine sites, according to permits received through the DEP. Of those 11 active mines, nine are surface mines, and two are mineral preparation plants. Associated with the active coal mine sites are seven discharge points. As shown in Figure 2-6, the active mine sites are associated with inactive coal mine sites, in the area of Ellwood City, and in Butler County's Muddy Creek, Lancaster, Jackson, Oakland, and Concord Townships.

Land Ownership

The majority of the watershed (99.4 percent) is privately owned. In addition to the numerous amounts of municipal parks there are five publicly managed areas. They include Brush Creek Park, ECOZ Park, Almeda Park, Rock Point Natural Area, and State Game Lands 164. Figure 2-7 displays the public and managed lands within the Connoquenessing Creek watershed.

Critical Areas

Critical areas are areas that have constraints that limit development and various other activities. Critical natural areas contain rare, threatened, or endangered species; natural communities of special

concern; or significant ecological and geological landscapes worthy of protection. Steep slopes, ridgetops, floodplains, streambanks, and wetlands are examples of critical natural areas. Figure 2-8 displays the environmentally sensitive areas.

Landslides

Landslides occur throughout the state, and are heavily concentrated in southwestern Pennsylvania. The entire region has a high to moderate risk of landslides. Most landslides occur in areas with steep slopes where loose colluvial soils exist. Gravity eventually forces this rock and debris down the slope in a gradual or sudden, flashy manner. Landslides can also occur as a slump, where a block of weathered rock or soil slides outward because of the force from the weight rotation of weathered rock or soil above it. Typically, landslides occur along road cuts having unstable bank conditions. Other 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 and Wilshusen, 2001).

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 in the long run than the clean up and repair that is required after a landslide. If development within a landslide-prone area 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 and Wilshusen, 2001).

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 (Kochanov, 1999). Subsidence usually occurs slowly over a long period, but 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 (Kochanov, 1999). Although subsidence is not common in the watershed, the potential for it exists because of numerous abandoned coal mines located in the study area.

Sinkholes

A sinkhole can be defined as a subsidence feature that can form rapidly. It is characterized by a distinct break 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 underlined 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 as a result 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 can generally be classified as either sinkhole subsidence or trough subsidence.

Sinkhole subsidence occurs in areas overlying shallow room-and-pillar underground mines. The majority of sinkholes usually 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 that the proposed mine working 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, yet 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 edges of the trough.

Researching areas where mining occurred in the past to determine the risk of subsidence is needed. 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 known as sedimentation. Erosion and sedimentation are natural earth-moving processes, but the extent of this movement can be greater than normal due to poor land-use practices. Erosion is common along streambanks, steep slopes, and ridgetops.

Siltation fences, as depicted in the photo, are a best management practice used to contain loose soil at construction sites

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 less than 5,000 square feet are required to minimize the potential for accelerated erosion and sedimentation through the implementation and maintenance of erosion and sediment control BMPs. A written erosion and sediment control plan is required for any disturbance 5,000 square feet or greater, if the disturbance has the potential to discharge to a high quality or exceptional value waterway, or is required under DEP regulations.

Any disturbance of one acre or more, except for agricultural plowing or tilling, timber harvesting, or road maintenance activities, requires a general or individual National Pollutant Discharge Elimination System (NPDES) permit. Timber harvesting or road maintenance activities involving 25 acres or more require an erosion and sedimentation control permit.

To help combat erosion, there are seven erosion and control permits located within the project area. Erosion and sedimentation are discussed in greater detail in the Water Resources chapter.

Fish and Wildlife Habitat

Habitats are the natural environments in which animals and plants reside. Healthy habitats are important to maintaining a diversity of biological resources. Interferences and changes to habitat affect the variety of plants and animals living there. 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. More specific information about riparian corridors is located in the Water Resources chapter.

Floodplains

A floodplain is the level land along the course of a river or stream that is formed by the deposition of sediment during periodic floods. Floodplains contain features such as levees, back swamps, delta plains, and oxbow lakes. These areas are critical to the waterway. These areas often contain a unique diversity of plant and animal species. Floodplains are discussed further in the Water Resources chapter.

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.

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.

Hazardous Areas

Hazardous areas are areas that 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, was enacted in 1980 to provide 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 where no responsible party could be identified. In 1986, the Superfund Amendments and Reauthorization Act (SARA) amended CERCLA.

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

There are two sites identified under the Superfund program—Keystone Aluminum Manufacturing and Spang & Company Manufacturing and Tool Division. Specific information about the sites is limited because neither site is currently listed on the NPL.

Spang & Company manufactures magnetic cores and power electronics, and is headquartered in Pittsburgh, Pennsylvania. East Butler is the home to one of Spang & Company's magnetic division production facilities, which is comprised of five buildings located on a 200-acre site. Ferrite, powder cores, and strip wound products are assembled at the East Butler location. Thus far, the only action that

has been taken is the discovery of the site, meaning that U.S. EPA has been alerted to the presence of the potentially hazardous waste.

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. Regulatory responsibilities, include obtaining permits, identifying and listing hazardous waste, adhering to proper procedures when transporting or disposing of waste, developing risk management plans, and maintaining records, may be controlled by federal facilities (U.S. EPA, 2002). Requirements for underground storage tanks, including cover tank design, operation, cleanup, and closure, are also contained in RCRA. There are 409 RCRA sites in the area; they are listed in Appendix F.

Illegal Dumpsites

In 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. Currently, it is the responsibility of each municipality to identify and clean up illegal dumpsites. Within Allegheny County and Butler County portions of the watershed, 103 illegal dumpsites have been identified through PA CleanWays Illegal Dump Surveys (PA CleanWays, 2005; PA CleanWays, 2007). The Lawrence County Survey will be released in 2008. No survey is currently scheduled for Beaver County.

Illegal dumpsites, in addition to being unsightly, can cause health and environmental impacts. Pictured above is an illegal dumpsite along Palmer Road north of Butler

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 area two to three times a year, similar to the Adopt a Highway program run by Pennsylvania Department of Transportation. Chapters and affiliates of PA CleanWays are organized by county governments or volunteer groups.

Two associations of PA CleanWays operate in the watershed—the Allegheny County affiliate and the Butler-Lawrence Counties affiliate. Since 1993, the Butler-Lawrence County affiliate has facilitated 44 cleanups, removed 215 tons of trash, recycled over 50 tons of trash, removed over 5,000 tires, and completed an illegal dump survey for Butler County. Since 2003, the Allegheny County affiliate has facilitated nine cleanups, removed 89.5 tons of trash, removed 1,127 tires, and completed an illegal dump survey (PA CleanWays, 2006). Beaver County is currently without a chapter or an affiliate of PA CleanWays.

Auto salvage yards can have major impacts on local streams

Auto Salvage Yards

Auto salvage yards are also commonly referred to as junkyards or wrecking yards, and 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, crankcase 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 of. All generated wastes and associated products must be managed in compliance with municipal ordinances, DEP and EPA regulations. Twenty-four known auto salvage yards are as listed in Table 2-3.

Table 2-3. Listing of Auto Salvage Yards.

Company	City	County
A-1 Auto Salvage	Evans City	Butler
A&B Salvage	Harmony	Butler
Best Rebuildable	Evans City	Butler
Bob's Auto Salvage	Butler	Butler
Dawson's Auto Wrecking	Butler	Butler
Ed Wagner Pickup & Van Parts	Harmony	Butler
Edward Donawitz Auto Wrecking	New Brighton	Beaver
Elliotts Auto Salvage	Butler	Butler
Gjs Auto Service and Sales Inc	Prospect	Butler
Greenberg Auto Parts	Ellwood City	Butler
John Wagner & Sons Foreign	Harmony	Butler
Lockaton Auto Wreckers	Butler	Butler
Milich Auto Wrecking	Butler	Butler
Noland's Auto Salvage	Renfrew	Butler
Novak's Auto Parts	New Brighton	Butler
Offstein Denny Auto Sales and Towing Service	Butler	Butler
Offstein, Marshall Auto Sales	Butler	Butler
Petry Auto Salvage	Zelienople	Butler
Reges Auto Wrecking	Butler	Butler
Saxonburg Blvd Auto Parts Inc.	Saxonburg	Butler
Soose Auto Wrecking	Butler	Butler
Tatko's Auto Wrecking	New Brighton	Beaver
Unionville Auto Wrecking	New Brighton	Beaver
Walters Auto Wrecking	Evans City	Butler

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 may be discarded into or onto the land. In the past, landfills were sited 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 sources.

Federal regulations for municipal solid waste landfills (MSWLFs) mandated by U.S. 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 (U.S. EPA, 2006b):

- **Location restrictions**—ensure that landfills are built in suitable geological areas away from faults, wetlands, flood plains, 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 systems**—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 soil helps reduce odor; control litter, insects, and rodents; and protect public health.
- **Groundwater monitoring requirements**—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**—controls and cleans up landfill release and achieves 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 land.

Seneca landfill is one of two active landfills in the area

Two active landfills—Seneca Landfill and Brunner's landfill— are located in the area. Seneca Landfill is approved to accept residual waste, fuel contaminated soils, sewage sludge, asbestos containing waste, infectious/chemotherapeutic waste incinerator ash, and autoclaved infectious waste. There are four inactive landfill sites, which may be of concern, as they may have been built previous to federal and state regulations, and could be a source of groundwater contamination (DEP, 2004a).

Table 2-4. Landfills

Site Name	Status	Location	Municipality	County
Brunner's Landfill	Active	Zelienople	New Sewickley	Beaver
Dreher Landfill	Inactive	Vogleyville	Summit	Butler
James R. Soda Inc. Waste Area	Inactive	Ellwood City	Ellwood Borough	Beaver
Neiper Landfill	Inactive	Middle Lancaster	Lancaster	Butler
Seneca Landfill	Active	Mars	Adams	Butler
Townsend-Div of Townsend Co.	Inactive	Ellwood City	Ellwood Borough	Beaver

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 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 their need. 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, 2006c).

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 at least 300 persons per square mile, by September 1991. Additionally, each county is responsible for developing its own municipal waste management plan (DEP, 2006c).

In 1992, Butler County became the first county in Pennsylvania to offer curbside collection of recyclable materials to every municipality throughout the entire county. Since that time, all of Butler County's municipalities have had curbside recycling service. Additionally, all five of Allegheny County's

municipalities, two municipalities in Beaver County—Franklin Township and North Sewickley Township and two municipalities in Lawrence County—the Borough of Ellwood City and Shenango Township—have curbside recycling programs.

Curbside recycling programs are supplemented by drop-off centers, which are mainly used by residents of smaller communities. Within the project area, there are currently four drop-off locations in the Beaver County, one drop-off location in Butler County, and one drop-off location in Lawrence County. County solid waste departments administer drop-off recycling programs. The various locations accept a variety of items to be recycled ranging from everyday household items, such as cans and bottles, to potentially hazardous items such as batteries and used motor oil (DEP, 2006c).

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 of undeveloped, open land, while improving and protecting the environment (U.S. EPA, 2006b)."

To address brownfields issues in Pennsylvania, DEP has created a Brownfields Action Team (BAT). BAT was 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 help obtaining liability protection for sites.

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. According to DEP, there are seven brownfields sites within the region (DEP, 2006b). Those brownfields are listed in Table 2-5.

Table 2-5. Listing of Brownfield Sites.

Site Name	City	Municipality	Zoning
Callery Chemical Property	Evans City	Forward Township	Unavailable
JDS Building	Butler	City of Butler	Manufacturing
Pullman Cafeteria & Office Building	Butler	City of Butler	Commercial
Pullman Center Business Park Expansion Parcel #1	Butler	City of Butler	Unavailable
Pullman Center Business Park Expansion Parcel #2	Butler	City of Butler	Unavailable
Pullman Locker Room & Dispensary Bldg	Butler	City of Butler	Manufacturing
Victory Road Business Park	Saxonburg	Clinton Township	Industrial, light manufacturing, commercial

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 coalmines are a significant hazard throughout western Pennsylvania. Prior to 1971, reclamation of closed coalmines was not required. As shown on Figure 2-X, significant coal mining has primarily occurred in the northern region. The southeast corner of the study area is completely free of coal mining, past or present.

In total, there are 90 inactive coalmines and four abandoned coalmines. Associated with these mines, there are also 63 inactive discharge points and two abandoned discharge points. Of the 90 inactive coalmines, three are mineral preparation plants, 86 are surface mines, and one is an underground mine. Of the four abandoned coalmines, three are surface mines and one is an underground mine.

All of the inactive mines are in the stage of "reclamation complete." Mine Reclamation is the process of restoring an inactive mine site to a useful or productive purpose through cleaning up environmental pollutants and safety hazards associated with the site. All of the abandoned coalmine sites are "bond forfeited," which means the operator of the mine failed or refused to comply with state and federal requirements, and the bond for the mine was forfeited. The earnings from the forfeited bond can then be used to reclaim the site. These abandoned mines may or may not be reclaimed.

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

Early coal mining gave little thought to the long-term environmental impacts that would occur from the practice. But as awareness of the environmental harm that was caused by the mining increased, regulations to address the issue improved. In 1971, Pennsylvania enacted the Surface Mining Conservation and Reclamation Act, and in 1977 the federal government passed 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, 2005).

To address the abandoned mine problem, the state created its Reclaim PA initiative. The four objectives of the initiative are:

- To encourage private and public participation in abandoned mine reclamation efforts
- To improve reclamation efficiency through better communication between reclamation partners
- To increase reclamation by reducing remining risks
- To maximize reclamation funding by expanding existing sources and exploring new sources

To accomplish these goals, Reclaim PA includes a set of policy, management, and legislative initiatives geared toward erasing the abandoned mine problem in the state. With more than a quarter-million acres of abandoned mines throughout the state, the initiative is ambitious and necessary (DEP, 2005).

Overall, Pennsylvania has created numerous programs available to tackle all types of abandoned mine problems. These available programs include: Operation Scarlift, Surface Mining Control and Reclamation Act (SMCRA), U.S. Department of Interior Office of Surface Mining (OSM) Emergency Reclamation Program, Bond Forfeiture Program, Mine Subsidence Insurance Fund, reclamation in lieu of civil penalties, surety reclamation, Landowner Reclamation Program, EPA Section 319 grants, and Government Financed Construction Contract program (GFCC).