
CHAPTER 2. LAND RESOURCES

Geology

Geology is the science that deals with the study of the earth and its history and is the name of the natural features of our planet. The present day landscape of Pennsylvania reflects millions of years of natural events. The different events that took place in various parts of the Commonwealth are reflected in the vast array of landscapes. Because forces acting on the land had different effects, the Commonwealth is divided into six physiographic provinces, each with a particular type of landscape and geology.

The Lower Crooked Creek and Tub Mill Run watersheds are located in the Appalachian Plateau Province. Extending from Greene and Somerset counties in the southwest to Wayne, Pike and Erie counties in the north the Appalachian Plateau Province covers the greatest area of Pennsylvania. It is primarily highland, eroded by streams that have created deep valleys and hilly topography.

The watersheds are a part of the Appalachian Geosyncline. Geosynclines were envisioned as two belts of sedimentary rock accumulating in great troughs formed by the folding of the entire crust. The strata generally rise from the southwest to the northeast. A series of weak folds cross the watershed including Dutch Run – Plumville Anticline, Murrysville – Roaring Run Anticline, Apollo Syncline, Greendale-Sabinsville Anticline, and the Duquesne-Fairmont Syncline.

Surface rock strata within the watershed include the Conemaugh Group on the uplands and the Allegheny Group along the valley sides of Crooked Creek and its larger tributaries. Both the Conemaugh and Allegheny Groups include sedimentary rocks – sandstone, shale, clay, limestone and coal. There is considerable interpoding of these beds and intermediate forms are common.

The economically important coals, clays, and limestone are all part of the Allegheny group of rocks. The important coals include: the Upper Freeport, Lower Freeport, Upper Kittanning, Middle Kittanning, and Lower Kittanning. These coal seams have been mined by surface and underground methods. Both methods are being actively employed in the watershed today.

The main limestone bed is the Vanport limestone and is being actively mined near South Bend and at a site between Girty and Cochran's Mills. Sandstone is also being quarried for riprap and aggregate at the South Bend site.



Rock formations in the Lower Crooked Creek (below) and Tub Mill Run (above) watersheds



Terrace deposits of alluvial material are extensive, particularly near the mouth of Crooked Creek and over the lower two thirds of Tub Mill Run. The terrace deposits formed from Allegheny River alluvium contain mostly material of glacial outwash. This material has significant amounts of igneous sand, pebbles and cobbles whose origin was the Canadian Shield. These alluvial deposits are found at various elevations indicating former river elevations. These levels correspond to different glaciations. No glaciation has occurred however within the Crooked Creek watershed. Alluvial deposits from Crooked Creek itself contain sedimentary material mainly from sandstone and shale beds originating within the watershed.

Water yields are low to moderate within these strata. In most areas unaffected by mining, yields from strata 100’ to 150’ below the water table are generally adequate for domestic uses. In many areas where deep mining has occurred, strata that were formerly water-bearing have been dewatered, thus creating supply problems for local residents. This is particularly true around Whitesburg.

Sandstones are generally the best aquifers. Water in shale and limestone strata is generally within bedding planes and fracture zones.

Soil Characteristics

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 the land.

Soil Associations

Soil associations are comprised of two or three major soil types and a few minor soil types. There are four soil associations found within the boundaries of the Lower Crooked Creek watershed. They are listed in Table 2-1.

The Weikert-Gilpin soil association consists of long, narrow, steep, dissected areas adjacent to rivers, creeks, and streams. The soils formed from material weathered from interbedded shale, siltstone, and sandstone. Steep slopes severely limit the use of the soils in this association. Much of the association is wooded, and areas that were cleared are now reverting to natural vegetation. Some of the most scenic areas of the county, as well as many areas that have been strip-mined, are in this association.

Soil Association	Description
Weikert-Gilpin	Well-drained, shallow and moderately deep, steep and very steep soils on uplands.
Gilpin-Weikert-Ernest	Well-drained and moderately well drained, shallow to deep, gently sloping to moderately steep soils on benches, ridges, and hillsides.
Rainsboro-Melvin-Steff	Moderately well drained to poorly drained, deep, nearly level to gently sloping soils on terrace and floodplains.
Rayne-Ernest-Hazleton	Well-drained and moderately well drained, deep, gently sloping to moderately steep soils in low-lying areas on ridge tops and on hillsides.

The Gilpin-Weikert-Ernest association consists of small gently sloping ridgetops, benches, and moderately steep hillsides. There are many narrow valleys cut by streams. The soils were formed from material weathered from shale, siltstone, and sandstone. The dissected landscape and complex slopes of the soils of this association make farming with modern machinery difficult. Much of the association was

farmed in the past but is now idle and returning to natural vegetation. Many of the steeper areas have been planted with Christmas trees. Some areas are suited for limited development.

The Rainsboro-Melvin-Steff association consists of broad acres adjacent to streams and rivers. The soils are underlain by stream sediment. Most of the early towns and boroughs of Armstrong County were built on this association and much of the recent development has been on the terraces adjacent to these towns. Railroads and early highways were built on this association because construction was easy on the gently sloping soils. Further development on the floodplains is limited by the hazard of flooding. Sites for development on the terraces should be investigated carefully because many areas have a high water table. Many of the terraces have been quarried for sand and gravel.

The Rayne-Ernest-Hazleton association consists of narrow ridgetops and knolls with some low-lying depressions and toe slopes. Most of the soils were formed in material weathered from shale, but some formed from colluvium (deposited at the edge of the slope), and some soils on the ridges formed from material weathered from sandstone. Many streams and drainage ways dissect this association. Some productive farms are on this association and many of the soils have only moderate limitations for development.

Prime Agricultural Soils

Soils that meet certain physical, chemical, and slope characteristics in addition to being extremely well suited for agricultural uses are identified as prime agricultural soils. Based upon a predetermined set of criteria they are designated by the United States Department of Agriculture (USDA), Natural Resource Conservation Service, in each county.

The criterion typically includes level to near level slopes, a well-drained structure, deep horizons, an acceptable level of alkaline or acid components, and the capacity for producing food and crops.

Within the Lower Crooked Creek watershed, 13 soil-mapping units have been classified as prime agricultural soils (Table 2-2). The characteristics that make these soils prime agricultural soils also make them suitable for development. Concentrated watershed-based efforts are important to determine the best use of these key soil types and maintain their agricultural use.

Table 2-2. Prime Agricultural Soils for Armstrong County

Symbol	Name	Slope Character
A1B	Allegheny silt loam	3 to 8 percent slopes
EnA	Ernest silt loam	0 to 3 percent slopes
HaB	Hazleton channery loam	3 to 8 percent slopes
Pm	Pope fine sandy loam	Not available
Po	Pope loam	Not available
RaA	Rainsboro silt loam	0 to 3 percent slopes
RnB	Rayne silt loam	3 to 8 percent slopes
Se	Steff loam	Not available
Sf	Steff loam high bottom	Not available
UgB	Upshur-Giplin silt loam	3 to 8 percent slopes
WrB1	Wharton silt loam	3 to 8 percent slopes
WtB	Wharton-Gilpin silt loam	3 to 8 percent slopes
WvB	Wharton-Vandergrift complex	3 to 8 percent slopes

Agricultural Security Areas

Agricultural security areas (ASAs) are lands enrolled in a statewide program that has been established to promote and conserve agricultural land and the agricultural community. ASAs serve as a tool to protect farmland from urbanization. They are designated by local municipalities in cooperation with landowners to secure agricultural land use and the right to farm. Areas of at least 250 collective acres are eligible. The acreage need not be continuous, but each parcel must be no less than 10 acres. Property established as an ASA must be viable agricultural land, including pasture, hayland, woodland, or cropland. The local governing body reviews ASAs every seven years.

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 negligibility of landowners to sell the development rights of their farm as a conservation easement to the Commonwealth of Pennsylvania. An easement is a deed restriction that landowners may voluntarily place on their property to protect its natural resources. 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.

The Lower Crooked Creek watershed currently has 3,428 acres in agricultural security areas. The county farmland preservation board is administering the program on behalf of Armstrong County. The board works with the agricultural community to enroll local farmlands in the ASA program and purchases development rights in accordance with the approved county program.

Land Use

Land use is often cited as a major determinant of environmental quality, and is an issue of much debate at the local, regional, state, and national levels. In Pennsylvania, land use has recently been given significant attention. In 1999, the Sound Land Use Advisory Committee was established to identify sustainable land use practices and make recommendations about their implementation. The passage of legislation supporting programs such as Growing Greener (1998) and Growing Smarter (1999) is also instrumental in promoting sound land use practices.

Forest and agricultural lands dominate the Lower Crooked Creek and Tub Mill Run watersheds. They account for over 97% of the land use as seen in Table 2-3 and Figure 2-4. Residential uses only account for .57 square miles and non-residential uses account for .59 square miles.

Forestry

The majority of the forests in the watershed are deciduous forest accounting for 99.8% of the forestland. The main cover types include oak and oak-hickory, northern hardwood, bottomland hardwood, hemlock and softwood plantations.

Most of the forestland within Lower Crooked Creek is classed as oak and oak hickory. On this forest type greater than 50% of the stocking is in oak species including red oak, black oak, scarlet oak, white oak and chestnut oak. Other species in this association include shagbark hickory, pignut, and bitternut. Shellbark and mockernut hickory may be present in very limited amounts. Red maple, sugar maple, black cherry, white ash, yellow poplar, slippery elm, and basswood are generally present in lesser amounts. This forest type is found on upper slopes, and ridge tops extending into valley areas on south and west facing slopes.

Table 2-3. Land Uses in the Watersheds, 1994
(Source: Southwestern Pennsylvania Commission, 2002)

Land Use Type	Square Miles	% of Land Area
Agriculture	42.90	41.41
<i>Agricultural - Crop</i>	14.55	14.05
<i>Agricultural - Pasture and Open</i>	28.35	27.37
Forest	58.19	56.17
<i>Coniferous</i>	0.09	0.09
<i>Deciduous</i>	58.08	56.06
<i>Mixed</i>	0.02	0.02
Maintained Grass	0.08	0.08
Non Residential	0.59	0.57
<i>Non Residential - Industrial</i>	0.29	0.28
<i>Non Residential - Mixed Use</i>	0.30	0.29
Residential	0.57	0.55
<i>Rural</i>	0.51	0.49
<i>Urban</i>	0.06	0.06
Strip Mines or Disturbed	0.14	0.14
Water/Wetlands	1.12	1.08

The northern hardwood forest type is generally dominated by black cherry, red and sugar maple, beech, basswood, ash elm, sweet birch, and yellow birch. Oaks, yellow poplar, and eastern hemlock are also often found in the forest type. This cover type is generally found on north and east facing slopes.

Eastern hemlock as a type is often found along north facing lower slopes and in deeply incised valleys where moisture remains high and temperatures cool even in the warmest weather. This type is generally nearly pure hemlock. Some yellow birch and other hardwoods may be present in minor amounts.

Plantations of various softwood species including red pine, white pine, Norway spruce, Japanese larch, Scotch pine, and others have been established on many former agricultural lands as well as many strip mined areas.

American sycamore, American elm, shingle oak, willow, and box elder dominate bottomland hardwoods. Swamp white oak, swamp chestnut oak, and pin oak are present in isolated wetland areas. This type is generally found on areas adjacent to the larger streams and sites are subject to periodic flooding.

A variant of the northern hardwood type are stands of nearly pure black cherry, which has become naturally established on former agricultural lands.

Growing sites range from poor on the south facing ridge tops to excellent on the lower north facing slopes and in protected coves. The incidence of poor sites is low. The most prevalent site condition is within the average range with mature trees capable of producing two to three 16-foot logs.

Generally management of these forests has been poor. Diameter limit cutting has been extensively practiced for over 50 years. Diameter limit cutting removes the largest fastest growing trees from the stand often in the most valuable species, red oak, black cherry, white oak, and white ash. Repeated diameter limit cutting reduces the overall productivity of the forest.

The gypsy moth devastated much of the oak forest during the early 1990s. This pest has subsided. The hemlock wooly adelgid is an insect, which is presently infesting the eastern hemlock within the watershed.

Since forests account for over 50 percent of the entire watershed, the proper stewardship and management of these areas is essential for the future, both aesthetically and financially. The Pennsylvania Bureau of Forestry can provide guidance on management, disease, and insect problems within the forests of the watershed. This organization is also responsible for administering the Forest Stewardship program in the Commonwealth.



One of the many local forests in the Lower Crooked Creek watershed

Other third party organizations, which provide certifications on good management, include the Sustainable Forestry Initiative, Smartwood, and the American Tree Farm System. The Service Forester from the Pennsylvania Bureau of Forestry can provide interested landowners information on any of these programs.

Another issue facing the forest within the watershed is the general over population of whitetail deer. The deer within this portion of Pennsylvania have not had as serious impacts on the vegetation and regeneration of our forest as has occurred in other areas of Pennsylvania. However, adjacent agricultural land has suffered a tremendous loss in productivity as a result of deer damage. The deer use the forest as a refuge and shelter, feeding heavily on adjacent agricultural crops.

Agriculture

Of the 42.9 square miles being used for agricultural lands 28.35 square miles are used as pastures, hayland, and open areas while the remaining 14.55 square miles are used for croplands. Trends show that the numbers of family farms are declining while the sizes of farms are increasing. The decreasing economy poses financial problems for many small farms in addition to meeting the increased government regulations. Support for agriculture is needed in the watershed since it is one of the major land uses in the watershed.

Gas Wells and Underground Storage

Since 1859, Pennsylvania has become an important area for the production of natural gas. It is



A gas fueled power plant in South Bend Township

primarily used for heating buildings and producing electricity at power plants. Pennsylvania produced 120 billion cubic feet of natural gas in 1994. It reached its highest level of production in Pennsylvania in 1989 with 191 billion cubic feet in a year. Current efforts are being taken to research other ways that natural gas can be utilized including vehicle fuel.

In 1955, with the passage of the Gas Operations Well-Drilling Petroleum and Coal Mining Act, underground oil and gas fields had their first regulations. The passage of the Oil and Gas Act in 1985 required that safety information be exchanged between underground storage operators, owners, operators of underground coalmines, and DEP. In 1994, the Oil and Gas Act was amended and additional safety

requirements for gas storage operations were added.

There are numerous natural gas wells located throughout the watershed. Most of the wells are narrow shallow wells. The Lower Crooked Creek watershed is also the home of an underground gas storage area. It is located in South Bend Township across from the gas-fueled power plant along State Route 56.

Active mines

Mining operations must have an active permit for the site they are mining to be considered an active mine. Even though the permits may be active, mining may not be physically occurring in the permitted areas. There are various stages to active permits including: not started, active, treatment, reclamation, and forfeited. Permits are generally issued for an area larger than the company is planning to mine to support the movement of material and equipment.

Within the Lower Crooked Creek watershed, 24 permits have been issued. Coal mining accounts for 79% of the permits issued and 21% are for other mineral extractions. Table 2-4 lists the active permits and their status within the watershed.



Active mining in the Lower Crooked Creek watershed

Table 2-4. Active Mining Permits Within the Watershed (Source: DEP 2003)

Permit Number	Mine	Permit Holder	Township	Status	Operation
3960107	Smith 16 Mine	Thomas J. Smith, Inc	Burrell	Inactive	Coal Surface Mining
3871302	Triple K #1 Mine	DLR Mining	Burrell	Active	Coal Deep Mine
3572SM17	Girty Strip	Manor Minerals	Burrell	Active	Large Industrial Mineral
3020114	Kaufman Mine	DJ&W Mining Inc	Kiskiminetas	Not Started	Coal Surface Mining
3574SM35	Geiger Strip Mine	Lakeside Coal Co	Kiskiminetas	Other Active	Coal Surface Mining
3900109	Campbell Run	State Industries, Inc	Kittanning	Not Started	Coal Surface Mining
3981301	Parkwood #1	Parkwood Resources, Inc	Plumcreek	Active	Coal Deep Mine
3000106	Blose #1 Operation	P&N Coal Co, Inc	Plumcreek	Active	Coal Surface Mining
3000101	Cherry Run 1 Mine	Amerikohl Mining	Plumcreek	Other Active	Coal Surface Mining
3910104	Cherry Run No. 1	Big Mack Leasing Co	Plumcreek	Inactive	Coal Surface Mining
3990105	Sedat 3 Mine	Seven Sisters Mining Co, Inc	South Bend	Active	Coal Surface Mining
3020112	Smith #31 Mine	Thomas J. Smith, Inc	South Bend	Active	Coal Surface Mining
3980106	Smith #18A Mine	Thomas J. Smith, Inc	South Bend	Inactive	Coal Surface Mining
3990102	Smith #21	Thomas J. Smith, Inc	South Bend	Other Active	Coal Surface Mining
3970301	Myers Mine	Seven Sisters Mining Co, Inc	South Bend	Active	Large Industrial Mineral
3860401	Coleman	Seven Sisters Mining Co, Inc	South Bend	Active	Large Industrial Mineral
3950114	Smith #12 Mine	Thomas J. Smith, Inc	South Bend	Inactive	Coal Surface Mining
3970107	Rupert Mine	Seven Sisters Mining Co, Inc	South Bend	Inactive	Coal Surface Mining
3960104	Smith #17 Mine	Thomas J. Smith, Inc	South Bend	Inactive	Coal Surface Mining
3930401	Coleman #2	Seven Sisters Mining Co, Inc	South Bend	Inactive	Large Industrial Mineral
3950113	Laurel Loop Mine	Seven Sisters Mining Co, Inc	South Bend	Not Started	Coal Surface Mining
3010106	Kunkle Mine	Seven Sisters Mining Co, Inc	South Bend	Not Started	Coal Surface Mining
3020108	Jacobs Mine	Seven Sisters Mining Co, Inc	South Bend	Not Started	Large Industrial Mineral
3901302	#1 Deep Mine	TJS Mining, Inc	South Bend	Other Active	Coal Deep Mine

Landfills

According to the DEP there are currently no active or inactive municipal landfills located in the Lower Crooked Creek watershed.

Ownership

The majority of the Lower Crooked Creek watershed is privately owned. These private holdings include residential areas, farmland, forested areas, commercial and industrial properties, and private camps. The United States Army Corps of Engineers (USACE) owns 2,664 acres which is federal land open to the public including: Crooked Creek Lake Park, Crooked Creek Environmental Learning Center, and the Crooked Creek Horse Park. Schools and municipalities publicly own other small portions of the watershed.

Critical Areas

Critical areas are considered to be areas having constraints that limit development and various other activities. Critical natural areas are those containing 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 natural critical areas.

Landslides

Landslides occur throughout the Commonwealth of Pennsylvania and are heavily concentrated in southwestern Pennsylvania. Areas in the Pittsburgh Low Plateau section have a moderate to high landslide susceptibility. Most landslides occur in areas containing 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. 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.

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 and sedimentation is discussed in greater detail 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 such features as levees, back swamps, delta plains, and oxbow lakes. These areas are critical to the waterway. Frequent flooding limits development. These areas often contain a unique diversity of plant and animal species. Floodplains in the watershed are discussed 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,” as defined by the USACE (USACE 2002). Wetlands are delineated according to hydrology, soil type, and vegetation. Whether man-made or naturally occurring, wetlands have a variety of appearances. Standing water, inundated soils, or an apparently dry field can be a wetland. More information about the wetlands located in the watershed can be found in the Water Resources chapter.

Fish and Wildlife Habitat

Fish and wildlife habitats involve both the wildlife species and their habitats including riparian areas. Riparian areas 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 varieties of wildlife. More information on fish and wildlife habitat in the watershed can be found in the Biological Resources chapter.



Fish habitat improvement project on Cherry Run

Hazardous Areas

Abandoned mines

A lack of federal rules and regulations prior to 1977 led to many mining areas being abandoned without water and land impacts being corrected.

Abandoned mine sites have left dangerous highwalls, open pits, coal refuse piles, old mine openings, and more than 3,000 miles of streams polluted by abandoned mine drainage (AMD) in Pennsylvania. Past coal mining practices have led to erosion, landslides, polluted water supplies, destruction of fish and wildlife habitat, and an overall reduction in natural beauty.

Many groups are working to reclaim abandoned mine lands throughout the Commonwealth and the United States. DEP is also pursuing legislative changes to the Pennsylvania Surface Mining Conservation and Reclamation Act (SMCRA), which would provide greater incentives for remining and reclamation of abandoned mine lands. These incentives could improve water quality, habitat, aesthetics, and increase profitability for mining companies. Other efforts underway to address mining related problems include:

- Requiring abatement or load reduction when sites are remined;
- Evaluation of the use of constructed wetlands, anoxic limestone drains, and diversion wells for treating AMD from certain sites;
- Special studies to determine the effectiveness of mine sealing to prevent long-term post-mining impacts on ground and surface water;
- Office of Surface Mining (OSM) Abandoned Mine Lands Program;
- Pennsylvania Bureau of Abandoned Mine Reclamation (BAMR) program; and
- The 10% Set-Aside Program administered by BAMR.

All efforts and programs to address mining related problems should be continued. Grassroots organizations need to be continuously encouraged and supported by county, state, and federal programs to continue reclamation projects throughout the watershed. For more information on abandoned mines in the watershed, refer to the Water Resources chapter.

Illegal dumpsites

In remote areas of the watershed, streambeds, hillsides, back roads, and old coal mine refuse piles are 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 cleanup dumpsites. With volunteers, PA CleanWays chapters throughout the Commonwealth work to clean up and prevent illegal dumping through action and education. Chapters are organized on a county basis and currently Armstrong County does not have an active chapter. Most local residents are familiar with the organization and its mission since a chapter once existed in the county. Reviving the organization in the county would help to address the illegal dumping occurring in the watershed.

Waste sites

The Comprehensive Environmental Response Compensation and Liability Act (CERCLA) 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. This act is mostly associated with regulating Superfund sites. No Superfund sites or active CERCLA sites have been identified in the watershed.

The Resource Conservation and Recovery Act (RCRA) regulates the transportation, handling, storage, and disposal of hazardous materials. There are currently no such facilities identified in the watershed.

Refuse piles

Historically, the portion of coal having no commercial value was brought to the surface and either hauled away or piled up near the mine forming refuse piles. High quality coal was sent to coke ovens or power plants. Modern technology allows a higher percentage of coal to be burned and the unused

portions to be reclaimed. Refuse piles, also known as bony, gob, or slag are composed of coal, coke, shale, and other impurities. Although no significant piles exist in the study area, piles in the Upper Crooked Creek watershed impact the Lower Crooked Creek watershed. Refer to the Upper Crooked Creek River Conservation Plan for more information on refuse piles.

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 of time, but can happen rapidly. The development of a sinkhole, for example occurs when the support of the land is gradually removed over a period of time causing the land surface to sag and finally collapse, leaving a hole or cavity. Although subsidence is not common in the watershed, the potential for it still exists.

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 surface materials into the resulting hole or cavity. Sinkholes only occur in certain parts of Pennsylvania underlined by carbonate bedrock, typically in central and eastern parts of the Commonwealth. The Lower Crooked Creek watershed 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 in the watershed. Homeowners at risk should check into the Mine Subsidence Insurance Fund.

Management Recommendations:

Agricultural Lands

- Encourage more farms be designated as agricultural security areas.
- Protect farmlands through the purchase of conservation easements.
- Identify additional funding for the implementation of agricultural best management practices.
- Promote conservation practices such as cover crops and crop residue, contour strips, grass/water ways, and minimal pesticide/herbicide use.
- Work with the agricultural community to establish best management practices on their property.

Erosion and Sedimentation

- Establish a permit process that ensures all resource extraction industries meet erosion and sedimentation standards of other earth moving industries.
- Establish land use planning and zoning to limit development in floodplains and control erosion and sedimentation.
- Encourage best management practices to control erosion and sedimentation in farming, forestry, and mining industries.

Forestry

- Encourage forestland owners to join stewardship programs and develop stewardship plans.
- Encourage DEP to enforce regulations on the logging industry to minimize erosion and sedimentation.
- Encourage proper logging techniques based upon forest type and size, under the direction of a professional forester.
- Host workshops and/or other programs promoting proper forestland management.
- Encourage forestland owners to seek advice of a professional forester in management of woodland areas.
- Replant trees on clear-cut and strip-mined areas.
- Maintain whitetail deer populations at levels that will ensure healthy forests, productive agricultural lands, and healthy deer populations.
- Educate landowners about the threats of various insects and disease problems.

Illegal Dumping/Waste Disposal

- Conduct an inventory and map of illegal dumpsites in the watershed and include strategies to cleanup and protect the areas.
- Educate homeowners on disposal of household hazardous waste.
- Educate the public on traditional and innovative ways to reduce, reuse, and recycle.
- Identify additional funding for illegal dump cleanups.
- Partner with local landowners, business/industry and community groups to identify, adopt, and cleanup illegal dumpsites in the watershed.
- Host special collection days for hard to get rid of items.
- Reestablish a chapter of PA CleanWays in Armstrong County.
- Strengthen enforcement of littering laws and increase penalties for littering.

Reclamation - Abandoned Gas Wells

- Plug abandoned gas wells in the watershed to prevent brine water from entering the streams and potable water supplies.

Reclamation - Mining

- Continue and expand efforts and programs underway to address mining-related issues.
- Continue support for industry-driven reclamation.
- Encourage DEP to establish and enforce requirements for sealing core-drilling openings with concrete to prevent contamination of water supplies.
- Reclaim abandoned strip mines in the watershed.

Riparian Corridors

- Educate landowners about the values of riparian buffers.
- Establish and protect riparian buffers along streams using smart land use practices.
- Establish greenway corridors and trails in the watershed.

Subsidence

- Conduct a study to determine the risk of subsidence occurring in the watershed.
- Encourage homeowners to determine the risk of subsidence if they are at risk for mine subsidence, and if so to purchase insurance from the Mine Subsidence Insurance Fund.