II. Watershed Description

Overview

The Anderson Creek watershed is located in central Pennsylvania, Clearfield County. Anderson Creek encompasses parts of Bloom, Brady, Penn, Pike, Pine, and Union townships, and lies approximately seven miles west of Clearfield Borough and five miles east of the City of Dubois. The watershed is mostly rural, with a few small communities located in the northern portion and several more densely populated communities in the southern portion. The communities of Chestnut Grove, Laborde, Anderson Station, Rockton, and Anderson Creek lie to the north, while the boroughs of Curwensville, Grampian, and Hepburnia, along with the community of Stronach, are in the southern part of the watershed.

Anderson Creek drains approximately 78 square miles. From its headwaters located in Pine Township, it flows in a southward arc, first to the west, and then back to the east, before its confluence with the West Branch of the Susquehanna River in the borough of Curwensville.

The watershed is primarily forested (83.9 percent) with minimal developed lands (1.3 percent). Agriculture, mainly croplands and hay fields, account for 11.7 percent of the land use. Surface coal and clay mines have impacted approximately 2.6 percent of the watershed. Waterbodies and wetlands account for the remaining area (SRBC 2002).

The highest elevations in the watershed lie on its eastern edge, approximately 2,400 feet above sea level. The mouth of Anderson Creek is about 1,100 feet above sea level.

The major tributaries of Anderson Creek are Whitney Run, Stony Run, Montgomery Run, and Coupler Run in the northern portion of the watershed; Little Anderson Creek, Rock Run, Panther Run, Irvin Branch, and Bear Run in the central area; and Bilger Run, Hughey Run, Fenton Run, Kratzer Run, and Roaring Run in the southern portion.

Interstate 80 intersects the watershed in an east-west direction to the north, just above the reservoir. PA Route 322 also dissects the watershed in an east-west direction, but approximately two miles south of the Dubois Reservoir. PA Route 219 traverses the eastern edge of the watershed in a mostly north-south direction. PA Route 879 parallels Kratzer Run in a mostly east-west direction for much of its length in the southern portion of the watershed. On the eastern side, Greenwood Road closely follows the watershed boundary of the study area between Curwensville and PA Route 322, which traverses the northern boundary east to west.

Dubois Reservoir, a key water feature located in the northwestern part of the watershed—and impounding water from only the main stem's upper reaches—covers approximately 210 acres. The reservoir serves as the water supply for the city of Dubois.

In 1999, the City of Dubois Watershed Commission received a comprehensive planning grant to complete a management plan for the upper part of the watershed (headwaters to Dubois Reservoir). The study indicates that the drainage area above the Dubois Reservoir is relatively unimpacted by NPS pollution, although acid rain appears to be having an increasingly negative effect over time, due to the geology of the area and its lack of buffering capability. This section of Anderson Creek is classified as a high-quality coldwater fishery (HQ-CWF). The area above the Dubois Reservoir was not included in this assessment report.

The Anderson Creek watershed could be described as having two distinctly different characters. To the north and east, the watershed is mostly forested, with relatively little disturbance. To the west and south, mainly below the Dubois Reservoir, the geology and the character of the watershed change significantly. Coal and clay deposits, located primarily within the western and southern portions of the watershed, have led to extensive mining of these important natural resources. Unregulated and under-regulated mining practices of the past have seriously degraded the land and water resources within this region of the watershed where most of mining has occurred. It is within this area of the watershed where most of this study has ultimately concentrated.

Except for slight acid rain impacts, naturally occurring acidic conditions, and minor flows of polluted mine drainage from a few old mine sites, the main stem of Anderson Creek remains relatively unpolluted for approximately 3.5 miles below the Dubois Reservoir, until its confluence with Little Anderson Creek. Little Anderson Creek drains much of the west-central portion of the watershed, which contains the coal and clay. It severely degrades Anderson Creek with acid and metals from numerous abandoned coal and clay mines for the remainder of its course to the confluence with the West Branch of the Susquehanna River at Curwensville. Several subwatersheds add acid and metals pollution directly to the main stem below the confluence with Little Anderson Creek, the more severely degraded caused chiefly by coal and clay mining, but some also caused by acid precipitation. Additionally, pollution from Kratzer Run and its sub-basins adds to the impairments of Anderson Creek when it joins the stream approximately two miles upstream of the mouth near Curwensville.

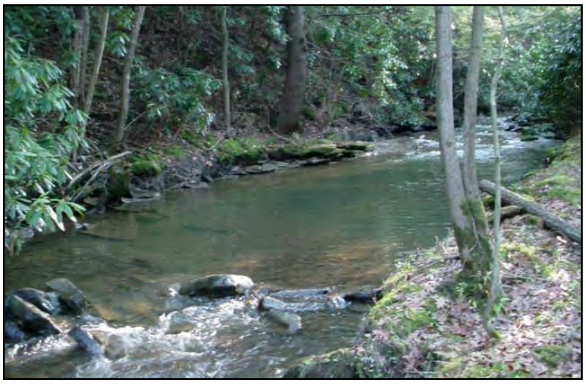
The Dubois Reservoir, located in the northern portion of Anderson Creek, serves as a water supply for the City of Dubois.

The different types of mining common throughout the region have compounded Anderson Creek's mining-related problems. Historically throughout Pennsylvania, coal mining has accounted for most resource extraction non-point source pollution. However, in Anderson Creek, abandoned clay mines may be an even more significant problem than

coalmines in some instances. Clay mines account for mine discharges containing high levels of aluminum, known for its toxicity to aquatic life, and are prevalent throughout the watershed. High levels of aluminum are also more difficult to treat using passive treatment technologies and usually require more complex and expensive treatment methods.

In the southern portion of the watershed is Kratzer Run, another major tributary to Anderson Creek, which flows west to east and parallels Route 879 for most of its length from Grampian to Curwensville. Bilger Run, which includes the tributaries of Hughey Run and Fenton Run, flows from the northwest and is Kratzer Run's largest tributary. Kratzer Run and Bilger Run have both have been identified as streams not meeting their designated use due to water quality impairments. Kratzer Run is polluted with metals, most of which come from Bilger Run, but it does contain alkalinity, which helps to neutralize some of the acidity in Anderson Creek.

Below the confluence of Kratzer Run and Anderson Creek, Roaring Run, a small tributary that is perhaps the highest quality stream within the watershed, joins Anderson Creek. Roaring Run drains from the southeastern portion of the watershed. Unlike most streams on the eastern side of the watershed, which are pH depressed and acidic, Roaring Run maintains a fairly consistent neutral pH and contains more alkalinity. Roaring Run provides additional alkalinity and good water quality to Anderson Creek, but it is not enough to neutralize the acidic conditions of Anderson Creek, and the stream remains polluted for the remainder of its course.



Roaring Run, a high-quality stream that enters Anderson Creek near Curwensville.

Near its confluence with the West Branch of the Susquehanna River, Anderson Creek flows through the borough of Curwensville. Anderson Creek becomes much wider and shallower near Curwensville and exhibits evidence of being channelized, very likely for flood-control purposes. Within Curwensville, another small tributary that drains the area just north of the borough enters the stream. This small tributary goes unnoticed for most of its course through Curwensville because it is a buried stream, only emerging in a flood-control channel as it nears the main stem.

Although many stream segments within the study area are impaired, the Anderson Creek watershed remains an important regional asset. Pike Township Water Authority (PTWA) relies on Anderson Creek for a water supply in times when its main water source is diminished during drought conditions. Approximately 4,500 area residents are served by PTWA, and assuring a clean, reliable water supply is critical to homeowners and local industry alike. Farming, although on the decline here as in other areas throughout Pennsylvania, remains an important industry within the watershed and

depends on good water sources and fertile land. Surface mining has affected much of the historic farmland within the watershed as diminishing profits prompted many farmers to take advantage of the value of coal lying beneath their fields. Recreation, which is becoming an increasingly valuable economic resource, could become a major source of revenue within the region once degraded areas within the watershed are addressed and water quality improves. Local citizens look optimistically at Anderson Creek as a major recreational draw for the region.

Geography

Anderson Creek is located within the Appalachian Plateau Province. The Appalachian Plateau is sometimes known in Pennsylvania as the Allegheny Plateau. The plateau is oriented in a northeast-southwest direction, covering much of northern and western Pennsylvania—nearly half of the state. Its topography is characterized by ridges of relatively similar elevations, downcut by streams into narrow valleys. Streams have developed into dendritic drainage patterns, characteristic of an area underlain by relatively horizontal sedimentary rocks of similar erosion resistance, in this case, shales, sandstone, and conglomerates. Many of the hilltops contain deposits of erosion-resistant sandstone, which prevented them from being significantly downcut. The maximum elevation of approximately 2,380 feet is found in the headwaters of Bear Run, and the minimum elevation of approximately 1,140 feet at the mouth of Anderson Creek (SRBC 2002).

Geology of Anderson Creek

The following information is published in the Anderson Creek Mine Drainage Abatement Project, Operation Scarlift. Project No. SL-1-17: 1-102.6. 1974. It provides a very good description of the geologic features found within the watershed.

Structural Features

The surface formations in the area, which includes the Anderson Creek watershed, are entirely of sedimentary origin. These rocks are primarily of the Allegheny and Pottsville Formations of Middle Pennsylvanian age.

Some higher locations in the southern part of the watershed, particularly around Grampian, have exposures of the Conemaugh Formation, which immediately overlies the Allegheny Formation and is also of Pennsylvanian age. The rocks of the Mauch Chunk and Pocono Formations of Mississippian age are present along Anderson Creek. The Mauch Chunk Formation is present along Bear Run as well, and it is also present to a lesser extent along several of the major tributaries of Anderson Creek. In some locations, but to a very limited extent, rocks of the upper Devonian, particularly those of the Oswayo Formation, are found. This is the case along Anderson Creek at some locations, particularly south of its confluence with Little Anderson Creek.

A pronounced structural feature in this area is the Chestnut Ridge Anticline. This Anticline was known as the Driftwood Anticline in many of the works of the earlier Pennsylvania Geological Surveys, but was later associated with the Chestnut Ridge Anticline of southwestern Pennsylvania and became known as such. The Anticline trends southwest-northeast across Clearfield and Elk counties. The Anticline enters the watershed about three miles southwest of Chestnut Grove and proceeds across the watershed in a northeasterly direction. It plunges at both ends with a dome centered two to three miles northwest of the watershed.

The dome is approximately 18 miles long with an average width of three miles. This surface structural closure is determined by the lowest closing contour of 2100 feet. The configuration of the contour closure suggests that there may be a saddle present just west of the Pine Township line. If so, then there would be "twin highs" on the dome.

Dips are relatively steep on the south flank of the Anticline and gentler to the north. Dips on the southern flank reach 350 feet to 400 feet to the mile. Topographically, this Anticline produces the highest ground in the watershed, in some places over 2,300 feet. This anticline exposes the pre-Pennsylvanian, uppermost Devonian strata where cut by streams. (See PLATE 4 taken from the Anderson Creek Mine Drainage Abatement Project, Operation Scarlift. Project No. SL-1-17: 1-102.6. 1974.)

In the area west of the Allegheny Front, the folding is quite gentle in contrast to the close folding and faulting to be found in the Appalachian Valley and eastward. In those portions of the project area divorced from the Chestnut Ridge Anticline, particularly to the south and northwest, the strata lie nearly flat or are only slightly folded. Faults are of no major consequence in this area and are present only of as light magnitude locally.

(For geologic cross sections showing regional structure see Exhibit No. 1 taken from the Anderson Creek Mine Drainage Abatement Project, Operation Scarlift. Project No. SL-1-17: 1-102.6. 1974.)

Geologic Column

The surface formations in the project area are sedimentary strata, primarily of Pennsylvanian age of the Allegheny and Pottsville Formations. Very limited exposures of Conemaugh Formation rocks are evident, and some Mississippian and Devonian age rocks also occur.

Coals and clays in the watershed usually occur in beds less than five feet thick. The sandstones and shales in the watershed are quite variable with some beds reaching 50 feet to 75 feet thick. The sandstones

and shales frequently grade into each other vertically and horizontally with no distinct delineation between beds. The sandstones are often massive and are very abundant.

Limestone beds in the watershed are limited, and those beds encountered are usually thin and impure. The underclays are perhaps the most persistent beds in the watershed, even more so than the coals. The clays range from one foot to 18 feet thick, with an average thickness of from two feet to four feet.

Only the lowermost members of the Conemaugh Formation are present in the project area. The lower beds of the Mahoning member are present primarily on hilltops in the synclines. The Conemaugh Group extends from the top of the Upper Freeport coal to the floor of the Pittsburgh coal underclay.

Below the Conemaugh Group end covering the greater part of the watershed is the Allegheny Formation. This formation has a vertical thickness of approximately 300 feet. One must remember that the thickness of most of the strata in this area is very variable and lateral extent of the beds are at best inconsistent, so that in talking about a geologic column for an area such as this one, only a generalized and theoretical column can be considered, as the column would probably not be the same at any two locations in the area.

The uppermost bed of the Allegheny Formation is the Upper Freeport coal, which is among the most persistent and workable beds in the area. It is usually present as a single bed, occasionally reaching a thickness of six feet, but usually is less then four feet thick. The Upper Freeport coal is overlain by fine-grained shales of an olive or yellowish-green cast which grade into a flinty shale. Limestone is found underlying this seam more so than any other.

The Upper Freeport clay almost invariably underlies the coal. With an average thickness of two feet to four feet, it is the thickest regular clay in the group. Underneath is the Upper Freeport limestone, which is present only locally. This limestone, when present, ranges from less than a foot to five feet in thickness.

Often occurring with, and underlying, this limestone is the Boliver fireclay. This clay is second only to the Mercer clay of the Pottsville Formation in economic significance in this area. Underlying the Bolivar fire clay is a dark gray to purple shale often containing layers of sandstone. The shale ranges from 20 feet to 60 feet thick and overlies the Lower Freeport coal. The Lower Freeport seam generally produces a coal of high quality and may appear as one bed or as two separate seams

ranging from 1½ foot to six feet thick. The Lower Freeport clay and limestone are often absent.

The Freeport sandstone separates the Lower Freeport coal from the Kittanning coals and is generally around 40 feet thick. The Upper Kittanning seam is usually quite thin compared to the other coals of the area, often less than a foot thick. The Upper Kittanning coal is underlain by approximately 50 feet of shales and some local sandstones. The Middle Kittanning coal seam is also thin and is often absent. Drab shales with rider coal and local sandstones underlie this seam. The Lower Kittanning coal is perhaps the most valuable seam in the area. The Lower Kittanning coal is very persistent and ranges from two feet to 4 ½ feet in thickness with an average thickness of two feet to 2 ½ feet. It is underlain everywhere by clay two feet to 20 feet in thickness and averaging six feet to eight feet thick. The VanPort limestone, which is usually a key bed, is almost entirely absent in this area.

Below the VanPort limestone lays the Clarion coal seam, another thin seam mined locally. The Clarion coal overlies the Clarion sandstone, which is very massive, and the Clarion flint clay. At the base of the Allegheny Formation are the Brookville coal and its clay underlier. The Brookville coal ranges from thin to four feet thick.

The Pottsville Formation is from 150 feet to 200 feet thick in this area. Its uppermost member is the Homewood sandstone. The Homewood sandstone is the most massive member of the group, being coarse-grained and often conglomeratic. The Homewood sandstone is generally light brown and often streaked with iron oxide. It may contain quartz pebbles an inch in diameter. The sandstone ranges from 20 feet to 80 feet thick and is economically important having been quarried extensively near Curwensville.

Underlying the Homewood sandstone is a thin layer of shale and Mercer coal. The Mercer coal seam is usually less than two feet thick and overlies the Mercer clay. The Mercer clay is the most economically significant clay in the area. It is usually eight feet to 10 feet thick and may reach a thickness of 18 feet.

The bottom member of the Pottsville Formation, locally, is the Connoquenessing sandstone. It is fine-grained and quite shaly in places, often nearly entirely replaced by sandy shale.

The Mauch Chunk and Pocono Formations of Mississippian age appear in some of the deeper stream valleys. In some deep stream valleys crossing the Chestnut Ridge Anticline, rocks of the Upper Devonian Oswayo or Catskill Formations may outcrop.

(For a generalized geologic column of the rocks of the watershed, see Exhibit No. 2 from the Anderson Creek Scarlift report, 1974.)

Coal Seams

Practically all of the coal mined in the project area is that of the Allegheny Group, originally known as the Lower Productive Coal Measures. The only possible exception might be the Mercer coal seam, which may be mined locally on a very limited scope. In general, this group increases in thickness from west to east and the number of coal beds increases in the same direction. Fixed carbon increases from west to east also. There may be as many as 15 or more coal beds in this area, four of which are quite widely workable and many more mined locally. These beds are on the average a little thinner in the project area than elsewhere in the county. Workable beds range from slightly less than two feet in thickness to about 52 feet thick. The coal beds in this area are generally quite shallow, none being over 1,000 feet deep, and, as a rule, most are considerably less than 400 feet deep.

Over part of the area, particularly in the lower-lying portions along the Chestnut Ridge Anticline, some or all of the Allegheny coals have been removed by erosion. The beds are underlain practically everywhere by clay.

The principal coals of the Anderson Creek watershed area are as follows:

Upper Freeport – Also known as E or cap seam. The Upper Freeport coal is one of the most valuable and persistent beds of the group. In this area, it may reach a thickness of six feet, but is most commonly less than four feet thick. The Upper Freeport coal is usually found as a single bed. The Upper Freeport in this area is overlain by olive or yellow green, fine-grained shales that may grade into a flinty shale. Limestone frequently underlies the underclay of the Upper Freeport, and often a layer of flint clay is present.

Lower Freeport – Also known as D or Moshannon seam. The Lower Freeport generally lies 20 feet to 60 feet below the Upper Freeport coal, with the average being about 40 feet. The Lower Freeport is a very variable bed and in some parts of the county, particularly to the southeast of the watershed, it splits into two seams, which are separated by as much as 55 feet. The Lower Freeport coal seam is generally of high quality averaging about two feet to 2 ½ feet thick, but reaching a thickness of five feet near Grampian.

Upper Kittanning – Also known as C′. The Upper Kittanning coal is of only minor importance. It is usually quite thin compared to other coals, and commonly averages around a foot thick. Most of the cannel coal in the state appears to occur at this horizon.

Middle Kittanning – Also known as C. Several coals occur between the Upper and Lower Kittanning seams. In the watershed there are at least three horizons in this interval, and perhaps as many as five in some parts of the county. It has been suggested that the variable vertical position of coals in this space may be due to the occurrence of non-persistent coals at several distinct horizons. The seams in the watershed are generally a foot or less thick. As a rule, these coals are of little value commercially, but in some locations it is thick enough to attract commercial exploitation.

Lower Kittanning – Also known as B seam. The Lower Kittanning is probably the most important coal in Clearfield County, and is the most persistent coal of the Allegheny Group. It is not a very thick bed, but is generally a bed of fine quality. It ranges from one foot eight inches to about five feet in thickness, and averages about two feet to 2 ½ feet thick. It is underlain everywhere by clay ranging in thickness from two feet to 20 feet, but generally being six feet to eight feet thick.

Clarion – Also known as A'. The Clarion coals are commonly quite thin and of little commercial value, but like the other minor coals of the Allegheny Group, they thicken locally so as to be of value. Generally, in this area they are a foot or less in thickness.

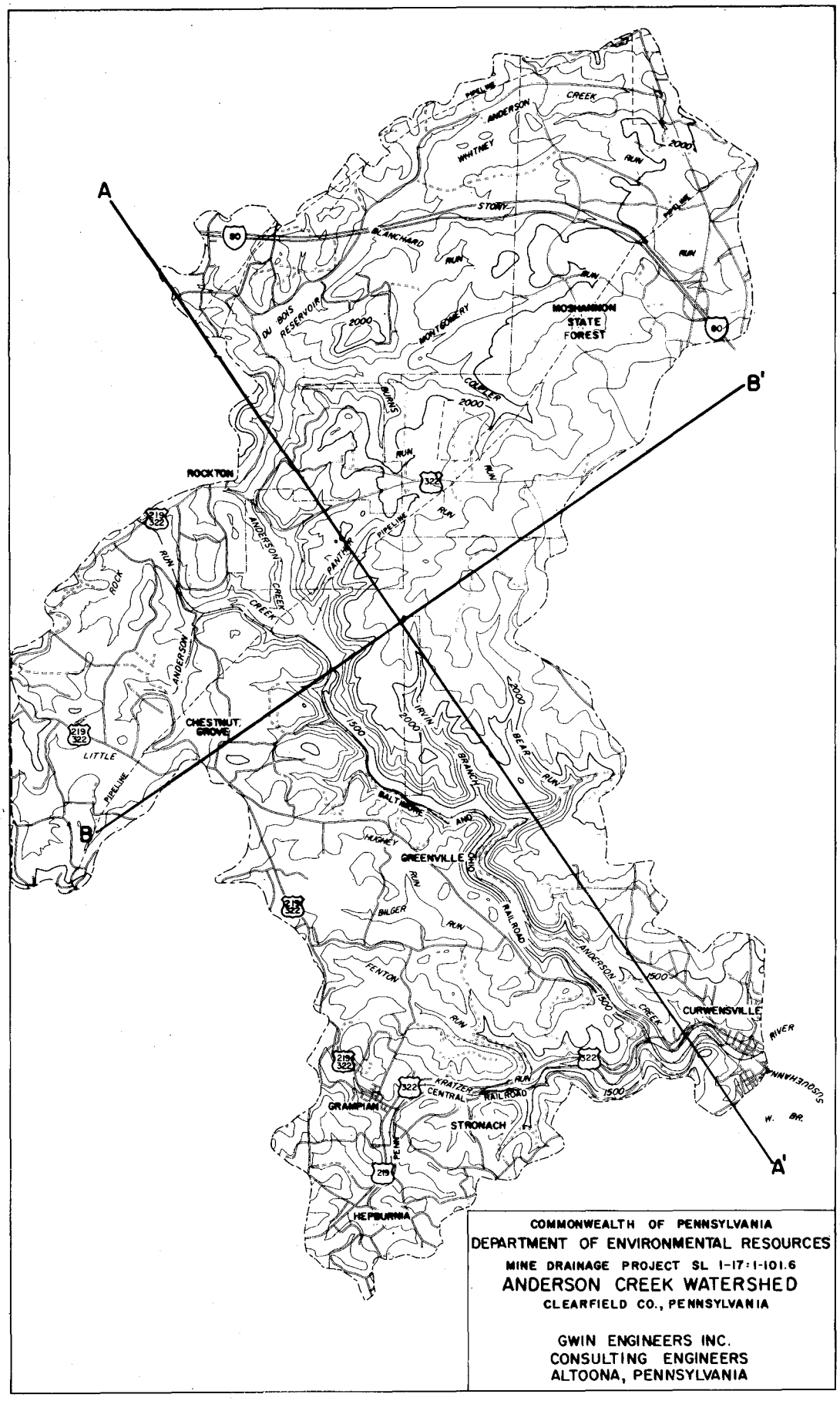
Brookville – Also known as A. This is the bottom coal of the Allegheny Group. This is generally not of too much importance in Pennsylvania. In the project area it is approximately a foot thick and has a tendency to carry a high percentage of ash.

Mercer – This is the uppermost coal of the Pottsville Series, but is not of much consequence economically in the project area. It is usually about a foot thick. At some places there are as many as four or five seams at this horizon. Generally of more interest than the coal is the Mercer clay, which underlies it. This clay has been both deep mined and strip mined quite extensively throughout the watershed, with many of the inactive clay operations being among the chief acid producers.

Watershed Impairments

Historic data shows many areas within the watershed are heavily impacted by past resource extraction activities, particularly mining. The various types of mineral resources common throughout the region have compounded Anderson Creek's mining-related problems. Historically in Pennsylvania, coal mining has accounted for most resource

GEOLOGIC CROSS SECTIONS



COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
MINE DRAINAGE PROJECT SL 1-17:1-101.6
ANDERSON CREEK WATERSHED
CLEARFIELD CO., PENNSYLVANIA

GWIN ENGINEERS INC.
CONSULTING ENGINEERS
ALTOONA, PENNSYLVANIA

GENERALIZED STRATIGRAPHY OF THE ANDERSON CREEK WATERSHED

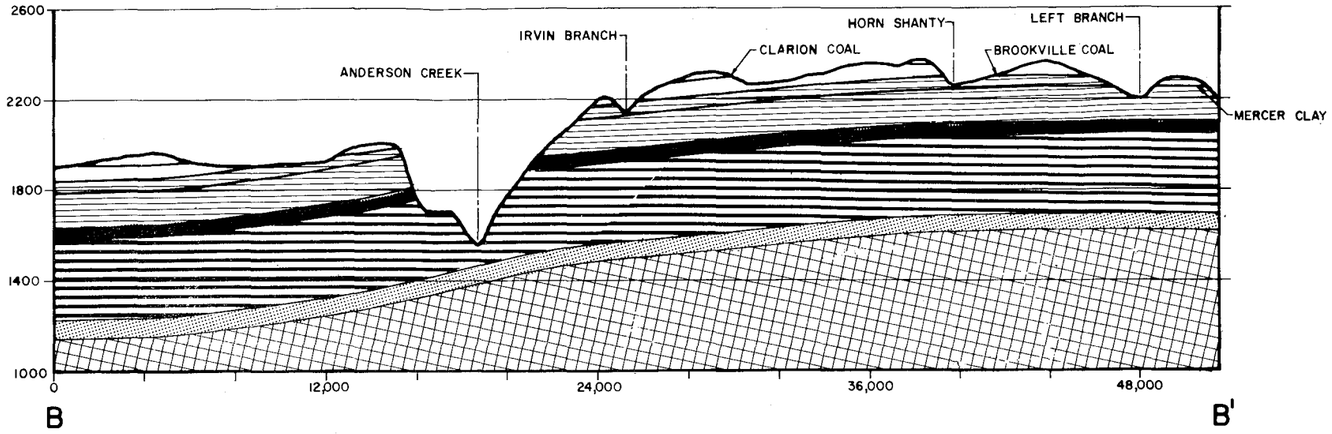
FORMATION	MEMBER	COLUMNAR SECTION	APPROXIMATE THICKNESS	ROCK TYPE
CONEMAUGH	BUFFALO		70'	SANDY SHALES SANDSTONES CONGLOMERATES COAL
	MAHONING		70'	
ALLEGHENY	FREEPORT		300'	COAL CLAYS SHALES SANDSTONES
	KITTANNING			
	CLARION			
	BROOKVILLE			
POTTSVILLE	MERCER		200'	COAL CLAYS SHALES SANDSTONES CONGLOMERATES
	CONNEQUE-NESSING			
MAUCH CHUNK	UPPER			
	LOWER		50'	SHALES
POCONO	BURGOON		350'	SANDSTONES CONGLOMERATES
	PATTON		25'	RED SHALES
	SUB-BURGOON		650'	SHALES SANDSTONES

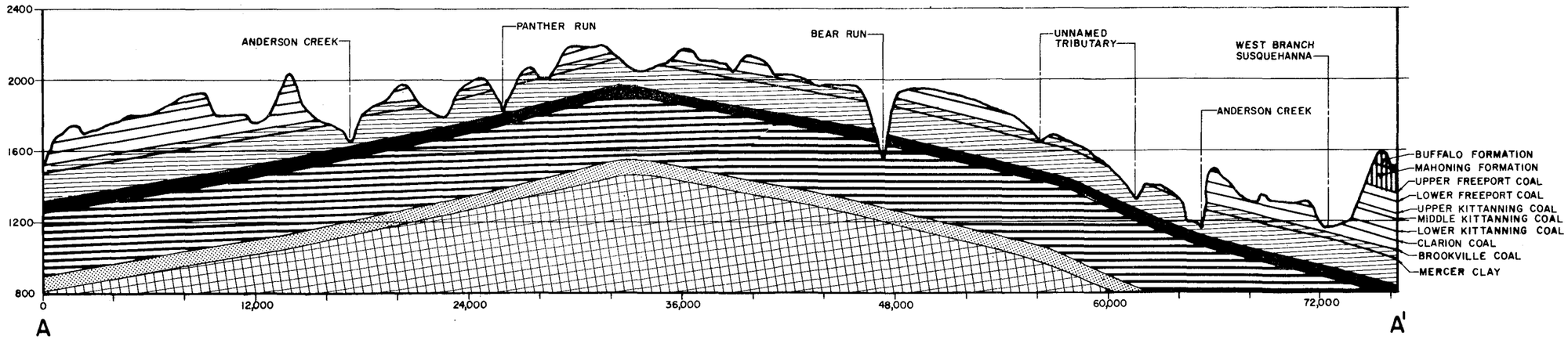
NOTES:

THE STRATA OF THE LOWER POTTSVILLE AND UPPER MAUCH CHUNK ARE SO SIMILAR THAT THEY CANNOT BE READILY DIFFERENTIATED.

GEOLOGIC INTERPRETATION OF WATERSHED CROSS-SECTIONS IS BASED ON THE BEST INFORMATION CURRENTLY AVAILABLE.

HORIZONTAL AND VERTICAL DISTANCES ON CROSS-SECTIONS ARE GIVEN IN FEET.





GENERALIZED COLUMNAR SECTION OF EXPOSED ROCKS

System	Group	Formation	Member	Section	Character of Member	General Character of Formation
PENNSYLVANIAN	CONEMAUGH		Lower Mahoning sandstone		Sandstone and sandy shale sometimes separated by thin lenses of coal Red shale occurs - 40' above Upper Freeport	Only the lower part of the formation is present - about 40'.
	ALLEGHENY	Glen Richey Fm.	Upper Freeport coal		Widely persistent average thickness 3' to 3½'.	A variable sequence of shale, sandstone, limestone, clay, and valuable beds of coal. Average thickness is about 300'.
			Lower Freeport coal		Variable, average 2' to 2½' thick.	
		Laurel Run Fm.	Freeport s.s. Upper Kittanning coal		Thin, about 1' to 1½' thick.	
		Mineral Springs Fm.	Middle Kittanning coal		About 3 seams present at this horizon. Usually 1' to 1½' thick.	
		Millstone Fm.	Lower Kittanning coal		Very persistent. Average thickness 2' to 2½'	
		Clearfield Fm.	Clarion coal		Thin, variable, about one foot thick.	
			Brookville coal		Thin, variable.	
	POTTSVILLE	Curwensville Fm.	Homewood s.s.		Massive s.s. often separated by shale.	Only the upper part of the formation is shown here - about 140'
			Mercer coal Mercer clay		Variable, often several thin beds present at this horizon.	
		Elliott Park Fm.	Connoquenessing s.s.		Fine grained, quite shaly in places almost completely replaced by sandy shale.	

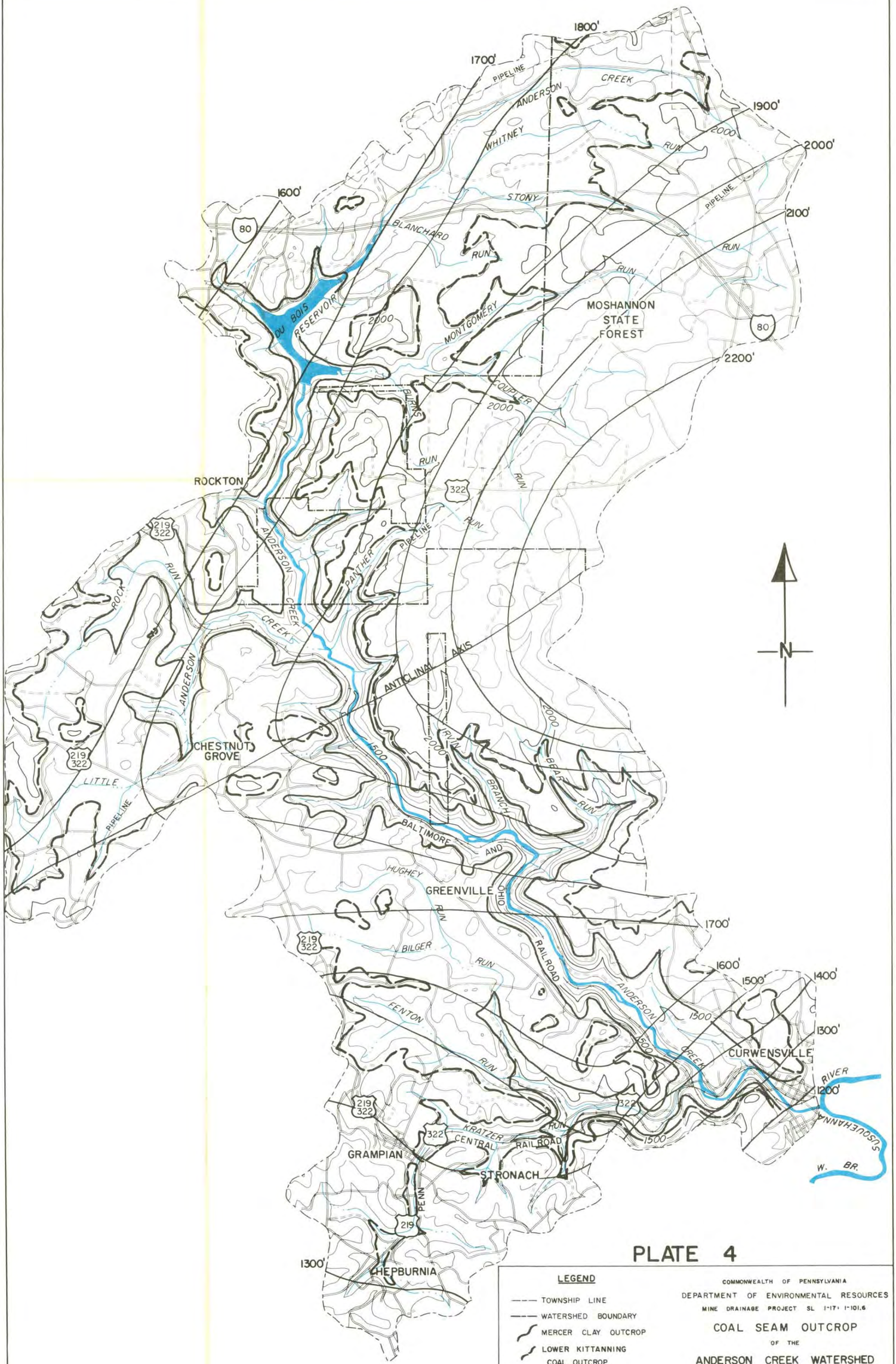


PLATE 4

LEGEND

- TOWNSHIP LINE
- WATERSHED BOUNDARY
- MERCER CLAY OUTCROP
- LOWER KITTANNING COAL OUTCROP
- 1500 SURFACE CONTOURS
- STATE FOREST LAND
- STRUCTURE CONTOURS BASE OF MERCER CLAY

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
MINE DRAINAGE PROJECT SL 1-17, 1-101.6

COAL SEAM OUTCROP
OF THE
ANDERSON CREEK WATERSHED

CLEARFIELD CO., PENNSYLVANIA

1000 0 2000
SCALE

1974

PREPARED BY
GWIN ENGINEERS, INC.
CONSULTING ENGINEERS
ALTOONA, PENNSYLVANIA

extraction non-point source pollution. In Anderson Creek, abandoned clay mines may be an even more significant problem than coalmines, in some instances. Extraction of natural gas has also been common throughout many areas within the Anderson Creek watershed, and has led to some erosion problems and forest fragmentation. Those problems are minor in comparison to those caused by the mining of clay and coal.

Clay mines account for mine discharges containing high levels of acidity and aluminum, known for its toxicity to aquatic life. Several high-flow discharges from abandoned underground clay mines account for a significant portion of the pollution entering Anderson Creek. In some instances, because the clay seams that were mined were relatively thick and often close to the surface, significant areas of subsidence have occurred. The subsidence not only creates surface depressions that develop flow paths of surface water into the mine voids, it also increases the opportunity for oxygen to enter the mine, which accelerates the chemical reactions that produce AMD. Furthermore, coal often lies above the clay. When subsidence occurs, the coal and surrounding materials, which contain the pyrite that produces AMD, collapses into the clay mine, increases acid production, and helps leach the aluminum from the clay. Eventually, the toxic AMD escapes from the mine and enters surface water streams where it has a devastating effect on all aquatic life.

Subsidence area above the Spencer clay mine. Note the numerous depressions. Such areas direct rain and surface water directly into the underground mine, which increases pollution. Subsidence areas are extremely hazardous to nearby residents.

Problems associated with unreclaimed surface mining also severely degrade the stream. Again, the problem is compounded by the fact that clay was surface mined and coal seams above the clay were regarded as an insignificant resource compared to the clay. Most often this coal and its associated shales were intermixed and "spoiled" on site, often left in un-vegetated, haphazard piles without proper drainage. Several of these areas exist throughout the watershed. Some do not show significant surface water impairments on-site, but can be associated with AMD discharges at lower elevations, where they often appear next to the stream. Others create AMD on-site and pollute adjacent watercourses.

Poorly vegetated mine spoil on an abandoned surface mine.

Pollution from resource extraction is not the only problems affecting the stream.

Agricultural practices in some areas of the watershed add nutrients and sediment loads to the streams as well. Some stream segments in headwater areas are directly accessible to cattle, which can trample streambanks and expose the water to animal waste. Direct runoff from barnyards can also impair receiving streams with the same pollution sources. Other sources of non-point source pollution also affect areas of the watershed. Poorly functioning or non-existent septic systems, uncontrolled stormwater, sediment from dirt and gravel roads, poor forest harvesting practices, and poor streamside vegetation cover all affect the watershed. Several stream segments have severe erosion and sedimentation problems related to land-use activities in the more residential areas of the watershed. Acid deposition affects many of the watershed's streams. However, none are as widespread or destructive as the problem caused by poorly regulated coal and clay mining and their associated AMD.

Studies of Anderson Creek

Several studies have identified the pollution problems on Anderson Creek. A study completed in 1974 under the state's Scarlift program, initiated by the Pennsylvania Department of Environmental Resources (DER), identified specific areas where abandoned mine problems, both land and water, existed within the watershed. The locations of abandoned underground and surface mine areas were noted, problems associated with the areas identified, and recommendations for the reclamation of the areas affected were developed.

The Scarlift study, along with later studies by Pennsylvania's Bureau of Abandoned Mine Reclamation (BAMR), identified Little Anderson Creek and Rock Run, its major tributary, as severely impacted by AMD. Anderson Creek was essentially devoid of fish life from the confluence of Little Anderson Creek to the mouth of the stream. The studies noted Kratzer Run and its tributaries as severely degraded as well. Recent water monitoring done by DEP, Clearfield County Conservation District, Susquehanna River Basin Commission, and ACW members tend to confirm the findings of those older studies, and show that many stream segments still contain toxic levels of metals and acidity. Many areas identified in the 1974 Scarlift study have never been addressed and remain significant sources of pollution today. Some water quality improvements have been made, mostly due to remining of previously affected areas and the incorporation of modern reclamation techniques. Significant areas of disturbed lands, which also affect surface waters, remain unreclaimed.

Other studies performed under the auspices of the local, state, and federal agencies and other organizations have noted the problems in the watershed. The most recent study, completed by the Susquehanna River Basin Commission in 2004 under the requirements of the federal Clean Water Act, identified the following studies as having been completed in the watershed:

- In 1990, the U.S. Army Corps of Engineers completed a hydrological study on Tanners Run. A control channel was constructed to reduce the flooding impacts in Curwensville from this tributary to Anderson Creek.

- The Pike Township Municipal Authority manages a public water supply reservoir on Bear Run. In 1991, the DER completed a special protection evaluation report and water quality standards review on Bear Run and the Irvin Branch. They recommended that Bear Run's designation be changed to a HQ-CWF to further protect its use as a public water supply. The designation change on Bear Run, from its source to the Pike Township Municipal Authority Dam, occurred shortly thereafter. Bear Run remains classified as a coldwater fishery (CWF) below the dam. Irvin Branch was recommended to remain a CWF because of elevated levels of metals and a lowered pH. Conflicting reports concerning Irvin Branch debate whether or not it is impaired by AMD. In the spring of 2002, an aquatic biology survey using the DEP SSWAP method was completed. Irvin Branch has excellent biological fauna and was determined to be meeting its designated use. In fact, the biologist recommended it be used as a reference for the aquatic life that should be found in the area streams. Irvin Branch has been recommended for de-listing.
- In 1998 and 1999, DEP's SSWAP surveyed the macroinvertebrate communities in most of the watershed to determine if the streams were meeting their designated uses.
- The Clearfield County Conservation District received a 104(b) 3 grant for an assessment of the Upper West Branch of the Susquehanna River, which includes the Anderson Creek watershed. The project report was completed in 1999.
- The Cambria County Conservation and Recreation Authority also received funding in 1999 from a Department of Conservation and Natural Resources (DCNR) Rivers Conservation Grant to conduct a study of the Upper West Branch of the Susquehanna River. Their final report was published in 2001 (WRAS 2000).
- In 2000, the Clearfield County Commissioners contacted the USDA NRCS to begin the process for a PL-566 study of Anderson Creek on behalf of the ACWA. A preliminary assessment was completed through the Headwaters Resource Conservation and Development Council and the Clearfield County Conservation District.
- In April 2000, the City of DuBois was awarded a Growing Greener Grant to identify the sources of metals, low pH, and other pollutants in order to develop a remediation plan for their drinking water supply. Most of the streams that flow into their reservoir have at least one water quality parameter that does not meet DEP drinking water standards. The parameters most often violated are pH, iron, manganese, sodium, and aluminum. The final report, entitled the DuBois Reservoir Watershed Water Quality Assessment Project, was completed in 2001. The water quality violations are due to natural conditions and, therefore, will not be addressed in this document because they are not caused by AMD. Anderson Creek and its tributaries above the DuBois Reservoir are meeting their designated uses for aquatic life according to the DEP SSWAP despite these chemical violations (SRBC 2004).

In addition to those studies, in July 1999 Headwaters Charitable Trust, in cooperation with the Pennsylvania Fish and Boat Commission, Canaan Valley Institute, and DEP

performed a biological survey of Anderson Creek and several of its major tributaries. The study found several of the relatively unimpaired sub-basins contained naturally reproducing brook trout populations. Little Anderson Creek only contained fish in its headwaters. No fish were found at the station sampled in Bilger Run. And the main stem of Anderson Creek only contained fish above the confluence with Little Anderson Creek.

Restoration: A Priority

Several studies have identified the restoration of Anderson Creek as a priority. The Upper West Branch Susquehanna River Conservation Plan identified the restoration of the Anderson Creek watershed as a priority in its management recommendations. The newly completed TMDL study has also identified the watershed as severely impacted and a priority for restoration. In addition, preliminary work on the NRCS PL-566 Small Watershed Protection Plan has indicated AMD as the main impairment to the watershed and a priority for cleanup.

Although many stream segments within the study area are impaired, Anderson Creek remains an important regional asset. Pike Township Water Authority (PTWA) relies on Anderson Creek for its water supply during drought conditions and must incur additional treatment costs to make the stream water potable during those times. Assuring a clean, reliable water supply is critical to PTWA homeowners and local industry alike.

Farming, although on the decline as in other areas throughout Pennsylvania, remains an important industry within the watershed and depends on good quality water sources and fertile land. As farm profits diminished, many farmers were prompted to take advantage of the value of coal lying beneath their fields by having it surface mined. Old surface-mining techniques often led to less-productive land and many fields are no longer considered as quality cropland. Restoration of abandoned mine land into productive agricultural or forest land is therefore also a priority

Recreation, which is becoming an increasingly valuable economic resource, could become a major source of revenue within the region once degraded areas within the watershed are addressed and water quality improves. Much of the streamside land remains wooded and riparian conditions and in-stream habitat are generally of high quality throughout most of the watershed. Restoration of degraded stream water quality would likely lead to higher recreational use for recreational fishing and other activities. There appears to be good potential to improve Anderson Creek enough to support fish below its confluence with Little Anderson Creek if several AMD-producing sites in the sub-basin are improved. Water quality monitoring indicated that with some improvement, Anderson Creek could recover.

Improvements in water quality would provide recreational stream users with a high-quality experience. Recognizing this, local citizens look optimistically at the

Anderson Creek gorge as a major recreational draw for the region. An abandoned railroad traverses much of the Anderson Creek gorge and development of a Rail-to-Trail using this rail line would connect nicely with the trail along Kratzer Run and the West Branch of the Susquehanna River. Additionally, other nearby rail trails could be connected to an

Whitewater rapids within the Anderson Creek gorge

Anderson Creek rail trail. Improving the water resource will be a key to developing any additional recreational and economic value within the watershed. Recreational boaters also consider Anderson Creek a challenging whitewater stream. Its numerous rapids and remote character make it an appealing whitewater run. Only its poor water quality degrades what could be a premier boating experience.