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Introduction

Purpose

There has been an increasing focus on using a watershed approach to improve the water quality waters of the Commonwealth of PA. In 1994, with funding from EPA 104(b)(3) program, the Department of Environmental Protection (DEP) District Mining Offices were to develop a Comprehensive Mine Reclamation Strategy (CMRS) on a select watershed in their district. The concept of CMRS is to evaluate a watershed or a portion of a watershed which is affected by acid mine drainage (AMD) and develop a strategy for improving the water quality through remining, land reclamation, installing passive treatment systems, and involving local citizens and industry by encouraging them to take ownership in their watershed. The Pottsville District Office has selected the northern headwaters (43 square miles, (11,137 hectares)), north of Ravine, PA) of the Swatara Creek Watershed as the Primary CMRS watershed. There have been several studies done over the past 30 years that have identified AMD as the principal type of pollution in this area. Much of this area has been heavily impacted by anthracite coal mining over the past 150 years which resulted in abandoned mine discharges. This Rehabilitation Plan is geared toward AMD and other mining related impacts on the watershed. There is currently very little industry other than mining and essentially no farming in this part of the watershed, therefore, pollutants associated with these activities were not addressed.

The AMD pollution from the headwaters of Swatara Creek has had a significant impact on the remainder of the watershed for many years. The Commonwealth proposed to construct a 750 acre, (304 ha), lake on Swatara Creek at Swatara Gap, 15 miles downstream of the study area, over 30 years ago. The project has been delayed primarily due to poor water quality coming from the headwaters. The water quality has improved greatly over time due to remediation projects, enforcement of regulations, mine reclamation, sewage treatment in several communities, and ongoing remediation efforts with passive treatment systems. It is likely that with the documented improvements and an abatement strategy to further improve the water quality, the Swatara State Park Lake project may soon become a reality.

The primary goal for several years was to improve the water quality to meet acceptable standards for the State Park Lake to be built. With the recent water quality and biological results and the involvement of the local community, the goal is now to restore the headwaters to a viable fishery. According to the PA Fish and Boat Commission, the water quality necessary to establish a healthy ecosystem would be pH 6.0-6.5, alkalinity > acidity by 20 mg/l, iron < 0.5 mg/l, and aluminum < 0.5 mg/l.

In the past, resources to abate the pollution sources in the watershed were limited. Projects were done in the 1970s by DER/Bureau of Abandoned Mine Reclamation at the recommendation of the Scarlift studies to restore and redirect stream channels. The only other resources available for pollution abatement were reclamation-in-lieu-of-civil-penalties and cooperation from active industry through remining. In recent years, EPA grants have become available for assessment and demonstration of passive treatment technologies. The increase in awareness of mine drainage treatment technologies and funding for projects has accelerated the efforts for improving the water quality in Swatara Creek. There has been a concentrated effort from state, federal, and local government, industry, and local citizens to apply for funding for abatement projects in the Swatara Creek watershed. Several passive treatment systems have been installed since 1995. There are also numerous major DEP/BAMR projects planned for the watershed through 2002 that will directly impact the water quality in many of the headwater streams.

Location and Watershed Characteristics

Swatara Creek flows from the mountains of east-central Pennsylvania southwest to the Susquehanna River and eventually to the Chesapeake Bay. The Swatara Creek watershed has a great diversity of natural resources, land uses, geologic, and geographic differences within its 576 sq. mi. (149,183 ha) area. The creek plays an important role in the everyday lives of many communities serving as drinking water, recreation, and use in industry.

Swatara's headwaters begin on the Broad Mountain in Schuylkill County in the Southern Anthracite Coal Field. The creek flows to the southwest through farmlands as it meanders through the limestone valleys of Lebanon and Dauphin Counties. The creek encounters several sources of pollution in its travels. Some of the pollution is caused by man and some is naturally occurring. In some areas natural pollution is accelerated by man. Such is the case with Swatara Creek. The northern 43 sq. mi. (11,137 ha) of the watershed are located in Schuylkill County, just north of Ravine, PA and they are the focus of this study. The geology in this area is quite different than the remainder of the watershed. The Carboniferous strata are rich in coal, which has been an important resource in fueling the nation since the 1850's. The creek played an important role in the transport of coal and other products over the years. It also served as a disposal medium for pollution. For over 100 years, the creek transported coal silt, acid mine drainage, and sewage. Due to increasing environmental awareness and regulation over the past several years, many of these pollutants have been extremely minimized. In addition, the decline of the anthracite mining industry and more stringent regulations resulted in very minimal pollution from the active industry. However, acid mine drainage pollution emanating from abandoned underground mine openings, coal waste piles, and abandoned surface mine pits, is still impacting the water quality in Swatara Creek. It is in this area that a great effort is being made to mitigate and/or eliminate the effects of acid mine drainage pollution in the watershed.

The major subwatersheds in the study area are the Upper Swatara Creek, Goodspring Creek, Middle Creek, Lower Rausch Creek, and Lorberry Creek. Each of these subwatersheds are impacted by AMD to some degree. The water quality in all of these subwatersheds has improved over the years and continues to improve as more projects are completed. The sources of pollution identified in previous studies may no longer be a contributing pollution factor, in some cases they may no longer exist.

Land Use

Most of the study area is undeveloped. According to Skelly & Loy, (1987) the primary land use is forestland, which accounts for 81% of the land area. Mining, primarily abandoned surface mines account for 18%, the remaining 2 % is urban or other uses. None of the area is used for agricultural purposes. This data reflects current conditions in the watershed. There hasn't been any major development changes or industrialization in the watershed since 1987.

Table 1. Land Uses in the Study Area (derived from Skelly & Loy 1987)

Watershed Location	**Subwatershed**	**Watershed** Acres/Hectares	**Forest** Acres/Hectares	**Surface Mine** Acres/Hectares	**Urban** Acres/Hectares
SWAT 101	Goodspring & Middle Creek	9,454 / 3,826	6,484 / 2,624	2,650 / 1,072	320 / 130
SWAT 02	Upper Swatara	6,226 / 2,520	5,291 / 2,141	935 / 378	Negligible
SWAT 03*	Swatara at Lorberry Junction	21,666 / 8,768	17,761 / 7,188	3,585 / 1,451	320 / 130
SWAT 22	Lower Rausch Cr.	3,021 / 1,223	2,144 / 868	877 / 355	None
L-2	Lorberry Creek	2,709 / 1,096	2,250 / 911	459 / 185	Negligible
**** Total (includes SWAT 03, SWAT 22 and L-2)**		**27,396 /11,087**	**22,155 / 8,966**	**4,921 / 1,992**	**320 / 130**

* SWAT 101 and SWAT 02 are part of SWAT 03

** The total is essentially the watershed above SWAT 19

Previous Investigations

* Water Quality Investigations to Determine Feasibility of a Recreational Reservoir on Swatara Creek at Swatara Gap, 1965, Roy F. Weston, Inc.

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* Operation Scarlift Reports (Swatara Creek Mine Drainage Abatement Project)
* Part 1, Project SL-126-1, 1972, Gannett Flemming, Corddry & Carpenter, Inc.
* Part 2, Project SL-126-2, 1972, Berger Associates, Inc.
* Part 3, Project SL-126-3, 1972, Anthracite Research & Development Co., Inc.
* Water-Resources Report 85-4023, Results of a Pre-impoundment Water Quality Study of Swatara Creek, PA, 1986, U.S. Geological Survey
* A Watershed Pollution Study of the Swatara Creek, 1987, Skelly and Loy Engineers-Consultants
* Additional investigations and studies were conducted by DEP formerly DER in the 1990's. The Pottsville District Mining Office conducted a water sampling study from January through May 1990 to specifically identify the pollution sources and to determine the impacts attributable to the active mining industry.
* A follow-up 9 month study was conducted by DER/Bureau of Water Quality with assistance from the Pottsville DMO, BAMR, Bureau of State Parks from 1992-93 to assess the water quality for the Swatara State Park Lake project and to further pinpoint pollution problem areas. BAMR established continuous flow recorders on Rowe Tunnel and Tracy Airhole which are still in operation.

Ongoing and future Investigations

* Since 1993 DEP/BWQM has collected annual aquatic and benthic macroinvertebrate data at various locations in the watershed.

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* Limestone Treatment of Acidic Mine Drainage in Headwaters of Swatara Creek, Schuylkill County, Pennsylvania, U.S. Geological Survey, 1996 - ongoing study to evaluate the effectiveness of 3 projects which use limestone for mine drainage treatment. In addition monitoring stations were installed in Ravine and Pine Grove to measure the cumulative effects of the treatments throughout the watershed.

* EPA Section 319 National Monitoring Program, Evaluation of Passive Treatment of Acidic Mine Drainage in Headwaters of Swatara Creek, Schuylkill County, Pennsylvania.

  This project began in October 1998. It is a continuation of the monitoring stations in Ravine and Pine Grove for the purpose of measuring the cumulative impact of treatment systems throughout the watershed. This project is the first National Monitoring Project which is focused on mine drainage and the land treatment practices needed to restore the chemical, physical and biological integrity. The project is to be funded cooperatively by Schuylkill County, Lebanon County, DCNR, DEP, USGS, and EPA 319.

* Monitoring at several key locations throughout the watershed is ongoing. Data is being currently being collected by DEP and Office of Surface Mining (OSM) and it is focused on areas where abatement is needed or recently completed.

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Summary

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- Swatara Creek is a tributary of the Susquehanna River and ultimately drains to the Chesapeake Bay.
- The Swatara Creek watershed covers 576 square miles, (149,183 ha), in Schuylkill, Lebanon, Dauphin and Berks Counties.
- Mine drainage pollution resulting from anthracite coal mining has been occurring for more than 150 years in the northern headwaters portion of the watershed.
- This study focuses on the mine drainage impacts in the 43 square mile, (11,137 ha) headwaters area which is located in the Southern Anthracite Coal Field, north of the Village of Ravine, in Schuylkill County, PA.
- The study area is in the Appalachian Region of the Valley and Ridge province. The geology of the study area consists of an alternating sequence of sedimentary rocks; conglomerate, sandstone, shale and anthracite coal with complex folding and faulting.
- The Commonwealth proposed to construct a lake in Swatara State Park more than 30 years ago by damming Swatara Creek near Lickdale, 15 miles, (24 kilometers), downstream of Ravine. However, the project has been delayed due to poor water quality, particularly due to acid mine drainage.
- There are 5 major subwatersheds in the study area; Goodspring Creek, Middle Creek, Upper Swatara, Lower Rausch Creek and Lorberry Creek. All of the subwatersheds are impacted by mine drainage pollution to some degree.
- There have been numerous studies conducted over the past 4 decades to assess the water quality and identify pollution sources in the watershed.
- More than 100 mine drainage discharges from abandoned underground mine openings, large culm piles, and abandoned surface mines have been identified in the watershed in previous studies.
- Mine drainage is still the main pollutant in the study area, particularly mine drainage from abandoned underground mines.
- There is an ongoing concerted effort to abate the pollution sources in the watershed involving State, Local, and Federal government agencies, watershed associations, sportsmans groups and local citizens.
- DER/Bureau of Abandoned Mine Reclamation completed $3,087,668 of mine drainage abatement projects in the 1970's as part of Scarlift. The work was primarily stream channel restoration work (flumes, steam sealing and stream diversions) in the Middle Creek, Goodspring Creek, and Upper Swatara Creek subwatersheds.
- Several mine drainage abatement projects have been completed in the past 5 years which have improved the water quality significantly. The projects include reclamation of abandoned mine areas through reclamation-in-lieu of civil penalties and installation of passive treatment systems, such as, diversion wells, anoxic drains, open limestone channels and constructed wetlands.

- * The main sources of coal sediment pollution "black water" were reclaimed from 1994-1996. With the numerous abandoned coal silt dams and culm piles in the watershed the potential for sediment pollution exists, however coal sediment pollution has been minimal in recent years.
- * Water quality has improved greatly over the past ten years. The water quality extremes have been reduced significantly.
- * Aquatic surveys have shown that benthic organisms as well as fish species diversity and quantities have increased dramatically over the past 10 years.
- * There are numerous reclamation projects planned over the next several years. There are 16 projects outlined, some of which will directly impact or treat mine drainage, others are land reclamation which will indirectly impact water quality by preventing surface water from entering the minepool. Projected cost of all the projects exceeds $7.5 million. The majority of projects are under design by the DEP/Bureau of Abandoned Mine Reclamation.
- * Swatara Creek has been recognized under the EPA 319 National Monitoring Program. The Ravine monitoring station is the featured monitoring point. It is the first AMD impacted stream in the United States to be a part of this program. The water quality data will continue to be collected by USGS up through 2001.

Conclusions

The water quality of Swatara Creek has improved greatly in recent years. As result of the numerous studies conducted since the 1960’s, there have been several remediation projects completed on some of the primary sources of pollution in the watershed. The Tracy Airhole and Rowe Tunnel were identified in Skelly & Loy (1986) as the most significant sources of pollution in the watershed. In spite of the fact that these two discharges still exist, the water quality and aquatic life in the stream continues to improve. Many of the discharges that historically produced pollution slugs have been addressed in remediation projects.

The watershed assessment is a dynamic process which changes from year to year as additional projects are completed.

The hydrology of the Goodspring and Middle Creek subwatersheds may be altered somewhat significantly over the next few years. The stream channel restoration projects alone will prevent 1.9 MGD of water from entering the mine pool and return the flow to the surface. It may result in a decrease flow and pollution load from several discharges. The numerous DEP/BAMR reclamation projects will also decrease infiltration to the minepool in the Donaldson, Tremont and Middle Creek areas. The diversion of the Tracy Airhole to the adjacent Rausch Creek watershed will eliminate 1.7 MGD of AMD from entering Goodspring Creek.

Since 1995, there have been several passive treatment projects installed or in process in each of the subwatersheds. USGS has been monitoring the effectiveness of the treatment systems and their overall effect on the watershed. Preliminary results show that passive treatments are effective when properly maintained. They do have limitations, particularly due to maintenance problems and sizing constraints.

The data collected in Ravine (SWAT 19) shows that the stream continues to improve. Even during storm events the stream maintains a fairly constant pH. Past data showed that there were acid slugs on occasion. The data collected since 1996 do not show that the acid slugs no longer occur. Although the water quality shows improvement, it is also evident that Swatara Creek is still degraded by AMD. The AMD in the discharges and stream segments is evident by the orange staining (yellow boy) accumulated on the stream bottom. It is obvious in the data collected during storm events that there is a scouring of the precipitated metals during rapid increases in the stream flow. The fact that the pH is consistently above 5.5 in Ravine, even during storm events, it is unlikely that these metals will redissolve further downstream.

The aquatic data throughout the watershed is very encouraging. It shows that Swatara Creek and it’s tributaries are in a recovery state. Fish and macroinvertebrates are present in streams that haven’t had aquatic life in years. All of the major tributaries in the watershed now have some aquatic life.

Recommendations

The main sources of AMD pollution, Tracy Airhole and Rowe Tunnel, still exist in the watershed and should continue to be a priority for abatement. However, the smaller discharges should not be ignored. The cumulative effect of projects on the smaller discharges greatly impacts the overall quality of the creeks. Each of the subwatersheds are impacted by AMD to varying degrees. Permanent solutions and abatement measures should be pursued where ever possible, such as, reclamation of abandoned mines, stream channel restoration, and low maintenance passive systems (i.e. constructed wetlands, anoxic limestone drains). If treatment is necessary, passive treatment systems should be the first approach to abating the pollution. However, in some instances an active treatment system may be necessary, possibly in conjunction with a passive system.

The water quality and biological monitoring which is currently ongoing should be continued at the same intensity and possibly enhanced in some areas. This information is critical for the continuation of the improvement efforts for several reasons:

1) To assure that the completed projects are working efficiently.
2) To determine the most effective method of treatment or abatement and for selecting the best location for the system. Background water quality is necessary for all future projects.
3) To demonstrate that the water quality improvements are continuing as necessary for the proposed Swatara State Park Lake.
4) To provide data for the EPA 319 National Monitoring Program station in Ravine.

Remining should be encouraged throughout the watershed. There are millions of cubic yards of culm material in the watershed which continue to produce acid and metals. The removal of these piles will result in water quality improvements in addition to eliminating the potential for coal sediment (black water) events. Remining of abandoned surface mines, daylighting deep mines, and reclamation with materials, such as fly ash, may also improve water quality by preventing infiltration.

Mine reclamation by DEP/BAMR will play an important role in the improvement of water quality over the next several years. Since 1980, there has only been one DEP/BAMR project completed in the watershed (a reclamation project with no direct influence on water quality) which cost approximately $322,000. Over the next 5 years BAMR has 14 projects planned for the Swatara watershed totaling in excess of $7 million. Many of these projects may have a direct effect on water quality. These projects are necessary to further improve the water quality in the headwaters of Swatara Creek and its tributaries.

A continued cooperative synergy between government agencies, local municipalities, watershed groups and the citizens is necessary to assure that funding is maximized, projects are completed, and that the public can once again appreciate the streams as a valuable resource.

Geology

Physiography

The study area lies within the Appalachian Mountain Section of the Valley and Ridge physiographic province. It is in the southern Pocono Mountains, in the southwest section of Pennsylvania's Southern Anthracite Coal Field. The land form consists of a series of northwestardly trending parallel valleys and ridges cut through in numerous places by streams. The area is characterized by steep ridges and narrow valleys. Elevations vary from 600 ft. (183 m) near Ravine to 1,720 ft. (524 m) near Tremont.

The study area includes all of Frailey Township, Tremont Township, and Tremont Borough and portions of Reilly and Porter Townships. The population of the area is less than 4,000 people according to 1996 information obtained from the U.S. Department of Commerce, Bureau of the Census.

There are six towns in the study area. Newtown is located to the extreme easterly border, Tremont and Donaldson are near the center, Good Spring is located to the extreme northwest border, Joliett and Molleystown are on the southwestern border. The village of Ravine is just below the study area to the south.

Stratigraphy

The youngest naturally occurring deposits in the area consist of Quaternary talus located on the upper slopes of many of the mountains. Bedrock in the study area is of Pennsylvanian Age and is of the Llewellyn Formation and the Sharp Mountain, Schuylkill and Tumbling Run members of the Pottsville Formation. There is a small portion of Mississippian Age from the Mauch Chunk Formation on the northeast border of the watershed.

There are 60 coal beds in the Pottsville and Llewellyn Formations and 25 of them are present in the study area. The coal beds have similar physical and chemical characteristics and are therefore difficult to correlate. According to U.S. Geological Survey the sulfur content of the coals in this area ranges from 0.5 percent to 2.0 percent, averaging 0.7 percent.

The main rock types in the study area consist of conglomerate, sandstone, shale and coal. There are no known limestones or carbonate lithologic units in this area. The streams in the headwaters usually have a low solids content, pH less than 7, and trace amounts of various metals including iron. The streams have a low buffering capacity and the pH is often depressed by acid rain and decaying organic matter.

Structure (Berger Associates, 1971)

The geologic structure in the area is rather complex consisting of a series of generally asymmetrical northeast-southwest striking anticlines and synclines whose structure is modified by a series of faults. Many of these individual structural features, appearing as somewhat separated to the west-southwest, converge in the area near Tremont. The synclinal axes branch out from Tremont toward the west and southwest, resembling the tail of a fish, and collectively from the most important structural feature in the area which is known as the Minersville Synclinorium. These synclinal troughs are referred to informally as the “Northern and Southern fishtails”, and are separated by the Joliet Anticline which is the crestal fold of the New Bloomfield Anticlinorium and the most significant anticlinal structure in the area.

The major anticlines in the area are the Joliet, Big Lick Mountain, and West West Falls Anticline. The major synclines are the Tremont, Donaldson, and Fisher Synclines. There are also numerous faults of various types, however, thrust faults are the dominant type.

The area has been subject to severe folding and faulting. In places the rock units are inverted. The folding and faulting has increased the amount of coal available in the area. The anthracite coal beds probably would have been eroded if it weren’t protected in the large synclinal basins. In some of these basins the coal is at depths of 6,000 ft. (1829m). The most significant faults in the study area are the Pottchunk fault and the Mine Hill fault complex.

Geologic and Mining Influences on Groundwater Hydrology

The study area, like most of the anthracite region, has a unique hydrologic system which results from extensive underground mining. Past mining has had the greatest effect on water quality in this area. Underground (deep) mines, surface (strip) mines, and coal processing plants (breakers) have left behind a legacy of large refuse piles, surface scars, and acid mine drainage (AMD). Extensive deep mining was done over the past 150 years, leaving the subsurface honeycombed with tunnels that are now flooded and pose the threat of surface subsidence in some areas. The deep mines varied in size from small operations to large complexes which extended several miles. In order to mine underground, many operations pumped large quantities of water. Years ago when deep mines were prevalent, tremendous quantities of water were pumped to allow the operations to mine to great depths. As the anthracite industry declined, the mines were abandoned and pumping ceased. The workings filled with surface water entering through some of the original openings, through crop falls and strip pits, and from ground water percolating through undisturbed aquifers. As the workings became flooded the water began to react with the pyrite in the shales adjacent to the coal veins. These underground “minepools” now discharge from what was once the entryway or airway to the deep mine. Often these discharges are on the magnitude of several hundred to several thousand gallons per minute and are polluted with acid and various heavy metals, such as iron, manganese, and aluminum.

Most of the minepools are contained to various elevations by a system of barrier pillars. Barrier pillars are sections of coal which were left in place underground to separate colliery workings and their water systems. The minepool levels are governed by the elevation of points of overflow to the surface or the elevation of breaches in these barrier pillars. The existing condition of these barrier pillars is largely unknown. Breaches may have been created in the pillars by “bootleg” deep mine operations (un-mapped) and/or geologic structural failure.

There are 9 minepools in the watershed which contain great quantities of water and all of them overflow and discharge AMD. The major minepools are the Blackwood, Colket, Goodspring #3, Indian Head, Lincoln, Middle Creek, New Lincoln, Rausch Creek East Franklin, and Westwood minepool. It was estimated in Scarlift that four of the minepools collectively contained in excess of 1.68 billion gallons, (6.04 billion liters), of water.

Mining

History

Anthracite coal mining was once the mainstay of the economy in the headwaters of the Swatara Creek watershed. Mining started in this area approximately 150 years ago and reached its peak during World War I. In 1917, Pennsylvania's anthracite production exceeded 100 million tons (90.7 million tonnes) which was mined by 156,000 men. The industry has declined significantly over the years due to changing market conditions and regulations. It hit its lowest production year in 1983 when less than 3 million tons (2.7 million tonnes) were produced. There has been an increase in production in recent years. In 1996 there were 11.5 million tons (10.4 million tonnes) of anthracite produced by 2,109 men. The increase in production is largely due to refuse recovery operations. New markets for the coal refuse have been developed in recent years for the production of electricity and the manufacture of titanium. This market has played a beneficial role in the watershed. There are and were extensive coal refuse piles throughout the study area which produce acid mine drainage. Some of these piles have decreased significantly and others may potentially mined.

Current Mining

There are currently 48 permitted anthracite mining operations in the watershed, 29 are active, see Appendix 1. The active operations consist of 12 underground (deep), 8 surface (strip), 8 refuse reprocessing, and 2 coal preparation. The remaining 19 operations are either inactive or haven't yet started. According to the 1996 Annual Production Report, 631,272 tons (572,680 tonnes) of coal were produced by 87 men in the Swatara Creek watershed.

Future Mining

In 1971, the U.S. Bureau of Mines indicated that the abandonment of mines in the Southern Anthracite Field resulted in the flooding of 34 percent of the field and that the largest tonnage of anthracite reserves lie where mining conditions are the most difficult. Large reserves underlie the abandoned workings and must be de-watered before they can be mined. Some of these reserves may be "lost" to future mining since the adjacent minepools, in many cases, must also be de-watered due to the unknown stability and effectiveness of the barrier pillars separating the minepools. Future mining will be governed mostly by economics and safety.

Since the mid-1980s the enormous abandoned culm piles which were once considered waste, became a marketable material. It is likely that the remining and reprocessing of these piles will continue for years to come. Most of the largest culm piles in the watershed are now permitted to be at least partially remined by DEP/Pottsville District.

Tributaries and Subwatersheds

There are several subwatersheds in the study area all of which are impacted with mine drainage from abandoned mines as shown in Map 2. Lorberry Creek, Lower Rausch Creek, Goodspring Creek, Middle Creek and the Upper Swatara Creek are the primary subwatersheds. Lorberry Creek, Lower Rausch Creek, and the main branch of Swatara Creek meet just north of the village of Ravine at the Lorberry Junction (Exit 32, Interstate 81). For this reason, Ravine is a reference point to measure the cumulative effects of the AMD pollution and improvements from remediation projects. Any coal material or AMD elsewhere below Ravine is secondary and is not included in this study.

Lorberry Creek

Lorberry Creek subwatershed drains 3.99 sq. mi. (1,033 ha) as it flows southeast to its confluence with Lower Rausch Creek. The headwaters of Lorberry Creek originate as a discharge of the abandoned Lincoln Colliery workings at the Rowe Tunnel. The tunnel is a gravity discharge of extensive interconnected underground mines. Skelly & Loy (1986) estimated that there are 460 ac. (186 ha) of unreclaimed surface mines in the headwaters area of Lorberry Creek. This area contributes to the flow from the Rowe Tunnel.

Prior to 1992 slugs of coal sediment pollution would discharge from the Rowe Tunnel. It was alleged that the active deep mine operations were washing their coal underground. These practices were halted thus greatly reducing the sediment pollution from the Rowe Tunnel. Acid and iron pollution is still discharging from the Rowe Tunnel. The tunnel discharges the majority of flow and pollutants to Lorberry Creek. A continuous flow recorder was placed on the discharge in 1992 and monthly water quality samples have been collected since that time by DEP.

Stumps Run enters Lorberry Creek 0.2 mi. (0.32 km) downstream of Rowe Tunnel. Historically, it was the major source of coal sediment pollution to Lorberry Creek and Swatara Creek, particularly during storm events. This area received much attention as result of the DEP study of 1990. The sediment pollution resulted from 24.4 ac. (9.87 ha) of abandoned coal siltation basins which were once part of the Lincoln Colliery complex. Stumps Run flowed through this area where it became ladened with coal sediment. Due to the size of the pollution source and the cost of reclamation, the area was broken down into three project areas. Three Reclamation-in-Lieu-of-Civil-Penalty projects were done to reclaim the area, thus mitigating the pollution. The projects were completed in 1994, 1995 and 1996 and totaled $131,175. Stumps Run is no longer a major source of pollution. Further enhancements may be needed in the future to insure that the erosion and sedimentation controls are maintained. The Pottsville District Mining Office employees have planted trees and wetland vegetation the past three years as an Earth Day project.

There is a discharge along Molleystown Road that is flowing from Shadle Coal Company deep mine. The mine is sealed and partially reclaimed. The discharge is currently under review by the DEP/Pottsville DMO and there are treatment method experiments are being performed by USGS & DOE. The mine operator will be obligated to treat this discharge.

There are several smaller mine discharges and streams that enter Lorberry Creek. The pollution effects of these waters are masked by the pollution from the Rowe Tunnel. This subwatershed is being addressed in 1998 under an EPA 319 Grant. The project includes a detailed analysis of Rowe Tunnel and at various locations along Lorberry Creek. Based on the data, a treatment system will be devised using aeration, filtration, alkaline addition, or a combination of any of the three techniques.

The project will utilize the expertise of U.S. Geological Survey, U.S. Department of Energy, DEP, and the Schuylkill County Conservation District.

Lower Rausch Creek

Lower Rausch Creek watershed drains 4.86 sq. mi. (1,258 ha) to its confluence with Lorberry Creek. Lower Rausch Creek originates from abandoned surface mining pits north of the juncture of I-81 and Rt. 209 (I-81, Exit 33) in the vacinity of the Westwood Energy complex. The creek flows south along I-81, at times in the median between the north and southbound lanes. It joins Lorberry Creek just below I-81, Exit 32 (Lorberry Junction). Lower Rausch Creek encounters several abandoned deep mine discharges along its path. In the past it carried a large coal sediment load, particularly during storm events and it continually receives acid and metals pollution from several sources.

The Westwood Energy complex is a power generating plant which was constructed in 1986. The area consists of large culm piles and coal siltation basins. The coal material and culm were used to fuel the plant. Prior to 1991, Lower Rausch Creek flowed through the siltation basins where it became ladened with coal sediment. This problem received attention following the DER 1990 study. Westwood Energy diverted Lower Rausch Creek around the siltation basins and established a rock lined channel to prevent sediment pollution. In addition, during normal operations they have consumed large quantities of the culm and silt material and reclaimed some areas with the residual flyash. Since 1991 there have not been recorded high sediment loads in Lower Rausch Creek attributable to this area. The water quality of Lower Rausch Creek shows that iron is currently the major pollutant in the creek.

As mentioned above, there are numerous abandoned deep mine discharges to Lower Rausch Creek. New Lincoln Tunnel, Rausch Creek Tunnel, East Franklin Discharge, North and South Orchard Drift, and several other minor discharges.

USGS installed an Anoxic/Oxic Drain experiment on the discharge adjacent on the South Orchard Drift in 1995 EPA 319 funds. The information from this project has been very useful in the design of the design of the anoxic drain on a headwaters discharge to Swatara Creek.

In order to reduce the iron pollution in Lower Rausch Creek a 2.3 ac. (0.93 ha) ‘wetland/impoundment’ was created on the creek just upstream of its confluence with Lorberry and Swatara Creek. It is located within the I-81, Exit 32 interchange. The “Lorberry Junction Wetland Project”, as it was called, was completed in late 1997 by DEP/BAMR, with partial funding under EPA 104(b)(3) grant. The wetland was designed to abate the iron and other metals of the stream as a whole, rather than treating the discharges individually. This is the only treatment planned for Lower Rausch Creek at this time. If the data shows that the system cannot achieve its goal, then some of the discharges may be dealt with individually.

Goodspring Creek

Goodspring Creek originates approximately 0.5 mi. (0.8 km) southeast of the village of Goodspring and has a drainage area of 14.8 sq. mi. (3,833 ha). The stream flows from abandoned strip pits in a northeast direction to I-81 and then easterly to Donaldson and south through Tremont where it joins Middle Creek. There are several sources of AMD which enter Goodspring Creek. Skelly & Loy (1986) estimated that there are 2,650 ac. (1,072 ha) of unreclaimed surface and coal reprocessing operations in the Goodspring and Middle Creek subwatersheds.

Historically, Goodspring Creek was also polluted with sewage from the village of Donaldson and Tremont. Although Tremont has had sewage treatment since the early 1980s, it is only since 1993 that Donaldson was connected to the Tremont sewer system. This has resulted in recent improvements in Goodspring Creek. AMD from abandoned deep mines is now the major pollutant in the creek. The creek receives drainage from the Goodspring #3 and the Colket minepools. In addition, there are numerous culm piles which have the potential for contributing sediment and acid during storm events.

The most significant source of pollution to Goodspring Creek is the Tracy Airhole discharge. The Tracy Airhole is an abandoned deep mine airway that serves as the main drainage point for the Goodspring #3 minepool. It is the most significant source of iron pollution in the Swatara Creek Watershed according to DER,1993. The impact of the discharge masks the effects of other discharges to Goodspring Creek. The average flow exceeds 1500 gpm (0.09m/s) and the average iron concentration is 18.3 mg/l. This discharge has been monitored extensively. There is data available from the last 3 decades. A continuous flow monitor has been in place since 1992 and monthly water samples have been collected. The discharge has shown improvement over the years, however, its impact is still significant. A concept of diverting the discharge to the adjacent Rausch Creek watershed where it would be treated at the DEP/BAMR operated Rausch Creek Treatment Plant is being explored. There is an agreement between DEP and Harriman Coal Corp. to breach the barrier pillar separating the Goodspring #3 minepool (Swatara watershed) and the Goodspring #1 minepool (Rausch Creek watershed) thus dewatering the Goodspring #3 minepool. This would eliminate the Tracy Airhole discharge from the Swatara watershed all together. If the diversion of this discharge does not take place, other treatment options will be developed.

Martin Run originates on the south slope of the Broad Mountain due north of Donaldson. As it flows south it is joined by the Eureka Tunnel discharge and then continues south approximately 2,000 ft. (610 km) to the Colket minepool discharge. Martin Run continues south under Rt. 125 and joins Goodspring Creek in Donaldson. The Eureka Tunnel was sealed in the early 1990's and it continues to flow. The primary source of AMD pollution is the Colket discharge. The discharge flows from and abandoned tunnel and it serves as an outlet of the Colket minepool. There is a significant amount of iron precipitate (in excess of 6 feet deep) which makes it nearly impossible to accurately measure the flow. The discharge braids and joins Martin Run at several points. To treat this discharge prior to Martin Run would be difficult due to the lack of sufficient space. The majority of data collected in this area is below the Colket discharge just north of Rt. 125 where a diversion well was installed on Martin Run in July 1996 with use of EPA 319 Funds. Martin Run joins Goodspring Creek approximately 200 ft. (61 km) south of the diversion well. The purpose of the diversion well was to add limestone, thus increasing the alkalinity and accelerating the precipitation of metals. This would result in an improvement to Goodspring Creek. The data shows an increase in pH and alkalinity in Martin Run just before it enters Goodspring Creek. It is difficult to measure the overall improvements resulting from the diversion well. It would have been ideal to construct a settling pond below the diversion well to allow the metals to settle. Since there is no room for such a pond the metals are precipitating in the stream channel. The positive effect of the diversion well may be more evident several hundred feet downstream in Goodspring Creek.

There have been extensive Scarlift Projects to reclaim pits just north of the Colket discharge to restore Martin Run. Prior to the reclamation, Martin Run was bisected by a stripping pit and water was conveyed to the Coal Run minepool via underground workings. The reclamation restored Martin Run to its original channel. There is a 3 phase, 120 ac. (48.6 ha) reclamation project planned by DEP/BAMR for areas north and west of the Colket discharge. The pits to be reclaimed are along the contour of the mountain. The project will decrease the amount of water infiltration into the minepool. It is uncertain what the impact on the Colket discharge will be. It may have a positive impact on the Colket minepool or discharges from the Middle Creek minepool. The surface runoff may dilute the AMD discharges and improve the water quality in the stream.

There are many strip pits that run in an east-west direction along the contour of Broad Mountain. They intercept the waters of mountain streams and runoff. Through reclamation much of this water will return to the surface. There is a power line approximately 0.5 mi. (0.8 km) west of Donaldson that crosses Rt. 125. To the west of the power line, there is an unnamed stream that flows south on Broad Mountain, enters a strip pit, and then disappears. The field water quality data indicates that the water is not mine drainage. A project was completed in September 1998 to restore the stream to the surface using EPA 104(b)(3) funds. This should have a positive impact on Goodspring Creek. It will keep the water from entering the minepool and will help dilute the iron pollution from the Tracy Airhole.

The John Behm Tunnel, a.k.a. Bowmen & Coleman Tunnel, discharge is directly adjacent to the pole line mentioned above. The tunnel was reclaimed in the early 1990s and it continues to drain. There is water quality data shows that the discharge is mildly acidic and contains approximately 5.0 mg/l of iron. An abatement strategy is being developed to improve the quality of the discharge. This discharge may be impacted by the reclamation projects being designed by DEP/BAMR for the near future.

There may be other AMD sources that impact Goodspring Creek, however they are masked by the pollution from the Tracy Airhole discharge. Further assessment of this subwatershed will be necessary following the completion of the Tracy Airhole diversion project. The discharges addressed in this study are the obvious and appear to be the most significant sources of pollution at this time.

The Goodspring Creek watershed has numerous abandoned stripping pits and culm piles which are potential sites for remining. There is currently an active mining permit to remove a portion of the large culm banks in Donaldson.

Middle Creek

The Middle Creek subwatershed originates on the Broad Mountain north and east of Donaldson and proceeds south to Tremont where it joins Goodspring Creek. The subwatershed includes the waters of Coal Run, Middle Creek, Gebhard Run, and Bailey Run and has a total drainage area of 8.5 sq. mi. (2,201 ha). This subwatershed was identified to contain the leading sources of acid pollution in Scarlift (SL-126-2, 1972). There was extensive mining both surface and underground in the past that deranged and relocated many of the streams. Many of these streams were lost in pits or in breaches to underground workings. There were numerous projects done in this subwatershed in the 1960s and 1970s as a result of and prior to Scarlift to restore the stream channels. Concrete flume installation, stream bed restoration, and reclamation of strip pits and deep mines were done on Gebhard Run, Middle Creek, Coal Run, and Bailey Run. The drainage patterns and water quality have changed significantly as result of these projects. Much of the data from past studies does not reflect today's conditions. Although this subwatershed is still impacted by AMD, it no longer contributes to the acid load to Swatara Creek.

There are still sections of Middle Creek stream channel which have not yet been restored. Middle Creek flows south from its origin near I-81. The stream channel is bisected by a large stripping pit on the Mammoth Vein. The stream was conveyed across the pit in a manmade channel constructed during the mining operation that ceased prior to 1970. During the Hurricane Agnes flood in 1972, the stream breached its channel and flowed into the abandoned strip pit. Since that time Middle Creek has continued to flow into the pit where it enters the Middle Creek minepool. The water resurfaces 150 ft. (46 km) north of T-571 at the Clinton #1 discharge (Middle Creek discharge). Water quality data has been collected at this discharge bi-weekly since 1995 and is ongoing. A weir was installed on the discharge in September 1998 to get accurate flow data. The water quality is poorer than that of Middle Creek upstream of the Mammoth Pit. A project to backfill the Mammoth Pit and restore Middle Creek to the surface is slated for March of 1999 to be done by DEP/BAMR. This project will result in a reduction of water to the Middle Creek minepool. With Middle Creek on the surface it will help to dilute AMD from other tributaries.

There are other discharges of the Middle Creek minepool west of the Clinton #1 discharge. DEP has been monitoring these discharges since 1995 at a sampling point referred to as Coal Run, which is actually a combination of two drainage outflows of the Middle Creek minepool, the Tracy Outflow and the Clinton #2 discharge. Past studies had this area ranked as the major contributor of acid to Middle Creek and Goodspring Creek. The water quality and flow of these two discharges has been positively impacted considerably by Scarlift reclamation projects completed in the area of Martin Run during the 1970s. The recent data shows that this stream is of marginally good water quality with an average pH=6 and Fe and Mn <2.0 ppm. It is likely that these discharges may decrease in flow as a result of the project restoring Middle Creek to the surface. Weirs were installed on the Tracy Outflow and just below the Clinton #2 discharge in September 1998.

There are 2 discharges from the Indian Head minepool which enter Coal Run a few hundred feet below T-571. They contribute AMD to Coal Run. They were referred to in Scarlift as the Marshfield #1 and #2 discharges. There is not a significant amount of background data on these discharges. The Indian Head minepool underlies large coal silt dams and culm piles associated with the abandoned Indian Head Colliery. Weirs were installed on the 2 discharges in the September 1998 with the use of EPA 104(b)(3) funds. Once the data is collected an abatement strategy will be developed.

Throughout the Middle Creek subwatershed there are opportunities for further improvements by remining. Some of the large silt and culm piles, particularly in the Indian Head area are currently permitted and may possibly be removed. Recently a surface mining permit application adjacent to the DEP/BAMR project on Middle Creek was submitted the DEP/DMO Pottsville.

Upper Swatara Creek

The headwaters of Swatara Creek originate in the northeastern portion the watershed. The Upper Swatara Creek subwatershed refers to the portion of Swatara Creek upstream of the mouth of Middle Creek. The drainage area of this subwatershed is 10 sq. mi. (2,589 ha). Swatara Creek begins in the vacinity of the I-81, east of Exit 34 (Hegins). The creek originates from runoff and abandoned pits. It flows south southeast where it encounters various abandoned deep mine discharges, the newly constructed Commonwealth Environmental Services Landfill which opened in November 1997, the inactive John Fry Landfill, active and abandoned mining operations, a beautiful waterfall, and numerous AMD treatment projects constructed recently. Swatara Creek is joined by Pollys Run, south of Rt. 209. It then proceeds west through a valley on the north side of Sharp Mountain known as Blackwood where it meets Panther Creek and continues past the Tremont Sewage Treatment Plant where it joins Middle Creek.

A DEP Study (1993) identified that there was a significant source of aluminum pollution in the Upper Swatara Creek. One source of aluminum was discovered and named Hegins Run. It is an unnamed abandoned drift mine discharge that enters Swatara Creek one mile north of Rt. 209. The water quality showed an excess of 5.0 ppm of aluminum and a pH of 3.2. The discharge is difficult to access. It was concluded that a treatment system on Swatara Creek may appropriately mitigate the effects of the discharge. In 1995, a partnership was formed between DEP/Pottsville District Mining Operations, Schuylkill County Conservation District, industry and the local citizens to construct two diversion wells on Swatara Creek along the north side of Rt. 209, downstream of the Hegins Run discharge. The funding was provided by Neil Minnig, an industry owner that wanted to donate to a stream improvement project. The Swatara Creek Diversion Wells project was completed with donations and volunteer efforts from several local citizens and industry in November 1995.

This portion of the watershed is the focus of a study by the USGS and DEP funded by EPA 104(b)(3) to monitor the effectiveness of three passive treatment methods that use limestone. As part of the study a continuous data recorder was established upstream and downstream of the Diversion Wells in 1996. In the Spring of 1997 an anoxic limestone drain and an open limestone channel were installed upstream of the Swatara Creek diversion wells with use of EPA 319 funds. Since the projects were installed at different times the effectiveness of the treatment systems may be evaluated. The pre- and post-treatment data has been very useful in determining the effectiveness of the various treatments. Preliminary results indicated that the Anoxic Limestone Drain is the most effective and maintenance free. The results will be detailed in a final report by USGS in the future.

In the Blackwood area, the Blackwood Tunnel, Panther Creek, and numerous other discharges in this subwatershed do not appear to have a negative impact on the quality of Swatara Creek, however, this area needs further study. There are several DEP/BAMR projects designed for the Blackwood area in the near future. In addition, a permit application has been submitted to DEP/DMO to remove the culm piles and silt dams from the abandoned Blackwood Breaker and also to remine some of the existing abandoned pits. Future reclamation will minimize the potential for AMD pollution from that area.

Water Quality Evaluation

The various studies of the watershed conducted over the past 3 decades detailed mine drainage pollution sources and the water quality associated with them. The Scarlift Reports (1972) identified 127 acid mine drainage discharge points. Skelly & Loy (1987) collected water quality samples at 73 monitoring locations in the watershed on discharges and streams. They also collected biological data at 2 of these locations. DER (1993) collected water quality data at 6 locations in the study area, benthic data at 11 locations, and fish data at 2 locations. The CMRS effort, which began in 1994 was a continuation of the ongoing water quality assessment work done for the Swatara State Park Lake project. DEP, USGS, and OSM have collected water quality and biological data at various locations in the watershed since 1994. The ongoing effort is focused on pinpointing areas for abatement projects, assessment of the individual abatement projects and their cumulative effect on the watershed, and documenting current water quality necessary for the Swatara State Park Lake Project. Map 3 shows the location of 45 key monitoring stations that demonstrate water quality of the streams and major AMD discharges.

The monitoring station located in Ravine (SWAT 19) is the focal point to determine the overall impacts of AMD on the water quality of Swatara Creek. USGS has installed a continuous monitor and flow gage at this location and it will be the main sampling point in the EPA 319 National Monitoring Program Project. There have been obvious improvements in the water quality at this station and in all of the major tributaries over the past 10 years as demonstrated in Table 2. The data reflects the water quality improvements over the past 2 decades and the mine drainage influences on Swatara Creek (SWAT 03), Lorberry Creek (LR-2), and Lower Rausch Creek (SWAT 17) prior to their confluence, in addition to Swatara Creek in Ravine (SWAT 19). Each of the locations show an increase in pH and a decrease in acid, sulfates, and metals associated with AMD. In recent years the pollution slugs during storm events has been minimized which probably has one of the greatest positive impacts on the aquatic life in the watershed. The reduction in the pollution parameter extremes is evident in Table 2.

Although the water quality has improved in many areas throughout the watershed, many of the discharges and streams are still polluted by AMD. The water quality data for 45 monitoring points in the watershed are presented in Table 3. The sample locations are shown on Map 3. The major AMD indicator parameters are listed in Table 3. A complete list of the raw data for all of the monitoring points with the range and average is presented in Appendix 2.

Table 2. Comparison of the water quality in the Swatara Creek Subwatersheds.

Location	Date	pH min-max median	Fe (mg/l) min-max median	SO_4 (mg/l) min-max median	Acid (mg/l) min-max median	Acid load (lbs/day) min-max median	Flow (gpm) min-max median
SWAT 03 Swatara Above Lower Rausch Creek	1971-72	3.2 - 4.5 4.0 avg	0.5 - 4.6 1.4 avg	55 - 240 124 avg	18 - 72 35 avg	3,788 – 13,678 8,324 avg	4,797 - 112,638 19,699 avg
	1985-86	4.4 - 5.9 5.1	0.12 - 4.8 1.5	50 - 160 106	4 - 37 6	273 - 7,672 1,560	3,384 – 106,651 15,502
	1992-93	5.1 – 6.8 6.0	0.15 - 4.7 1.1	36 - 152 79	0 - 14 8	0 – 7,188 3,537	5,135 - 85,636 32,316
L-2 Lorberry Creek at mouth	1971-72	4.0 - 6.3 5.2 avg	5.0 - 15.6 9.7 avg	60 - 120 80 avg	17 - 44 27 avg	681 - 1,763 1,746 avg	1,058 - 25,163 5,336 avg
	1985-86	3.3 - 5.4 4.1	3.5 - 26.2 6.4	51 - 232 97	6 - 167 14	133 - 3,415 562	834 - 9,740 2,601
	1996-97	5.0 - 6.0 5.8	2.3 – 31.0 4.2	41 - 100 68	8 - 14 11	214 – 2,001 725	1,620 - 13,913 4,5334
SWAT 17 Lower Rausch Creek above Lorberry Creek	1971-72	4.2 - 6.6 5.9 avg	3.4 - 20.5 8.8 avg	65 - 320 159 avg	10 - 49 26 avg	691 - 2,749 1,216 avg	751 - 19,165 3,914 avg
	1985-86	4.6 - 7.3 6.6	4.4 - 8.5 5.6	98 -215 165	2 - 25 5	48 – 595 143	566 - 9,695 1,804
	1996-98	5.6 - 6.6 6.3	1.2 - 5.0 2.5	50 - 178 124	0 - 16 2	0 - 1,117 33	581 - 10,582 2,734
SWAT 19 Swatara Creek in Ravine	1985-86	4.5 - 7.2 5.0	0.43 - 4.1 2.5	52 - 156 103	3 - 28 5	329 - 8,571 2,065	6,688 – 142,998 22,322
	1996-97	5.8 - 6.9 6.2	0.46 -120 4.1	24 - 100 64	0 - 8 3	0 - 37,847 2,164	9,798 – 388,432 37,957

Table 3. Water quality summary of sampling points in the study area.

Monitoring Point	pH median	Iron (mg/l) median	SO_4 (mg/l) median	Acid (mg/l) median	Flow (gpm) median
SWAT 04	5.8	8.600	106	18	1771
SWAT 11	6.0	0.109	16	3	225
L-1	3.3	540.000	1,800	1,196	25
SWAT 18	5.3	3.450	89	16	3,523
L-2	5.8	4.200	68	11	4,533
LR-1	6.3	0.300	55	0	108
LR-2	3.7	0.416	52	42	6
LR-3	3.5	1.900	225	69	16
LR-4	6.2	23.000	378	28	25
LR-5	6.3	9.940	49	0	10
SWAT 17	6.3	2.455	124	2	2,733
SWAT 22	6.2	2.270	82	1	3,787
GS-1	6.3	0.300	40	0	
SWAT 01	6.0	18.800	291	5	1,133
GS-2	4.8	0.181	20	6	247.5
GS-3	6.0	5.310	35	6	30
GS-4	4.7	0.888	25	9	832
GS-5	6.1	17.050	168	30	
GS-6	4.9	2.800	67	14	504
GS-7	6.0	2.600	61	7	466
SWAT 12	6.3	2.715	97	0	11,400
SWAT 13	6.1	2.260	93	10	
M-1	6.3	0.382	26	0	81
M-2	5.1	0.460	20	7	1,083
SWAT 21	5.0	2.330	76	15	1,591
M-3, M-4	NO DATA AVAILABLE				
SWAT 20	6.0	1.695	80	4	910
M-5	6.5	3.335	101	0	277
M-6	6.5	8.700	124	0	293
SWAT 101	6.4	1.150	138	1	
SW-1	4.5 (6.5)	9.150 (9.350)	45 (42)	28 (0)	166 (60)
SW-2	4.3	0.160	13	11	707
SW-3	3.6	0.274	159	57	75
SW-4	4.0	0.332	42	22	765
SW-5	4.3 (5.15)	0.457 (0.285)	39 (41)	17 (7)	1,058 (878)
SWAT 15	6.2	0.395	43	0	1,243
SW-6	5.0	1.760	87	16	160
SWAT 14	4.2	1.060	88	26	
SWAT 16	6.3	0.886	79	0	
SW-7	5.9	0.679	108	1	
SWAT 02	5.1	0.447	73	10	7,495
SWAT 103	6.5	2.010	149	0	
SWAT 104	6.4	0.145	11	3	
SWAT 03	6.0	1.130	79	8	32,315
SWAT 19	6.1	1.200	77	2	26,705

() indicate water quality after installation of limestone treatment project.

The water quality improvements are also evident in the biological surveys conducted over the past 10 years. Table 4 lists the results of the aquatic surveys conducted from 1996-1998 by DEP and USGS at Middle Creek below its confluence with Goodspring Creek. Table 5 compares the aquatic surveys conducted by Skelly & Loy in 1985 and by DEP and USGS in the 1990's at SWAT 19. Table clearly shows that Swatara Creek is a recovering stream. In 1985 no fish were found at SWAT 19, however, in 1994 six species of fish were found. The number of fish and the species diversity have increased significantly from 6 species to 15 species between 1996 and 1997.

In addition to fish surveys, macroinvertebrates were collected over a 5-year period to determine the effects of AMD on the macroinvertebrate community in the Swatara Creek watershed. Four stations were chosen within the watershed: (1) Middle Creek at mouth, (2) Swatara Creek above Middle Creek, (3) Lower Rausch Creek at mouth, and (4) Swatara Creek at Ravine. Macroinvertebrates collected at these stations are listed in Tables 6-9. Information collected at these sites was used to determine if macroinvertebrates are being affected by AMD, how the macroinvertebrate community has changed over time, and how the communities differ between sampling stations. Because most of the watershed is AMD impacted, no reference stations were established for macroinvertebrates within the watershed.

In general, a healthy macroinvertebrate community will consist of organisms from several orders, including ephemeroptera, plecoptera, trichoptera, diptera, megaloptera, odonata, and coleoptera. Insects from the ephemeroptera (mayflies), plecoptera (stoneflies), and trichoptera (caddisflies) are considered the most pollution sensitive. Therefore, streams which contain a diversity of these organisms would be considered healthy, while a stream with few or no insects from these insect orders could be considered pollution impacted.

Swatara Creek above Middle Creek has the most insects compared to the other three stations and is the second most diverse station (Table 7). However, only one mayfly and two stoneflies were collected at this site during the past five years. The lack of stoneflies and mayflies indicates that this station is pollution impacted. The mouth of Middle Creek is also AMD impacted. One mayfly and two stoneflies were collected during the past five years (Table 6). The greatest number of insects collected was 31 on September 4, 1997. This site had at least 75% fewer insects than Swatara Creek upstream of Middle Creek in 4 out of 5 samples.

The mouth of Lower Rausch Creek is also AMD impacted. No mayflies have been collected at this site and only one stonefly has been collected in the last 5 years. This station seemed to have the fewest number of individuals and the least diversity of the four stations that were sampled (Table 8). Swatara Creek (in Ravine) is on the southern edge of the northern headwaters watershed. This station is being used to measure the cumulative impact of treatment systems throughout the northern headwaters watershed. While some treatment systems have been completed in the watershed and fish populations have shown a substantial increase in numbers and diversity (Table 5), the macroinvertebrate community is still being impacted by AMD pollution (Table 9). No mayflies were collected in 1985, 1994, or 1996, but three different mayfly genera were collected in the 1997 sample, indicating the water quality is improving on Swatara Creek.

Macroinvertebrate sample locations are being influenced by AMD discharges in the Swatara Creek watershed. While numbers and diversity have remained low over the last five years, there seems to be a slight trend towards increasing macroinvertebrate numbers. With the treatment of AMD sources throughout the Swatara Creek watershed, both the number and diversity of macroinvertebrates should improve. This improvement is beginning to be seen at the Swatara Creek (at Ravine) station, that is already receiving the benefits of passively treated water. With the placement of additional treatment systems throughout the watershed, water quality will improve in northern sections of the watershed. This will lead to healthier macroinvertebrate populations both in Swatara Creek and its numerous tributaries.

Table 4. Fish Population survey on Middle Creek 1996 -1998

Middle Ck (upstream of SWAT 101) near Tremont (behind Behm's Restaurant)			
	Number of each specimen		
Species Name	**7/22/96**	**10/1/97**	**9/28/98**
Blacknose dace, *Rhinichthys atratulus*	3	21	23
Chain pickerel, *Esox niger*			1
Creek chub, *Semotilus atromaculatus*	13	30	11
Fall fish, *Semolitus corporalis*	10	23	17
White sucker, *Catostomus Commersoni*	5		4
Brown trout, *Salmo trutta*	3	2	2
Brook trout, *Salvelinus fontinalis*	11	16	13
River chub, *Nocomis micropogon*		1	
Rainbow trout, *Onorhynchus mykiss*		1	
Rock bass, *Ambloplites rupestris*		1	
Redbreast sunfish, *Lepomis auritus*		1	1
Pumpkinseed, *Lepomis gibbosus*		2	2
Smallmouth bass, *Microptreus dolomieui*		1	
Total	**45**	**99**	**74**
# of species identified	**6**	**11**	**9**

Table 5. Fish population surveys of Swatara Creek in Ravine 1985-1997.

SWAT 19	**# per Species**	**# per Species**	**# per Species**	**# per Species**
Species Name	**10/85**	**9/8/94**	**7/23/96**	**10/1/97**
Blacknose dace, *Rhinichthys atratulus*		1	22	47
Brook Trout, *Salvelinus fontinalis*			19	10
Brown bullhead, *Ameiurus nebulosus*				1
Brown trout, *Salmo trutta*			2	
Creek chub, *Semotilus atromaculatus*		3		7
Cutlips minnow, *Exoflossum maxillingua*				1
Fall fish, *Semolitus corporalis*		15		66
Largemouth bass, *Micropterus salmoides*				1
Longnose dace, *Rhinichthys atratulus*		1	12	1
Pumpkinseed, *Lepomis gibbosus*				1
River chub, *Nocomis micropogon*		7	1	14
Rosyface shiner, *Notropis rubellus*				1
Smallmouth bass, *Micropterus dolomieu*				7
Tessellated darter, *Etheostoma olmstedi*				12
White sucker, *Catostomus commersoni*		2	20	25
Yellow bullhead, *Ameiurus natalis*				1
Total	**0**	**29**	**76**	**195**
# of species identified	**0**	**6**	**6**	**15**

Table 6. Benthic Macroinvertebrate survey on Middle Creek at Mouth, 1993 –1997

SWAT 101	**Number of each specimen**				
Taxa	**8/17/93**	**8/26/94**	**8/24/95**	**10/9/96**	**9/4/97**
EPHEMEROPTERA (mayflies)					
Stenacron			1		
PLECOPTERA (stoneflies)					
Leuctridae; *Leuctra*			1		
Nemouridae; *Amphinemoura*					1
TRICOPTERA (caddisflies)					
Diplectrona	2	4	14	7	3
Hydropsyche				4	6
Rhyacophilidae; *Rhyacophila*	1				
DIPTERA (true flies)					
Empididae; *Chelifera*		1		1	
Hexatoma					1
Tipula	1	1			1
Chironomidae	1	4	2	8	17
MEGALOPTERA (dobson-,alder-, fishflies)					
Corydalidae; *Nigronia*		1			
Sialidae; *Sialis*		1			
ODONATA (dragon-, damselflies)					
Gomphidae; *Lanthus*				1	
COLEOPTERA (aquatic beetles)					
Dryopidae; *Helichus*				1	
Stenelmis		1			
Non-Insect Taxa					
Oligochaeta Tubificidae		1	1		2
Number of Species	4	8	5	6	7

Table 7. Benthic Macroinvertebrate survey on Swatara Creek above Middle Creek, 1993-1997

SWAT 02	**Number of each specimen**				
Taxa	**8/17/93**	**8/26/94**	**8/24/95**	**10/9/96**	**9/4/97**
EPHEMEROPTERA (mayflies)					
Caenis				1	
PLECOPTERA (stoneflies)					
Leuctridae; *Leuctra*				1	
Nemouridae; *Amphinemoura*					1
TRICOPTERA (caddisflies)					
Diplectrona	44	12	41	11	27
Hydropsyche	3	2	35		11
DIPTERA (true flies)					
Empididae; *Chelifera*	2			1	
Hemerodromia			1		
Simuliidae; *Prosimulium*					1
Dicranota	1		6		1
Tipula	1		2		
Chironomidae	34	3	93	57	79
MEGALOPTERA (dobson-,alder-, fishflies)					
Corydalidae; *Nigronia*	5		3	3	7
Sialidae; *Sialis*				1	2
COLEOPTERA (aquatic beetles)					
Elmidae; *Optioservus*				2	
Stenelmis	1				
Psephenidae; *Psephenus*			1		
NON-INSECT TAXA					
Cura			1		
Oligochaeta Lumbricidae				3	
Cambaridae; *Cambarus*	1				
Number of Species	**9**	**3**	**9**	**9**	**8**

Table 8. Benthic Macroinvertebrate survey on Lower Rausch Creek at Mouth, 1993-1997.

below SWAT 22	**Number of each specimen**				
Taxa	**8/17/93**	**8/26/94**	**8/24/95**	**8/21/96**	**9/4/97**
PLECOPTERA (stoneflies)					
Nemouridae; *Amphinemoura*			1		
TRICOPTERA (caddisflies)					
Diplectrona	3	1	7	1	10
Hydropsyche		12	1	3	1
Philopotamidae; *Dolophilodes*					1
DIPTERA (true flies)					
Empididae; *Chelifera*				1	
Hemerodromia	1				
Simulium		1			
Tipula	2	1		1	
Chironomidae	5	3		13	7
MEGALOPTERA (dobson-,alder-, fishflies)					
Sialidae; *Sialis*				1	
COLEOPTERA (aquatic beetles)					
Haliplidae					
Promoresia		1			
Stenelmis					1
NON-INSECT TAXA					
Bryozoa	1				
Oligochaeta Lumbricidae					1
Lymnaeidae	1				
Number of Species	**6**	**6**	**3**	**6**	**6**

Table 9. Benthic Macroinvertebrate studies of Swatara Creek at Ravine 1985-1997.

SWAT 19	**Number of each specimen**			
Taxa	**Fall 1985**	**8/26/94**	**10/16/96**	**9/4/97**
EPHEMEROPTERA (mayflies)				
Baetidae; *Acentrella*				3
Baetis				14
Stenonema				1
PLECOPTERA (stoneflies)				
Leuctridae; *Leuctra*		1	1	
TRICOPTERA (caddisflies)				
Hydropsychidae;	X			
Diplectrona		2		5
Hydropsyche		18	12	25
Rhyacophilidae; *Rhyacophila*				1
DIPTERA (True Flies)				
Ceratopogonidae; *Bezzia*	X			
Empididae; *Chelifera*		1	5	1
Hemerodromia		2	6	
Rhagionidae	X			
Dicranota			1	
Chironomidae	X	33		63
MEGALOPTERA (dobson-,alder-, fishflies)				
Sialidae; *Sialis*		1	3	
COLEOPTERA (Aquatic Beetles)				
Haliplidae	X			
Dytiscidae;	X			
Dropidae; *Helichus*				1
Stenelmisy				1
NON INSECT TAXA				
Oligochaeta *Lumbricidae*	X	3		2
Hirundinea (leeches)	X			
Decapoda (crayfish)	X			
Cambaridae; *Cambarus*			1	
Lymnaeidae	X			
Sphaeriidae	X			
Total number of species	**11**	**7**	**8**	**11**

Reclamation and Watershed Projects

Operation Scarlift Projects

Numerous State contracted projects were done over the last 3 decades to reclaim abandoned mine lands and improve the quality of streams in the watershed. There were several projects in the 1970s which focused on the restoration of stream channels, installation of concrete flumes to keep the stream from loosing water to the deep mines, and land reclamation. The work targeted some of the main pollution sources identified in Scarlift and previous studies, particularly those is the Middle Creek, Upper Swatara, and Goodspring Creek subwatersheds.

All three of the Scarlift Investigation Reports recommended various AMD abatement projects throughout the coal mine areas of the watershed. The initial cost and maintenance program to rehabilitate the watershed estimates were in excess of 33 million dollars.

A review of all recommendations was conducted by DER's Bureau of Abandoned Mine Reclamation and abatement projects were selected based upon the severity of the source, cost of abatement, and the cost of pollution loading reduction.

Twelve different abatement projects were performed under Operation Scarlift funding programs. Since the 1970's there was one additional reclamation project in the watershed that was completed with AML funds in the amount of $322,795. The Lorberry Junction Project (OSM54(2011)101.1), in the headwaters of Lower Rausch Creek, was completed in the early 1990's. Maps 4 & 5 show the Scarlift project areas. Table 8 indicates the areas and gives a project description of the Scarlift projects that were completed, corresponding with Maps 4 & 5. Table 9 summarizes Scarlift project and the costs. More that 3.4 million dollars were spent during the 1970s on projects in the Swatara Creek watershed, particularly in the Middle Creek and Goodspring Creek subwatersheds.

Table 10. Scarlift Abatement Projects description.

Map Identification	Abatement Description and SL-Project I.D.
Area 1	Rechannelization of Martin Run regrading and revegetation of approximately 200 ft. (61 m) buffer zone from centerline of the stream. SL-126-2-9, 1975
Area 1	Western portion of Area 1 was regraded and revegetated. Diversion ditches were constructed around perimeter of abatement area. Flumes were constructed within the existing channel of Baily's Run. SL-126-2-7, 1973-77
Area 1	Installation of flume on Coal Run, drainage ditches, reconditioning of stream beds, SL-126-2-1, 1970
Area 1	Area west of the existing flume of Coal Run construction included diversion ditches along northern perimeter of site and regrading and revegetation of the entire area. Several fiber flumes were constructed to control east-west drainage within the surface mined areas. SL-126-2-7, 1973-77
Area 1	Eastern portion of Area 1 west of Martin Run was regraded and revegetated. SL-126-2-7, 1973-77
Areas 1 & 2 .	Installation of flumes, construction of drainage ditches and reconditioning of stream beds. SL-126-2-2, 1970
Area 2	Eastern portion of Area 2, a 1,637 ft. (499km) fiber flume, which drains Gebhard Run just below existing flume at headwaters was constructed. SL-126-2-7, 1973-77
Area 2	Western portion of Area 2 consisted of the installation of 1,060 ft. (323 km) fiber flume across the central portion of the site running east-west. The area was also regraded and revegetated. SL-126-2-7, 1973-77
Area 3.	Regrading and revegetation. SL-126-2-7, 1973-77
Area 4	All work within this area terminated at landowners request following initial regrading. No revegetation work completed under SL-126-2-7, 1973-77
Area 5	Rechannelization of Middle Creek. SL-126-2-7, 1973-77
Area 6	Acid mine drainage abatement on Gehard Run, SL-126-2-6, 1973-78
Area 6	Relocation of Gebhard Run. SL-126-2-7, 1973-77
Area 7	Relocation of Gebhard Run. SL-126-2-7, 1973-77,
Area A	Grading and revegetation plus the construction of the Primrose vein channel. SL-126-1-5, 1977
Area B	Grading, revegetation, and channel reconstruction. SL-126-1-5, 1977
Area C	Closing of two shafts, stream channelization, regrading, and revegetation of the area. SL-126-1-5, 1977
Area D	Regrading and revegetation of the area. SL-126-1-5, 1977
Area E	Rechannelization of Swatara Creek and grading along the rechannelized streambed.

Table 11. Scarlift Abatement Projects Summary

Scarlift Abatement Project #	**Map Identification**	**Subwatershed**	**Project Costs**
SL-126-1-5	Areas A, B, C, D	Middle Creek	$ 271,001
SL-126-2-1	Area 1	Middle Creek	$ 57,964
SL-126-2-2	Areas 1 & 2	Middle Creek	$ 100,015
SL-126-2-6	Area 6	Middle Creek	$ 184,675
SL-126-2-7	Areas 1,2,3,4,5,6,7	Middle Creek	$2,273,165
SL-126-2-9	Area 1	Goodspring Creek	$ 200,848
OSM54(2011)101.1		Lower Rausch Creek	$ 322,795
		Total	$3,410,463

Most of the abatement work completed dealt with the diversion of polluted waters away from the mined areas, thus eliminating contact with the coal refuse materials. In addition the flumes prevented surface waters from entering the minepool. Several diversion ditches and in-ground flumes were installed to achieve this objective and they are still in good condition today. Also, regrading and revegetation was completed to limit the amount of surface runoff and surface water infiltration to the deep mine groundwater pools. No treatment facilities and or lagoon complexes were incorporated into the abatement projects as were suggested in the Scarlift Reports.

Projects Completed Since 1990

1991- Relocation of Lower Rausch Creek (40 37 20, 76 26 45) - At the request of DER/Pottsville Office, Westwood Energy, Inc. redirected Lower Rausch Creek around the large silt dams on their property. This eliminated the large quantities of coal silt from washing into the creek during storm events and snow melt.

1994 - Stumps Run Reclamation Project #1 (40 35 35, 76 27 39) - Reclamation of the largest source of coal sediment pollution in the Swatara Creek watershed. Stumps Run, a tributary of Lorberry Creek, meandered through abandoned coal siltation basins which were remnants of Lincoln Colliery. During storm events and snow melts, the stream flowed extremely black with coal sediment exceeding concentrations of 1615 ppm. Due to the size of the area in need of reclamation and lack of funding, the area was broken down into 3 projects. This project addressed the major pollution area. Lehigh Coal & Navigation regraded and removed silt, revegetated, and installed erosion and sedimentation controls on 12.2 ac. (4.9 ha) in lieu of $40,000 in fines which were assessed by the DEP/Pottsville District Mining Office. Upon completion of this project the suspended solids load in the stream has not exceeded 20 ppm.

1995 - Stumps Run Reclamation Project #2 (40 35 38, 76 26 43) - This project was also a reclamation-in-lieu of civil penalty project and it addressed an abandoned siltation basin adjacent to Project #1 which drained to Lorberry Creek upstream of Stumps Run. The drainage also carried a high sediment load. Harriman Coal Corporation regraded and removed silt, revegetated, and installed erosion and sedimentation controls on 8.2 ac. (3.3 ha) in lieu of $41,175 in fines which were assessed by the DEP/Pottsville District Mining Office.

1996 - Stumps Run Reclamation Project #3 (40 35 30, 76 26 49) - This final project was a rec-in-lieu project completed by Lehigh Coal & Navigation in lieu of $50,000 in fines. The 4.0 ac. (1.6 ha) area is below Project #1 and Stumps Run flows through it. The area was graded, revegetated, and E & S controls were installed. In addition, further work was done to improve upon the Project #1 area.

Since 1994 the Pottsville District Mining Office has planted trees and wetland vegetation annually for Earthday. The work has served to further stabilize the area. Wetlands are now established in the sedimentation ponds.

These three projects which reclaimed 24.4 ac. (9.8 ha) have shown the most dramatic improvement in the watershed. Black water events have been a very rare occurrence on Lorberry Creek and Swatara Creek in recent years. Stumps Run now helps to improve the water quality of Lorberry Creek.

1995 - Swatara Creek Diversion Wells (40 39 31, 76 20 47) - Two diversion wells were installed on Swatara Creek 3 mi. (4.8 km) from the creek's origin, on the north side of Rt. 209 east of Newtown. The water quality of the creek indicated that pH adjustment was necessary. There are a few AMD discharges (i.e. 'Hegins Run') that enter Swatara Creek upstream of the diversion wells which are remote and inaccessible. The natural low pH of this stream allows the metals to remain in solution and carry for long distances. When the diversion wells are working properly, they increase the pH in the stream by 1 to 1.5 units. Several unique modifications have been introduced to make maintenance easier.

This project was to be done with EPA 319 funds in 1996, however a local businessman offered to fund the project in honor of his father, who was an avid fisherman. Since the project began it became a community project and it involved over 50 citizens, businesses, and agencies. It is highly visible from Rt. 209 and sparked enormous local interest. This project paved the way for the formation of the Northern Swatara Creek Watershed Association, which was formed in January of 1996.

1996 - Diversion Well on Martin Run (40 38 15, 76 24 18) - This diversion well was installed in the Village of Donaldson on the north side of Route 125 on Martin Run. Martin Run is made up primarily of 2 abandoned mine discharges, Colket minepool and the Eureka Tunnel. Martin Run is a tributary of Goodspring Creek. The quality shows a need for pH adjustment and metals removal. The topography does not allow for cost effective treatment at the pollution sources. The diversion well increases the pH 1 to 1.5 pH units. The metals precipitate in the stream channel. The work was completed with EPA 319 funds and volunteer efforts from the PA National Guard and local citizens.

1996 - Study of treatment systems and current water quality of Swatara Creek - A cooperative effort between the USGS and DEP to evaluate the effectiveness of the various limestone treatment devices installed on Swatara Creek. The project is titled "Limestone Treatment of Acidic Mine Drainage in Headwaters of Swatara Creek, Schuylkill and Lebanon Counties, PA". It is a multi-year effort in which four continuous water quality monitoring stations were established to evaluate the individual treatments in addition to their cumulative effects. This project has received funding through EPA 104(b)(3) for 1996, 97, 98.

1997 - Limestone Channel on Swatara Creek (40 40 22, 76 21 41) - To increase the pH on Swatara Creek upstream of the diversion wells, a limestone channel was constructed upstream of

'Hegins Run', less than a mile from Swatara Creek's origin. The channel was constructed using EPA 319 funds in March 1997.

1997 - Anoxic Limestone Drain on tributary to the headwaters of Swatara Creek (40 40 32, 76 22 29) - An anoxic limestone drain was constructed on an unnamed abandoned mine drainage discharge at the headwaters of Swatara Creek (pH 4.0, Fe 9.0 mg/l). The anoxic drain was constructed with EPA 319 funds, donated assistance, and materials from Commonwealth Environmental Services (a landfill which was under construction, adjacent to the discharge). The project was designed by USGS and numerous testing features were added to allow monitoring and maintenance. The project has shown a marked improvement in the water quality at the discharge and three miles downstream at the diversion wells. The pH now exceeds 6.5 at the effluent from the drain and has raised the pH from 4.0 to 5.5 upstream of the diversion wells. This project seems to be very effective and the most maintenance free of all the 'passive treatment systems'.

1997 - Pollys Run Project (40 39 20, 76 20 27) - This project is actually a stream bank stabilization and rechanneling work on Swatara Creek 0.25 mi. (0.4 km) downstream of the Swatara Creek Diversion Wells in the vacinity of Swatara Coal Company. During heavy flooding in January 1996 Swatara Creek washed away large quantities of coal silt from a portion of the stream bank and deposited much of it in a wetland area just downstream. The creek braided and a portion of it pooled and leached heavy metals, as it seeped through coal silt, into a canal that drains to Pollys Run. The project included a 700 ft. (213.4 m) limestone riprap channel, to redirect and stabilize Swatara Creek, and revegetation of the area. The project prevents the possibility of a future sedimentation event and prevents water from Swatara Creek from entering the canal. The project was done with funding from EPA 319 funds.

1997 - Lorberry Junction Wetland Project (40 35 29, 76 24 41) - This project is located in the interchange of I-81, Exit 32, Ravine (also known as Lorberry Junction) on PennDOT property. Two shallow water impoundments were constructed to serve as aerobic wetland treatment of AMD on Lower Rausch Creek. There are several abandoned mine discharges which enter Lower Rausch Creek at various locations. The project treats all of Lower Rausch Creek near the mouth, thus treating all of the discharges collectively. The wetland cells total 2.3 ac. (0.93 ha) and the stream flow ranges from 900 gpm (0.056 m^3/s) to in excess of 11,000 gpm (0.69 m^3/s). This project was completed in December 1997 and modifications were made throughout 1998. Post-project data is not available. The current water quality upstream of the wetland has a pH 6.3, Fe 3 ppm, and Mn 1.5 ppm. The goal of this project is to reduce metals pollution that Lower Rausch Creek contributes to Swatara Creek. This project was funded partially by EPA 104 (b)(3) and fines that were assessed against Pine Grove Landfill by DEP/Bureau of Waste Management. All of the construction work was done by DEP/Bureau of Abandoned Mine Reclamation. The project was designed by William Hellier from DEP/BMR. Additional materials and equipment were donated by local industries. This project involved cooperation from numerous agencies and industries. It is very visible to the public and it will serve as an educational area as well as a treatment facility.

1998 - Development of treatment for Rowe Tunnel discharge, Lorberry Creek (40 35 39, 76 26 29) - This project is a cooperative effort between the US DOE, USGS, DEP, and the Schuylkill County Conservation District to develop a treatment system on the Rowe Tunnel discharge which is the main flow in Lorberry Creek. Rowe Tunnel is one of the two major sources of AMD pollution in the watershed with an average flow greater than 3,000 gpm (0.19 m^3/s) and moderate levels of iron and acid. Treating the discharge will require pH adjustment, aeration, filtration, or a combination of these methods. A detailed characterization of the water is necessary to determine the most effective method. A prototype will be developed and tested. Ultimately, a full scale treatment system will be installed. The work is being funded by EPA 319 grant and matching funds from USGS and DOE.

1998 Swatara Creek designated as an EPA 319 National Monitoring Program Project (40 34 56, 76 24 41) - The USGS proposal titled "Evaluation of Passive Treatment of Acidic Mine Drainage in Headwaters of Swatara Creek, Schuylkill and Lebanon Counties, Pennsylvania" has been accepted as an EPA 319 National Monitoring Program Project. It is the first National Monitoring Project in the country that is focused on mine drainage and the land treatment practices needed to restore water quality. The project will continue some of the water monitoring efforts currently ongoing that are listed above, including the monitoring gauge in Ravine. The project will continue from 1998 through 2001. The data from this effort will be very important for the Swatara Creek State Park Lake project. The evaluation of the data and the cumulative effects of the various treatments will be very useful in developing a treatment strategy on various other streams in the Anthracite Region.

1998 Reconstruction of a Stream Channel near the John Behm Tunnel – (40 38 03, 76 25 58) - An unnamed stream that previously flowed into an abandoned stripping pit, west of Donaldson and north of Rt. 125, has been restored to the surface and now flows to Goodspring Creek. A 360 foot limestone channel was constructed to convey the spring fed stream to the surface resulting in a reduction of water entering the minepool system. The project was done using EPA 104(b)(3) Funds.

1998 Assessment of 5 discharges – Weirs were installed on 5 discharges in the Middle Creek subwatershed: Tracy Outflow, Clinton #1, Clinton #2, Marshfield #1, and the Marshfield #2. These 5 discharges will be assessed for possible remediation under the BAMR Ten Percent Set Aside program.

Potential Remediation and Reclamation Projects

The efforts to improve the water quality of Swatara Creek will continue for years to come. There are major remediation and reclamation projects scheduled for the next five years that will impact the water quality directly and indirectly. Some of the projects listed below, such as the Middle Creek Stream Rehabilitation Project already have the funds appropriated and should be completed in the next year. The other projects are in the design stage and may be completed contingent on available funding.

Table 12. Proposed projects in the Swatara Watershed.

Funding Year	Project Name	Subwatershed	Estimated Cost $	Funding Source
1998-99	Lorberry Creek. Remediation (Rowe Tunnel)	Lorberry Creek	87,000	EPA 319
1999	Diversion of the Tracy Airhole Discharge	Goodspring Creek		
1999	Middle Ck. Stream Rehabilitation	Middle Creek	1,400,000	AML/Set Aside
1999	Donaldson 1 Backfilling	Goodspring Creek	750,000	AML/Set Aside
1999	Indian Head Passive Treatment (Marshfield Discharges)	Middle Creek	250,000	AML/Set Aside
2000	Red Mountain Backfilling	Upper Swatara Creek	140,000	AML
2000	Donaldson 2 Backfilling	Goodspring Creek	750,000	AML
2000	Newtown South 1 Backfilling	Upper Swatara Creek	200,000	AML
2000	Colket Discharge Passive Treatment	Goodspring Creek	250,000	AML/Set Aside
2000	Clinton-Tracy Passive Treatment	Middle Creek	250,000	AML/Set Aside
2000	Clinton Discharge Passive Treatment	Middle Creek	250,000	AML/Set Aside
2001	Tremont North Backfilling	Middle Creek	630,000	AML/Set Aside
2001	Blackwood West Backfilling	Upper Swatara Creek	1,250,000	AML/Set Aside
2002	Donaldson 3 Backfilling	Goodspring Creek	1,000,000	AML/Set Aside
2002	Newtown South 2 Phase 1 Backfilling	Upper Swatara Creek	250,000	AML/Set Aside
2002	Newtown South Phase 2 Backfilling	Upper Swatara Creek	280,000	AML/Set Aside
		Estimated Costs	***$7,650,000***	

Project Descriptions

OSM 54(3022)101.1 RED MOUNTAIN SOUTH WEST - THIS 25.2 ACRE PROJECT INVOLVES BACKFILLING THREE STRIP PITS. ATOTAL OF 4,500 FEET OF DANGEROUS HIGHWALL WILL BE ELIMINATED BY THIS PROJECT. CERTAIN AREAS OF THE PROJECT WILL BE PARTIALLY BACKFILLED TO CREATE APPPROXIMATELY 0.4 ACRES OF WETLAND HABITAT. TOTAL COST FOR THIS PROJECT HAS BEEN ESTIMATED AT $140,000.

OSM 54(3024)101.1 TREMONT NORTH - THIS 85 ACRE PROJECT INVOLVES BACKFILLING STRIP PITS AND BACKFILLING A MINE OPENING TOTAL COST FOR THIS PROJECT HAS BEEN ESTIMATED AT $630,000. ATOTAL OF 3,000 FEET OF DANGEROUS HIGHWALL AND ONE MINE OPENING WILL BE ELIMINATED BY THIS PROJECT.

OSM 54(3648)101.1 BLACKWOOD WEST - THIS 75 ACRE PROJECT INVOLVES BACKFILLING STRIP PITS AND INSTALLING PASSIVE TREATMENT SYSTEMS TO TREAT OUTFLOWS TOTAL COST FOR THIS PROJECT HAS BEEN ESTIMATED AT $1,250,000. ATOTAL OF 6,800 FEET OF DANGEROUS HIGHWALL WILL BE ELIMINATED BY THIS PROJECT

OSM 54(3649)101.1 NEWTOWN SOUTH 2 I - THIS 19 ACRE PROJECT INVOLVES BACKFILLING STRIP PITS INSTALLING PASSIVE TREATMENT SYSTEMS TO TREAT OUTFLOWS TOTAL COST FOR THIS PROJECT HAS BEEN ESTIMATED AT $250,000. ATOTAL OF 500 FEET OF DANGEROUS HIGHWALL WILL BE ELIMINATED BY THIS PROJECT.

OSM 54(3649)102.1 NEWTOWN SOUTH 2 II - THIS 41 ACRE PROJECT INVOLVES BACKFILLING STRIP PITS AND INSTALLING PASSIVE TREATMENT SYSTEMS TO TREAT OUTFLOWS TOTAL COST FOR THIS PROJECT HAS BEEN ESTIMATED AT $280,000. ATOTAL OF 2,200 FEET OF DANGEROUS HIGHWALL AND THREE HAZARDOUS WATER BODIES WILL BE ELIMINATED BY THIS PROJECT.

OSM 54(3650)101.1 NEWTOWN SOUTH 1 - THIS 32 ACRE PROJECT INVOLVES BACKFILLING STRIP PITS AND BACKFILLING MINE OPENINGS TOTAL COST FOR THIS PROJECT HAS BEEN ESTIMATED AT $200,000. ATOTAL OF 7,200 FEET OF DANGEROUS HIGHWALL AND THREE MINE OPENINGS WILL BE ELIMINATED BY THIS PROJECT.

OSM 54(3703)101.1 NORTH DONALDSON I - THIS 36 ACRE PROJECT INVOLVES BACKFILLING STRIP PITS, BACKFILLING A MINE OPENING AND INSTALLING A MONITORING WEIR ON THE COLKET DISCHARGE. TOTAL COST FOR THIS PROJECT HAS BEEN ESTIMATED AT $750,000. ATOTAL OF 2,200 FEET OF DANGEROUS HIGHWALL WILL BE ELIMINATED BY THIS PROJECT.

OSM 54(3703)102.1 NORTH DONALDSON II - THIS 48 ACRE PROJECT INVOLVES BACKFILLING STRIP PITS, BACKFILLING MINE OPENINGS. TOTAL COST FOR THIS PROJECT HAS BEEN ESTIMATED AT $750,000. ATOTAL OF 2,200 FEET OF DANGEROUS HIGHWALL WILL BE ELIMINATED BY THIS PROJECT.

OSM 54(3703)103.1 NORTH DONALDSON III - THIS 85 ACRE PROJECT INVOLVES BACKFILLING STRIP PITS AND BACKFILLING MINE OPENINGS. TOTAL COST FOR THIS PROJECT HAS BEEN ESTIMATED AT $1,000,000. ATOTAL OF 2,200 FEET OF DANGEROUS HIGHWALL WILL BE ELIMINATED BY THIS PROJECT.

OSM 54(4214)101.1 MIDDLE CREEK - THIS PROJECT INVOLVES BACKFILLING STRIP PITS AND STREAM CHANNEL RECONSTRUCTION. THE TOTAL AREA RECLAMED WILL BE 58 ACRES AND THE AMOUNT OF STREAM CHANNEL RESTORED WILL BE 1100 LINEAR FEET. TOTAL COST FOR THIS PROJECT HAS BEEN ESTIMATED AT $1,400,000.

OSM 54()101.1 INDIAN HEAD PASSIVE TREATMENT - THIS PROJECT INVOLVES BACKFILLING STRIP PITS AND INSTALLING A PASSIVE TREATMENT SYSTEM TO TREAT TWO OUTFLOWS (MARSHFIELD #1 AND #2), WHOSE AVERAGE FLOW IS 100 GALLONS PER MINUTE AND 150 GALLONS PER MINUTE RESPECTIVELY. TOTAL COST FOR THIS PROJECT HAS BEEN ESTIMATED AT $250,000.

OSM 54()101.1 COLKET DISHCARGE - THIS PROJECT INVOLVES INSTALLING A PASSIVE TREATMENT SYSTEM TO TREAT ONE OUTFLOW (COLKET WATER LEVEL TUNNEL), WHOSE AVERAGE FLOW RATE IS.500 GALLONS PER MINUTE TOTAL COST FOR THIS PROJECT HAS BEEN ESTIMATED AT $250,000.

OSM 54()101.1 CLINTON - TRACY DISCHARGE - THIS PROJECT INVOLVES INSTALLING A PASSIVE TREATMENT SYSTEM TO TREAT AN OUTFLOW (COAL RUN DISCHARGE), WHOSE AVERAGE FLOW IS 1,250 GALLONS PER MINUTE TOTAL COST FOR THIS PROJECT HAS BEEN ESTIMATED AT $250,000.

OSM 54()101.1 CLINTON DISCHARGE - THIS PROJECT INVOLVES INSTALLING PASSIVE TREATMENT SYSTEMS TO TREAT AN OUTFLOW (T-571), WHOSE AVERAGE FLOW IS 2,000 GALLONS PER MINUTE TOTAL COST FOR THIS PROJECT HAS BEEN ESTIMATED AT $250,000.

Appendicies

Appendix 1: Permitted Anthracite Mines in the Swatara Watershed

Twp	Name	SMP#	Acres	Status	Type
Frailey	Lucas & Partners	54851314	2.0	Active	Deep
Tremont	D & D Coal Co.	NPDM-015	1.0	Regraded	Deep
Tremont	D.G.W Coal Co.	54851302	1.7	Regraded	Deep
Tremont	Kintzel Coal Co.	54851304	6.0	Inactive	Deep
Reilly	Rhen Coal Co.	54851317	2.5	Active	Deep
Tremont	Shadle Coal Co.	54851323	1.6	Active	Deep
Porter	Summit Anthracite, Inc.	54851336	5.7	Active	Deep
Foster	Neumeister Coal Co.	54851340	5.0	Active	Deep
Tremont	Little Buck Coal Co.	54851342	5.0	Active	Deep
Frailey	Buck Mountain Coal Co.	54851343	4.6	Active	Deep
Reilly	A.K.A Coal Co., Inc.	54851345	16.0	Active	Deep
Tremont	New Lincoln Coal Co.	54851347	1.8	Regraded	Deep
Tremont	R. & D. Coal Coal Co.	54861303	7.8	Active	Deep
Tremont	Big Diamond Coal Co.	54861310	1.5	Regraded	Deep
Frailey	J. R. & L. Coal Co.	54871301	5.0	Active	Deep
Tremont	West End Coal Co.	54871302	2.7	Active	Deep
Frailey	Mountain Run Enterprises	54871343	1.0	Regraded	Deep
Tremont	Summit Coal Co.	54881301	2.0	Inactive	Deep
Frailey	L. & L. Coal Co.	54901301	2.5	Active	Deep
Tremont	Potts Contracting Co., Inc.	54901305	1.0	Regraded	Deep
Frailey	M & H Coal Co.	54921303	8.7	Active	Deep
Tremont	B. K. & K. Coal Co.	54921304	4.0	not started	Deep
Frailey	D.J.T. Coal Co.	54941303	3.0	Active	Deep
Tremont	H.L.&W. Coal Co.	54951302	6.4	not started	Deep
Reilly	Hegins Mining Co.	54840205	64.0	Active	Preparation
Frailey	Shermans Coal Co.	54931601	7.3	Active	Preparation
Frailey	A. & J. Processing Co.	54941601	1.5	Active	Preparation
Reilly	Jeddo-Highland Coal Co.	54773215	46.4	Active	Reprocessing
Tremont	Meadowbrook Coal Co.	54830206	11.1	Active	Reprocessing
Reilly	Swatara Coal Co.	54830702	180.4	Active	Reprocessing
Porter	Westwood Energy Properties LTD PRNSH	54860206	441.4	Active	Reprocessing
Tremont	Harriman Coal Corp.	54880203	15.8	Active	Reprocessing
Reilly	Peppi Coal Co.	54900101	1794.0	Active	Reprocessing
Tremont	Meadowbrook Coal Co.	54910206	190.0	Active	Reprocessing
Frailey	Devil's Hole, Inc.	54960203	16.0	Active	Reprocessing
Frailey	Jeddo-Highland Coal Co.	54970204	265.0	not started	Reprocessing
Tremont	Harriman Coal Corp.	54713018	600.0	Active	Surface
Tremont	Harriman Coal Corp.	54840102	115.0	Active	Surface
Tremont	Michael Coal Co.	54850103	217.6	Active	Surface
Foster	Lone Eagle Coal Co., Inc.	54850107	59.9	Active	Surface
Tremont	Lensco Coal Co.	54860106	330.0	Active	Surface
Tremont	Harriman Coal Corp.	54860109	35.0	Active	Surface
Frailey	Meadowbrook Coal Co.	54900102	56.1	Active	Surface
Foster	Greenland Realty Co., Inc.	54900106	443.8	Active	Surface
Foster	Harriman Coal Corp.	54910102	378.0	Active	Surface
Foster	Mountain Valley Mgmt.	54910103	312.0	Active	Surface
Tremont	Harriman Coal Corp.	54920103	47.6	Active	Surface
		Total	**5726.4**		

Appendix 2: Water quality data collected at 45 monitoring in the Swatara Creek Watershed

not yet available

Appendix 3: Co-operators in the Water Quality Improvement of the Swatara Creek Watershed

Federal

- **Environmental Protection Agency (EPA)** - Providing EPA 319, 104(b)(3) grants which have been the major source of funding for the Swatara cleanup projects.
- **Office of Surface Mining (OSM)** – Background water quality and flow data collection on discharges and streams targeted for improvement projects.
- **PA Air National Guard 201st Red Horse Civil Engineer Flight** - Equipment and construction assistance on the Martin Run Diversion Well project.
- **USDA/Natural Resource Conservation Service (NRCS)** - Providing technical assistance in remediation site review, survey and design.
- **US Department of Energy (USDOE) -** Partner in a project to develop a treatment system on Lorberry Creek in the Swatara Creek Watershed which may have application throughout the Anthracite Region.
- **US Geologic Survey (USGS)** – A multi-year effort to monitor and assess stream quality improvements and the effectiveness of water treatment systems individually and cumulatively, and to provide technical assistance in designing pollution abatement systems. Instrumental in having Swatara Creek recognized under the EPA 319 National Monitoring Program.

State

- **DCNR/Bureau of State Parks** - Coordinating all efforts concerning the Swatara State Park and the proposed lake. Also, one of the key funding sources for the EPA 319 National Monitoring Program Project.
- **DEP/Bureau of Abandoned Mine Reclamation (Wilkes-Barre BAMR)** – Construction of the Lorberry Junction Wetland. Currently designing numerous large scale reclamation projects in Middle Creek and Upper Swatara Creek subwatersheds. BAMR is also a key part of negotiations to divert the Tracey Airhole to the Rausch Creek Treatment Plant.
- **DEP/Bureau of Dams, Waterways and Wetlands** - Providing technical assistance and cooperation in the mine drainage abatement efforts.
- **DEP/Bureau of Land & Water Conservation** - Assisting and appropriating EPA 319 and other funding sources for mine drainage abatement projects. Also, one of the key funding sources for the EPA 319 National Monitoring Program Project.
- **DEP/Bureau of Water Quality Management (Harrisburg WQM)** - Data collection and assessment of water quality improvements both biological and chemical.
- **DEP/District Mining Operations (Pottsville DMO)** - Coordinating the water quality improvement effort in the mine drainage affected areas, data collection, assisting to acquire funding for abatement projects, encouraging remining, provide technical assistance and project design, integrating with the local community.

- **PennDOT** - Cooperating as the landowner and assisting in the Lorberry Junction Wetland Project.

Local

- **Schuylkill County Conservation District (SCCD)** – Primary funding administrator for water quality improvement projects and providing technical assistance in project design. Coordinating the water quality improvement effort in the mine drainage affected areas, data collection, assisting to acquire funding for abatement projects. Also involved in nutrient management and streambank stabilization in the farming areas near Pine Grove.
- **Schuylkill County** - Identification of landowners, seeking funding for stream improvement projects and assistance in project design. Also, one of the key funding sources for the EPA 319 National Monitoring Program Project.
- **Municipalities** - Reilly Township, Frailey Township and Tremont Borough have participated in and are cooperating in the mine drainage abatement efforts. They have provided equipment, maintenance, and permission to install treatment structures.
- **Watershed Associations** - The Swatara Creek Watershed Association (SCWA) focuses of the entire Swatara Watershed, which includes 4 counties, emphasizes water quality improvements in addition to recreational improvements in the watershed. The Northern Swatara Creek Watershed Association (NSCWA) focuses primarily upper part of the watershed in Schuylkill County and addresses the mine drainage pollution. The associations work together on stream improvement projects and watershed awareness.
- **Public Organizations** - Trout Unlimited (Schuylkill County Chapter), Schuylkill County Sportsman's Association, Little Run Sportsman's Club and local citizens have donated time, equipment, and supplies to aid in the treatment efforts.
- **Industry** - The local industries have been very cooperative and several have expressed interest in participating when they are needed. The Pennsylvania Coal Association (PAC), several coal companies, limestone quarries, landfills, and several local businesses have donated supplies, services, and expertise on many of the water quality restoration projects.

Acknowledgements

References

MAPS