Updated 2/2004 DEP Bureau of Watershed Management

Watershed Restoration Action Strategy (WRAS)
State Water Plan Subbasin 06B
Mahanoy Creek and Shamokin Creek Watersheds
(Susquehanna River)
Northumberland and Schuylkill Counties

Introduction

Subbasin 06B consists of Mahanoy Creek, Shamokin Creek and the Susquehanna River and its eastern tributaries from below the confluence of the West Branch of the Susquehanna River at Sunbury downstream to the village of Dalmatia. The subbasin encompasses a drainage area of 341 square miles, with 157 square miles in Mahanoy Creek and 137 square miles in Shamokin Creek. A total of 385 streams flow for 506 miles through the subbasin. The major streams flow in a westerly direction towards the Susquehanna River. The subbasin is included in **HUC Area 2050201**, Lower Susquehanna River, Penns Creek, a Category I, FY99/2000 Priority watershed in the Unified Watershed Assessment.

<u>Geology/Soils</u>:
The subbasin is in the Ridge and Valley Ecoregion. The western two-thirds of the subbasin is in the Northern Shale Valleys and Slopes (67b). Rocks in this portion are red, brown, or gray shale and sandstone of the Silurian, Devonian and Mississippian Ages. The subbasin has the typical topography of Appalachian Mountains region with mountains forming its northern and eastern watershed boundaries. Narrow valleys between these northeast-southwest trending ridges have medium sized creeks flowing towards the Susquehanna River and contain the best agricultural lands. Soils in Ecoregion 67b have a greater susceptibility to soil erosion, turbidity, and poorer habitat conditions than soils in nearby limestone valleys.

The eastern third of the subbasin is in the Anthracite (67e) coal Ecoregion. This valuable "hard coal" in Schuylkill and Northumberland Counties was extensively deep mined for over 150 years and lead to much of the settlement in the eastern portion of the subbasin. Surface mining was also prevalent through the coal basin. The coal fields have been largely depleted of the easily obtainable coals and mining has declined significantly since its heyday in the early to mid-1900's. Most of the mines have been abandoned and discharge high volumes of water polluted with iron, aluminum, and often, acid into the receiving streams. The two major streams in the subbasin, Mahanoy Creek and Shamokin Creek originate in the Anthracite coal fields.

<u>Land Use</u>:
The watershed includes 15 boroughs, 6 of which are located in upper Mahanoy Creek watershed, and 5 of which are located in upper Shamokin Creek watershed. Boroughs and villages in the eastern portion of the subbasin were originally associated with Anthracite coal mines. The coal industry has declined and many of the people in the region now commute to Harrisburg and surrounding areas to work. The population of the subbasin was 91,400 in 1990 and is projected to decrease to 81,000 by 2040.

The eastern portion of the subbasin contains extensive abandoned surface mines, spoil banks, collieries, coal refuse piles and high volume deep mine discharges. Areas of unreclaimed surface mines and spoil banks resemble a moonscape in the upper Mahanoy Creek watershed. Extensive forested lands are located on the unmined portions of the mountains. Water supply reservoirs are located in the higher elevations on the slopes of the forested mountains and headwaters of small tributaries. Farming is the main land use in the western portion of the subbasin.

Natural/Recreational Resources:
The long, narrow State Game Lands #84 parallels the southern side of Mahanoy Creek from near the village of Helfenstein to the village of Dornsife. Part of Weiser State Forest is located east of the Game Lands.

DEP Chapter 93 Exceptional Value (EV) and High-Quality (HQ) Stream Listings:
None.

Water Quality Impairment
Mahanoy Creek and Shamokin Creek and several of their tributaries are impaired by abandoned coal mine drainage. The mined areas are located only in the upper third of both watersheds; however, iron precipitate often covers stream substrates all the way down to their confluences with the Susquehanna River. Huge spoil piles remain throughout the upper Shamokin Creek and Mahanoy Creek watersheds. Mountains of coal refuse surround the City of Shamokin. The mine drainage discharges in Shamokin Creek watershed generally have pH greater than 6.0; however the iron loading is very high. Mahanoy Creek watershed is also impaired by abandoned mining in the upper main stem and the Zerbe Creek and Shenandoah Creek tributary watersheds.

Leaky on-lot septic systems also degrade local stream sections throughout the subbasin. These problems need to be addressed with construction of sewage treatment plants or through innovative combined AMD/ sewage treatment systems. Agriculture practices affect some portions of the western subbasin.

The complicated nature of mining and the difficulties in determining the responsible parties for discharges in the Anthracite region can be illustrated the following information provided by the DEP Pottsville District Mining Office on historical mining in Shamokin Creek watershed.

Shamokin Creek watershed has had a long history of coal mining throughout the upper watershed south of Big Mountain. Anthracite coal mining was once the mainstay of the regional economy. At peak production in 1917, the watershed contributed approximately 6,200,000 tons of coal through the efforts of 4,400 men. Mining is not expected to increase substantially in the near future because the remaining coal lies very deep beneath the surface and within large flooded abandoned mines.

Shamokin Creek watershed contained significant amounts of coal in 15 mineable coal beds and an additional 19 locally occurring coal veins. All 34 coal veins were deep or surface mined to some extent. The deep mining methods were a function of the orientation of the coal veins, which pitch steeply as deep as 2,600 feet beneath the ground surface from their outcrops along watershed ridges. Slope entries were driven down the steeply pitching veins for a few hundred feet and tunnels were driven through intervening rock to intercept other coal veins. Several different veins were usually mined through tunnels and slopes connected to the surface. Subsidence into the underlying voids occurred where mining extended too close to the ground surface. When the mineable coal had been removed from one area, slopes were extended to deeper levels where the same extraction procedures were repeated. Shafts were also constructed at strategic places throughout the overlying rock. A system of interconnected slopes, shafts, and rock tunnels was formed as deep mining was extended throughout the area. Barriers of coal were left between mines developed by different owners. Each mine had its own system of shafts, slopes, and rock tunnels connecting the veins being mined.

Water was encountered as deep mining developed and continued. Water flowed down the mined coal veins to the working levels; water had to be pumped to the surface to allow mining to continue. As mining progressed to even deeper levels, more water was intercepted. Eventually mine operators established pump relay stations to remove water in stages from the deepest levels. Mining became uneconomical due to increasing costs of pumping and mine dewatering and a depressed coal market. The mines filled with water after the mining and pumping stopped.

After large mine operators discontinued mining, independent miners opened smaller operations within the large mines to recover remaining available coal that had been left in barrier pillars. Removal of pillars caused additional surface subsidence and created additional openings through which surface water could enter underground mine workings. Water flowed from one mine to another through numerous interconnections forming vast underground pools. Water under pressure in the mine pools surfaced through mine entries and drifts.

Precipitation entering the groundwater system is conveyed into and out of the Shamokin Creek watershed through interconnected mine systems extending under adjacent watershed divides. Water from Shamokin Creek watershed flows into Mahanoy Creek watershed through the Douteyville, Helfenstein, Locust Gap, and Centralia Mine Discharges. Drainage from the Mahanoy Creek watershed flows into Shamokin Creek watershed through interconnected mine workings to become part of the overflow from the Henry Clay Stirling Discharge.

Abandoned surface mines serve as catch basins that collect and direct precipitation and surface runoff into the groundwater. The Excelsior Strip Pit Overflow is one example of a discharge created from water overflowing from a surface mine pit. Significant volumes of water enter underlying deep mine workings through surface mine cuts or through fissures in the intervening rock. In certain areas, almost all the water that should flow in surface streams is intercepted by surface mines and interconnected deep mines. Water flowing into deep mines comes in contact with coal and acid-producing rock in the mines before discharging as acid mine drainage to streams.

Monitoring/Evaluation:
Forty-six percent of the subbasin had been assessed under the Department's unassessed waters program as of fall 2000. The United States Geological Survey (USGS) is conducting a water quality assessment and developing a remediation plan for the coal mined portion of Shamokin Creek watershed. The Wilkes Barre office of DEP Bureau of Abandoned Mine Reclamation (BAMR) is assisting in the evaluation of discharges in the Shamokin Creek watershed for potential passive treatment. The Mahanoy Creek Watershed Association received funding in fall 2000 for an assessment and development of a restoration plan for the mined portion of the Mahanoy Creek watershed.

The entire length of the main stem Shamokin Creek, downstream to its confluence with the Susquehanna River, is coated with iron precipitate; even though mining is restricted to the upper third of the Shamokin Creek watershed. Abandoned coal mining also adversely impacts all the tributaries upstream of Big Mountain. North Branch, the tributaries Locust Creek, Quaker Run, Carbon Run, and several unnamed tributaries are coated with iron precipitate. Iron precipitate is especially thick and solidly packed in Quaker Run. Shamokin Creek and these tributaries support few aquatic macroinvertebrates. Investigations by the USGS in 1999 and 2000, however, revealed that a variety of fish species live in portions of the main stem.

The Northcentral Regional Office evaluated Dalmatia Creek, Fidlers Run, Mahanoy Creek, Middle Creek, Schwaben Creek, Mouse Creek, Zerbe Run, and 3 unnamed tributaries to the Susquehanna River under the unassessed waters program in 2000. Two unnamed tributaries to Mahanoy Creek, Schwaben Creek, Middle Creek and Fidlers Run are impaired by siltation, low dissolved oxygen/organic enrichment, and removal of vegetation from agricultural activities. Zerbe Run is impaired by abandoned mine drainage. Eight unnamed tributaries of Mahanoy Creek are impaired by atmospheric deposition.

Future threats to water quality:
Water quality conditions in streams affected by abandoned mining are likely to improve as the technology for passive treatment improves and treatment systems are installed to treat the discharges.

The completion of the Dauphin bypass project to widen U.S. Route 322/22 into a divided highway will make commuting to Harrisburg easier from the subbasin and could accelerate the expansion of residential areas. Expanding residential lands in the basin have the potential to modify stream hydrology from increased paving and increase sedimentation from urban runoff.

Restoration Initiatives

Pennsylvania Growing Greener Grants:

- $75,000 (FY2002) to the Northumberland County Planning Commission for an assessment and restoration plan for all sources of impairment to Shamokin Creek watershed.
- $20,000 (FY2001) to the Northumberland County Conservation District for start up of a watershed association for Little Shamokin Creek.
- $76,700 (FY2000) to the Mahanoy Creek Watershed Association to assess the effects of and possible remedial alternatives for abandoned mine lands and abandoned mine drainage in the Mahanoy Creek watershed. The assessment will identify priorities among an estimated 31 mine discharges and will form the basis for later development of a watershed management plan for remediation of 45 square miles of the watershed.

U.S. Environmental Protection Agency (EPA) Clean Water Act Section 319 Grants:

- Northumberland County Conservation District and Shamokin Creek Restoration Alliance:
  - $454,150 (FY2003) for design and construction of a passive treatment system for Site 15 AMD discharge on Shamokin Creek.
  - $64,673 (FY2003) for design of a treatment system for the Big Mountain AMD discharge to Shamokin Creek.
- $46,000 (FY2001) to the Schuylkill County Conservation District and the Mahanoy Creek Watershed Association to expand a 3-acre wetland constructed to treat abandoned mine drainage at a site funded under a Watershed Rehabilitation and Partnership Act (WRAP) grant through DEP Bureau of Mining and Reclamation. This expansion will allow for treatment of 750 to 1500 gallons per minute of discharge. A parking area will also be constructed to accommodate visitors and school groups at the planned environmental education center. Information and photographs of the constructed wetlands, known as “The Swamp” can be found on the DEP website at http://www.dep.state.pa.us/; at directLINK, enter “The Swamp”.
- $79,305 (FY1999) to Northumberland County Conservation District for passive treatment of abandoned mine drainage to Carbon Run (AMD Site #42), a tributary of Shamokin Creek. Bucknell University, USGS, and the Shamokin Creek Restoration Alliance are cosponsors. The Bucknell University Geology Department is conducting research and monitoring of the treatment system. Information on this treatment site is available on the Bucknell University website at http://www.facstaff.bucknell.edu/kirby/Site 42.
- $52,830 (FY1999) to Northumberland County CD for an assessment of effects of AMD discharges in Shamokin Creek watershed. Bucknell University, USGS, and the Shamokin Creek Restoration Alliance are cosponsors of the project. Water chemistry, fish and macroinvertebrates will be assessed by USGS.

Eastern Pennsylvania Coalition for Abandoned Mine Reclamation (EPCAMR) Grants:

- $5,000 (1999) to Shamokin Creek Restoration Alliance to purchase monitoring equipment for water samples and flow measurements in the watershed. An education and awareness presentation will be held before the annual Earth Day Stream Bank Cleanup.
- $3,750 (1999) to Mahanoy Creek Watershed Association to raise awareness of AMD impacts in the communities within the watershed by setting up a monitoring program for teachers and students

within the 9 school districts. The data collected will form a foundation for development of a comprehensive watershed reclamation plan. A website will be developed by students for use as public education and outreach.

DEP Bureau of Abandoned Mine Reclamation (BAMR) Projects:

- Reclamation of unsafe highwalls and openings on east and west Mahanoy Mountain in 1999.
- Elimination of a hazardous water body in an abandoned highwall and pit in Ashland Borough. The site was revegetated with trees for wildlife habitat and a 5.5-acre wetland constructed in 1999.

DEP Bureau of Mining and Reclamation WRPA Grants:

- $8,000 (FY1999) to Shamokin Creek Watershed Alliance for maintenance and evaluation of passive treatment and limestone aeration on AMD Sites 37, 41 and 43.
- $31,450 (FY1999) to Shamokin Creek Watershed Alliance for passive treatment of Shamokin Creek AMD Site 48.
- $58,180 (FY1999) to Mahanoy Creek Watershed Association for constructed wetlands to treat an AMD discharge.

Agricultural Projects:

- The 1997 and 1998 U.S. Department of Agricultural, Natural Resource Conservation Service Environmental Quality Improvement Program (EQIP) funded technical, educational, and financial assistance for agricultural activities in the subbasin. $89,650 was awarded in FY97 under 12 contracts for 136,000 acres; and $239,600 in FY98 for 136,000 acres
- The Northumberland County Conservation District has worked with farmers to improve agricultural practices in the Mahanoy Creek area under the Chesapeake Bay Program.

Public Outreach

Watershed Notebooks

DEP's website has a watershed notebook for each of its 104 State Water Plan watersheds. Each notebook provides a brief description of the watershed with supporting data and information on agency and citizen group activities. Each notebook is organized to allow networking by watershed groups and others by providing access to send and post information about projects and activities underway in the watershed. The notebooks also link to the Department's Watershed Idea Exchange, an open forum to discuss watershed issues. The website is www.dep.state.pa.us. Choose Subjects/Water Management/Watershed Conservation/Watershed and Nonpoint Source Management/Watershed Notebooks.

Citizen/Conservation Groups

- Shamokin Creek Restoration Alliance (SCRA) was formed in 1996 to encourage partnerships and develop incentives and methods to facilitate funding for reclamation of abandoned mine lands (AML) in Shamokin Creek watershed. SCRA and faculty and students from Bucknell University have been monitoring to determine reclamation needs and the effects of constructed treatment sites. SCRA has been a partner for several grants received for restoration and has been developing a comprehensive plan for the watershed which will focus on agriculture and sewage runoff as well as AML. More information on their activities can be found at http://www.facstaff.bucknell.edu/kirby/SCRAblurb.
- Mahanoy Creek Watershed Association is dedicated to the restoration of Mahanoy Creek from problems associated with abandoned coal mine drainage. They have successfully applied for grants to raise awareness of abandoned mine drainage (AMD) problems in the communities of the watershed, to set up a monitoring program for high school teachers and students, and to construct wetlands to treat AMD. They also have sponsored stream cleanups at Ashland, Girardville, and Helfenstein, where 60 to 85 people have participated at each cleanup.

Funding Needs

The total dollars needed for addressing all nonpoint source problems in the watershed is undetermined. Stream assessments have been conducted and TMDLs will be developed for impaired waters in the subbasin. Watershed restoration plans developed for impaired waters will help determine what Best Management Practices (BMPs) are necessary to reduce pollution sources and provide estimates of restoration needs.

Funding sources available to support the development of site-specific implementation plans and remediation projects that address the sources of water quality impairment include the EPA Clean Water Act Section 319 grant program and the newer Pennsylvania funded Growing Greener program which target reductions in nonpoint source pollution. Pennsylvania has generally placed more emphasis on funding projects slated for implementation on water bodies where TMDLs have been completed or where water quality impairments have been documented.

Total Maximum Daily Loads (TMDL's)

TMDL's identify the amount of a pollutant that a stream or lake can assimilate without violating its water quality standards. TMDL's are calculated to include a margin of safety to protect against a mathematical or data error. TMDL's are set for each pollutant causing impairment.

<u>Draft TMDL for Shamokin Creek Watershed</u>:

The Susquehanna River Basin Commission and the DEP Pottsville District Mining Office developed a draft TMDL in 2000 to address degradation from abandoned mining in Shamokin Creek watershed. The watershed contains numerous abandoned mines, open surface mine pits, abandoned highwalls, huge coal refuse piles, streams that disappear into spoil, and many high volume discharges flowing from abandoned deep mines. Twenty-five active coal mining permits were located in the Shamokin Creek watershed in 2000.

Existing loadings and allowable long-term averages (LTA) and load reductions necessary to achieve water quality standards were calculated for iron (Fe), manganese (Mn), acidity and, in some cases, aluminum (Al), for the following discharges and drainage areas upstream of stream monitoring points:

- <u>NB1</u> is located on North Branch Shamokin Creek just upstream of its confluence with Shamokin Creek and includes the Mid Valley Discharge.
- <u>Mid Valley Discharge</u> is located approximately 2.8 miles upstream of the mouth of North Branch Shamokin Creek. Fifty percent of the flow from the Mid Valley Discharge is lost by infiltration into a mine pool discharging into the neighboring Mahanoy Creek watershed. Flow is also lost by infiltration into another mine pool that reappears in the Scott Ridge Mine Tunnel Discharge in the Quaker Run watershed. Marion Heights Borough and the Village of Strong are located in this portion of the watershed.
- <u>SC1</u> is located on Shamokin Creek upstream of the confluence of Locust Creek. The TMDL area includes upper Shamokin Creek except for the North Branch Shamokin Creek.
- <u>Excelsior Mine Strip Pit Overflow Discharge</u>, which receives drainage from the Reliance, Alaska, Enterprise and Excelsior-Corbin Collieries, is one of the largest discharges in the Shamokin Creek watershed and almost doubles the volume of Shamokin Creek.
- <u>Corbin Water Level Discharge</u> drains the Excelsior-Corbin Colliery. The original drainage path of the discharge has changed by blockage of a culvert under PA Route 901 by sludge material. The discharge presently flows close to the berm of the highway and into Shamokin Creek upstream of its confluence with Quaker Run.
- <u>Scott Ridge Mine Tunnel Discharge</u> is located approximately 1.2 miles upstream of the mouth of Quaker Run and drains the Morris Ridge, Sayre, Stuartsville, Sioux, Richards, Greenough, Pennsylvania, Scott and Natalie Collieries. This discharge surfaces through two different openings and drains into a tributary locally known as Dark Run.

- Colbert Mine Breach Discharge is located approximately 1.0 mile upstream of the mouth of Quaker Run and drains directly into Dark Run and drains the Morris Ridge, Sayre, Stuartsville, Sioux, Richards, Greenough, Pennsylvania, Scott and Natalie Collieries.
- Maysville Mine Borehole Discharge is located approximately 0.3 miles upstream of the mouth of Quaker Run, drains the Maysville Colliery. The discharge emerges through a pipe and flows directly into Quaker Run.
- QR1 is located at the mouth of Quaker Run. The majority of the water flowing in Quaker Run comes from three discharges, the Scott Ridge Mine Tunnel and Colbert Mine Breach Discharges, which become a tributary locally called Dark Run, and the Maysville Mine Borehole Discharge that flows into lower Quaker Run. Quaker Run watershed also receives drainage form the Borough of Kulpmont Wastewater Treatment Plant and the Borough of Marion Heights.
- Big Mountain Discharge drains the Big Mountain, Burnside and Enterprise Collieries. Along with a few small discharges, it makes up a tributary locally called Buck Run.
- SC2 is located on Shamokin Creek, downstream of locally named tributary Buck Run, receives the Big Mountain Discharge, the Excelsior Discharge, the Corbin Discharge, and the Big Mountain Discharge. Quaker Run, comprised of the Colbert, Scott, and Maysville Discharges, flows into Shamokin Creek upstream of SC2.
- Royal Oak Discharge drains the Buck Ridge #1 and Luke Fidler Collieries and is located approximately 0.7 miles upstream of the mouth of Coal Run.
- Stirling Slope Discharge is located approximately 1.5 miles upstream of the mouth of Carbon Run and drains the Henry Clay, Stirling, Neilson, Bear Valley, Burnside, Royal Oak, and Buck Ridge Collieries. The Stirling Discharge is the largest discharge in the Coal Run watershed and one of the largest in the Shamokin Creek watershed. Water from the Stirling Slope Discharge flows from a mine pool through a slope opening.
- CAR1 is located on Carbon Run upstream of its confluence with Shamokin Creek. Much of the Carbon Run watershed is comprised of spoil piles and abandoned surface mines. The stream disappears underground at various points and reemerges due to infiltration into the mine pools and reemergence in a discharge.
- SC3 is located on Shamokin Creek upstream of the mouth of Carbon Run, just outside of the city of Shamokin. This section includes the City of Shamokin and the Stirling Slope Discharge.
- Cameron Air Shaft Discharge is the first of a pair of discharges flowing from the Glen Burn Colliery Complex. This discharge also receives drainage from the Hickory Ridge, Colbert, Hickory Swamp, Cameron, Glen Burn, Natalie and Luke Fidler Collieries, and.
- Cameron Drift Discharge, a drift opening, is the second in a pair of discharges flowing from the Glen Burn Colliery. This discharge receives drainage from the Hickory Ridge, Colbert, Hickory Swamp, Cameron, Glen Burn, Natalie and Luke Fidler Collieries.
- SC4 is located on Shamokin Creek near the Glen Burn Colliery at the southern base of Big Mountain, downstream of the Cameron Drift and the Cameron Air Shaft Discharges and Carbon Run.
- SC5 is located upstream of the confluence of Bennys Run and downstream of the city of Shamokin and Big Mountain and Little Mountain. Shamokin Creek receives high quality water in this reach from Trout Run and Eagle Run. Trout Run flows through forested land between Big and Little Mountains and is used as a water supply for the Coal Township State Prison Complex. A local sportsman club maintains a small hatchery on Trout Run near its confluence with Shamokin Creek.
- SC6 is located at the USGS gage on Shamokin Creek downstream of the unimpaired tributaries Benny’s Run and Millers Run.
- SR7 is located near the village of Snydertown. Shamokin Creek receives water of good quality from several tributaries, including Lick Creek, Elysburg Creek, and other unnamed tributaries. The land use in this part of the watershed switches from mining to agriculture, with forested areas on the ridge tops.

- SR8 is located at the mouth of Shamokin Creek in the city of Sunbury downstream of Little Shamokin Creek and several unnamed tributaries. Some of these tributaries have historically been impacted by agricultural activities and carry large loads of nutrients and sediment. Agricultural impairments were not addressed in the TMDL.

TMDL's for Shamokin Creek Watershed						
Station	**Parameter**	**Measured Sample Data**		**Allowable**		**Reduction Identified**
		Conc (mg/l)	**Load (lb/day)**	**LTA Conc (mg/l)**	**Load (lb/day)**	**%**
Mid Valley Discharge	Fe	14.6	336.8	0.7	16.9	95
	Mn	2.45	56.4	0.6	14.7	74
	Acidity	131.7	3030.8	0	0	100
	Alkalinity	0	0			
NB1	Fe	9.3	236.6	0.5	11.7	0
	Mn	2.8	70.8	0.7	17.0	42
	Al	6.2	157.3	0.2	4.7	97
	Acidity	96.0	2441.5	0.4	9.7	0
	Alkalinity	2.5	63.6			
SC1	Fe	1.32	159.7	0.43	51.6	0
	Mn	0.26	32.0	0.26	31.8	0
	Acidity	3.0	363.3	1.89	228.8	0
	Alkalinity	15.6	1889.1			
Excelsior Discharge	Fe	16.0	822.6	0.8	41.3	95
	Mn	2.6	135.7	0.7	34.0	75
	Al	1.6	80.5	0.3	16.9	79
	Acidity	29.0	1488.7	0.9	47.1	97
	Alkalinity	13.0	666.8			
Corbin Discharge	Fe	42.7	295.3	0	0	100
	Mn	5.3	36.3	0.8	5.8	84
	Acidity	196.7	1361.4	0	0	100
	Alkalinity	0	0			
Scott Discharge	Fe	25.2	822.8	0.8	24.7	97
	Mn	3.9	126.2	0.7	23.9	81
	Acidity	29.9	974.4	14.4	469.7	52
	Alkalinity	42.5	1385.9			
Colbert Discharge	Fe	33.0	272.5	0.7	5.5	98
	Mn	3.9	32.2	0.8	6.4	80
	Acidity	125.3	1034.8	10.0	82.8	92
	Alkalinity	28.7	237.0			
Maysville Discharge	Fe	34.0	453.7	0.3	4.5	99
	Mn	3.5	46.7	0.5	6.0	87
	Acidity	141.3	1886.0	36.6	488.9	74
	Alkalinity	107.0	1427.8			
QR1	Fe	16.1	1183.3	0.8	59.2	0
	Mn	2.4	175.7	0.3	21.0	0
	Al	0.9	65.7	0.01	0.7	99
	Acidity	11.5	847.8	3.4	250.4	0

	Alkalinity	22.4	1651.5			
Big Mountain	Fe	20.4	306.0	0.6	9.2	97
Discharge	Mn	6.1	92.0	0.4	6.5	93
	Al	6.9	103.1	0.3	5.1	95
	Acidity	89.1	1338.0	3.6	54.3	96
	Alkalinity	9.0	135.1			
SC2	Fe	17.9	13495.8	0.9	259.6	98
	Mn	3.6	5195.2	0.5	157.3	97
	Al	2.5	1049.9	0.2	50.8	94
	Acidity	46.5	729.3	2.3	678.8	0
	Alkalinity	6.0	1741.4			
Royal Oak Discharge	Fe	3.1	0.8	0.3	0.1	91
	Mn	2.0	0.5	0.2	0.1	89
	Al	6.2	1.6	0.1	0.03	98
	Acidity	43.1	10.8	0.9	0.2	98
	Alkalinity	13.4	3.4			
Stirling Discharge	Fe	27.1	1222.4	0.5	24.5	98
	Mn	3.5	158.6	0.7	33.2	79
	Al	0.6	26.6	0.6	06.6	0
	Acidity	19.3	870.0	5.0	223.1	75
	Alkalinity	61.8	2783.2			
CAR1	Fe	14.6	672.0	0.9	40.4	0
	Mn	2.6	117.7	0.3	14.0	0
	Al	1.1	51.9	0.1	5.3	90
	Acidity	21.5	991.6	5.0	230.1	33
	Alkalinity	30.5	1406.7			
SC3	Fe	18.5	7656.3	0.4	152.1	0
	Mn	3.1	1264.2	0.4	176.0	0
	Al	1.2	475.0	0.4	162.5	0
	Acidity	24.9	10189.8	8.3	3393.5	64
	Alkalinity	23.0	9406.9			
Cameron Air	Fe	37.5	643.8	0.4	6.3	99
Shaft Discharge	Mn	4.6	79.5	0.5	8.0	90
	Al	1.4	24.6	0.2	3.0	88
	Acidity	69.0	1185.4	0	0	100
	Alkalinity	30.0	515.4			
Cameron Drift	Fe	41.7	496.9	0.4	4.9	99
Discharge	Mn	5.0	59.7	0.5	5.3	91
	Al	0.6	7.3	0.3	3.4	53
	Acidity	104.6	1247.1	4.2	49.9	96
	Alkalinity	30.0	357.8			
SC4	Fe	1.1	468.1	0.9	361.8	0
	Mn	29.8	12665.2	0.1	63.5	99.4
	Al	17.4	7399.0	0.2	73.8	99
	Acidity	328.2	139505.3	0	0	100
	Alkalinity	0	0			
SC5	Fe	19.6	9021.3	1.0	451.6	95
	Mn	3.6	1668.3	0.7	333.8	0
	Al	2.2	993.5	0.5	207.9	0

	Acidity	47.1	21715.1	17.1	7869.7	0
	Alkalinity	35.2	16240.2			
SC6	Fe	13.2	6492.0	0.9	453.8	0
	Mn	2.7	1334.1	0.5	266.9	0
	Al	1.4	702.7	0.4	184.7	0
	Acidity	21.5	10597.4	1.3	637.3	0
	Alkalinity	11.5	5667.3			
SC7	Fe	8.9	619.3	0.4	258.5	0
	Mn	3.4	895.2	0.8	591.1	0
	Al	1.3	521.4	0.3	222.0	0
	Acidity	18.4	25085.5	0.7	495.7	97
	Alkalinity	3.8	2736.6			
SC8	Fe	1.0	619.3	0.01	5.5	98
	Mn	1.5	895.2	0.2	125.8	79
	Al	0.9	521.4	0.1	63.2	72
	Acidity	18.4	10901.0	1.8	1090.2	0
	Alkalinity	2.1	1247.5			

Restoration Needs
The numerous discharges in the list above are indicative of the extent and severity of impairment from abandoned mine drainage in the Shamokin Creek watershed. A similar long list could be developed for Mahanoy Creek watershed. The extensive scarred lands and numerous discharges in both watersheds will require a huge amount of money and cooperation between governmental agencies and the private industrial sector for surface restoration to be successful. Surface restoration and revegetation should reduce the infiltration of water into the deep mines and should lessen the volume of water exiting the mines and reaching the streams. Restoration of streams and the land surface would also eliminate public safety hazards associated with abandoned highwalls and open surface mine pits.

Restoration and assessment activities:

- Reclamation of abandoned surface mines, including removal of abandoned highwalls and spoil banks and filling abandoned surface mine pits. Reclamation would eliminate surface water accumulations that become contaminated with mine drainage through contact with exposed acid-producing strata and greatly reduce the amount of surface runoff directed into the mine pool systems by promoting surface drainage. The regrading of disturbed areas would provide a more natural flow pattern for runoff and prevent surface flows from percolating through abandoned refuse and entering underground mine pools and emerging as mine discharges.
- Removal, regrading and replanting of abandoned coal refuse piles would reduce the amount of sediments, silt and coal waste runoff into surface streams and eliminate a source of acid mine drainage.
- Restoration of surface channels to streams that now disappear into spoil banks and enter deep mine pools. This would reduce the amount of water entering the deep mines and lessen the amount of water in the mine discharges.
- Assessments to determine whether passive treatment is practical and which type of systems are best suited for specific discharges. Assessments should include discharge water chemistry and flow, topographical setting, construction costs, and long-term operation and maintenance costs. The technology may not be available to passively treat many of these very high volume discharges.
- Substantial remining incentives, alternate bonding requirements, and simplified permitting requirements should be more actively pursued in areas that have been severely impacted by past mining practices. Incentives to make remining more attractive to the coal industry would accelerate the rate of reclamation. The DEP Bureau of Abandoned Mine Reclamation maintains responsibility

for reclamation of mines posing safety hazards or other areas in which remining is not feasible or profitable.

The Shamokin Creek Restoration Alliance, the Mahanoy Creek Watershed Association, the Northumberland County Conservation District and the Eastern Pennsylvania Coalition for Abandoned Mine Reclamation (EPCAMR) have received or applied for grants to install passive treatment systems and wetlands, and to reclaim mined areas in the subbasin. Bucknell University and the U.S. Geological Survey are conducting a comprehensive watershed assessment of the upper Shamokin Creek watershed that includes GIS coverages and water quality and biological data. The Northumberland County Conservation District is developing a comprehensive plan for the Shamokin Creek watershed which will address the abandoned mine drainage in the upper watershed and the agricultural problems in the lower watershed. The Mahanoy Creek Watershed Association is developing a restoration plan for upper Mahanoy Creek. These plans should be used to prioritize and direct restoration efforts in the subbasin.

The reclamation of abandoned discharges and mine lands should be a priority; however, measures for controlling stormwater runoff should also be planned, developed and implemented. A joint effort in identifying flood prone areas and providing guidelines should be made in order to accomplish the goals of government, industry and local watershed organizations. The DEP Bureau of Waterways Engineering is evaluating a $13.85 million dollar flood protection project in Mount Carmel Borough and Mount Carmel Township designed to protect 270 buildings in the 100-year flood plain along Shamokin and Butternut Creeks. The project would be built assuming that all land areas upstream of Mount Carmel would be reclaimed. Surface reclamation would prevent water from infiltrating into mine pools; however, reduction of infiltration into mine pools could increase the amount of water and the flooding potential of Shamokin Creek.

Shamokin Creek

Results of the Assessment Project:

Sixty-five abandoned mine discharges have been ranked and potential treatment systems determined. Sites were identified using the site numbers in the 1972 Operation Scarlift Report. The locations of many of the sites and the very high flows will present challenges to design of treatment systems. In many instances, little room is available near the discharge or the discharge is adjacent to roads or the receiving stream. The three top ranked sites may require active treatment because of very high flow volumes. Innovative treatment options, such as treatment within the deep mine pool or active treatment using iron oxidation may be necessary. Land reclamation could help reduce the inflow into the mines and the discharge volumes. Some discharges many need to be relocated to provide sufficient treatment area. Funding was received via 319 grants in 2003 for the number 5 and 6 ranked sites. See appendix below for a list of the top 10 discharges in Shamokin Creek watershed.

The Northumberland County Conservation District (NCCD), in conjunction with the DEP Bureau of Abandoned Mine Reclamation and Bucknell University, installed the second system, a Successive Alkalinity Producing System (SAPS) on Site 42 in the upper Carbon Run watershed. This system settles out metals, adds alkalinity, and raises the pH of the water leaving the system. Other passive treatment systems are planned as funds become available. A biological assessment by USGS in fall 2000 revealed that more creek chubs were found in Carbon Run downstream of the passive treatment system sponsored by NCCD than were present upstream. Preliminary results of sampling by Bucknell University indicated that macroinvertebrates have begun to repopulate Carbon Run downstream of the treatment system. Chemical sampling of the effluent from the system indicates removal of most of the iron and a significant increase in alkalinity of the discharge.

The Shamokin Creek Restoration Alliance, in partnership with the Northumberland County Vocational-Technical School, the Department of Environmental Protection, and the U.S. Office of Surface Mining, constructed the second passive mine drainage treatment system in the Shamokin Creek watershed at Site 48, also in the Carbon Run watershed. The discharge is located along the Venn Access Road on land owned by the Northumberland County Vocational-Technical School.

The mine water has a pH of approximately 7.0, dissolved oxygen concentration of approximately 9 mg/L, and an iron concentration of approximately 4 mg/L. The flow rate averages about 40 gallons per minute, and the iron loading is the 4th highest in the Carbon Run watershed. The project diverts all of the water from Scarlift Site 48 at low flow into a series of three oxidation/ settling ponds. Due to the neutral pH, no limestone is needed to add alkalinity or increase pH. The primary goals are to allow sufficient time for iron oxidation, precipitation, and settling. Treated water flows back into the stream channel. Sampling from January 2001 indicated that the influent iron concentration was 2.6 mg/L and the concentration of iron leaving the first pond was 0.2 mg/L. The preliminary data suggest that the pond system will be effective in removing iron from this discharge.

A display and educational area was constructed to allow for display of relevant information on this project and related efforts so that local schools can use the facility to teach students about mine drainage, its treatment, and their community.

<u>Agricultural Impairment</u>:
The Schwaben Creek watershed has the most impairment from agricultural and removal of streamside vegetation; only 1.14 miles of the main stem are unimpaired. Agricultural best management practices should begin in this portion of the watershed. Implementation of agricultural BMPs in subbasin streams affected by agricultural activities should reduce nutrient and sediment loads. Streambank stabilization and fencing should help reduce sediment loads. Stabilizing streambanks will also help reduce instream erosion. Fencing will keep livestock out of the stream and provide a riparian zone along the stream to trap sediment and phosphorus, thus keeping these pollutants from reaching the stream. Contour farming and grass waterways will help reduce sediment runoff during storms.

References/Sources of information

- State Water Plan, Subbasin 6. Department of Environmental Protection,
- USGS Topographic Maps
- 319 project proposals and summaries
- DEP Watershed Notebooks, Unified Assessment Document, and information from files and databases.
- Map of Draft Level III and IV Ecoregions of Pennsylvania and the Blue Ridge Mountains, Ridge and Valley, and Central Appalachians of EPA Region III.
- U.S. Geological Survey Assessment of Shamokin Creek, 1999 and 2000.
- Draft Total Maximum Daily Load for Shamokin Creek Watershed for DEP. 2000.

Streams in Subbasin 06B: 303d/305b Listings

Stream	Stream Code	Drainage area square miles	Miles meeting at least one designated use	Miles Impaired	Causes/Sources
1-**Susquehanna River**	06685		10.58 miles of 10 UNTs		Main stem unassessed
2-**Shamokin Creek**	18489	137		32.6 miles man stem & 8.5 miles of 9 UNTs	Metals & siltation from AMD
3-North Branch Shamokin Creek	18657	5.73		4.9 miles main stem	Metals & siltation from AMD
3-Locust Creek	18655	5.75		4 miles main stem & 1 mile of UNT #18656	Metals from AMD
3-Quaker Run	18652	3.62		3.8 miles main stem & 1 mile of one UNT	Metals & siltation from AMD
3-Coal Run	18651	6.25		4.7	Metals & water flow variability from AMD
3-Carbon Run	18647	8.78	5.28 miles main stem & 2.81 miles of 2 UNTs	5.3 miles main stem; 2.8 miles in 3 UNTs	Metals & siltation from AMD
3-Furnace Run	18646	1.61		0.64	Channelization & other habitat alterations
3-Trout Run	18645	3.01	All		
3-Bennys Run	18633	6.12	All		
3-Millers Run	18621	5.48	All		
3-Lick Creek	18615	2.46	All		
3-Little Shamokin Creek	18490	29.0	32.75 miles main stem	6.2 miles main stem & 7.1 miles of 11 UNTs	Siltation & organic enrichment/low DO from AG- grazing
4-Plum Creek	18493	10.2	4 miles main stem & all of UNTs	0.7 miles main stem	Siltation & organic enrichment/low DO from AG- grazing
2-Rolling Green Creek	18475	2.04			
2-Seaholtz Run	18473	0.77	All		
2-Hallowing Run	18448	7.71	All		
2-Boile Run	18438	5.97	All		

2-**Mahanoy Creek**	17556	157	20 miles of 32 UNTs	53.7 miles main stem; 1.62 miles of 2 UNTs; 4.65 miles of 8 UNTs	Metals from AMD Siltation from crop related AG Low pH from Atmospheric deposition
3-North Mahanoy Creek	17687	5.99		3.8 miles main stem & 0.7 miles of UNT #17688	Metals & siltation from AMD
3-Shenandoah Creek	17683	12.1		2.8 miles of main stem	Metals & siltation from AMD
4-Kehly Run	17685	1.63	All		
4-Lost Creek	17684	1.32	1.57 miles main stem	0.5 miles main stem	Metals from AMD
3-Little Mahanoy Creek	17677	11.0	All		
4-Rattling Run	17678	2.75	All		
3-Crab Run	17670	3.50	2.58 miles main stem & 1 mile of UNT #17672	1.4 miles main stem; 1.4 miles of UNT #17670	Metals from AMD Siltation & organic enrichment/low DO from AG- grazing
3-Zerbe Run	17639	13.1	0.82 miles of 3 UNTs	4.83 miles main stem; 2.84 miles- one UNT	Metals & pH from AMD
3-Schwaben Creek	17561	30.2	1.14 miles main stem	11.08 miles man stem; 29.68- 44 UNTs	Siltation & organic enrichment/low DO from AG general & crop related & removal of vegetation
4-Middle Creek	17594	3.28	2.5 miles main stem	2.5 miles main stem; 2.96 miles- 5 UNTs	Siltation from AG
4-Mouse Creek & 14 UNTs	17562	7.19	All		
3-Fidlers Run	17540	6.88	3.4 miles of main stem; 8.02 miles-3 UNTs	2.47 miles of 3 UNTs	Siltation from AG & grazing related AG
3-Silver Creek	17532	5.92			
3-Chapman Creek	17521	2.81			
3-Independence Run	17513	3.24			

3-Dalmatia Creek	17499	2.80		3.7 miles main stem; 1.73 miles- 7 UNTs	Siltation from Crop related AG & Removal of vegetation
3-Hoffer Creek	17488	2.34			

Streams are listed in order from upstream to downstream. A stream with the number 2 is a tributary to a number 1 stream, 3's are tributaries to 2's, etc. Susquehanna River=1.

AG= Agriculture; AMD= Abandoned mine drainage; UNT= Unnamed tributary

Appendix A: Rankings of the top 12 abandoned mine discharges and potential remediation alternatives for the Shamokin Creek Watershed

From watershed assessment prepared by C. Cravotta, USGS

Discharge rank based on total metals load. Site number adapted from Gannett Fleming Corddry and Carpenter, Inc. (1972). Rankings of remedial alternatives indicate order of preference; any treatment design would require additional data. ALD = anoxic limestone drain; VFCW = vertical-flow compost wetland; OFLD = oxic flushable limestone drain; OLC = open limestone channel.

Rank	Site #	Characteristics	% of total metals load	Potential Treatment Options	Comments
1	19	Very high flow and Fe conc.; suboxic, intermediate pH, net acidic	24.4	Active treatment	Treatment difficult due to site topography
2	12	Very high flow and Fe conc.; oxic, intermediate pH, net acidic	18.0	Aerobic ponds or active treatment	In-situ alkaline addition to existing abandoned mine pond or active treatment
3	49	Very high flow and Fe conc.; anoxic, near-neutral pH, net alkaline	14.2	ALD & aerobic ponds, or active treatment	For passive treatment- discharge would need to be routed across Carbon Run
4	53	Very high flow, Fe, Mn, and Al conc.; suboxic, low pH, net acidic	13.1	Active treatment	Discharge adjacent to Shamokin Creek, no area for passive treatment
5	23	High flow, Fe, Mn, and Al conc.; anoxic, low pH, net acidic	6.0	VFCW, OLD or OFLD	Flow and discharge point variable; surface runoff may be a problem *Design under investigation through a FY 2003 319 program grant*
6	15	High flow; very high Fe, Mn, and Al conc.; oxic, low pH, net acidic	5.5	ALD, Aerobic ponds, OFLD or active treatment	Small available area near discharge for complete treatment system; measured flow changes *Design & construction funded through a FY 2003 319 program grant*
7	51A	High flow; very high Fe and Mn conc.; anoxic, intermediate pH, net acidic	4.6	ALD or active treatment	Small area for passive treatment system
8	21	High flow; high Fe and moderate Mn conc.; oxic, near-neutral pH, net alkaline	4.1	Active treatment	Discharge adjacent to Quaker Run; little or no area available for passive treatment
9	5B	High flow, moderate Fe, Al, and Mn conc.; anoxic, low pH, net acidic	3.0	Culm bank removal or active treatment	Remote site; difficult for active or passive treatment; treatment in mine pool or reclamation of land area above discharge may be best

					option
10	20	High flow and Fe conc.; oxic(?), near-neutral pH, net acidic	2.1	ALD, aerobic ponds or active	May be oxic; extreme turbulence at outlet pipe makes measurements of DO difficult
11	42	High flow & Fe, oxic, intermediate pH, net acidic	0.9	VFCW & aerobic ponds	Treatment system constructed & successfully removing iron & raising pH
12	5A	High glow, moderate Fe, Al & Mn; anoxic (?), low pH, net acidic	0.8	Culm bank removal or active?	Remote site, difficult for active & passive treatment; could lower Al conc. by preventing water infiltration. Water quality similar to Site 5B