UPPER SWATARA CREEK TMDL WATERSHED IMPLEMENTATION PLAN

Schuylkill County, Pennsylvania

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INTRODUCTION

This document is to serve as a Watershed Implementation Plan for the Swatara Creek in Schuylkill County as required under Pennsylvania's Non-Point Source Management Program. The portion of Swatara Creek covered under this plan has been one of the most studied stream stretches in the state. Since the 1960s there have been numerous studies conducted to evaluate the potential for the construction of a lake in Swatara State Park just a few miles south of Pine Grove. Impacts due to abandoned mine drainage in the headwaters and nutrient pollution from agricultural areas have historically degraded the water quality of the Swatara Creek Watershed. Since the 1970s there have been intense efforts to improve the water quality in Swatara Creek in both the mining and agricultural areas. Many of these efforts have been documented in previous studies. The water quality of Swatara Creek has improved dramatically in recent years; however, there are still severe impacts to Swatara Creek that need to be addressed.

Many of the stream improvement projects have been completed through the efforts of the Schuylkill Conservation District (SCD). The SCD works closely with the Northern Swatara Creek Watershed Association and the Schuylkill Headwaters Association, Inc. (SHA). The SHA has recently completed a similar plan on the Upper Schuylkill River and they have agreed to complete this plan on behalf of the Northern Swatara Creek Watershed Association.

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IDENTIFICATION AND SUMMARY OF PROBLEM AND POLLUTION SOURCES

Swatara Creek originates on the Broad Mountain in southwestern Schuylkill County near the borough of Tremont and flows through the western edge of Berks County, Lebanon County, and southern Dauphin County to its confluence with the Susquehanna River at the borough of Middletown. The watershed varies in topography and land use as Swatara Creek travels 73 miles from its headwaters at an elevation of 1,510 feet to the mouth at 279 feet. The entire Swatara Creek watershed is 576 square miles and there have been overall assessments of the watershed by the Lebanon County based Swatara Creek Watershed Association.

This implementation plan is focused primarily on the Upper Swatara Creek Watershed above Ravine in Schuylkill County. The Upper Swatara Creek watershed is approximately 43 square miles and consists of the headwaters of the main stem of Swatara Creek and its tributaries that have been affected by anthracite coal mining over the past 200 years.

Geology, soil, and land use greatly differ in the headwaters from those downstream. The primary land use is forestland, which accounts for 80% of the land area north of Blue Mountain. Mining, primarily abandoned surface mines account for 18%, and the remaining 2% is urban or other uses. Urbanized areas include Tremont, Pine Grove, and a number of small villages. Light industrial development is centered along the Interstate 81 corridor. Farms consist of mainly pasture and fields of row crops, primarily corn. The agriculture that does take place is located in the southern portion of the watershed, south of the Second Mountain to the Swatara Gap in the Blue Mountain.

Abandoned Mine Drainage (AMD)

The major pollution source in the Upper Swatara Creek Watershed is abandoned mine drainage (AMD), which causes high levels of metals and low pH in the stream and a number of its tributaries. The watershed consists of the headwaters of the main stem of Swatara Creek and is bound by Sharp Mountain which extends across the watershed from east to west. Sharp Mountain marks the southern boundary of the Southern Anthracite Coal Field. Within the Upper Swatara Creek drainage area, a total of 26.14 miles of streams are listed as impaired by metals, a total of 2.36 miles of streams are listed as impaired by metals and suspended solids, and a total of 33.12 miles of streams are listed as impaired by metals, pH, and suspended solids on the 303(d) listing.

The Upper Swatara Creek watershed was heavily mined for anthracite coal through the late 19th and early 20th centuries. The landscape and groundwater have been severely altered in the mining areas. Huge coal refuse piles (culm banks) and numerous abandoned, open surface mine pits cover extensive portions of this area. Twenty-five coal seams were present and mined in the watershed. The strata are steeply tilted and mines penetrated deep into the hillsides. The folding and faulting increased the amount of coal available to mine. The rock units are inverted in some places and lie in bowl-like basins. In some basins, the coal is located at depths of 6,000 feet. Tunnels bored between mountains allowed water exchange between watersheds within and outside the sub-basin. Deep underground tunnel systems extended for miles. After the mines were abandoned, the tunnels filled with water and many formed surface discharges from the abandoned entryways. Many of these tunnel discharges are very large and are responsible for much of the water quality impairment in the region. The major sources of AMD are in the Lorberry Creek and Good Spring Creek watersheds. Over 100 discharges from deep mine openings, culm piles and surface mines have been identified. Eight major mine pools underlie the upper watershed containing over 5.2 billion gallons of contaminated water. The pH of the water exiting the mines is below neutral in most instances and iron precipitate coats the substrate downstream of the discharges. Reclamation projects have resulted in significant decreases in the chemical effects of the discharges. The biological community has also improved; however, affected streams generally still have low diversity and abundance of macroinvertebrates. The numbers and diversity of fish species have been increasing steadily each year at Ravine, the downstream limit of the mined area.

Over 35 years ago, the Commonwealth proposed to construct a 750-acre lake on Swatara Creek at Swatara Gap. The State Park lake project was 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. The primary goal for several years was to improve the water quality to meet acceptable standards for the lake to be built in the State Park. 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 (PFBC), 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.

<u>Sediment Runoff and Abandoned Mine Drainage from Refuse Piles</u>

In areas of historic mining, vegetation, soil, and rock layers (known as overburden) were stripped away to expose the coal vein. In many cases, this overburden was stockpiled adjacent to the mining operation and remains there still today. These spoil piles are a source of coal fines or culm that, if not properly contained, can run off into nearby streams covering stream bottoms which serve as habitat for macroinvertebrates. This culm often contains iron pyrite, which negatively impacts not only the stream bottom but also the water column by producing abandoned mine drainage. Several refuse piles within the study area are currently being reprocessed for energy at nearby cogeneration plants. Reprocessing involves mining existing culm piles and mixing the mined material with fluidized bed ash to increase the effectiveness of the material for burning. The final product can then be used in cogeneration plants as fuel. Culm varies in grade for fuel and some piles are more efficient to reprocess than others. Reclamation should decrease the loading to the receiving stream if a site is chosen as being an economically feasible source of fuel for cogeneration. Implementing Best Management Practices (BMPs) on site will also decrease runoff.

<u>Uncontrolled Stormwater Runoff</u>

Development within the Upper Swatara Creek Watershed can produce uncontrolled runoff of stormwater directly to local streams. Soil erosion and sedimentation are accelerated because of the disturbance of stabilized soil. Excavation, construction, subdivision and other activities associated with urbanization all expose erodable soil. The problems caused by increased sedimentation include an increase in the embeddedness of the stream bottom, or the percentage of the stream bottom covered with sediment, variation in stream flow, the alteration of flow/depth regimes, and the formation of islands or point bars in the stream. Each of these factors represents impacts on the health of a stream and the ability of the stream to support aquatic life.

In addition to sedimentation, diverted stormwater from paved roads, parking areas and other infrastructure can increase natural stream flow that may in turn cause bank erosion and channeling. The runoff, usually from roads and parking areas, can also contain varying contaminants. Petroleum hydrocarbons and other fuel related contaminants entering the streams are detrimental to the aquatic life and health of the stream. Additionally, thermal pollution, resulting from the heating of the water as it runs over paved surfaces, can have negative effects on aquatic life, especially on cold-water fisheries.

Stormwater management involves the control of water that runs off the surface of the land from rain or melting ice or snow. The volume or amount of runoff and its rate of runoff, increases as land development occurs. The paved areas also restrict replenishment of groundwater and contribute to flash flooding during storm events and extreme fluctuations in stream water levels. Extreme flow fluctuations cause difficulties in the attachment of bottom dwelling organisms to the stream substrate and also cause a scouring of the substrate.

Pennsylvania's Stormwater Management Act of 1978 (Act 167) provides grant monies to counties to develop stormwater management plans for designated watersheds. Upon completion of the plan by the county and approval by Pa. DEP, municipalities in the watershed adopt ordinances consistent with the plan. Developers are then required to follow the local drainage regulations that incorporate the standards of the watershed plan when preparing their land development plan. Currently, there are no municipalities within the Upper Swatara Creek Watershed that have adopted or started the development of Act 167 stormwater management plans. Proper planning and engineering of development is crucial to the maintenance of the watershed. Currently, efforts are being pursued to retrofit existing BMPs that have been found to be ineffective and to develop alternative BMPs (Pennsylvania Handbook of Best Management Practices for Developing Areas, 1988).

<u>Sewage</u>

Raw sewage discharges mainly from leaking on-lot septic systems are a continuing problem in the Upper Swatara Creek Watershed. These discharges are usually point source discharges that can be traced to specific discharge locations. The problems created by the discharge of raw sewage include the obvious human health hazards, possible proliferation of fauna, odor, and depletion of the dissolved oxygen content of the stream. In most cases, a healthy stream may be able to overcome the effects of sewage discharge if there is a sufficient supply of oxygen to support an aerobic environment. The bacteria and other organisms in the sewage will cause biochemical decay. However, abandoned mine drainage present in the stream complicates the problem by creating a toxic environment which inhibits self-purification. The microorganisms normally present in the sewage are either destroyed or severely inhibited in their ability to oxidize the waste. In this situation, the sewage remains prevalent in the stream until conditions favorable to self-purification are reached. Efforts to improve infrastructure are being pursued in areas where sewage is still a problem.

The Borough of Pine Grove and the Borough of Tremont are the largest population centers located in the Upper Swatara Creek Watershed. Both of these municipalities have sewage treatment plants and both are in the process of expanding and upgrading their facilities.

There are also 5 permitted public and non-public wastewater treatment systems considered minor dischargers (hydraulic design less than 1.0 million gallons per day) and 3 permitted industrial dischargers in the Upper Swatara Creek Watershed.

A. Impairment of Water Quality and Aquatic Life

The impairment of water quality and aquatic life is well documented in numerous studies that have been completed over the past four decades. Studies conducted by Roy F. Weston (1965), USGS (1981 and 1985), Skelly & Loy (1986), and Koury (1998) documented the water quality of the watershed and identified impairments and potential projects. USGS has been collecting continual monitoring data at several stations in the watershed since 1996 as part of the EPA 319 National Monitoring Program and they conduct annual aquatic sampling at several locations in the watershed. A TMDL, entitled "Upper Swatara Creek Watershed TMDL," was conducted by Pa. DEP in March 1999 and focused primarily on the mine drainage affected stream segments in the watershed. Other sources of pollution, including small residential development, habitat alterations, channelization, upstream impoundments, urban runoff, road runoff, and agriculture related pollution may all impact the watershed. No quantative assessment of these other potential sources has yet been made, due to the overwhelming impact of AMD on the watershed. Following the abatement of AMD problems in the watershed, other potential sources for impairment will be assessed. This assessment will occur after 2012.

As noted in the table below, many of the stream segments in the Upper Swatara Creek Watershed are listed on the 303d and 305b lists as being impaired.

STREAMS IN SUB-BASIN 07D, UPPER SWATARA CREEK: 303d/305b LISTINGS					
STREAM	**STREAM CODE**	**DRAINAGE AREA (sq. mi.)**	**MILES IMPAIRED**	**MILES ATTAINED**	**CAUSES/SOURCES**
2-Swatara Creek (Headwaters to Ravine)	09361	47.19	11.89		Metals & pH from AMD.
3-Panther Creek	10086	1.82	1.73		Siltation from AMD
3-Middle Creek	10078	5.80	4.20		Metals & pH from AMD
4-Coal Run	10083	1.27	0.80		Metals from AMD
5-Gebhard Run	10084	2.06	1.75 main stem; 0.73, one UNT	1.99 main stem	pH from AMD
4-Good Spring	10079	14.20	6.45		Siltation from AMD

5-Poplar Creek	10080	0.87		1.39	
3-Black Creek	10077	6.31		6.75	
3-Lower Rausch Creek	10074	8.88	4.00		Siltation & pH from AMD
4-Lorberry Creek	10075	4.21	2.07		pH from AMD
5-Stumps Run	10076	0.65	0.62		pH from AMD
3-Adams Run	10073	1.12		1.10	

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 is number 1.
UNTs=unnamed tributaries, AG=agriculture; AMD=abandoned mine drainage; EV=exceptional value.

The Upper Swatara Creek Watershed has been identified as a high priority degraded watershed impacted by NPS pollution (acidity and metals). The 43 square mile area of the Upper Swatara Creek Watershed includes the Main stem of Swatara Creek and its tributaries; Lorberry Creek, Lower Rausch Creek, Good Spring Creek, Coal Run, Middle Creek, Gebhard Run and Panther Creek. Each of these tributaries is either directly or indirectly affected by past coal mining with numerous unreclaimed open surface mines, coal refuse, culm banks, and abandoned mine pits that divert surface water into the large underground mine pools. Tunnels connect many of the mine pools and discharge high volumes of mine drainage. Iron precipitate coats most stream substrates in the mined areas. A few discharges contain high levels of aluminum and manganese that precipitates after reaching the surface. The level of these pollutants is severe enough to restrict bioproductivity in each of the above named tributaries and the Main stem, downstream to the village of Ravine. Mining is still taking place in the sub-basin, but on a much more limited basis than in the past.

Resources to abate pollution sources in the watershed were limited in the past. In the 1970s the DEP Bureau of Abandoned Mine Reclamation (BAMR) restored and redirected stream channels, as recommended in the Operation Scarlift studies. The only other resources available for pollution abatement were reclamation-in-lieu-of civil penalties and cooperation from the mining industry through re-mining. U. S. EPA 319 and 104b(3) Programs, OSM, and Pennsylvania Growing Greener grants became available in the 1990s to fund assessments and demonstrations of passive treatment technologies. The increase in awareness of mine drainage treatment technologies and new sources of funding has accelerated the efforts for improving water quality in Swatara Creek. Several passive treatment systems have been installed since 1995. Through partnerships with the USGS, U.S. Dept. of Energy and DEP District Mining Operations, there has been thorough assessment, implementation and evaluation of the projects in the watershed. The water chemistry, project effectiveness and overall ecologic impact of the projects are well documented in several publications by Dr. Charles Cravotta, USGS. In addition to pollution abatement projects, there has been extensive reclamation and land restoration completed by Pa. DEP BAMR from 1998 to the present that is improving the water quality in many of the tributaries.

Biological surveys conducted by USGS at the Swat-19 (Ravine Monitoring Station) between 1985 and 2004 indicate that Swatara Creek is a recovering stream. In 1985 no fish were found at Swat-19; in 1994 six species of fish were found. Both the abundance and diversity of species fish have increased every year since 1994 to a total of 25 species in 2002. The data for 2003 and 2004 show a decrease in numbers primarily due to the fact that extremely high flow conditions at the time the sampling was conducted hindered accurate data collection.

Aquatic sampling is also conducted annually by USGS at three other locations in the watershed: (1) Good Spring Creek in Tremont, (2) Swatara Creek at Newtown, and (3) Lorberry Creek at the Lorberry Junction. The information collected at these sites is used to determine how the macroinvertebrate community has been affected by AMD, changes in the community 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.

A healthy macroinvertebrate community consists of organisms from several insect orders including ephemeroptera, plecoptera, and trichoptera, diptera, megaloptera, odonata, and coleoptera. Insects from the ephemeroptera (mayflies), plecoptera (stoneflies), and trichoptera (caddisflies), known as the EPT taxa, are considered the most pollution sensitive. Streams that contain a diversity of these organisms are considered healthy, while a stream with few or none of these insects would be considered pollution impacted.

The macroinvertebrate communities at the different sample locations are affected by AMD discharges. While numbers and diversity remained low during the study period, a slight trend towards increasing macroinvertebrate numbers was noted. Installation of additional AMD treatment systems and reclamation of affected land areas should continue the improvement in number and diversity of macroinvertebrates.

B. Total Maximum Daily Loads (TMDLs)

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

A TMDL was prepared for stream segments in the upper portion of the Swatara Creek watershed to address the impairments noted on the 303(d) list caused by high levels of metals, and in some areas, the runoff of suspended solids from abandoned coal mines. The TMDL addresses the three primary metals associated with abandoned mine drainage, iron, manganese, and aluminum, as well as suspended solids.

No mining operations in the watershed are actively pumping and treating water. Almost all of the discharges in the watershed are from abandoned mining operations and, therefore, are treated as nonpoint sources. The distinction between nonpoint and point sources is determined on the basis of whether or not there is a responsible party for the discharge. Discharges with no responsible party are considered a nonpoint source. TMDLs were expressed as long-term average loadings, which give a better representation of the data used for the calculations due to the nature and complexity of mining effects on the watershed.

Applicable Water Quality Criteria

Parameter	***Criterion Value (mg/l)***	***Duration***	***Total Recoverable/Dissolved***
Aluminum** (Al)	0.10 of the 96 hour LC 50 0.75	Maximum One hour	Total Recoverable
Iron (Fe)	1.50	1 day average	Total Recoverable Dissolved
Manganese (Mn)	1.00	Maximum	Total Recoverable Dissolved
Total Suspended Solids	N/A	N/A	N/A

** This TMDL was developed using the value of 0.75 mg/l as the instream criteria for aluminum. This is the EPA national acute fish and aquatic life criterion for aluminum. Through the Regulatory Basics Initiative Pennsylvania is proposing to delete its current aluminum criterion and adopt the EPA national acute fish and aquatic life criteria of 0.75 mg/l. Pennsylvania's current aluminum criterion is 0.1 of the 96 hour LC-50 and is contained in PA Title 25 Chapter 93. The EPA adopted criterion would be placed in Pennsylvania's Chapter 16 Water Quality Toxics Management Strategy - Statement of Policy. In light of this pending change, the TMDL was developed with the EPA national criterion.

TMDL Segments

Lorberry Creek Watershed

Lorberry Creek watershed is comprised of the main stem and a tributary, Stumps Run, which are impaired by low pH, suspended solids and metals. The most significant contributor of impairment is an abandoned deep mine discharge from the Rowe Tunnel, which makes up over 75% of the flow of Lorberry Creek. The Rowe Tunnel has been listed as the second largest contributor of iron loading to the entire Swatara Creek basin. The two other major influences on Lorberry Creek are Stumps Run, which provides some assimilation capacity, and the fairly new Shadle Discharge, which is from an active mine and, therefore, considered a point source discharge with a waste load allocation. No known pollutant sources exist downstream of the Shadle Discharge. A limestone diversion well and mine drainage wetland treatment system was installed along Lorberry Creek in 2001. The Lorberry Wetland Project treats approximately one-third of the flow from the Rowe Tunnel Discharge.

The suspended solids (TSS) problem that previously existed in Lorberry Creek resulted from coal silt being washed into the stream during storm events. The sedimentation sources have largely been abated over the past 10 years. There is still sedimentation due to transportation of the metal flocculants that scour the stream channel. Prior to the completion of reclamation projects on Stumps Run from 1994 to 1996, the concentrations of TSS had been recorded as high as 1600 mg/l in Lorberry Creek.

Lower Rausch Creek

Low pH, siltation, and metals from a number of abandoned seeps and mine discharges impair Lower Rausch Creek. Several mine drainage discharges enter Lower Rausch Creek as it winds its way south along Interstate 81. Due to the number of discharges, the local topography, and proximity to the interstate highway, it is impractical to address the discharges individually. A wetland treatment system was constructed near the mouth of the stream to treat AMD in the whole stream. Data sampling point Swat-17, located on Lower

Rausch Creek immediately upstream of the wetland, was used in the TMDL to characterize the stream prior to treatment.

Middle Creek Watershed

The Middle Creek Watershed is composed of the main stem and four tributaries, Good Spring Creek, Coal Run, Gebhard Run and Poplar Creek. Cumulative loads from the 4 tributaries were used in the loading analysis of the main stem of Middle Creek. Due to the many years of mining and stream diversions, the topographic maps no longer accurately show the locations of Coal Run and Gebhard Run. Middle Creek has undergone a great transformation recently. In 2003, BAMR completed a $1.4 million reclamation project to restore the flow of Middle Creek to the surface. Prior to this project, Middle Creek had been lost to an abandoned surface mine that it was diverted into in 1972. The entire stream had disappeared to the underground mines and surfaced as the Clinton #1 and #2 Discharges. These discharges comprised the main flow in Middle Creek and Coal Run. Since the project completion, there has been exceptionally high rainfall and the effectiveness of the stream restoration on the flow of the discharge has not yet been realized. However, the overland flow of Middle Creek has been a permanent measure in preventing mine drainage and provides surface waters to dilute other pollution sources in the watershed.

Good Spring Creek

Good Spring Creek is impaired by metals and siltation from abandoned deep mine discharges and abandoned coal silt piles adjacent to the creek. The most significant source of metals pollution is the Tracey Airhole, the primary drainage point for the Good Spring #3 mine pool. This discharge contributes the largest amount of iron loading to the entire Upper Swatara Creek Watershed and masks the effects of other discharges in the watershed. For years, the remediation considered for the discharge was to divert it to the adjacent Rausch Creek watershed where it would be treated at the Rausch Creek Treatment Plant. This option is no longer being considered due to economic and technical issues. The Schuylkill Conservation District received funding for 2005 to address the Tracey Airhole Discharge with an aerobic wetland.

Two other sources of metals pollutants were evaluated in the TMDL, the John Behm Tunnel (GS-3) and sample point GS-7 at the mouth of an unnamed tributary of Good Spring Creek, which contains two abandoned discharges. GS-7 was treated as a single discharge point for the purpose of expressing a load allocation above that point.

There is extensive siltation in Good Spring Creek due to the culm banks and coal silt deposits along the creek in Donaldson that are remnants from past mining practices. The creek has been moved and straightened in the past and it is subject to erosion during storm events that cause black water. The character of the stream channel has been altered and does not provide an adequate floodplain to relieve the stream during high flow. As a result, silt, sediments, and metals are transported downstream and sediment deposition near Tremont poses potential flooding threats. Re-mining of the coal silt and culm banks should be encouraged and reestablishment of stable stream characteristics including floodplains, meanders, and riparian buffers would help to alleviate the sedimentation. A project to reestablish a floodplain on a completed re-mining operation was applied for in a Growing Greener grant in

2004. Options for reducing sedimentation in Good Spring Creek have been well documented in the Good Spring Creek and Middle Creek Watershed Assessments (Land Studies, 2003).

There has been extensive reclamation in the Good Spring Creek Watershed since 2000. Over $2.5 million in land reclamation has been completed by BAMR to backfill abandoned pits and restore natural drainage to over 150 acres. This surface flow will help to dilute the pollutants. However, the increased flow may impact the sediment transport in the creek.

Gebhard Run

Gebhard Run was listed as impaired by metals on the 1996 303d list; however, a biological survey under the DEP unassessed waters program conducted in 1998 showed that the stream segment was not impaired and no TMDL was developed. (Note: the 2000 305b list indicates that Gebhard Run is impaired by low pH.)

Coal Run

Coal Run is on the 303(d) list for impairment due to metals from AMD and it consists primarily of the flow from the Clinton #2 Discharge. It is anticipated that the flow from the discharge may decrease with the extensive reclamation that was completed in 2003 by a BAMR land reclamation project.

Main Stem Middle Creek

The main stem of Middle Creek is on the 303(d) list for impairment due to low pH and metals. Swat-21, located on the upper portion of Middle Creek, characterizes the main stem above its confluence with Gebhard Run. No other known pollutant sources exist on the main stem below point Swat-21. The downstream influences on Middle Creek are Gebhard Run, which is not impaired, and Coal Run, which has a separate TMDL. The TMDL for Middle Creek consists of a load allocation above point Swat-21.

Main Stem Swatara Creek

The main stem of Swatara Creek is on the 303(d) list for impairment due to metals. Included in this analysis are one unnamed tributary (locally named Polly's Run) and Panther Creek that are also on the 303(d) list. Sample point Swat-15 was used to characterize the main stem Swatara Creek above the confluence of Polly's Run. TMDLs were developed for the main stem using sample points Swat-15, SW-6 (Polly's Run), and Swat-16 (Panther Creek).

POLLUTANT LOAD REDUCTIONS REQUIRED TO MEET TMDL

The Upper Swatara Creek Watershed TMDL focused on the identified numerical reduction targets for each subwatershed as shown in Table 2 below. The Upper Swatara Creek Restoration Plan contains a listing and description of completed and proposed remediation projects in the watershed. Each project has or will have before and after monitoring done to determine remediation technique efficiencies. The TMDL will be reevaluated after additional restoration projects are completed and water quality changes occur.

Table 2. Load Allocations of Stream Segments in the Upper Swatara Creek Watershed

		Upper Swatara Creek Watershed Estimated reductions identified for all points in the watershed				
		Measured Sample Data		Allowable		Reduction Identified
Station	**Parameter**	**Conc (mg/l)**	**Load (lbs/day)**	**LTA Conc (mg/l)**	**Load (lbs/day)**	**% reduction**
Swat-04	**Rowe Tunnel discharge at headwaters of Lorberry Creek**					
	Al	1.01	21.45	0.27	5.79	73.0
	Fe	8.55	181.45	0.77	16.33	91.0
	Mn	2.12	44.95	0.49	10.34	77.0
Swat-11	**Instream monitoring point on Stumps Run**					
	Al	0.08	0.24	0.08	0.24	0.0
	Fe	0.18	0.51	0.18	0.51	0.0
	Mn	0.09	0.27	0.09	0.27	0.0
L-1	**Point source discharge to Lorberry Creek (active coal mine)**					
	Al	34.90	9.03	6.63	1.71	81.0
	Fe	6.00	1.55	6.00	1.55	0.0
	Mn	4.00	1.03	4.00	1.03	0.0
Swat-17	**Instream monitoring point on Lower Rausch Creek above the treatment wetland**					
	Al	1.03	4.49	0.19	0.81	82.0
	Fe	2.87	12.53	0.72	3.13	75.0
	Mn	1.46	6.36	0.60	2.61	59.0
GS-3	**John Behm Tunnel discharge to Good Spring Creek**					
	Al	0.48	1.61	0.48	1.61	0.0
	Fe	6.47	21.79	2.33	7.85	64.0
	Mn	1.31	4.40	1.31	4.40	0.0
GS-7	**Instream monitoring point on unnamed tributary to Good Spring Creek**					
	Al	0.35	1.95	0.35	1.95	0.0
	Fe	2.35	13.17	2.35	13.17	0.0
	Mn	0.75	4.21	0.75	4.21	0.0
Swat-20	**Instream monitoring point on Coal Run**					
	Al	0.32	3.66	0.26	2.92	20.0
	Fe	1.71	19.47	0.67	7.59	61.0
	Mn	1.08	12.25	0.65	7.35	40.0
M-5	**Abandoned discharge to Coal Run**					
	Al	0.18	0.49	0.18	0.49	0.0
	Fe	3.05	8.20	1.00	2.71	67.0
	Mn	1.24	3.35	0.97	2.61	22.0
M-6	**Abandoned discharge to Coal Run**					
	Al	0.18	0.49	0.18	0.49	0.0
	Fe	9.23	24.85	1.38	3.73	85.0
	Mn	1.95	5.26	0.98	2.63	50.0
Swat-21	**Instream monitoring point on Middle Creek**					
	Al	1.02	20.96	0.44	9.06	57.0
	Fe	2.18	45.06	0.83	17.10	62.0
	Mn	1.07	21.99	0.63	12.99	41.0
Swat-15	**Instream monitoring point on Swatara Creek**					
	Al	0.81	12.92	0.10	1.55	88.0
	Fe	0.48	7.70	0.17	2.77	64.0

	Mn	0.39	6.14	0.39	6.14	0.0
SW-6	**Instream monitoring point at mouth of unnamed tributary to Swatara Creek**					
	Al	0.93	7.57	0.31	2.50	67.0
	Fe	1.84	14.87	0.70	5.65	62.0
	Mn	2.67	21.59	0.43	3.45	84.0
Swat-16	**Instream monitoring point at mouth of Panther Creek**					
	Al	0.69	12.83	0.42	7.83	39.0
	Fe	0.85	15.78	0.85	15.78	0.0
	Mn	0.71	13.24	0.56	10.46	21.0

All sample points are shown on the maps included in Attachment A. The Upper Swatara Creek is listed for both high metals and low pH from AMD as being the cause of the degradation to the stream.

MANAGEMENT MEASURES REQUIRED TO ACHIEVE PRESCRIBED LOAD REDUCTIONS

A. General Remediation Strategies and Design Standards for AMD Discharges

As a first step in the recommendation of remediation alternatives for the prioritized sites identified above, a series of broad goals have been established. These goals will be used to assist in the analysis of alternatives and ultimately to assess the performance of the remediation measures.

- The first goal involves the specific chemistry associated with the discharges. This is difficult to summarize since the chemistry will vary with each location, even seasonally, and following precipitation events. However, the general goals for the treatment alternatives will be to achieve typical Title 25 standards for the following parameters at the discharge of each remediation system:

  1. Reduction of iron concentration to less than 1.5 mg/l
  2. Reduction of aluminum concentration to less than .75 mg/l
  3. Reduction of manganese concentration to the extent practical
  4. pH levels with the range of 6.0 – 9.0
  5. Alkalinity exceeding acidity

- The second goal is to increase public awareness of environmental issues and help to restore a sense of pride and community partnership within the watershed. Since the region has a long history of mining and the associated mine discharge problems, citizens have grown used to seeing orange streambeds devoid of life. Environmental change associated with remediation of mine discharge problems will result in an increase in local interest in the streams. A small (but noticeable) change can have a significant impact on community involvement. As such, it will be important to locate the proposed remediation sites in areas where the improvement will be highly visible to the residents.

- The third goal is to establish a recreation corridor along the various waterways to take advantage of the improving environmental conditions in the streams. This will make the improvements more obvious to the public and further expand public awareness of the need for additional improvements. If possible, the remediation techniques should incorporate walking paths with information placards describing the treatment methodologies. In addition, signs identifying those groups responsible for the remediation will pay dividends.

Awareness of the three goals will aid in the selection of remediation strategies for each of the prioritized sites. General strategies, which will be evaluated for each site, will include the following:

1. Elimination of the source of the discharge
2. Passive treatment of collected flows
3. Active treatment of collected flows

Examples of each of these techniques are discussed below:

Elimination of the sources of discharge
Where possible, the most cost-effective means of dealing with AMD discharges is to eliminate the source of the discharge. This can involve: capping refuse piles to reduce infiltration through the waste materials, sealing mine openings, preventing upstream recharge of abandoned mines, and reclaiming abandoned sites to eliminate exposed highwalls and deep mine entries. Since these methods are very site-specific, it is difficult to assess their use in this report, and the remainder of the document will generally emphasize the use of passive and active treatment systems. However, it should be noted that these methods should be evaluated for certain sites, especially those where stream flow loss to deep mines has been noted.

Passive treatment of collected flows
There are a host of passive treatment methodologies available for remediation of the discharges identified throughout the watershed. Passive treatment is accomplished primarily via contact with limestone, which tends to raise the pH and neutralize the acidity of the flows. In addition, some passive treatment methods utilize sulfate-reducing bacteria and wetland vegetation to assist with removal of metals. The interaction of the limestone and bacteria can form a complex bio-chemical reaction, which results in a sulfate-reducing environment that promotes the oxidation and precipitation of dissolved metals in the drainage upon aeration. This same process can be achieved in stand-alone wetlands if the influent chemistry is appropriate.

The use of passive treatment is a relatively new process and although there is significant literature available regarding different methods, the systems still tend to be rather experimental in nature. As such, hard design standards have not been generated for these techniques, but various "rules-of-thumb" are included herein for use in sizing the structures.

Passive treatment systems have been shown to be very effective on relatively small discharges, with space of creation of treatment systems identified as the critical issue. As such, for discharges with relatively large flows or flows that tend to fluctuate dramatically during precipitation events, passive treatment may not be appropriate. In addition, passive treatment systems do tend to accumulate metal precipitate, which must be removed periodically, and portions of the treatment system may require cleaning or replacement to remove deposition. Some systems also require a considerable initial "breaking-in" period before the sulfate-reducing bacteria are present in sufficient quantity to aid in treating the influent. There is also frequently an initial biological oxygen demand (BOD) problem with the discharge, resulting from the compost material used within the treatment system, although this problem tends to decrease rapidly.

The following is a brief discussion of various passive treatment techniques, with special emphasis on the site conditions that are appropriate for use of these methods, as well as general design considerations for use.

Aerobic Wetlands – These systems are man-made pools or enhancements of existing swampy areas, which tend to be the simplest and least expensive treatment systems to establish. However, they require influent with a relatively high pH (over 6.0), impermeable bases to limit infiltration, an imported highly organic substrate, and specific wetland vegetation capable of continuous submersion.

The principal function of these systems is the removal of certain metals resulting from the action of aerobic bacterial activity and oxidation. This results in the precipitation of the solution as a metal hydroxide sludge, which settles to the bottom of the wetland. Maintenance may be required periodically to prevent excessive clogging. The oxidation process results in increased acidity and decreased pH, and some of the limestone neutralization may be required at the outlet prior to discharge.

Aerobic wetland systems require influent pH ranges of between 6.0 and 8.0 and sufficient surface area and retention time for adequate oxidation to permit metal precipitation. Some systems utilize multiple ponds constructed in parallel to spread the flows over a larger area, which makes it easier to maintain the system. Aerobic wetlands are primarily used for the reduction of ferrous iron in concentrations up to 70 mg/l, but they have not been shown to be effective on aluminum or manganese concentrations.

Based on the equations presented in the text "*The Science of AMD and Passive Treatment,*" the minimum wetland size is computed as follows:

> (Ac)= (Fe loading / 180) + (Mn loading / 90) + (Acidity / 60)
> (where loadings are listed as lb./day, and the 180, 90 and 60 represent typical lb./ac./day capacity values)

Loadings are computed by multiplying the flow (gpm) by the concentration (mg/l) and then by 0.12 to convert gpm and mg/l to pounds per day. Use of this equation results in a recommended aerial extent of aerobic wetland, although this value must be evaluated to include specific site conditions, including fluctuations in inflow rate, site topography, and site accessibility.

Anaerobic Wetlands – These systems are similar to aerobic wetlands, except that the bio-chemical activity takes place within the thick, oxygen-free organic substrate, consisting of composted organic materials containing high concentrations of iron-reducing bacteria. These bacteria break down the sulfates in the influent, raise the pH level and precipitate some dissolved metals.

They are suitable for use with influent pH as low as 3.0 without additional alkalinity being added to the system, but high dissolved oxygen levels in the influent can be problematic. These systems tend to work well with certain metals (including copper, lead, zinc, cadmium, and iron), but they are inadequate for large concentrations of aluminum or manganese.

Like aerobic systems, anaerobic wetlands are most effective when used to treat small AMD flows of moderate water quality. Hedin, et al ("*Treatment of acid coal mine drainage with constructed wetlands*," 1989) indicate that anaerobic wetland systems for the treatment of net acid influent can be sized based on using a factor of 3.5 grams for acidity/m^2/day.

When used in combination with limestone, anaerobic wetlands are frequently sized to provide a minimum retention time in excess of six hours, but when used independently this value should probably be extended to roughly 24 hours. As such, for a flow of 100 gpm, the anaerobic wetland would be sized to contain roughly 19,250 cubic feet of submerged, composed materials. This would be equivalent to a pond with surface area of approximately 60' x 160' x 2' deep.

If aluminum concentrations are relatively high (greater than l.0 mg/l), a vertical drain system, which incorporates anaerobic wetlands and limestone flow paths, may be more cost-effective. Since the anaerobic activity results in significant metal precipitate, these systems may require periodic cleaning, and the substrate may need to be replaced if the precipitate results in a decrease of bacterial action.

Oxic/Anoxic Limestone Trenches – For the treatment of low pH flows with limited metal content, oxic (in the presence of atmospheric oxygen) channels are highly efficient and inexpensive. These systems utilize open channels filled with high-carbonate crushed limestone, which is less than lime. Since limestone dissolves slowly, it cannot result in overdosing in the treatment system and tends to dissolve more rapidly in poor water quality conditions, which is desirable.

However, if the limestone treatment occurs when the metal content is relatively high, and atmospheric oxygen is present, a buildup of metallic hydroxide compounds results on the surface of the stone. This armoring reduces the limestone contact surfaces with a subsequent decrease in effectiveness. When working properly, oxic channels can function for 5-10 years before they require replacement, but if the metal content is fairly high, they may lose effectiveness much more rapidly.

For situations where the metal content is higher than that recommended for oxic channels, anoxic limestone drains can be utilized. These systems typically utilize subsurface trenches, covered by an impermeable cap, to exclude atmospheric oxygen.

Anoxic trenches can be cheap and effective, but the life of the system is a direct function of the influent water quality and carbonate content of the limestone. When the stone has deteriorated to an extent that it has lost its effectiveness, the entire system must be dug up and replaced. If the influent has a significant dissolved oxygen content prior to introduction into the trench, anoxic trenches are less effective, so it is recommended that these trenches be connected directly with mine pools before the discharge has significant contact with the atmosphere.

There is little in the literature regarding sizing of oxic limestone channels since they are easily accessible, and maintenance involves merely replacing the deteriorated stone as required. Anoxic trench maintenance is more problematic since the system is buried throughout its entire length, so sizing is more critical. Based on the equations in "*The Science of AMD and Passive Treatment*," the mass of limestone required (M) is:

M (tons) = (Qpt/Vv) + (QCT/x), where:
Q = flow in m^3/day
p = bulk density of limestone (approx. 145#/cf=2.56 tons/m^3)
t = retention time in days (generally 15 hours = 0.625 days)
Vv= bulk void ratio of limestone (use 0.48 based on experience)
C = effluent alkalinity concentration
T = design life of drain in days (25 years = 9125 days)
x = $CaCO_3$ content of limestone (use 0.90 for high quality stone)

Limestone Diversion Wells/Ponds – In addition to oxic channels and anoxic trenches, there are applications for other, similar systems. Diversion wells consist of a low dam, which is used to divert flow through a pipe into the top of a cylinder filled with limestone gravel. High velocity flows generated by dropping the flow 5 to 10 feet are flushed through this system to keep the armoring scoured and to encourage degradation of the limestone for very efficient treatment. However, these systems require high maintenance by the nature of the construction, and the gravel must be replaced frequently (as much as twice per month). These systems are best used in conjunction with a wetland or a settling pond to permit settlement of the oxidized metals, but they can be used mid-stream.

Other sites have used limestone ponds, in which seepage from a mine opening is forced to flow vertically upward through a crushed limestone layer to force anoxic conditions. These systems also generally discharge to a settling pond or wetland for deposition of the precipitated metals. Again, this can be a relatively high-maintenance arrangement, and the limestone may have to be replaced frequently.

Limestone treatment is ineffective in situations where the pH is higher than neutral, and armoring of the stones causes a dramatic reduction in the performance of the system if not cleaned periodically. When O_2 is present, or when iron levels are in excess of 5 mg/l, the systems tend to develop armoring rapidly. Armoring can occur even more rapidly if the sulfate levels are in excess of 2,000 mg/l, wherein an insoluble gypsum precipitate occurs.

Vertical Drain Systems – These treatment systems, sometimes referred to as Successive Alkalinity-Producing Systems, combine the bio-chemical properties of anaerobic wetlands and limestone ponds to produce very effective treatment systems. They are generally comprised of a several ponds placed in series, as follows: a small settling pond used to drop large diameter suspended solids and attenuate peak runoff events; an anaerobic wetland designed to remove O_2 and begin the sulfate reduction process; a "vertical drain" composed of perforated pipes placed at the bottom of a pond overlain with layers of limestone and compost; and a settling pond for the metal precipitate.

Multiple systems can be constructed in series to permit cleaning (by taking one system "off-line") and to allow for peak inflows following precipitation events. If sufficient elevation difference is available between the third and fourth pond, a flushing system can be incorporated to permit periodic cleaning of the perforated pipes and limestone layer. This permits use of vertical drain systems for influent conditions with low pH and high iron and aluminum contents without removal of the limestone for cleaning.

The general approach to sizing vertical drain systems is to create a series of ponds with sufficient volume to permit adequate retention times. For practical purposes, the rule-of-thumb used by the Natural Resources Conservation Service (NRCS) ("*Design Considerations and Construction Techniques for SAPS*," 1998) for the various ponds is as follows:

- Pond #1 – settling pond – 24 hour retention time
- Pond #2 – anaerobic wetland – 6-8 hour retention time
- Pond #3 - vertical drain – 12 hour retention within the
- limestone zone (excluding the organic zone above) assuming a
- porosity of 0.48-.050
- Pond #4 – settling pond – as large as possible given site constraints, with a minimum recommendation of 2-3 days

As discussed in previous sections, limestone is a very efficient means of increasing pH values for acidic influent from AMD sites. However, it tends to deteriorate with time and does require long-term maintenance. The rules-of-thumb identified above are based on the creation of a system with an effective life of 20-25 years, at which time the limestone will probably require replacement. However, there are no existing systems that have been in place for more than 20 years, so this is speculation.

Vertical drain systems are very efficient for flows of approximately 500 gpm, assuming that sufficient room is available to construct ponds large enough to meet the retention time requirements discussed above. The ponds can treat influent with very low pH and relatively high iron, aluminum, and sulfate levels, and if a flushing mechanism has been included in the design, armoring of the limestone and piping can be controlled for many years.

However, the systems require some level of hands-on manipulation, at least initially, to achieve a workable system. This is partially a function of the need for sufficient bacteriological activity to develop a balance of the bio-chemical reactions, and frequent flushing may be required for some months. In addition, there is typically a high BOD discharge from the settling pond in the first few weeks until the compost becomes stabilized.

Active Treatment of Collected Flows

Active treatment of mine discharges has been on-going for hundreds of years with techniques ranging from dilution of the influent to the establishment of sophisticated treatment plants. These methods typically integrate components that employ chemical, biological, and physical processes.

The chemical components involve bringing the flows in contact with alkaline substances to neutralize the acid in the mine discharges through the buffering action of the alkaline materials. Raising the pH of the discharge is often essential for treatment since highly acidic discharges prevent the oxidation and precipitation of metals in settling ponds. Alkaline materials frequently used for pH adjustment include limestone, hydrate lime, quick lime, soda ash briquettes, caustic soda, and anhydrous ammonia. These additives tend to neutralize the acidity of the discharges and permit precipitation of dissolved metals, which can also be removed by application of potassium permanganate, other oxidizing agents, and physical aeration.

In addition to straight chemical reactions, some methods utilize bacteria-induced reduction so that the metal precipitates become stable and settle out. Physical aeration accelerates this process by exposure to large pool surface areas or by use of bubbler systems, waterfalls, or fountains. Larger systems may incorporate several of these techniques.

Since there are currently numerous packaged systems available involving hydrated lime treatment plants or water-wheel addition of caustic soda, which can be designed for specific flows and water quality conditions, it is difficult to recommend a general approach to active treatment of AMD sites.

Active systems tend to require a relatively high annual operation and maintenance (O&M) cost, and this is typically not included in funding available to watershed groups. As such, relatively inexpensive active treatment systems may be very difficult to maintain as compared to passive systems, depending on the source of funding.

B. Constructed Treatment Systems

- ***Adopt-A-Stream Project:*** In 1988, Schuylkill Conservation District began a project on the Upper Little Swatara Creek to enhance streambank stabilization and fish habitat enhancement. The project included constructing mud sills, log deflectors, rock deflectors, root wads and saw-tooth deflectors to stabilize 1,895 feet of streambank. Basket willows were also planted in the eroded areas to further stabilize eroded banks. In 2003, three and one-half miles of streambank fencing was installed on both sides of the stream and a 19.9 acre riparian buffer was planted along the stream above Sweet Arrow Lake.

- ***Assessment of 5 AMD Discharges:*** Weirs were installed on the Tracey Outflow, Clinton #1, Clinton #2, Marshfield #1, and the Marshfield #2 in the Middle Creek watershed to determine proper remediation systems. Funded under the BAMR Ten Percent Set Aside program.

- ***Hegins Run Oxic Limestone Channel Project:*** A 190- foot long oxic limestone channel was constructed on the Hegins Run discharge, an abandoned drift mine to Swatara Creek. The channel consists of over 800 tons of limestone and was constructed in 4 cells to maximize retention time. This project targeted one of the main sources of pollution mentioned under Swatara Creek Diversion Wells project. Funded by a Watershed Restoration and Protection Act (WRAP) grant. Completed in 2000.

- ***Reconstruction of Stream Channel near the John Behm Tunnel:*** A 360-foot limestone channel was constructed to convey an unnamed spring-fed stream that previously flowed into an abandoned surface mine pit. The stream now flows into Good Spring Creek and reduces the volume of water entering the mine pool system. Funded by U.S. EPA 104(b)(3). Completed in 1998.

- ***Lorberry Junction Strip Mine Pits Reclamation:*** Lorberry Junction Reclamation consisted of backfilling of several abandoned strip mine pits near the headwaters of Lower Rausch Creek. This was a Pa. DEP BAMR land reclamation project with no AMD treatment. Costs were $322,795 in AML funds. Completed in 1995.

- ***Lorberry Junction Wetland Project:*** Two shallow water aerobic wetland impoundments were constructed in the interchange of I-81, Exit 104, Ravine (also known as Lorberry Junction) to treat several abandoned mine discharges on Lower Rausch Creek. The wetlands remove metals from all of the discharges collectively from Lower Rausch Creek. Funded by a U.S. EPA 104 (b)(3) grant and with fines assessed against Pine Grove Landfill by Pa. DEP Bureau of Waste Management. Designed by Pa. DEP Bureau of Mining and Reclamation and constructed by Pa. DEP Bureau of Abandoned Mine Reclamation. Additional materials and equipment were donated by local industries. This visible site also serves as a public educational area. Completed in 1997.

- ***Relocation of Lower Rausch Creek:*** Westwood Energy, Inc. redirected Lower Rausch Creek around the large silt dams on their property, thus eliminating large quantities of coal silt from washing into the creek during storm events and snowmelt. Completed in 1991.

- ***Diversion Well on Martin Run, North Side of Route 125 - Village of Donaldson:*** This well was installed to abate discharges from the Colket mine pool and the Eureka Tunnel. The topography of the site did not allow for cost effective treatment at the pollution sources. The well increases the pH 1 to 1.5 units; however, metals precipitate in the stream channel. The work was completed with U.S. EPA 319 funds and volunteer efforts from local citizens and the PA National Guard. Completed in 1996.

- ***Operation Scarlift Abatement Projects:*** In 1972, Operation Scarlift Investigation Reports recommended a variety of AMD abatement projects in the Middle Creek and Good Spring Creek Watersheds. At a cost of $3 million dollars, 12 abatement projects consisting of stream channel restoration, installation of concrete flumes to help streams from losing water to deep mines, diversion of surface waters from coal refuse materials and land reclamation were completed. Additional mine spoil regrading and revegetation projects also helped to limit the amount of surface water infiltration to deep mines. Projects were completed between 1973 and 1977.

- ***Orchard South Discharge Anoxic/Oxic Drain:*** USGS installed an anoxic/oxic drain on the Orchard South Discharge in the Lower Rausch Creek sub watershed as an experiment to monitor the effect of oxygen on the limestone in limestone drain systems. Funded under a U.S. EPA 319 grant. Completed in 1995.

- ***Pollys Run Project:*** Streambank stabilization and rechanneling of Swatara Creek 0.25 miles downstream of the Swatara Creek diversion wells, near the Swatara Coal Co. During heavy flooding in January 1996, Swatara Creek washed away large quantities of coal silt from a portion of the streambank and deposited it in a downstream wetland area. The creek braided and a portion pooled and leached heavy metals as it seeped through coal silt into a canal that drains to Pollys Run. The project included a 700-foot limestone riprap channel to redirect and stabilize Swatara Creek and revegetation. The project prevents the possibility of a future sedimentation event and prevents water from Swatara Creek from entering the canal. Funded by a U.S. EPA 319 grant. Completed in 1997.

- ***Rowe Tunnel Discharge Treatment Development:*** A cooperative effort between the U.S. Department of Energy (DOE), USGS, Pa. DEP, and SCD. Treating the discharge required pH adjustment, aeration, filtration, or a combination of these methods. A detailed characterization of the water was conducted to determine the most effective treatment method. Two diversion wells were installed on the Rowe Tunnel Discharge in November 1998 as part of a prototype system.

  Following the experimentation on the Rowe Tunnel Discharge, an aerobic wetland and Aquafix treatment system was installed on the outflow from the diversion wells. Approximately one-third of the flow from the Rowe Tunnel is treated with the diversion wells and then flows into a series of four wetland cells for settling. An Aquafix system was installed at the inflow of the wetland to add pebble limestone, thus increasing the pH and accelerating iron precipitation. Funding for the project was provided by a U.S. EPA 319 grant and the Growing Greener Grant program. Completed in 2001.

- ***Stumps Run Reclamation Project #1:*** 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 from the abandoned Lincoln Colliery. During storm events and snowmelt, the stream flowed black with coal sediment exceeding concentrations of 1,615 ppm. The area was broken down into 3 projects because of the large area in need of reclamation and lack of funding. This portion addressed the major pollution source. Lehigh Coal & Navigation regraded and removed silt, revegetated, and installed erosion and sedimentation controls on 12.2 acres in lieu of $40,000 in fines that were assessed by the Pa. DEP Pottsville District Mining Office. Suspended solids have not exceeded 20 ppm since completion of this project. Completed in 1994.

- ***Stumps Run Reclamation Project #2:*** A Harriman Coal Corporation reclamation-in-lieu of civil penalty project that addressed an abandoned siltation basin with a high sediment discharge adjacent to Project #1. The site drained to Lorberry Creek upstream of Stumps Run. The operation removed silt, regraded and revegetated 8.2 acres, and installed erosion and sedimentation controls. Completed in 1995.

- ***Stumps Run Reclamation Project #3:*** This 4.0-acre project was completed by Lehigh Coal & Navigation through a reclamation-in-lieu of civil penalty of $50,000. The site was graded, revegetated, and erosion and sedimentation controls were installed. Additional work was done to improve upon the Project #1 area. Completed in 1996.

- ***Study of Treatment Systems & Current Water Quality of Swatara Creek:*** A cooperative effort between the USGS and Pa. DEP to evaluate the effectiveness of individual limestone treatment systems installed and their cumulative effects on Swatara Creek. Four continuous water quality monitoring stations were installed with U.S. EPA 104(b)(3) grants for 1996, ‘97, ‘98 and continued under the U.S. EPA 319 National Monitoring Program and other funding sources. Completed in 1996.

- ***Limestone Channel on Swatara Creek:*** A limestone channel was constructed upstream of the discharge known as Hegins Run to increase the pH of Swatara Creek upstream of the diversion wells. Funded by a U.S. EPA 319 grant. Completed in 1997.

- ***Swatara Creek Diversion Wells:*** Two diversion wells were installed on Swatara Creek, 3 miles downstream of the headwaters to treat inaccessible upstream discharges. Several unique modifications were installed for easier maintenance. A local businessman funded the project in honor of his father, an avid fisherman. The project has involved businesses, state, federal and local agencies, and over 50 citizens of the local community and sparked the formation of the Northern Swatara Creek Watershed Association. Completed in 1995.

- ***Swatara Creek Headwaters - Anoxic Limestone Drain:*** An anoxic limestone drain was constructed on an unnamed abandoned mine drainage discharge at the headwaters of Swatara Creek (pH 4.0, iron 9.0 mg/l), with U.S. EPA 319 funds, donated assistance, and materials from an adjacent landfill. The project was designed by USGS and contains several testing features to allow for monitoring and maintenance. Completed in 1997.

- ***Swatara Creek EPA 319 National Monitoring Program Project:*** This was the first National Monitoring Project in the country that focused on mine drainage and treatment practices. The evaluation of the cumulative effects of various treatments will be useful in developing a treatment strategy for other discharges in the Anthracite Region. The initial phase of this project was completed in 1998; however, this monitoring program continues to receive funding through the EPA 319 program and is ongoing.

C. Future Remediation Projects

Since the 1960s there have been detailed studies and assessments of the Swatara Watershed in which priorities were identified to improve the water quality. Numerous projects over the past four decades have addressed some of those priorities. The following list contains priorities to address the principal pollution sources in the watershed. Abandoned mine drainage is the main pollutant in the watershed. The abandoned mine drainage priorities were previously identified in studies by Roy F. Weston (1965), USGS (1985), Skelly & Loy (1986), Koury (1998), and current evaluation and monitoring conducted by USGS under the EPA 319 National Monitoring Program. In addition, an assessment of the sedimentation sources in the headwater tributaries (Good Spring Creek and Middle Creek) completed by Land Studies (2003) identified 10 priorities to reduce sediment pollution in those tributaries.

High Priorities

- ***Tracey Airhole Discharge:*** With an average discharge of 1,500 gpm and an average iron concentration of 18.3 mg/l, the Tracey Airhole is the most significant source of pollution to Good Spring Creek. The airway serves as a drainage point for the Good Spring #3 Mine pool. Although monitoring data shows that the discharge has improved slightly, it still has a significant impact on the watershed. The remediation considered for the discharge was to divert it to the adjacent Rausch Creek watershed where it would be treated at the Rausch Creek Treatment Plant. However, this option has been abandoned due to economic and technical issues. The Schuylkill Conservation District received funding for 2005 to address the Tracey Airhole Discharge with an aerobic wetland. (**Treatment system option(s)**: Anoxic Limestone Drain, Wetland)

- ***Rowe Tunnel:*** The Rowe Tunnel is a gravity discharge of extensive interconnected underground mines that contribute the majority of flow (75%), acidity, iron and other pollutants to Lorberry Creek. This discharge is the second largest contributor of iron loading to the entire Swatara Creek Basin. Two diversion wells were installed on the Rowe Tunnel discharge in November 1998 however, and an aerobic wetland and Aquafix system were installed in 2001 to capture the flow from the diversion wells.

The total flow receiving treatment is approximately 800 gpm of the total 3,000 gpm of the discharge. Additional aerobic wetlands to address the remaining flow could treat a greater portion of the overall flow of the discharge. The discharge masks the effects of several smaller discharges and tributaries that enter Lorberry Creek. In addition, an estimated 460 acres of unreclaimed surface mines exist in the headwaters of Lorberry Creek. This site could benefit from upstream land restoration to reduce water flow into the Rowe Tunnel. (**Treatment system option(s)**: Aerobic Wetland)

- ***Shadle Discharge:*** This discharge surfaces from a deep mine operation and flows along Molleystown Road and into Lorberry Creek. The water quality of the discharge is very polluted with high acidity and high metals. There are several large mine subsidences and surface pits surrounding the discharge and there is a potential for a land reclamation project to reduce infiltration. There is limited space to treat the discharge, however. (**Treatment system option(s)**: Anoxic Limestone Drain, and Aerobic Wetland)

- ***Clinton #1 & #2 Discharges:*** Previously ranked as major contributors of acid to Middle Creek and Good Spring Creek, surface reclamation projects in the 1970s reduced discharge flow and improved water quality. In 2003, BAMR completed a $1.4 million reclamation project to restore the flow of Middle Creek. Prior to this project, Middle Creek had been lost to an abandoned surface mine that it was diverted into in 1972 and the stream flow contributed heavily to the Clinton #1 and #2 Discharges. The quality and quantity of the discharges are currently being monitored to determine the overall effect of the reclamation project and the remaining flow will be evaluated for an appropriate treatment system. (**Treatment system option(s)**:Aerobic Wetland)

- ***Colket Discharge:*** The Colket Discharge flows into Martin Run in the village of Donaldson. In 1996, a diversion well was installed on Martin Run to address the effects of the discharge. BAMR completed three significant land reclamation projects from 2000-2003 in which 120 acres of abandoned surface mines were backfilled along the contour of the mountain north and west of the Colket Discharge. The reclamation has restored the drainage to the surface and will decrease the amount of water infiltration into the mine pool. A passive treatment system is also supposed to be developed by BAMR to treat the Colket Discharge. (**Treatment system option(s)**: Aerobic Limestone Drain and Anaerobic Wetland)

- ***John Behm Tunnel:*** This discharge (also known as the Bowmen & Coleman Tunnel) is located 0.5 mile west of Donaldson and was sealed in the 1990s but continues to drain mildly acidic water with an average iron concentration of 5.0 mg/l. The tunnel discharge flows to Good Spring Creek. An abatement strategy should be developed and implemented to improve the water quality of the discharge. (**Treatment system option(s)**: Aerobic Wetland)

- ***Martin Run:*** Martin Run still receives AMD water from the Eureka Tunnel Discharge and the Colket Discharge. The topography of the site does not allow for cost effective treatment at the pollution sources. A limestone diversion well was installed along Martin Run to abate discharges from the Colket mine pool and the Eureka. However, a large amount of iron precipitate still accumulates in the stream channel. (**Treatment system option(s)**: Aerobic Wetland)

- ***Lower Rausch Creek:*** This creek originates from an abandoned surface mine and encounters several deep mine discharges along its 3-mile path adjacent to I-81 to the Swatara Creek. A 2.3–acre wetland was created by Pa. DEP and BAMR just upstream of the confluence of Lorberry and Swatara Creeks in 1997 to abate iron and other metals as a whole from the stream. The wetland has been effective and is in need of upgrades and enhancements. Due to significant storms in 2004, the spillway is in need of repair and the inlet will require dredging of sediments (**Treatment system option(s)**: repairs to current system).

- ***Continued Monitoring under EPA's 319 National Monitoring Program:*** USGS continued monitoring in the Swatara Creek Watershed is necessary to evaluate the dynamic changes in the watershed. Since the mid-1990's there have been numerous BMPs installed to address the AMD in the watershed. In the past five years there has been extensive land reclamation, particularly in the Good Spring Creek, Middle Creek, and Blackwood areas. The data collected will document the cumulative effects of all of the projects in the restoration of the watershed. In addition, the monitoring efforts will continue to emphasize the areas still in need of treatment.

Medium Priorities

- ***Unnamed Tributary of Good Spring Creek:*** Identified in Land Studies (2003), this small, unnamed tributary less than one-half mile upstream of Tremont, is contributing large amounts of sediment to Good Spring Creek. Restoration would involve relocating the stream channel and backfilling the existing channel. Estimated cost is $100,000.

- ***Good Spring Creek, Donaldson to Tremont:*** Identified in Land Studies (2003), two restoration opportunities exist that would significantly reduce erosion, restore floodplain functions, and improve water quality. Both projects include the removal of large piles of coal fines within the floodplain. These areas would then be graded to an elevation that would flood several times each year. Wetlands would be created to improve water quality through natural filtering. Estimated cost is $140,000.

- ***Good Spring Creek, I-81 to Donaldson:*** More than one mile of coal refuse and silt lies along the streambanks of the creek and it continually washes into Good Spring Creek during storm events. Re-mining should be encouraged to eliminate the source of the sediment and wetlands and a natural stream channel should be established to prevent sedimentation and flooding potential farther downstream in Tremont.

Other Priorities

As treatment systems are constructed and discharges meet applicable water quality criteria for specific treatment parameters, remediated discharges will be removed from this plan and new untreated discharges will be added from those listed in the Swatara Creek Watershed Rehabilitation Plan. The following sites include such future potential remediation initiatives to be undertaken:

- ***Blackwood Breaker (Upper Swatara Creek):*** Several BAMR reclamation projects were designed for the Blackwood Tunnel Area. A surface mine permit operation is removing culm piles and silt dams from the abandoned Blackwood Breaker and re-mining some of the abandoned pits. Future re-mining and reclamation permit operations should help to further minimize the potential for AMD pollution.

- ***Miscellaneous Improvements (Middle Creek):*** Many opportunities for further water quality improvements exist throughout the Middle Creek Watershed (particularly in the Indian Head area) by re-mining culm piles and removing silt piles.

D. Land Reclamation

Land reclamation should be conducted wherever possible in conjunction with construction of treatment systems. Reclamation should involve restoring streams to surface flow through land reclamation, filling abandoned surface mine pits and sealing under the new surface channel so that flow remains on the surface. Alkaline material should be added to the backfill material and in-stream in order to raise the pH and alkalinity where required.

Pa. DEP, BAMR has concentrated several land reclamation, stream restoration and mine drainage treatment projects in the Swatara Watershed since 2000. Over $5.5 million was spent on 12 projects, and the cumulative effect of these projects should greatly improve the portions of the watershed where they were focused. The tributaries that should experience the most improvement are Good Spring Creek, Middle Creek, and the Main Stem of the Swatara Creek in the Blackwood area. All of the land reclamation projects incorporated erosion and sedimentation controls that restore stormwater flow to the surface streams preventing these waters from entering the underground mine pool. Each year from 2002 to 2005 has been marked by excessive rainfall totals and the water quality improvements from these projects may not yet be realized.

The future of abandoned mine reclamation within the watershed is dependent on many factors. The most significant factor is the reauthorization of the Surface Mining Control and Reclamation Act of 1977. Without the reauthorization of the Act, funds will not be as readily available to perform reclamation activities. Another important factor is the cooperation of landowners. If landowners within the watershed are reluctant to allow any reclamation on their properties, funding would most likely be shifted to watersheds that have cooperative property owners. The final major factor that may dictate future reclamation work within the watershed is the technical feasibility of any proposed project. At first glance, many projects appear to have beneficial environmental impacts. However, after more in-depth evaluation of a project, that project may not be technically feasible due to physical, economical, and/or social constraints.

Eliminating drainage from abandoned mines and restoring the Upper Swatara Creek Watershed and its tributaries to a healthy state represent significant challenges. The vast majority of impacts are from mines and mining practices of the past, predating the 1977 federal Surface Mining Control and Reclamation Act (SMCRA). However, for the past 30 years, both national and state laws require mining companies to develop operation and reclamation plans to eliminate or minimize environmental impacts. Companies are required to reclaim land disturbed by exploration or extraction. Lands are considered reclaimed when the disturbed land is returned to its pre-mining use or another use determined to be beneficial such as a recreation area or wildlife habitat.

Re-mining of previously abandoned mine lands also presents the opportunity for land reclamation. All active mining operations are required to reclaim mined land to its approximate original contour once mining has ended. As protection in case a coal company would become bankrupt or leave a site before reclamation takes place, the company is required to post bond. If a coal company abandons a site, the bond money is handed over to the BAMR, which essentially steps into the shoes of the operator and reclaims the land just as the operator would have. BAMR already has completed 20 projects in the Upper Swatara Creek Watershed reclaiming hundreds of acres of abandoned mine land. In addition, five (5) BAMR reclamation projects, approximately 170 acres, are either under construction or in the development or design phase. A map of the reclaimed mine land in the Upper Swatara Creek Watershed is available in Attachment A.

There are no active mining operations in the watershed that are actively pumping and treating water. Almost all of the discharges in the watershed are from abandoned mining operations and are considered non-point sources. All of the active mining sites are re-mining permits since they are mining and reclaiming previously mined areas. A list of active mining permits in the Upper Swatara Creek Watershed is available in Attachment B.

Additional information for specific management measures and proposed load reductions can be found in the Upper Swatara TMDL Reduction Summary Tabled. The tabled is located in Attachment C of this document.

TECHNICAL AND FINANCIAL ASSISTANCE NEEDED TO IMPLEMENT BMPS

A. Estimate of Remediation Costs

Members of the project team are not construction contractors and therefore probable project cost opinions are based solely upon information from AMDTreat software, experience with construction, and knowledge of the proposed sites. This requires the project team to make a number of assumptions as to actual conditions which will be encountered on the site; the specific decisions of other design professionals engaged; the means and methods of construction the contractor will employ; the cost and extent of labor, equipment, and materials that the contractor will employ; the contractor's techniques in determining prices and market conditions at the time, and other factors over which the project team has no control.

Project Name	Design & Permitting	Construction	Total for Construction	Annual Operations & Maintenance
Tracey Airhole Discharge	$101,454	$507,271	$608,725	$38,561
Rowe Tunnel	$41,946	$209,732	$251,678	$17,101
Shadle Discharge	$39,733	$198,664	$238,397	$7,319
Clinton Discharge	$74,987	$374,934	$449,921	$10,824
Colket Discharge	$25,618	$128,090	$153,708	$4,141
John Behm Tunnel	$12,575	$62,874	$75,449	$7,752
Martin Run	$19,662	$98,312	$117,974	$7,027
Lower Rausch Creek	$12,500	$78,500	$91,000	$4,300
Totals	**$296,313**	**$1,481,565**	**$1,777,878**	**$85,698**

B. Funding Sources

Sources of funding for restoration design and construction have been identified and secured for portions of the required restoration measures. It is expected that many of these same funding sources will be available for design and construction of the additional treatment systems required.

Funding or in-kind support for watershed restoration and environmental education efforts in the Upper Swatara Creek Watershed has been provided by:

- Environmental Protection Agency (EPA) 319, 104 (b)(3) grants program.
- Office of Surface Mining (OSM) provided background water quality and flow data collection on discharges and streams targeted for improvement projects.
- PA DEP Growing Greener Environmental Stewardship/Watershed Protection and Technical Assistance Grant (TAG) programs.
- USDA Natural Resource Conservation Service (NRCS) provided technical assistance in remediation site review, survey and design.
- U. S. Geologic Survey (USGS) provided a multi-year monitoring and assessment program to assess stream quality improvements and the effectiveness of water treatment systems. USGS also provided technical assistance in designing pollution abatement systems and was instrumental in having Swatara Creek recognized under the EPA 319 National Monitoring Program.
- U. S. Department of Energy (DOE) supplied matching funds to develop a treatment system on Lorberry Creek that may have application throughout the entire Anthracite Region.

- Pa. Air National Guard 201st Red Horse Civil Engineer Flight provided equipment and construction assistance on the Martin Run Diversion Well project.

C. Additional Support for Watershed Restoration Efforts

- Pa. DCNR Bureau of State Parks coordinated all efforts concerning the Swatara State Park and the proposed lake. Assisted in the completion of the Lorberry Junction Wetland project. Also, was one of the key funding sources for the EPA 319 National Monitoring Program Project.
- Pa. DEP Bureau of Abandoned Mine Reclamation (BAMR), Wilkes Barre constructed the Lorberry Junction Wetland.
- Pa. DEP Bureau of Dams, Waterways and Wetlands provided technical assistance and cooperation in the mine drainage abatement efforts.
- Pa. DEP Bureau of Land & Water Conservation (LWC) assisted and appropriated EPA 319 and other funding sources for mine drainage abatement projects. Also, LWC was one of the key funding sources for the EPA 319 National Monitoring Program Project.
- Pa. DEP Bureau of Water Quality Management (WQM) Harrisburg provided data collection and assessment of water quality improvements both biological and chemical.
- Pa. DEP Bureau of Mining and Reclamation (BMR) assisted and appropriated EPA 104(b)(3) funds for mine drainage abatement projects.
- Pa. DEP District Mining Operations (DMO), Pottsville coordinated the water quality improvement effort in the mine drainage affected areas, data collection, assisted in acquiring funding for abatement projects, encouraged re-mining, provided technical assistance and project design, integrated with the local community.
- PA Fish and Boat Commission (PFBC) assisted in aquatic surveys.
- Pa. Department of Transportation (PennDOT) cooperated as the landowner and assisted in the Lorberry Junction Wetland Project.
- Schuylkill Conservation District (SCD) served as the primary funding administrator for water quality improvement projects and provided technical assistance in project design. Coordinated the water quality improvement effort in the mine drainage affected areas, data collection, assisted in acquiring funding for abatement projects. SCD was also involved in nutrient management and streambank stabilization in the farming areas near Pine Grove.
- Schuylkill County provided identification of landowners, sought funding for stream improvement projects and assisted in project design. Schuylkill County was also one of the key funding sources for the EPA 319 National Monitoring Program Project.
- Municipalities including 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.
- The Swatara Creek Watershed Association (SCWA) focuses on 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 on the 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 including 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.

PUBLIC INFORMATION AND PARTICIPATION

A. Partners and Stakeholders

Pa. DEP, Pottsville District Mining Office, and BAMR have been committed to coordinating reclamation efforts and water quality improvements in the watershed. The Pottsville District Mining Office will continue to assure that active mining operations will not negatively impact the watershed and that abandoned mine lands are re-mined and reclaimed to the maximum extent possible.

BAMR has implemented a comprehensive reclamation approach for the watershed to address AML and AMD problems. Several projects have been completed over the past five years and several other projects are designed for the next few years.

SCD works to improve water quality throughout Schuylkill County. The SCD administers six key water quality protection programs: nutrient management, erosion and sediment pollution control, environmental education, The Chesapeake Bay program, Coastal Non-Point Pollution program, and National Pollution Discharge Elimination System (NPDES) permitting. Conservation districts, sub-units of state government supported by state and county funding, are governed by locally appointed boards of volunteer citizen directors who have a long term interest in the welfare of their communities.

The SCWA focuses on the entire Swatara Watershed, which includes 4 counties, and emphasizes water quality improvements in addition to recreational improvements in the watershed. The NSCWA focuses primarily on the upper part of the watershed in Schuylkill County and addresses the mine drainage pollution. As stated previously, both associations work together on stream improvement projects and watershed awareness.

The USGS began a study in 1996 to evaluate the effectiveness of the use of limestone for mine drainage treatment in three AMD remediation projects in the Swatara Watershed. In addition, monitoring stations were installed at Ravine and Pine Grove to measure the cumulative effects of the treatments throughout the upper watershed. USGS was also instrumental in having Swatara Creek included in the EPA Section 319 National Monitoring Program. This project is the first National Monitoring Project that is focused on mine drainage and the land treatment practices needed to restore chemical, physical and biological integrity.

Local industries have been very cooperative and several have expressed interest in participating when they are needed. The Pennsylvania Coal Association (PCA), several coal companies, limestone quarries, landfills, and several local businesses have donated supplies, services, and expertise on many of the water quality restoration projects. Among the industries that have donated services or equipment are Arthur “Pat” Aungst Inc., Carmuese, PA limestone quarry, Hegins Mining Company, Harriman Coal Corporation, Blaschak Coal Corporation, White Pine Coal Company, Angelo and Reber Trucking, Commonwealth Environmental Services Landfill, and Pine Grove Landfill.

B. Outreach Activities

Outreach activities are a vital component of improving the overall health of the Upper Swatara Creek Watershed. Additionally, education and outreach will be a critical component in the remediation of the pollution problems of the prioritized sites identified in this report. Various levels of outreach will be required from governmental agencies and nonprofit groups working to alleviate the negative effect of pollution in the Upper Swatara Creek Watershed. Outreach activities must be focused on the general public, area businesses and landowners, farmers, and municipal officials. An overall educational mission must aim to inform these stakeholders of the causes, remediation, and prevention of pollution problems.

The SCD, through its various departments and programs, provides various forms of outreach to all stakeholders in the implementation of remedial actions of pollution problems in the Upper Swatara Creek Watershed. The SCD has active programs promoting the remediation of pollution from agriculture, AMD, erosion and sedimentation, and stormwater runoff. The SCD has a fulltime environmental educator, erosion and sediment control technicians, nutrient management technicians, and a County Natural Resource Specialist, who all provide outreach for their respective programs and activities. The SCD provides technical assistance for landowners, municipal officials, farmers, and the general public. The SCD also assists municipalities, farmers, and nonprofits obtain grant funding for educational and pollution remediation projects.

The NSCWA is a local watershed group providing outreach on issues affecting the Upper Swatara Creek Watershed. Its mission is to promote the environmental integrity of Swatara Creek, its tributaries and watershed that lie within the boundaries of Schuylkill County, Pa. To advocate the wise use and conservation of the natural resources in the watershed to the aesthetic, recreational and economic benefit of all concerned. Public meetings of the NSCWA are held every other month at the Sweet Arrow Lake County Park Clubhouse in Pine Grove, Pa. The NSCWA maintains a web site at www.nscwa.homestead.com. The organization is also involved in a cooperative effort with the PFBC, Roedersville Game and Fish Association, and the Friedensburg Fish and Game Association to run the Swatara Cooperative Trout Nursery. The nursery provides over 45,000 trout annually to the main stem of Upper Swatara Creek, its three major tributaries, and Sweet Arrow Lake. Individuals with disabilities are permitted to fish at Laurel Run Pond near the nursery.

Significant gains in public awareness of water quality improvements have been made as a result of the trout stocking program. Public respect for the Upper Swatara Creek has increased dramatically, especially for the main stem, which has been converted from a lifeless stream to a trout fishery. This is evidenced by the fact that the annual stream cleanups that previously yielded tons of debris are no longer required except after major storm events.

Knowledge gained from restoration efforts in the Upper Swatara Creek Watershed will continue to be distributed through the World Wide Web, PowerPoint presentations, and presentations at the Statewide Conference on AMD/AMR.

Members of the public, local community organizations and the media will be invited to attend meetings and will be provided press releases for important events such as review of final designs, contract bidding, groundbreaking, and dedication of completed treatment systems.

IMPLEMENTATION SCHEDULE AND EVALUATION

A. Implementation Schedule

The following implementation schedule is based upon the assumption that funding is available and approved and that landowner approval is available or has been obtained.

- ***Tracey Airhole Discharge***

Funding Received	Spring 2005
Design & Permitting	Summer 2005
Begin Construction	Spring 2006
Project Completion	Fall 2006

- ***Rowe Tunnel***

Apply for Funding	February 2007
Funding Awarded	October 2007
Design & Permitting	Spring 2008
Begin Construction	Fall 2008
Project Completion	Spring 2009

- ***Shadle Discharge***

Apply for Funding	February 2007
Funding Awarded	October 2007
Design & Permitting	Spring 2008
Begin Construction	Fall 2008
Project Completion	Spring 2009

- ***Clinton Discharge***

Apply for Funding	February 2007
Funding Awarded	October 2007
Design & Permitting	Spring 2008
Begin Construction	Fall 2008, early Spring 2009
Project Completion	Spring 2010

- ***Colket Discharge***

Apply for Funding	February 2008
Funding Awarded	October 2008
Design & Permitting	Spring 2009
Begin Construction	Fall 2010
Project Completion	Spring 2011

- ***John Behm Tunnel***

Apply for Funding	February 2008
Funding Awarded	October 2008
Design & Permitting	Spring 2009
Begin Construction	Fall 2010
Project Completion	Spring 2011

- ***Non-AMD Assessment***

Assessment started	2012 (or after AMD problems have all been addressed)

MILESTONES TO DETERMINE IF IMPLEMENTATION MEASURES ARE BEING MET

The scheduled dates in the projects planned for each year will serve as the implementation milestones of this plan. The SCD holds regular monthly meetings and the progress of the planned watershed restoration and grants will be discussed at those meetings. Additional meetings between SCD and the Pa. DEP Pottsville District Mining Office project advisors will be scheduled yearly to determine if the implementation schedule milestones are achieved and to chart progress of the projects. If the milestones are not achieved due to lack of funding, weather, or other unforeseen factors that might prevent construction of all of the scheduled projects in a given year, the group will continue to follow progress of the projects and reschedule uncompleted projects for the following year.

When construction of each project is completed, the evaluation process will begin and the conceptual designs of the next project will be reconsidered to determine if changes should be made prior to submittal of a proposal for the next grant.

Under the EPA 319 National Monitoring Program, USGS will continue to monitor several points in the watershed, particularly the Ravine monitoring station. The Ravine station monitors the cumulative impacts of all of the projects.

A. Water Quality Monitoring and Evaluation

Treatment systems will continue to be monitored on a regular basis. If performance of individual treatment systems is less than expected, the project partners will make adjustments to the treatment systems, as necessary, to try to improve results. Accumulated metals in the passive treatment systems will be flushed regularly to ensure that metals are not being retained in the system. If additional metals reductions or alkalinity increases are required at some systems, an evaluation of the design parameters will be made, and changes recommended. Chemical and physical parameter monitoring will follow the efficiency and progress of each AMD treatment system on a quarterly basis. Specific parameters that will be measured include Al, Fe, Mn, and Acidity. These parameters will be measured against applicable water quality criteria (see page 10). Aquatic biological surveys will be conducted annually during base flow conditions at selected reaches of receiving streams to determine the effects of treatment systems on the recovery of aquatic life. When the water quality parameters meet state standards, and as biological surveys show significant improvements, these criteria will be used to determine if milestones are being met.

The project partners will analyze water quality and benthic macroinvertebrate biometric data. Annual evaluations of performance of installed treatment systems, instream load reductions, and restoration of aquatic life will be held through meetings and discussions between USGS, SCD, Pa. DEP Pottsville District Mining Office, consultants, and any other individuals who could provide ideas or assistance in determining how restoration goals may be better achieved. Quarterly progress reports will be completed and submitted to SCD.

Since the TMDLs established load reductions for each of the discharges in the Upper Swatara Creek Watershed, these load reductions are the targets to be met in evaluating stream recovery. The Technical Committee will meet annually to evaluate the progress and milestones of the monitoring to determine if these TMDL load reductions are being met. Results of the previous year's monitoring will be used to calculate the loadings and percent reductions the completed projects achieve. The newly calculated loadings will be compared with the overall required TMDL loading reductions for the TMDL points for that discharge. The effects of the individual treatment systems on the watershed will be evaluated by comparisons with the downstream TMDL points. The comparisons and load reduction achievements will be used to determine what type of additional implementation measures are necessary to achieve the desired load reductions or if any improvements to the treatment systems efficiency need to be considered.

B. Remedial Actions

The project partners have assumed operation and maintenance responsibility for all the projects they have implemented in the watershed. The USGS has conducted a water quality monitoring program in the watershed for 8 years and has accumulated an impressive water quality database. These data have been very beneficial in the development of new AMD remediation project proposals and the evaluation of how well existing projects are functioning. The project partners are committed to continuing this monitoring for new project development and existing project operation and maintenance.

The project partners have developed a very close relationship and continue to partner with project development, grant writing, and water quality monitoring activities. SCD staff is also committed to the long-term operation and maintenance of the projects that they sponsor. The Conservation District's County Natural Resource Specialist will play a key role in project monitoring and maintenance coordination.

Annual evaluations of performance of installed treatment systems, instream load reductions, and restoration of aquatic life will be held through meetings and discussions between the project partners, consultants, and any other individuals who could provide ideas or assistance in determining how restoration goals may be better achieved.

ATTACHMENT A

Upper Swatara Creek Watershed Maps

ATTACHMENT B
Upper Swatara Creek Watershed Active Mining Permits

Active Mining Permits in the Swatara Creek Watershed

Permit No.	*Company & Operation Name*	*Operation Status*
54040102	Neumeister Coal Co.; Neumeister 2 Mine	Active surface mine.
54000102	RSK Mines; Harriman Keffers W Mine	Active surface mine.
54921303	Little Rock Coal Co.; Lykens Valley Mine	Active underground mine, Stage 2 approved.
54930102	Harriman Coal Corp.; Good Spring 1 S Mine	Active surface mine.
54970103	Harriman Coal Corp.; Keffers W Mine	Active surface mine.
54030202	Michael Coal Co.; Branchdale Mine	Active surface mine.
54773215	Jeddo Highland Coal Co.; Indian Head Mine	Active coal refuse reprocessing.
54830702	Swatara Coal Co.; Swatara Mine	Active coal refuse disposal. Coal refuse disposal facility.
54840205	Hegins Mining Co.; Hillside Breaker	Active surface mine.
54851317	Rhen Coal Co.; Skidmore Mine	Active underground mine.
54713018	Harriman Coal Corp.; Lincoln Mammoth Mine	Active surface mine.
54830206	Meadowbrook Coal Co., Inc.; Lorberry Mine	Active coal refuse reprocessing.
54850103	Michael Coal Co.; Tremont Mine	Active surface mine.
54851342	Little Buck Coal Co.; Little Buck Mine	Active underground mine.
54851347	New Lincoln Coal Co., Inc.; #1 Mine	Active underground mine, Stage 1/regraded.
54860109	Harriman Coal Corp.; Lincoln Mine	Active surface mine.
54861303	R & D Coal Co.; Buck Mountain Mine	Active underground mine.

54880203	Meadowbrook Coal Co., Inc.; Lincoln Refuse	Active coal refuse reprocessing.
54910206	Meadowbrook Coal Co., Inc.; Lincoln Refuse Mine	Active coal refuse reprocessing.
54920103	Harriman Coal Corp.; Tremont Twp. 3 Mine	Active surface mine.
54951302	HL & W Coal Co.; 7 Ft. Vein Deep Mine	Underground mine, reclamation complete.
54970104	Harriman Coal Corp.; Lincoln #6 Mine	Surface mine, not started.

ATTACHMENT C

Upper Swatara TMDL Reduction Summary Table

Sub-watershed	Discharge, TMDL Point or Completed Project	Priority	Status; Projected Construction Start	Average Flow (gpm)	Potential System Type	Potential Problems or Other Issues	Estimated Loadings (lb./day)	Estimated Reductions (%)
Swatara Creek – Headwaters to Ravine	**Blackwood Breaker**	**L**	N/A	250	Future re-mining & reclamation.	Active mining site.	Al = 0.37 Fe = 0.78 Mn = 2.78 Acidity = 138.11	N/A; active mining site.
	Hegins Run Oxic Limestone Channel	**X**	Completed 2000.	216	Four limestone retention cells.	Covered with compost and enlarged 2005.	Al = 10.93 Fe = 0.36 Mn = 3.86 Acidity = 69.70	Al = 30 Fe = 0 Mn = 5 Acidity = 30
	Pollys Run Project	**X**	Completed 1997.	8,540	Streambank stabilization & rechanneling.		Al = N/A Fe = N/A Mn = N/A Acidity = N/A	N/A
	Limestone Channel	**X**	Completed 1997.	1,549	Limestone channel to increase pH.	Erosion; potential for stream loss to underground deep mines..	Al = 13.17 Fe = 21.35 Mn = 6.29 Acidity = 0	Al = 70 Fe = 85 Mn = 5 Acidity = 0
	Swatara Creek Diversion Wells	**X**	Completed 1995.	3,347	Two limestone diversion wells.	Erosion, sedimentation at intakes; repaired 2005.	Al = 78.46 Fe = 88.47 Mn = 18.73 Acidity = 0	Al = 50 Fe = 65 Mn = 10 Acidity = 0
	Swatara Creek Headwaters - Anoxic Limestone Drain	**X**	Completed 1997.	522	Anoxic limestone drain.	Erosion; repaired and enlarged 2005.	Al = 2.93 Fe = 14.84 Mn = 2.97 Acidity = 86.03	Al = 55 Fe = 70 Mn = 20 Acidity = 45

Sub-watershed	Discharge, TMDL Point or Completed Project	Priority	Status; Projected Construction Start	Average Flow (gpm)	Potential System Type	Potential Problems or Other Issues	Estimated Loadings (lb./day)	Estimated Reductions (%)
Middle Creek	**Miscellaneous Improvements**	**L**	N/A	1,257	Re-mining culm piles; removing silt piles.		Al = 9.51 Fe = 33.20 Mn = 13.28 Acidity = 10.91	No project
	Clinton #1 Discharge	**H**	2010	500	Limestone drain w/aerobic wetland		Al = 0 Fe = 8.01 Mn = 2.13 Acidity = 36.48	Al = 0 Fe = 75 Mn = 15 Acidity = 80
Coal Run	**Clinton #2 Discharge**	**H**	2010	1,377	Aerobic wetland with limestone enhancement.		Al = 3.95 Fe = 31.32 Mn = 17.41 Acidity = 0	Al = 15 Fe = 50 Mn = 0 Acidity = 0
Good Spring Creek	**Tracy Airhole Discharge**	**H**	2006	1,964	Aerobic wetland at source.		Al = 2.57 Fe = 217.89 Mn = 37.11 Acidity = 0	Al = 50 Fe = 70 Mn = 10 Acidity = 0
	John Behm Tunnel	**H**	Stream channel reconstruction completed 1998. (2011)	250	Aerobic wetland.	Topography does not lend itself to installing an aerobic wetland.	Al = 0 Fe = 12.01 Mn = 2.10 Acidity = 40.53	Al = 0 Fe = 50 Mn = 5 Acidity = 40

Sub-watershed	Discharge, TMDL Point or Completed Project	Priority	Status; Projected Construction Start	Average Flow (gpm)	Potential System Type	Potential Problems or Other Issues	Estimated Loadings (lb./day)	Estimated Reductions (%)
Good Spring Creek	**UNT of Good Spring Creek**	**M**	By 2010	N/A	Stream channel relocation.	Sedimentation.	Al = N/A Fe = N/A Mn = N/A Acidity = N/A	N/A
	Donaldson to Tremont	**M**	N/A	7,937	Land reclamation.	Erosion, sedimentation.	Al = 72.63 Fe = 247.83 Mn = 90.36 Acidity = 0	Al = 20 Fe = 30 Mn = 10 Acidity = 0
	I-81 to Donaldson	**M**	By 2010	2,400	Coal refuse & silt removal; overbank wetland and stream restoration.	Erosion, sedimentation.	Al = 0 Fe = 230.58 Mn = 43.23 Acidity = 0	Al = 0 Fe = 30 Mn = 10 Acidity = 0
Lower Rausch Creek	**Lower Rausch Creek Wetland**	**H**	Repairs: 2006	3,061	Repairs to current wetland system.		Al = 4.75 Fe = 9.50 Mn = 4.73 Acidity = 0	Al = 20 Fe = 40 Mn = 10 Acidity = 0
	Relocation of Lower Rausch Creek	**X**	Completed 1991.	N/A	Relocation to keep stream flow out of mine pool.		Al = N/A Fe = N/A Mn = N/A Acidity = N/A	N/A
	Orchard South Discharge	**X**	Completed 1995.	22	Anoxic/oxic limestone drain.	System clogged; reconstruction planned for 2006.	Al = 1.20 Fe = 9.27 Mn = 1.51 Acidity = 13.42	Al = 60 Fe = 75 Mn = 15 Acidity = 80

Sub-watershed	Discharge, TMDL Point or Completed Project	Priority	Status; Projected Construction Start	Average Flow (gpm)	Potential System Type	Potential Problems or Other Issues	Estimated Loadings (lb./day)	Estimated Reductions %
Lorberry Creek	**Rowe Tunnel**	**H**	2009	2,841	Aerobic wetland; upstream land restoration.		Al = 57.19 Fe = 421.26 Mn = 70.71 Acidity = 461.26	Al = 65 Fe = 70 Mn = 30 Acidity = 85
	Rowe Tunnel Discharge Treatment	**X**	LDW completed 1998; aerobic wetland & Aquafix system completed 2001.	3,233	Additional aerobic wetlands to address remaining 2,300 gpm flow.		Al = 33.94 Fe = 228.42 Mn = 63.17 Acidity = 335.04	Al = 70 Fe = 85 Mn = 25 Acidity = 80
	Shadle Discharge	**H**	2009	11	Limestone drain w/anaerobic wetland	Limited space to treat discharge.	Al = 1.28 Fe = 35.62 Mn = 1.84 Acidity = 79.71	Al = 75 Fe = 85 Mn = 15 Acidity = 80
	Lorberry Junction Strip Mine Pits Reclamation	**X**	Completed 1995.	N/A	Mine land reclamation.		Al = N/A Fe = N/A Mn = N/A Acidity = N/A	N/A
	Lorberry Junction Wetland	**X**	Completed 1997.	3,061	Aerobic wetland	Highly visible; public education site.	Al = 40.26 Fe = 80.48 Mn = 40.08 Acidity = 0	Al = 20 Fe = 45 Mn = 5 Acidity = 0
	Stumps Run Reclamation Projects #1, #2, & #3	**X**	Completed 1994, 1995, & 1996 respectively.	682	Mine land reclamation to reduce sedimentation.		Al = 1.74 Fe = 3.73 Mn = 1.69 Acidity = 0	Al = 25 Fe = 35 Mn = 5 Acidity = 0

Sub-watershed	Discharge, TMDL Point or Completed Project	Priority	Status; Projected Construction Start	Average Flow (gpm)	Potential System Type	Potential Problems or Other Issues	Estimated Loadings (lb./day)	Estimated Reductions %
Martin Run	**Colket Discharge**	**H**	2011	156	Aerobic wetland.		Al = 0.64 Fe = 42.84 Mn = 2.95 Acidity = 31.25	Al = 20 Fe = 55 Mn = 10 Acidity = 70
	Martin Run	**H**	Current site conditions prevent completing the project at this time.	N/A	Aerobic wetland.		Al = N/A Fe = N/A Mn = N/A Acidity = N/A	N/A
	Limestone Diversion Well	**X**	Completed 1996.	689	Limestone Diversion Well	Streambank erosion & sedimentation; metals precipitate in stream channel.	Al = 5.07 Fe = 46.14 Mn = 6.90 Acidity = 11.52	Al = 65 Fe = 35 Mn = 0 Acidity = 70
Upper Little Swatara Creek	**Adopt-A-Stream Project**	**X**	Completed.	N/A	Streambank stabilization; riparian buffers planted.	Streambank erosion & sedimentation.	Al = N/A Fe = N/A Mn = N/A Acidity = N/A	N/A

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