SANDY CREEK WATERSHED TMDL
Clearfield County

Prepared for:

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TMDL[1]
Sandy Creek Watershed
Clearfield County, Pennsylvania

INTRODUCTION

This report presents the Total Maximum Daily Load (TMDL) developed for stream segments in the Sandy Creek Watershed (Attachment A). This was done to address impairments noted on the 1996, 1998, 2002, 2004, and 2006 Pennsylvania Section 303(d) lists required under the Clean Water Act and covers fourteen segments on this list (Table 1). High levels of metals and depressed pH caused these impairments. All impairments resulted from acid drainage from abandoned coal mines. The TMDL addresses the three primary metals (iron, manganese, aluminum) associated with acid mine drainage (AMD) and pH.

Table 1. Sandy Creek Segments Addressed

State Water Plan (SWP) Subbasin: 08-C Susquehanna River								
Year	**Miles**	**Segment ID**	**DEP Stream Code**	**Stream Name**	**Designated Use**	**Data Source**	**Source**	**EPA 305(b) Cause Code***
1996	4.2	7161	25948	Sandy Creek	CWF	305(b) Report	RE	Metals, Other Inorganics
1998	4.27	7161	25948	Sandy Creek	CWF	SWAP	AMD	Metals, Other Inorganics
2002	4.1	990819-1400-LMS	25948	Sandy Creek	CWF	Unassessed Waters	AMD	Metals, Other Inorganics, pH
2004	4.1	990819-1400-LMS	25948	Sandy Creek	CWF	Unassessed Waters	AMD	Metals, Other Inorganics, pH
2006	4.11	11113	25948	Sandy Creek	CWF	Unassessed Waters	AMD	Metals, pH
2004	0.7	990819-1400-LMS	25949	UNT Sandy Creek	CWF	Unassessed Waters	AMD	Metals, Other Inorganics, pH
2006	0.68	11115	25949	UNT Sandy Creek	CWF	Unassessed Waters	AMD	Metals, pH
2004	0.6	990819-1400-LMS	25950	UNT Sandy Creek	CWF	Unassessed Waters	AMD	Metals, Other Inorganics, pH
2006	0.57	11115	25950	UNT Sandy Creek	CWF	Unassessed Waters	AMD	Metals, pH
2004	0.7	990819-1400-LMS	25951	UNT Sandy Creek	CWF	Unassessed Waters	AMD	Metals, Other Inorganics, pH
2006	0.7	11115	25951	UNT Sandy Creek	CWF	Unassessed Waters	AMD	Metals, pH
2006	1.2	5968	25951	UNT Sandy Creek	CWF	Unassessed Waters	AMD	Metals, pH

[1] Pennsylvania's 1996, 1998, 2002, 2004, and 2006 Section 303(d) lists were approved by the Environmental Protection Agency (USEPA). The 1996 Section 303(d) list provides the basis for measuring progress under the 1996 lawsuit settlement of *American Littoral Society and Public Interest Group of Pennsylvania v. EPA.*

State Water Plan (SWP) Subbasin: 08-C Susquehanna River								
Year	***Miles***	***Segment ID***	***DEP Stream Code***	***Stream Name***	***Designated Use***	***Data Source***	***Source***	***EPA 305(b) Cause Code****
2004	0.6	20030929-1833-JCO	25952	UNT Sandy Creek	CWF	Unassessed Waters	AMD	pH, Metals
2006	0.59	5968	25952	UNT Sandy Creek	CWF	Unassessed Waters	AMD	Metals, pH
2006	0.53	5968	25953	UNT Sandy Creek	CWF	Unassessed Waters	AMD	Metals, pH
2006	0.67	5968	25954	UNT Sandy Creek	CWF	Unassessed Waters	AMD	Metals, pH
2004	0.7	990819-1400-LMS	25955	UNT Sandy Creek	CWF	Unassessed Waters	AMD	Metals, Other Inorganics, pH
2006	0.72	11115	25955	UNT Sandy Creek	CWF	Unassessed Waters	AMD	Metals, pH
2004	0.8	990819-1400-LMS	25956	UNT Sandy Creek	CWF	Unassessed Waters	AMD	Metals, Other Inorganics, pH
2006	0.75	11115	25956	UNT Sandy Creek	CWF	Unassessed Waters	AMD	Metals, pH
2006	0.67	5968	25957	UNT Sandy Creek	CWF	Unassessed Waters	AMD	Metals, pH
2006	1.57	5968	25958	UNT Sandy Creek	CWF	Unassessed Waters	AMD	Metals, pH
2006	0.77	5968	25959	UNT Sandy Creek	CWF	Unassessed Waters	AMD	pH, Metals
2006	1.64	5968	25960	UNT Sandy Creek	CWF	Unassessed Waters	AMD	pH, Metals

See Attachment B, Excerpts Justifying Changes Between the 1996, 1998, 2002, 2004, and 2006 Section 303(d) lists.
The use designations for the stream segments in this TMDL can be found in PA Title 25 Chapter 93.

*Other inorganics listings are not included in the 2006 Integrated List; therefore, they are not addressed in the TMDL.

CWF = Cold Water Fishes
RE = Resource Extraction
AMD = Abandoned Mine Drainage

LOCATION

The Sandy Creek Watershed is approximately 17.3 square miles in area. The town of Frenchville, Clearfield County, Pennsylvania is located in the central, western side of the watershed. Sandy Creek flows about ten miles south from its headwaters in Girard Township, Clearfield County, until its confluence with the West Branch Susquehanna River in Covington Township, Clearfield County. The headwaters of Sandy Creek are located in a forested area upstream of coal areas. The coal mined areas are located in the southern half of the watershed. Sandy Creek Watershed can be accessed traveling west on Interstate 80 to exit 147. Take State Route 144 to State Route 879. State Route 879 bisects the watershed near the town of Frenchville.

SEGMENTS ADDRESSED IN THIS TMDL

The Sandy Creek Watershed is affected by pollution from AMD. This pollution has caused high levels of metals and low pH in the mainstem of Sandy Creek and several of its tributaries. About four miles of the mainstem of Sandy Creek are impaired, beginning at river mile 4.06 and continuing downstream to its confluence with the West Branch Susquehanna River. There are twelve unnamed tributaries to Sandy Creek that are impaired by AMD.

CLEAN WATER ACT REQUIREMENTS

Section 303(d) of the 1972 Clean Water Act requires states, territories, and authorized tribes to establish water quality standards. The water quality standards identify the uses for each waterbody and the scientific criteria needed to support that use. Uses can include designations for drinking water supply, contact recreation (swimming), and aquatic life support. Minimum goals set by the Clean Water Act require that all waters be “fishable” and “swimmable.”

Additionally, the federal Clean Water Act and the U.S. Environmental Protection Agency’s (USEPA) implementing regulations (40 CFR Part 130) require:

- States to develop lists of impaired waters for which current pollution controls are not stringent enough to meet water quality standards (the list is used to determine which streams need TMDLs);

- States to establish priority rankings for waters on the lists based on severity of pollution and the designated use of the waterbody; states must also identify those waters for which TMDLs will be developed and a schedule for development;

- States to submit the list of waters to USEPA every two years (April 1 of the even numbered years);

- States to develop TMDLs, specifying a pollutant budget that meets state water quality standards and allocate pollutant loads among pollution sources in a watershed, e.g., point and nonpoint sources; and

- USEPA to approve or disapprove state lists and TMDLs within 30 days of final submission.

Despite these requirements, states, territories, authorized tribes, and USEPA had not developed many TMDLs since 1972. Beginning in 1986, organizations in many states filed lawsuits against the USEPA for failing to meet the TMDL requirements contained in the federal Clean Water Act and its implementing regulations. While USEPA has entered into consent agreements with the plaintiffs in several states, many lawsuits still are pending across the country.

In the cases that have been settled to date, the consent agreements require USEPA to backstop TMDL development, track TMDL development, review state monitoring programs, and fund studies on issues of concern (e.g., AMD, implementation of nonpoint source Best Management Practices, etc.). These TMDLs were developed in partial fulfillment of the 1996 lawsuit settlement of *American Littoral Society and Public Interest Group of Pennsylvania v. EPA.*

SECTION 303(D) LISTING PROCESS

Prior to developing TMDLs for specific waterbodies, there must be sufficient data available to assess which streams are impaired and should be on the Section 303(d) list. With guidance from the USEPA, the states have developed methods for assessing the waters within their respective jurisdictions.

The primary method adopted by the Pennsylvania Department of Environmental Protection (PADEP) for evaluating waters changed between the publication of the 1996 and 1998 Section 303(d) lists. Prior to 1998, data used to list streams were in a variety of formats, collected under differing protocols. Information also was gathered through the Section 305(b)[2] reporting process. PADEP is now using the Unassessed Waters Protocol (UWP), a modification of the USEPA Rapid Bioassessment Protocol II (RPB-II), as the primary mechanism to assess Pennsylvania's waters. The UWP provides a more consistent approach to assessing Pennsylvania's streams.

The assessment method requires selecting representative stream segments based on factors such as surrounding land uses, stream characteristics, surface geology, and point source discharge locations. The biologist selects as many sites as necessary to establish an accurate assessment for a stream segment; the length of the stream segment can vary between sites. All the biological surveys include kick-screen sampling of benthic macroinvertebrates, habitat surveys, and measurements of pH, temperature, conductivity, dissolved oxygen, and alkalinity. Benthic macroinvertebrates are identified to the family level in the field.

After the survey is completed, the biologist determines the status of the stream segment. The decision is based on the performance of the segment using a series of biological metrics. If the stream is determined to be impaired, the source and cause of the impairment is documented. An impaired stream must be listed on the state's Section 303(d) list with the documented source and cause. A TMDL must be developed for the stream segment. A TMDL is for only one pollutant. If a stream segment is impaired by two pollutants, two TMDLs must be developed for that stream segment. In order for the process to be more effective, adjoining stream segments with the same source and cause listing are addressed collectively, and on a watershed basis.

[2] Section 305(b) of the Clean Water Act requires a biannual description of the water quality of the waters of the state.

BASIC STEPS FOR DETERMINING A TMDL

Although all watersheds must be handled on a case-by-case basis when developing TMDLs, there are basic processes or steps that apply to all cases. They include:

1. Collection and summarization of pre-existing data (watershed characterization, inventory contaminant sources, determination of pollutant loads, etc.);
2. Calculate TMDL for the waterbody using USEPA approved methods and computer models;
3. Allocate pollutant loads to various sources;
4. Determine critical and seasonal conditions;
5. Submit draft report for public review and comments; and
6. USEPA approval of the TMDL.

This document will present the information used to develop the Sandy Creek Watershed TMDL.

WATERSHED BACKGROUND

The Sandy Creek Watershed lies within the Pittsburgh Low Plateau Section of the Appalachian Plateaus Province. There is a vertical drop in the watershed of 1,045 feet from its headwaters to its mouth. The average annual precipitation is 42 inches. The region is characterized by warm summers and long, cold winters. Temperatures change frequently and sometimes rapidly.

Sandy Creek Watershed is dominated primarily by forested land, constituting 75.2 percent of the area. The northern half of the watershed is almost totally forested with the headwaters of Sandy Creek beginning in Moshannon State Forest. Agriculture comprises 14.1 percent of the land use and is located along the western edge and middle section of the watershed. Disturbed land (abandoned coal mines, quarries, etc.) comprises over ten percent of the watershed. The majority of the mining that was done in the watershed is located below State Route 879 towards the eastern side of the Sandy Creek Watershed.

The surficial geology in the Sandy Creek Watershed is primarily sandstone rock, which accounts for 77 percent of the watershed. Interbedded sedimentary rock comprises the remaining 23 percent of the area. The predominant soil association in the watershed is Hazelton-Cookport-Ernest, accounting for 60.5 percent of the watershed. This association is found in the forest areas. Almost 11 percent of the watershed is considered an Udorthents-Ernest-Giplin soil association. An Udorthents soil has been excavated; this soil association is found on the southeastern portion of the watershed where most of the mining occurred. Currently, the entire basin of Sandy Creek and its tributaries are listed as cold-water fishes (CWF) by Pennsylvania Code Title 25.

Historical data shows that mining began in this area in the early nineteenth century and continued until the 1980s. The majority of mining done in the area was strip mining. Currently, there is no mining activity in the watershed. The last two mining companies in the watershed were Al Hamilton Contacting Co. and K & J Coal Co. Al Hamilton Contracting Co. (Permit #17793169) released its final bond on October 6, 1997. The area has been reclaimed to meet standards. Another bond for Al Hamilton Contracting Co. (Permit #4577SM8) was forfeited on

September 30, 2003 and Al Hamilton Contacting Co. has declared bankruptcy and no longer exists. Discharges from this permit have alternated between being treated and not treated. Currently, the discharges to Sandy Creek are being treated under a federal order.

K & J Coal Co., permit #4571BSM15, began mining in the watershed in the 1970s. It was recommended the bond be forfeited when the discharge was not meeting standards. The mined area had been reclaimed to meet standards. The bond was forfeited on February 2, 2003. Treatment on the discharge after the bond forfeiture was discontinued because of low flow, with larger discharges being located in the surrounding area (Mital, 2004). When permit #4571BSM15 was issued, very little bond was posted, leaving minimal bond to treat the discharge.

In 1931, the Pennsylvania Fish and Boat Commission (Sorenson, 1931) approved Sandy Creek to be stocked with brook trout in the lower five miles. At that time brook and brown trout, along with minnows were present in the creek (Sorenson, 1931). In 1975, the PFBC reassessed Sandy Creek and removed 1.5 miles from the approved stocking length. The creek was no longer stocked below Frenchville because of acidic water conditions from natural causes and mine discharges (Hollender and Marcinko, 1975). And then on December 15, 1980, the remaining portion of Sandy Creek was removed from the trout stocking list because of low fertility and pH (Hollender and others, 1980). Sandy Creek contributed 4,200 pounds of acid per day to the West Branch Susquehanna, according to historical reports (Rhodes and Davis, 1968).

AMD METHODOLOGY

A two-step approach is used for the TMDL analysis of AMD impaired stream segments. The first step uses a statistical method for determining the allowable instream concentration at the point of interest necessary to meet water quality standards. This is done at each point of interest (sample point) in the watershed. The second step is a mass balance of the loads as they pass through the watershed. Loads at these points will be computed based on average annual flow.

The statistical analysis described below can be applied to situations where all of the pollutant loading is from nonpoint sources, as well as those where there are both point and nonpoint sources. The following defines what are considered point sources and nonpoint sources for the purposes of our evaluation; point sources are defined as permitted discharges or a discharge that has a responsible party, nonpoint sources are then any pollution sources that are not point sources. For situations where all of the impact is due to nonpoint sources, the equations shown below are applied using data for a point in the stream. The load allocation made at that point will be for all of the watershed area that is above that point. For situations where there are point source impacts alone, or in combination with nonpoint sources, the evaluation will use the point source data and perform a mass balance with the receiving water to determine the impact of the point source.

Allowable loads are determined for each point of interest using Monte Carlo simulation. Monte Carlo simulation is an analytical method meant to imitate real-life systems, especially when other analyses are too mathematically complex or too difficult to reproduce. Monte Carlo simulation calculates multiple scenarios of a model by repeatedly sampling values from the probability distribution of the uncertain variables and using those values to populate a larger data set. Allocations were applied uniformly for the watershed area specified for each allocation point. For each source and pollutant, it was assumed that the observed data were log-normally distributed. Each pollutant source was evaluated separately using @Risk[3] by performing 5,000 iterations to determine the required percent reduction so that the water quality criteria, as defined in the *Pennsylvania Code, Title 25 Environmental Protection, Department of Environmental Protection, Chapter 93, Water Quality Standards*, will be met instream at least 99 percent of the time. For each iteration, the required percent reduction is:

PR = maximum {0, (1-Cc/Cd)} where (1)

PR = required percent reduction for the current iteration

Cc = criterion in mg/l

Cd = randomly generated pollutant source concentration in mg/l based on the observed data

Cd = RiskLognorm(Mean, Standard Deviation) where (1a)
Mean = average observed concentration

Standard Deviation = standard deviation of observed data

The overall percent reduction required is the 99th percentile value of the probability distribution generated by the 5,000 iterations, so that the allowable long-term average (LTA) concentration is:

LTA = Mean * (1 – PR99) where (2)

LTA = allowable LTA source concentration in mg/l

Once the allowable concentration and load for each pollutant is determined, mass-balance accounting is performed starting at the top of the watershed and working down in sequence. This mass-balance or load tracking is explained below.

Load tracking through the watershed utilizes the change in measured loads from sample location to sample location, as well as the allowable load that was determined at each point using the @Risk program.

There are two basic rules that are applied in load tracking; rule one is that if the sum of the measured loads that directly affect the downstream sample point is less than the measured load at the downstream sample point it is indicative that there is an increase in load between the points being evaluated, and this amount (the difference between the sum of the upstream and

[3] @Risk – Risk Analysis and Simulation Add-in for Microsoft Excel, Palisade Corporation, Newfield, NY, 1990-1997.

downstream loads) shall be added to the allowable load(s) coming from the upstream points to give a total load that is coming into the downstream point from all sources. The second rule is that if the sum of the measured loads from the upstream points is greater than the measured load at the downstream point this is indicative that there is a loss of instream load between the evaluation points, and the ratio of the decrease shall be applied to the load that is being tracked (allowable load(s)) from the upstream point.

Tracking loads through the watershed gives the best picture of how the pollutants are affecting the watershed based on the information that is available. The analysis is done to insure that water quality standards will be met at all points in the stream. The TMDL must be designed to meet standards at all points in the stream, and in completing the analysis, reductions that must be made to upstream points are considered to be accomplished when evaluating points that are lower in the watershed. Another key point is that the loads are being computed based on average annual flow and should not be taken out of the context for which they are intended, which is to depict how the pollutants affect the watershed and where the sources and sinks are located spatially in the watershed.

For pH TMDLs, acidity is compared to alkalinity as described in the following section. Each sample point used in the analysis of pH by this method must have measurements for total alkalinity and total acidity. Net alkalinity is alkalinity minus acidity, both in units of milligrams per liter (mg/l) $CaCO_3$. Statistical procedures are applied, using the average value for total alkalinity at that point as the target to specify a reduction in the acid concentration. By maintaining a net alkaline stream, the pH value will be in the range between six and eight. This method negates the need to specifically compute the pH value, which for streams affected by low pH from AMD may not a true reflection of acidity. This method assures that Pennsylvania's standard for pH is met when the acid concentration reduction is met.

Information for the TMDL analysis performed using the methodology described above is contained in the "TMDLs by Segment" section of this report.

TMDL ENDPOINTS

One of the major components of a TMDL is the establishment of an instream numeric endpoint, which is used to evaluate the attainment of acceptable water quality. An instream numeric endpoint, therefore, represents the water quality goal that is to be achieved by implementing the load reductions specified in the TMDL. The endpoint allows for comparison between observed instream conditions and conditions that are expected to restore designated uses. The endpoint is based on either the narrative or numeric criteria available in water quality standards.

Because of the nature of the pollution sources in the watershed, the TMDLs component makeup will be load allocations that are specified above a point in the stream segment. All allocations will be specified as long-term average daily concentrations. These long-term average daily concentrations are expected to meet water quality criteria 99 percent of the time. Pennsylvania Title 25 Chapter 96.3(c) specifies that a minimum 99 percent level of protection is required. All metals criteria evaluated in this TMDL are specified as total recoverable. Pennsylvania does have dissolved criteria for iron; however, the data used for this analysis report iron as total recoverable. Table 2 shows the water quality criteria for the selected parameters.

Table 2. Applicable Water Quality Criteria

Parameter	Criterion Value (mg/l)	Total Recoverable/Dissolved
Aluminum (Al)	0.75	Total Recoverable
Iron (Fe)	1.50 0.3	30-day average; Total Recoverable Dissolved
Manganese (Mn)	1.00	Total Recoverable
Sulfate	250	Total Recoverable
pH *	6.0-9.0	N/A

*The pH values shown will be used when applicable. In the case of freestone streams with little or no buffering capacity, the TMDL endpoint for pH will be the natural background water quality. These values are typically as low as 5.4 (Pennsylvania Fish and Boat Commission).

TMDL ELEMENTS (WLA, LA, MOS)

A TMDL equation consists of a wasteload allocation (WLA), load allocation (LA) and a margin of safety (MOS). The WLA is the portion of the load assigned to point sources. The LA is the portion of the load assigned to nonpoint sources. The MOS is applied to account for uncertainties in the computational process. The MOS may be expressed implicitly (documenting conservative processes in the computations) or explicitly (setting aside a portion of the allowable load).

TMDL ALLOCATIONS SUMMARY

Methodology for dealing with pH impairments is discussed in Attachment C. Information for the TMDL analysis using the methodology described above is contained in the TMDLs by segment section in Attachment D.

This TMDL will focus remediation efforts on the identified numerical reduction targets for each watershed. As changes occur in the watershed, the TMDL may be reevaluated to reflect current conditions. Table 3 presents the estimated reductions identified for all points in the watershed. Attachment D gives detailed TMDLs by segment analysis for each allocation point.

Table 3. Summary Table–Sandy Creek Watershed

Station	Parameter	Existing Load (lbs/day)	Allowable Load (lbs/day)	WLA	LA	Load Reduction (lbs/day	Percent Reduction
SC3.0	Sandy Creek above impaired segment						
	Fe	ND	NA	NA	NA	0.0	0
	Mn	6.5	6.5	0.0	6.5	0.0	0
	Al	ND	NA	NA	NA	0.0	0
	Acidity	900.1	197.7	0.0	197.7	702.4	78
	Alkalinity	753.4					
SCT4.0	UNT 25960 near confluence with Sandy Creek						
	Fe	ND	NA	NA	NA	0.0	0

Station	Parameter	Existing Load (lbs/day)	Allowable Load (lbs/day)	WLA	LA	Load Reduction (lbs/day	Percent Reduction
	Mn	0.4	0.4	0.0	0.4	0.0	0
	Al	ND	NA	NA	NA	0.0	0
	Acidity	27.2	17.2	0.0	17.2	10.0	37
	Alkalinity	111.0					
SCT3.0	UNT 25955 near confluence with Sandy Creek						
	Fe	ND	NA	NA	NA	0.0	0
	Mn	5.8	4.3	0.0	4.3	1.5	26
	Al	8.0	3.4	0.0	3.4	4.6	58
	Acidity	158.1	23.7	0.0	23.7	134.4	85
	Alkalinity	44.3					
SCT2.0	Mouth of UNT 25951						
	Fe	29.3	2.9	0.0	2.9	26.4	90
	Mn	24.7	2.5	0.0	2.5	22.2	90
	Al	14.7	1.9	0.0	1.9	12.8	87
	Acidity	388.1	62.0	0.0	62.0	326.1	84
	Alkalinity	124.6					
SCT1.0	Mouth of UNT 25950						
	Fe	19.6	4.1	0.0	4.1	15.5	79
	Mn	190.4	0.0	0.0	0.0	190.4	100
	Al	98.3	1.0	0.0	1.0	97.3	99
	Acidity	1,205.6	0.0	0.0	0.0	1,205.6	100
	Alkalinity	0.0					
SC2.0	Sandy Creek below UNT 25950						
	Fe	96.6	58.9	0.0	58.9	0.0	0
	Mn	642.3	18.9	0.0	18.9	409.3	96
	Al	397.1	23.6	0.0	23.6	258.8	92
	Acidity	7,839.0	235.7	0.0	235.7	5,224.8	96
	Alkalinity	650.5					
SC1.0	Mouth of Sandy Creek						
	Fe	263.6	78.5	0.0	78.5	147.1	65
	Mn	627.7	19.6	0.0	19.6	0.0	0
	Al	332.2	19.6	0.0	19.6	0.2	1
	Acidity	5,860.2	175.3	0.0	175.3	1.5	1
	Alkalinity	711.1					

ND, not detected. NA, meets WQS; no TMDL necessary.

In the instance that the allowable load is equal to the measured load (e.g. manganese SC3.0 Table 3), the simulation determined that water quality standards are being met instream 99 percent of the time and therefore no TMDL is necessary for the parameter at that point. Although no TMDL is necessary, the loading at the point is considered at the next downstream point. In addition, when all measured values are below the method detection limit, denoted by ND (e.g. iron point SC3.0, Table 3), no TMDL is necessary. In this case the accounting for upstream loads is not carried through to the next downstream point. Rather, there is a disconnect noted and the allowable load is considered to start over because the water quality standard is satisfied.

RECOMMENDATIONS

There is currently no watershed group in the Sandy Creek Watershed. However, the Mosquito Creek Sportsman's Association is active in this watershed. It is recommenced their activities are given continued support in the watershed.

The PADEP BAMR administers an environmental regulatory program for all mining activities, including mine subsidence regulation, mine subsidence insurance, and coal refuse disposal. PADEP BAMR also conducts a program to ensure safe underground bituminous mining and protect certain structures from subsidence; administers a mining license and permit program; administers a regulatory program for the use, storage, and handling of explosives; and provides for training, examination, and certification of applicant's blaster's licenses. In addition, PADEP BAMR administers a loan program for bonding anthracite underground mines and for mine subsidence, administers the EPA Watershed Assessment Grant Program, the Small Operator's Assistance Program (SOAP), and the Remining Operator's Assistance Program (ROAP).

Reclaim PA is PADEP's initiative designed to maximize reclamation of the state's quarter million acres of abandoned mineral extraction lands. Abandoned mineral extraction lands in Pennsylvania constitute a significant public liability - more than 250,000 acres of abandoned surface mines, 2,400 miles of stream polluted with AMD, over 7,000 orphaned and abandoned oil and gas wells, widespread subsidence problems, numerous hazardous mine openings, mine fires, abandoned structures, and affected water supplies – representing as much as one third of the total problem nationally.

Since the 1960s, Pennsylvania has been a national leader in establishing laws and regulations to ensure mine reclamation and well plugging occur after active operation is completed. Mine reclamation and well plugging refers to the process of cleaning up environmental pollutants and safety hazards associated with a site and returning the land to a productive condition, similar to PADEP's Brownfields Program. Pennsylvania is striving for complete reclamation of its abandoned mines and plugging of its orphan wells. Realizing this task is no small order, PADEP has developed Reclaim PA, a collection of concepts to make abandoned mine reclamation easier. These concepts include legislative, policy, and land management initiatives designed to enhance mine operator/volunteer/PADEP reclamation efforts. Reclaim PA has the following four objectives:

- To encourage private and public participation in abandoned mine reclamation efforts.
- To improve reclamation efficiency through better communication between reclamation partners.
- To increase reclamation by reducing remining risks.
- To maximize reclamation funding by expanding existing sources and exploring new sources.

PUBLIC PARTICIPATION

In the beginning stages of the Sandy Creek Watershed TMDL, an early notification letter was sent to inform stakeholders and interested parties that a TMDL would be completed in their watershed and offer them the opportunity to submit information for TMDL development. The PADEP considered all the information submitted and all pertinent information was included in the report.

Public notice of the draft TMDL was published in the *Pennsylvania Bulletin* on January 8, 2005, and The Progress on January 27, 2005, to foster public comment on the allowable loads calculated. A public meeting was held on February 2, 2005, at the Karthaus Fire Hall in Karthaus, Pa., to discuss the proposed TMDL.

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Hollender, Wilberding, and Kepler. 1980. Stream Examination Report – Sandy Creek. Pennsylvania Fish Commission.

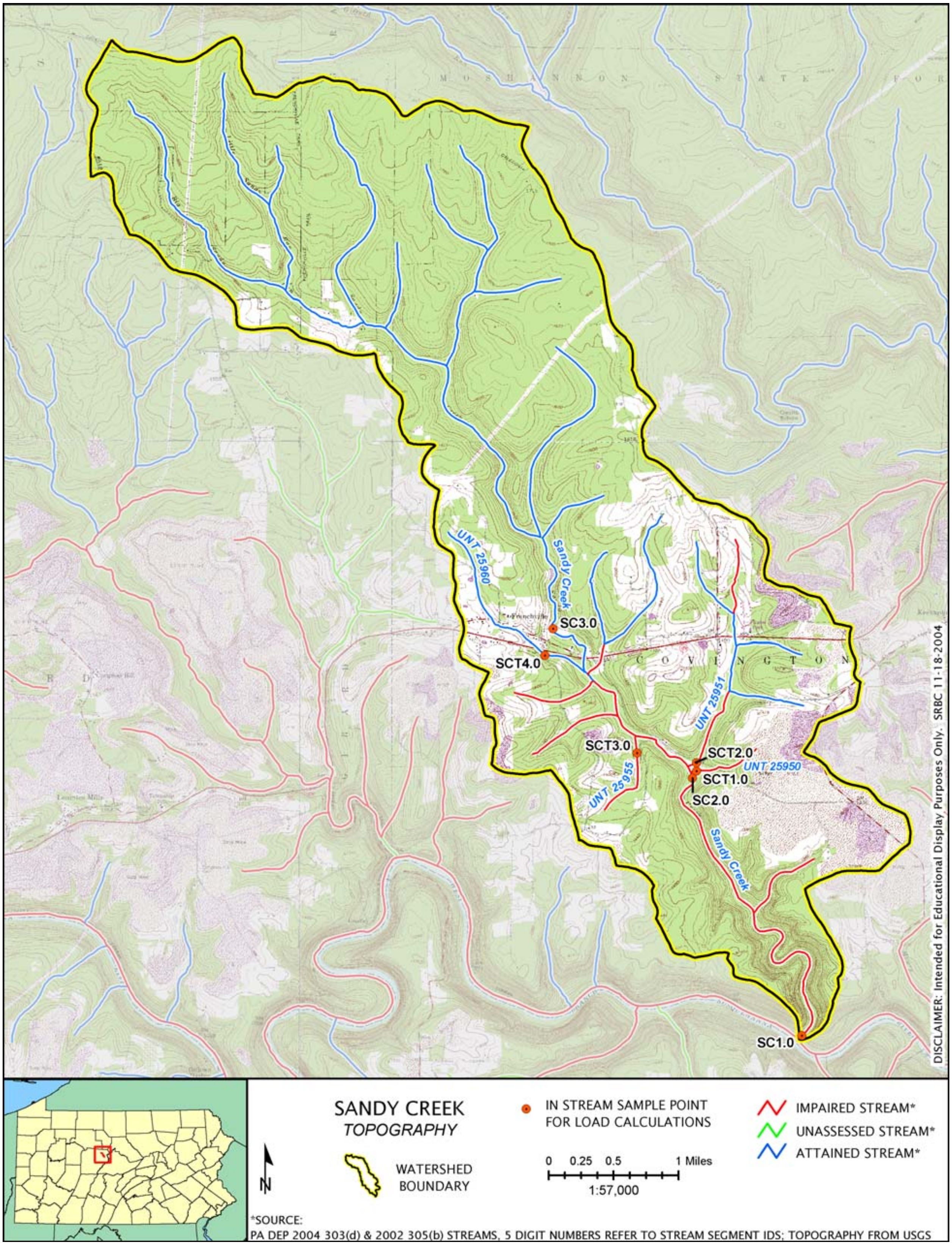
Mital, John. 2004. Email on K & J Coal Co.

Rhodes, Ralph L. and Robert S. Davis. 1968. Mine Drainage in the Susquehanna River Basin. Federal Water Pollution Control Administration, Middle Atlantic Region, Charlottesville, Va.

Sorenson, Dewey. 1931. Stream Survey Report – Sandy Creek. Commonwealth of Pennsylvania Board of Fish Commissioners.

Attachment A

Sandy Creek Watershed Map


SC3.0
SCT4.0
SCT3.0
SCT2.0
SCT1.0
SC2.0
SC1.0
UNT 25960
Sandy Creek
UNT 25951
UNT 25950
UNT 25955
Sandy Creek
DISCLAIMER: Intended for Educational Display Purposes Only. SRBC 11-18-2004
SANDY CREEK
TOPOGRAPHY
WATERSHED BOUNDARY
IN STREAM SAMPLE POINT FOR LOAD CALCULATIONS
0 0.25 0.5 1 Miles
1:57,000
IMPAIRED STREAM*
UNASSESSED STREAM*
ATTAINED STREAM*
N
*SOURCE:
PA DEP 2004 303(d) & 2002 305(b) STREAMS, 5 DIGIT NUMBERS REFER TO STREAM SEGMENT IDS; TOPOGRAPHY FROM USGS

Attachment B

Excerpts Justifying Changes Between the 1996, 1998, 2002, 2004, and 2006 Section 303(d) Lists

The following are excerpts from the Pennsylvania DEP 303(d) narratives that justify changes in listings between the 1996, 1998, 2002, 2004, 2006 lists. The 303(d) listing process has undergone an evolution in Pennsylvania since the development of the 1996 list.

In the 1996 303(d) narrative, strategies were outlined for changes to the listing process. Suggestions included, but were not limited to, a migration to a Global Information System (GIS), improved monitoring and assessment, and greater public input.

The migration to a GIS was implemented prior to the development of the 1998 303(d) list. As a result of additional sampling and the migration to the GIS some of the information appearing on the 1996 list differed from the 1998 list. Most common changes included:

1. Mileage differences due to recalculation of segment length by the GIS;
2. Slight changes in source(s)/cause(s) due to new USEPA codes;
3. Changes to source(s)/cause(s), and/or miles due to revised assessments;
4. Corrections of misnamed streams or streams placed in inappropriate SWP subbasins; and
5. Unnamed tributaries no longer identified as such and placed under the named watershed listing.

Prior to 1998, segment lengths were computed using a map wheel and calculator. The segment lengths listed on the 1998 303(d) list were calculated automatically by the GIS (ArcInfo) using a constant projection and map units (meters) for each watershed. Segment lengths originally calculated by using a map wheel and those calculated by the GIS did not always match closely. This was the case even when physical identifiers (e.g., tributary confluence and road crossings) matching the original segment descriptions were used to define segments on digital quad maps. This occurred to some extent with all segments, but was most noticeable in segments with the greatest potential for human errors using a map wheel for calculating the original segment lengths (e.g., long stream segments or entire basins). The 2002 Pa. Section 303(d) list was written in a manner similar to the 1998 Section 303(d) list.

In 2004, Pennsylvania developed the Integrated List of All Waters. The water quality status of Pennsylvania's waters is summarized using a five-part categorization of waters according to their water quality standard (WQS) attainment status. The categories represent varying levels of WQS attainment, ranging from Category 1, where all designated water uses are met, to Category 5, where impairment by pollutants requires a TMDL to correct. These category determinations are based on consideration of data and information consistent with the methods outlined by the Statewide Surface Water Assessment Program. Each PADEP five-digit waterbody segment is placed in one of the WQS attainment categories. Different segments of the same stream may appear on more than one list if the attainment status changes as the water flows downstream. The listing categories are as follows:

Category 1: Waters attaining all designated uses.

Category 2: Waters where some, but not all, designated uses are met. Attainment status of the remaining designated uses is unknown because data are insufficient to categorize a water consistent with the state's listing methodology.

Category 3: Waters for which there are insufficient or no data and information to determine, consistent with the state's listing methodology, if designated uses are met.

Category 4: Waters impaired for one or more designated use but not needing a TMDL. States may place these waters in one of the following three subcategories:

- TMDL has been completed.
- Expected to meet all designated uses within a reasonable timeframe.
- Not impaired by a pollutant.

Category 5: Waters impaired for one or more designated uses by any pollutant. Category 5 includes waters shown to be impaired as the result of biological assessments used to evaluate aquatic life use even if the specific pollutant is not known unless the state can demonstrate that nonpollutant stressors cause the impairment or that no pollutant(s) causes or contribute to the impairment. Category 5 constitutes the Section 303(d) list that USEPA will approve or disapprove under the Clean Water Act. Where more than one pollutant is causing the impairment, the water remains in Category 5 until all pollutants are addressed in a completed USEPA-approved TMDL or one of the delisting factors is satisfied.

The 2006 Integrated List of All Waters was written in a manner similar to the 2004 List.

Attachment C

Method for Addressing 303(d) Listings for pH

Method for Addressing 303(d) Listings for pH

There has been a great deal of research conducted on the relationship between alkalinity, acidity, and pH. Research published by the Pa. Department of Environmental Protection demonstrates that by plotting net alkalinity (alkalinity-acidity) vs. pH for 794 mine sample points, the resulting pH value from a sample possessing a net alkalinity of zero is approximately equal to six (Figure 1). Where net alkalinity is positive (greater than or equal to zero), the pH range is most commonly six to eight, which is within the USEPA's acceptable range of six to nine and meets Pennsylvania water quality criteria in Pa. Code, Chapter 93.

The pH, a measurement of hydrogen ion acidity presented as a negative logarithm, is not conducive to standard statistics. Additionally, pH does not measure latent acidity. For this reason, and based on the above information, Pennsylvania is using the following approach to address the stream impairments noted on the 303(d) list due to pH. The concentration of acidity in a stream is at least partially chemically dependent upon metals. For this reason, it is extremely difficult to predict the exact pH values, which would result from treatment of abandoned mine drainage. Therefore, net alkalinity will be used to evaluate pH in these TMDL calculations. This methodology assures that the standard for pH will be met because net alkalinity is a measure of the reduction of acidity. When acidity in a stream is neutralized or is restored to natural levels, pH will be acceptable. Therefore, the measured instream alkalinity at the point of evaluation in the stream will serve as the goal for reducing total acidity at that point. The methodology that is applied for alkalinity (and therefore pH) is the same as that used for other parameters such as iron, aluminum, and manganese that have numeric water quality criteria.

Each sample point used in the analysis of pH by this method must have measurements for total alkalinity and total acidity. Net alkalinity is alkalinity minus acidity, both being in units of milligrams per liter (mg/l) $CaCO_3$. The same statistical procedures that have been described for use in the evaluation of the metals is applied, using the average value for total alkalinity at that point as the target to specify a reduction in the acid concentration. By maintaining a net alkaline stream, the pH value will be in the range between six and eight. This method negates the need to specifically compute the pH value, which for mine waters is not a true reflection of acidity. This method assures that Pennsylvania's standard for pH is met when the acid concentration reduction is met.

There are several documented cases of streams in Pennsylvania having a natural background pH below six. If the natural pH of a stream on the 303(d) list can be established from its upper unaffected regions, then the pH standard will be expanded to include this natural range. The acceptable net alkalinity of the stream after treatment/abatement in its polluted segment will be the average net alkalinity established from the stream's upper, pristine reaches. Summarized, if the pH in an unaffected portion of a stream is found to be naturally occurring below six, then the average net alkalinity for that portion of the stream will become the criterion for the polluted portion. This "natural net alkalinity level" will be the criterion to which a 99 percent confidence level will be applied. The pH range will be varied only for streams in which a natural unaffected net alkalinity level can be established. This can only be done for streams that have upper segments that are not impacted by mining activity. All other streams will be required to meet a minimum net alkalinity of zero.

Reference: *Rose, Arthur W. and Charles A. Cravotta, III 1998. Geochemistry of Coal Mine Drainage. Chapter 1 in Coal Mine Drainage Prediction and Pollution Prevention in Pennsylvania. Pa. Dept. of Environmental Protection, Harrisburg, Pa.*

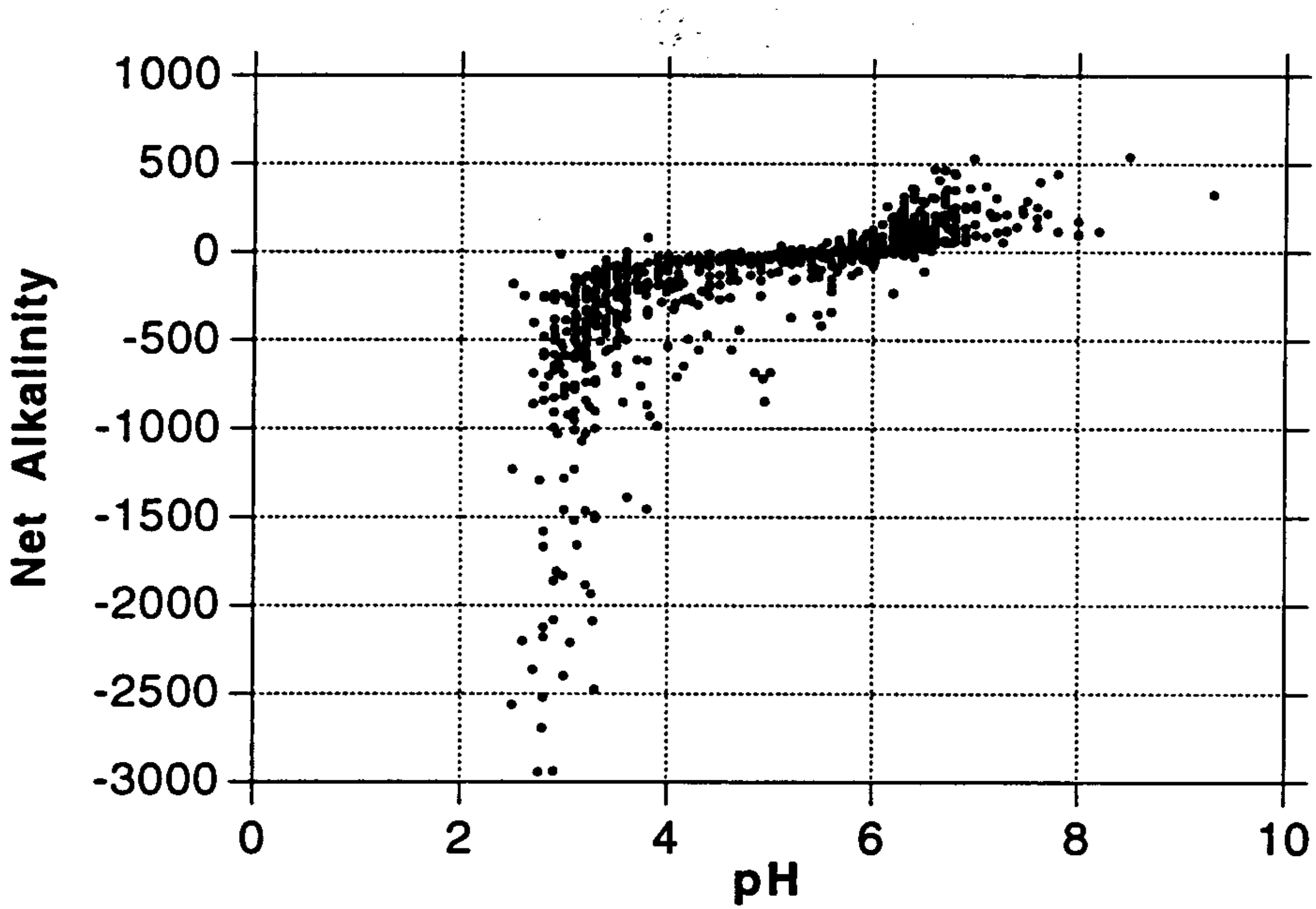


Figure 1. Net Alkalinity vs. pH. Taken from Figure 1.2 Graph C, pages 1-5, of Coal Mine Drainage Prediction and Pollution Prevention in Pennsylvania.

Attachment D
TMDLs By Segment

Sandy Creek

The TMDL for the Sandy Creek Watershed consists of load allocations for four tributaries and three sampling sites along the mainstem. There is currently no active mining in the watershed, therefore, no WLA was needed.

Sandy Creek is listed as impaired on the Section 303(d) list by high levels of metals and low pH from AMD. For pH, the objective is to reduce acid loading to the stream that will in turn raise the pH to the acceptable range. The result of this analysis is an acid loading reduction that equates to meeting standards for pH (see TMDL Endpoint section in the report, Table 2). The method and rationale for addressing pH is contained in Attachment C.

An allowable long-term average instream concentration for iron, manganese, aluminum, and acidity was determined at each sample point. The analysis is designed to produce a long-term average value that, when met, will be protective of the water quality criterion for that parameter 99 percent of the time. An analysis was performed using Monte Carlo simulation to determine the necessary long-term average concentration needed to attain water quality criteria 99 percent of the time. The simulation was run assuming the data set was lognormally distributed. Using the mean and the standard deviation of the data set, 5,000 iterations of sampling were completed and compared against the water quality criterion for that parameter. For each sampling event a percent reduction was calculated, if necessary, to meet water quality criteria. A second simulation that multiplied the percent reduction times the sampled value was run to insure that criteria were met 99 percent of the time. The mean value from this data set represents that long-term daily average concentration that needs to be met to achieve water quality standards.

Sandy Creek above SC3.0

Sandy Creek above point SC3.0 has been determined to be reaching its attained use. The headwaters of Sandy Creek are located in a heavily forested area that is sparsely populated. The forested area consists of both coniferous and deciduous trees.

While Sandy Creek above SC3.0 is not listed as impaired on the 303(d) list, the water quality data set in Attachment F shows impairment does exist for acidity, therefore a TMDL was completed for this segment. The TMDL for this section of Sandy Creek consists of a load allocation to all of the watershed area above point SC3.0. Addressing the natural causes of high acidity above this point, such as sandstone geology with little buffering capacity, addresses the impairment. An instream flow measurement was available for point SC3.0 (8.62 mgd). The load allocations made at point SC3.0 for this stream segment are presented in Table D1.

Table D1. Reductions for Sandy Creek Above SC3.0					
	Measured Sample Data		Allowable		Reduction Identified
	Conc. (mg/l)	Load (lb/day)	LTA Conc. (mg/l)	Load (lb/day)	Percent
Fe	ND	NA	NA	NA	0
Mn	0.09	6.5	0.09	6.5	0
Al	ND	NA	NA	NA	0
Acidity	12.52	900.1	2.75	197.7	78
Alkalinity	10.48	753.4			

All values shown in this table are long-term average daily values.

The TMDL for Sandy Creek at point SC3.0 requires that a load allocation be made for all areas above SC3.0 for total acidity.

UNT 25960 Above SCT4.0

UNT 25960 is a tributary to Sandy Creek that enters below point SC3.0. This tributary had been assessed at the time of this report, and determined to be impaired by AMD. UNT 25960 begins in a forested area and then flows through the town of Frenchville before it meets Sandy Creek. There has been very little mining in this area of the watershed.

The TMDL for UNT 25960 consists of a load allocation to all of the watershed area above point SCT4.0. Addressing the mining impacts and other causes of high acidity above this point, such as sandstone geology with little buffering capacity, addresses the impairment for the segment. An instream flow measurement was available for point SCT4.0 (0.53 mgd). The load allocations made at point SCT4.0 for this stream segment are presented in Table D2.

Table D2. Reductions for UNT 25960 Above SCT4.0					
	Measured Sample Data		Allowable		Reduction Identified
	Conc. (mg/l)	Load (lb/day)	LTA Conc. (mg/l)	Load (lb/day)	Percent
Fe	ND	NA	NA	NA	0
Mn	0.09	0.4	0.09	0.4	0
Al	ND	NA	NA	NA	0
Acidity	6.16	27.2	3.88	17.2	37
Alkalinity	25.12	111.0			

All values shown in this table are long-term average daily values.

The TMDL for UNT 25960 at point SCT4.0 requires that a load allocation be made for all areas above SCT4.0 for total acidity.

UNT 25955 Above SCT3.0

UNT 25955 is a small tributary to Sandy Creek that enters from the west side of the creek. This tributary drains portions of forested and mined areas. UNT 25955 has been determined to be impaired by AMD.

The TMDL for this section of Sandy Creek consists of a load allocation to all of the watershed area above SCT3.0. Addressing the mining impacts above this point addresses the impairment. An instream flow measurement was available for point SCT3.0 (0.79 mgd). The load allocations made at point SCT3.0 for this stream segment are presented in Table D3.

Table D3. Reductions for UNT 25955 Above SCT3.0					
	Measured Sample Data		Allowable		Reduction Identified
	Conc. (mg/l)	Load (lb/day)	LTA Conc. (mg/l)	Load (lb/day)	Percent
Fe	ND	NA	NA	NA	0
Mn	0.88	5.8	0.65	4.3	26
Al	1.21	8.0	0.51	3.4	58
Acidity	24.00	158.1	3.60	23.7	85
Alkalinity	6.72	44.3			

All values shown in this table are long-term average daily values.

The TMDL for UNT 25955 at point SCT3.0 requires that a load allocation be made for all areas above SCT3.0 for total manganese, total aluminum, and total acidity.

UNT 25951 above SCT2.0

UNT 25951 is a tributary to Sandy Creek that empties into the creek below point SCT4.0. UNT 25951 drains an area that has been heavily strip mined in the past. UNT 25951 has been severely impacted by AMD.

The TMDL for UNT 25951 consists of a load allocation to all of the watershed area above point SCT2.0. Addressing mining impacts above this point addresses the impairment for the segment. An instream flow measurement was available for point SCT2.0 (1.35 mgd). The load allocations made at SCT2.0 for this stream segment are presented in Table D4.

Table D4. Reductions for UNT 25951 Above SCT2.0					
	Measured Sample Data		Allowable		Reduction Identified
	Conc. (mg/l)	Load (lb/day)	LTA Conc. (mg/l)	Load (lb/day)	Percent
Fe	2.60	29.3	0.26	2.9	90
Mn	2.19	24.7	0.22	2.5	90
Al	1.31	14.7	0.17	1.9	87
Acidity	34.47	388.1	5.51	62.0	84
Alkalinity	11.07	124.6			

All values shown in this table are long-term average daily values.

The TMDL for UNT 25951 at point SCT2.0 requires that a load allocation be made for all areas above SCT2.0 for total iron, total manganese, total aluminum, and total acidity.

UNT 25950 Above SCT1.0

UNT 25950 is a small tributary to Sandy Creek that enters just below tributary UNT 25951. This tributary also drains an area that has been extensively mined in the past. UNT 25950 has been determined to be impaired by AMD.

The TMDL for UNT 25950 consists of a load allocation to all of the watershed area above SCT1.0. Addressing the mining impacts above this point addresses the impairment. An instream flow measurement was available for point SCT1.0 (0.67 mgd). The load allocations made at SCT1.0 for this stream segment are presented in Table D5.

Table D5. Reductions for UNT 25950 Above SCT1.0

	Measured Sample Data		*Allowable*		*Reduction Identified*
	Conc. (mg/l)	*Load (lb/day)*	*LTA Conc. (mg/l)*	*Load (lb/day)*	*Percent*
Fe	3.51	19.6	0.73	4.1	79
Mn	34.08	190.4	0.00	0.0	100
Al	17.60	98.3	0.18	1.0	99
Acidity	215.76	1,205.6	0.00	0.0	100
Alkalinity	0.00	0.0			

All values shown in this table are long-term average daily values.

The TMDL for UNT 25950 at point SCT1.0 requires that a load allocation be made for all areas above SCT1.0 for total iron, total manganese, total aluminum, and total acidity.

Sandy Creek Between SC3.0 and SC2.0

Sandy Creek between SC3.0 and SC2.0 represents the segment of Sandy Creek between SC3.0 and SC2.0. There are seven unnamed tributaries that enter Sandy Creek between SC3.0 and SC2.0 that are impaired by AMD. Water quality data are available from four of these tributaries: UNT 25960, UNT 25955, UNT 25951, and UNT 25950. This segment of Sandy Creek has been determined to be impaired by AMD.

The TMDL for this section of Sandy Creek consists of a load allocation to all of the watershed area above point SC2.0. Addressing the mining impacts above this point addresses the impairment for the segment. An instream flow measurement was available for point SC2.0 (14.13 mgd).The load allocations made at point SC2.0 for this stream segment are presented in Table D6.

Table D6. Long Term Average (LTA) Concentrations for Sandy Creek Between SC3.0 and SC2.0				
	Measured Sample Data		*Allowable*	
	Conc. (mg/l)	*Load (lb/day)*	*LTA Conc. (mg/l)*	*Load (lb/day)*
Fe	0.82	96.6	0.50	58.9
Mn	5.45	642.3	0.16	18.9
Al	3.37	397.1	0.20	23.6
Acidity	66.52	7,839.0	2.00	235.7
Alkalinity	5.52	650.5		

All values shown in this table are long-term average daily values.

The loading reductions for points SC3.0, SCT4.0, SCT3.0, SCT2.0, and SCT1.0 were used to show the total load that was removed from upstream sources. For each parameter, the total load that was removed upstream was subtracted from the existing load at point SC2.0. This value was compared to the allowable load at point SC2.0. Reductions at point SC2.0 are necessary for any parameter that exceeds the allowable load at this point. Necessary reductions at point SC2.0 are shown in Table D7.

Table D7. Reductions Necessary at Point SC2.0				
	Iron (lb/day)	*Manganese (lb/day)*	*Aluminum (lb/day)*	*Acidity (lb/day)*
Existing Loads at SC2.0	96.6	642.3	397.1	7,839.0
Existing load from upstream points (SC3.0, SCT4.0, SCT3.0, SCT2.0, SCT1.0)	48.9	227.8	121.0	2,679.1
Difference of existing load and upstream existing load	47.7	414.5	276.1	5,159.9
Allowable load from upstream points	7.0	13.7	6.3	300.6
Total load at SC2.0	54.7	428.2	282.4	5,460.5
Allowable load at SC2.0	58.9	18.9	23.6	235.7
Load Reduction at SC2.0 (Total load at SC2.0 – Allowable load at SC2.0)	0.0	409.3	258.8	5,224.8
Percent Reduction required at SC2.0	0	96	92	96

The TMDL for Sandy Creek at point SC2.0 requires that a load allocation be made for all areas between SC3.0 and SC2.0 for total manganese, total aluminum, and total acidity.

Sandy Creek Between SC2.0 and SC1.0

Sandy Creek between SC2.0 and SC1.0 represents the segment of Sandy Creek between SC2.0 and SC1.0. Point SC1.0 is located near the confluence of Sandy Creek and the West Branch Susquehanna River. There is an unnamed tributary that enters Sandy Creek between SC2.0 and SC1.0 that is impaired by AMD. This segment of Sandy Creek has been determined to be impaired by AMD.

The TMDL for this section of Sandy Creek consists of a load allocation to all of the watershed area above point SC1.0. Addressing the mining impacts above this point addresses the impairment for the segment. An instream flow measurement was available for point SC1.0 (14.7 mgd).The load allocations made at point SC1.0 for this stream segment are presented in Table D8.

Table D8. Long Term Average (LTA) Concentrations for Sandy Creek Between SC2.0 and SC1.0				
	Measured Sample Data		Allowable	
	Conc. (mg/l)	Load (lb/day)	LTA Conc. (mg/l)	Load (lb/day)
Fe	2.15	263.6	0.64	78.5
Mn	5.12	627.7	0.16	19.6
Al	2.71	332.2	0.16	19.6
Acidity	47.80	5,860.2	1.43	175.3
Alkalinity	5.80	711.1		

All values shown in this table are long-term average daily values.

The loading reduction for point SC2.0 was used to show the total load that was removed from upstream sources. For each parameter, the total load that was removed upstream was subtracted from the existing load at point SC1.0. This value was compared to the allowable load at point SC1.0. Reductions at point SC1.0 are necessary for any parameter that exceeds the allowable load at this point. Necessary reductions at point SC1.0 are shown in Table D9.

Table D9. Reductions Necessary at Point SC1.0				
	Iron (lb/day)	Manganese (lb/day)	Aluminum (lb/day)	Acidity (lb/day)
Existing Loads at SC1.0	263.6	627.7	332.2	5,860.2
Existing load from upstream point (SC2.0)	96.6	642.3	397.1	7,839.0
Difference of existing load and upstream existing load	166.7	-14.6	-64.9	-1,978.8
Percent load loss due to instream process	0	2	16	25
Allowable load from upstream points	58.9	18.9	23.6	235.7
Percent load remaining at SC1.0	100	98	84	75
Total load at SC1.0	225.6	18.5	19.8	176.8
Allowable load at SC1.0	78.5	19.6	19.6	175.3
Load Reduction at SC1.0 (Total load at SC1.0 – Allowable load at SC1.0)	147.1	0.0	0.2	1.5
Percent Reduction required at SC1.0	65	0	1	1

The TMDL for Sandy Creek at point SC1.0 requires that a load allocation be made for all areas between SC2.0 and SC1.0 for total iron, total aluminum, and total acidity.

Margin of Safety (MOS)

For each TMDL calculated in this study the MOS is applied implicitly. A MOS is built in because the allowable concentrations and loadings were simulated using Monte Carlo techniques and by employing the @Risk software. Other margins of safety used for this TMDL analysis include the following:

- Effluent variability plays a major role in determining the average value that will meet water-quality criteria over the long term. The value that provides this variability in our analysis is the standard deviation of the dataset. The simulation results are based on this variability and the existing stream conditions (an uncontrolled system). The general assumption can be made that a controlled system (one that is controlling and stabilizing the pollution load) would be less variable than an uncontrolled system. This implicitly builds in a margin of safety.

- A MOS is also the fact that the calculations were performed with a daily iron average instead of the 30 day average.

Seasonal Variation

Seasonal variation is implicitly accounted for in each TMDL because the data used represent all seasons.

Critical Conditions

The reductions specified in each TMDL apply at all flow conditions. A critical flow condition could not be identified from the data used for this analysis.

Attachment E

Water Quality Data Used In TMDL Calculations

TMDL Site	Study Point	Company	Permit #	Date	Flow (gpm)	Acid (mg/l)	Alk (mg/l)	Fe (mg/l)	Mn (mg/l)	Al (mg/l)	pH	Sulfate
SC3.0	SAND3.0	SRBC-604(b) Report	*	2/7/2002	9,603.19	25.2	7.8	<0.3	0.145	<0.5	5.1	<20
	SAND3.0	SRBC-604(b) Report	*	3/26/2002	8,671.87	16.6	9.2	<0.3	0.065	<0.5	4.9	<20
	SAND3.0	SRBC-604(b) Report	*	6/4/2002	3,671.44	7.8	8.6	<0.3	0.094	<0.5	5.6	<20
	SAND3.0	SRBC-604(b) Report	*	6/18/2002	7,356.34	13.0	8.8	<0.3	0.095	<0.5	6.2	<20
	SAND3.0	SRBC-604(b) Report	*	7/23/2002	642.28	0.0	18.0	<0.3	<0.05	<0.5	6.6	<20
				Average=	5,989.02	12.52	10.48	<0.30	0.09	<0.50	5.7	<20
				StDev=	3,744.61	9.44	4.23	0.00	0.04	0.00	0.7	0.00
SCT4.0	SDTR4.0	SRBC-604(b) Report	*	12/26/2001	328.54	0.0	28.0	0.309	0.099	<0.5	6.6	28.1
	SDTR4.0	SRBC-604(b) Report	*	2/7/2002	502.69	0.0	17.6	<0.3	0.086	<0.5	6.5	<20
	SDTR4.0	SRBC-604(b) Report	*	3/26/2002	591.11	15.4	20.0	<0.3	0.091	<0.5	6.1	<20
	SDTR4.0	SRBC-604(b) Report	*	6/4/2002	104.13	0.0	34.0	<0.3	0.09	<0.5	6.4	36.4
	SDTR4.0	SRBC-604(b) Report	*	6/18/2002	326.30	15.4	26.0	<0.3	0.079	<0.5	6.4	22.5
				Average=	370.56	6.16	25.12	0.309	0.09	<0.5	6.4	29.0
				StDev=	187.62	8.43	6.53	0.00	0.01	0.00	0.19	7.0
SCT3.0	SDTR3.0	SRBC-604(b) Report	*	12/26/2001	123.88	21.8	8.8	<0.3	0.796	1.26	4.1	37.3
	SDTR3.0	SRBC-604(b) Report	*	2/7/2002	270.65	30.4	7.2	<0.3	0.86	1.29	4.6	22.6
	SDTR3.0	SRBC-604(b) Report	*	3/26/2002	1,966.33	31.6	6.0	0.49	0.736	1.41	4.6	28.3
	SDTR3.0	SRBC-604(b) Report	*	6/4/2002	83.93	16.0	5.8	<0.3	0.815	0.877	4.5	45.8
	SDTR3.0	SRBC-604(b) Report	*	6/18/2002	282.31	20.2	5.8	<0.3	1.18	1.22	4.5	47.1
				Average=	545.42	24.00	6.72	0.49	0.88	1.21	4.5	36.22
				StSev=	799.12	6.75	1.30	0.00	0.17	0.20	0.21	10.72
SCT2.0	SDTR2.0	SRBC-604(b) Report	*	12/26/2001	883.75	18.8	11.8	1.03	1.06	<0.5	4.4	66.6
	SDTR2.0	SRBC-604(b) Report	*	2/6/2002	1,129.71	34.4	7.6	0.76	1.08	0.551	5.0	48.4
	SDTR2.0	SRBC-604(b) Report	*	3/26/2002	2,391.37	45.2	8.4	1.77	1.13	2.55	5.8	57.7
	SDTR2.0	SRBC-604(b) Report	*	6/4/2002	346.95	25.8	17.8	1.7	1.53	<0.5	6.0	313.8
	SDTR2.0	SRBC-604(b) Report	*	6/18/2002	793.98	36.4	8.6	1.49	5.81	0.839	5.3	268.5
	SDTR2.0	SRBC-604(b) Report	*	7/23/2002	83.03	46.2	12.2	8.83	2.53	<0.5	6.0	<20
				Average=	938.13	34.47	11.07	2.60	2.19	1.31	5.4	151.0
				StDev=	806.60	10.74	3.80	3.08	1.86	1.08	0.64	129.10

TMDL Site	Study Point	Company	Permit #	Date	Flow (gpm)	Acid (mg/l)	Alk (mg/l)	Fe (mg/l)	Mn (mg/l)	Al (mg/l)	pH	Sulfate
SCT1.0	SDTR1.0	SRBC-604(b) Report	*	2/6/2002	1,018.85	79.6	0.0	2.78	13.3	4.52	3.5	387.6
	SDTR1.0	SRBC-604(b) Report	*	3/26/2002	585.28	90.6	0.0	3.99	10.7	3.9	3.5	258.6
	SDTR1.0	SRBC-604(b) Report	*	6/4/2002	166.07	187.8	0.0	2.92	26.0	16.2	3.3	732.3
	SDTR1.0	SRBC-604(b) Report	*	6/18/2002	391.83	378.2	0.0	2.51	46.2	30.3	3.3	1,430.9
	SDTR1.0	SRBC-604(b) Report	*	7/23/2002	173.70	342.6	0.0	5.36	74.2	33.1	3.1	33.1
				Average =	467.14	215.76	0.0	3.51	34.08	17.60	3.3	568.50
				StDev =	353.82	139.16	0.0	1.18	26.46	13.80	0.17	544.51

TMDL Site	Study Point	Company	Permit #	Date	Flow (gpm)	Acid (mg/l)	Alk (mg/l)	Fe (mg/l)	Mn (mg/l)	Al (mg/l)	pH	Sulfate
SC2.0	SAND2.0	SRBC-604(b) Report	*	2/7/2002	13,196.09	53.0	7.6	0.322	0.719	<0.5	5.0	<20
	SAND2.0	SRBC-604(b) Report	*	3/26/2002	20,280.44	59.6	7.0	0.965	1.57	1.52	4.9	70.7
	SAND2.0	SRBC-604(b) Report	*	6/4/2002	4,964.52	43.4	7.2	0.586	2.33	1.41	4.9	120.7
	SAND2.0	SRBC-604(b) Report	*	6/18/2002	9,512.53	67.4	5.8	0.689	6.74	4.03	4.4	221.3
	SAND2.0	SRBC-604(b) Report	*	7/23/2002	1,123.42	109.2	0.0	1.56	15.9	6.53	3.9	535.0
				Average=	9,815.40	66.52	5.52	0.82	5.45	3.37	4.6	236.93
				StDev=	7418.21	25.43	3.16	0.47	6.29	2.43	0.47	208.35

TMDL Site	Study Point	Company	Permit #	Date	Flow (gpm)	Acid (mg/l)	Alk (mg/l)	Fe (mg/l)	Mn (mg/l)	Al (mg/l)	pH	Sulfate
SC1.0	SAND1.0	SRBC-604(b) Report	*	2/13/2002	16,427.22	33.2	7.2	1.25	1.09	<0.5	4.9	52.6
	SAND1.0	SRBC-604(b) Report	*	4/9/2002	10,960.46	32.8	8.2	1.53	1.33	<0.5	5.0	53.7
	SAND1.0	SRBC-604(b) Report	*	6/4/2002	8,775.55	29.8	7.0	2.84	3.02	1.09	4.8	137.9
	SAND1.0	SRBC-604(b) Report	*	6/18/2002	13,739.62	38.4	6.6	1.89	3.56	1.86	4.6	136.6
	SAND1.0	SRBC-604(b) Report	*	7/23/2002	1,143.62	104.8	0.0	3.25	16.6	5.19	3.5	752..4
				Average=	10,209.29	47.80	5.80	2.15	5.12	2.71	4.6	226.64
				StDev=	5,829.50	32.01	3.30	0.86	6.50	2.18	0.61	296.90

"*" signifies no data were collected

Note: All concentrations are in units of milligrams per liter (mg/l); all discharge measurements are in units of gallons per minute (GPM)

Attachment F
Comment and Response

No formal comments were received for the Sandy Creek Watershed TMDL.