Final

Wabash Creek Watershed TMDL
Schuylkill County

For Acid Mine Drainage Affected Segments

Prepared by the Pennsylvania Department of Environmental Protection

July 3, 2002

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Introduction

This report presents the Total Maximum Daily Loads (TMDLs) developed for stream segments in the Wabash Creek Watershed (Attachment A). These were done to address the impairments noted on the 1996 Pennsylvania Section 303(d) list of impaired waters, required under the Clean Water Act, and covers one segment on this list (shown in Table 1). High levels of metals are the cause for these impairments. All impairments resulted from drainage from abandoned coalmines. The TMDL addresses the three primary metals associated with acid mine drainage (iron, manganese, aluminum), and pH.

Table 1. 303(d) Sub-List

State Water Plan (SWP) Subbasin: 03-A

Year	SWP	Miles	Segment ID	DEP Stream Code	Stream Name	Designated Use	Data Source	EPA 305(b) Cause Code
1996	03-A	2.2	6185	02251	Wabash Creek	CWF	Resource Extraction	Metals
1998	03-A	2.03	6185	02251	Wabash Creek	CWF	SWMP	Metals
2000	03-A	2.03	6185	02251	Wabash Creek	CWF	SWMP	Metals
2002	03-A	2.0	20000621-1010-CJD	02251	Wabash Creek	CWF	SWMP	Metals, Flow Alterations, Siltation, Water/Flow Variability

CWF=Cold Water Fishery
SWMP= Surface Water Monitoring Program
See Appendix E, *Excerpts Justifying Changes Between the 1996, 1998, Draft 2000 and Draft 2002 Section 303(d) Lists.*
The use designations for the stream segments in this TMDL can be found in PA Title 25 Chapter 93.

Location of the Wabash Creek Watershed

The Wabash Creek Watershed is located in northeast Schuylkill County, approximately 14 miles northeast of Pottsville. To visit the site, take Route 309 into the Borough of Tamaqua. Turn

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[1] Pennsylvania's 1995 and 1998 Section 303(d) lists were approved by the Environmental Protection Agency (EPA). The 2000 Section 303(d) list was not required by U. S. Environmental Protection Agency. 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.*

south on Route 209 and proceed approximately three (3) miles to the village of Reevesdale and Wabash Creek is located between Reevesdale and Route 209.

Segments addressed in this TMDL

There are two mining operations in the watershed. The F and P Mining Company facility is a reprocessing operation authorized by Mining Permit No. 54840204 and NPDES Permit No. PA0614050. Mining and reclamation operations on the site have been completed. The Reily Mineral Resources, Inc. facility is a strip mining operation authorized by Mining Permit No. 54980101 and NPDES Permit No. PA0223921. This operation is in the Wabash Creek Watershed and the adjacent Schuylkill River Watershed to the west. All runoff from the site is directed to the west and discharged into the Schuylkill River Watershed. Pertinent permit information is listed below in the table.

Table 2 Active Mine Permits in this TMDL

Permittee	Operation	Mining Permit No.	Type Permit	NPDES No.	Receiving Stream
F&P Coal Company		54840204	Refuse Remine	PA0614050	Wabash Creek
Reily Mineral Resources Inc.		54980101	Surface Remine	PA0223921	Schuylkill River

All other discharges in the watershed are from abandoned mines and will be treated as non-point sources. The distinction between non-point and point sources in this case is determined on the basis of whether or not there is a responsible party for the discharge. Where there is no responsible party the discharge is considered to be a non-point source. Each segment on the 303(d) list will be addressed as a separate TMDL. These TMDLs will be expressed as long-term, average loading. Due to the nature and complexity of mining effects on the watershed, expressing the TMDL as a long-term average gives a better representation of the data used for the calculations.

See Appendix D for TMDL calculations.

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 have 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 (BMPs), 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 water bodies, 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 (Pa. DEP) 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. Pa. DEP is now using the Unassessed Waters Protocol (UWP), a modification of the

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

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 included kick-screen sampling of benthic macro invertebrates, habitat surveys, and measurements of pH, temperature, conductivity, dissolved oxygen, and alkalinity. Benthic macro invertebrates 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 two pollutants impair a stream segment, 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.

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 water body using USEPA approved methods and/or 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 Wabash Creek Watershed TMDL.

Watershed History

The Wabash Creek Watershed (Attachment A) is approximately five (5.0) square miles in area. It originates west of the village of Reevesdale and flows northeast 3.2 miles, along Route 209, to the confluence with the Little Schuylkill River in the borough of Tamaqua. The watershed is a narrow valley bordered on the north by Locust Mountain and on the south by Sharp Mountain. The towns of Tamaqua, Newkirk and Reevesdale are located in the watershed.

The watershed has been extensively deep mined beginning in the early 1800's and was later surface mined for anthracite coal. When the deep mines ceased operation they filled with water and formed large mine pools on the north and south sides of Wabash Valley. Abandoned strip mines retained most surface runoff and served to recharge the mine pools. Five (5) deep mine discharges from the two deep mine pools are negatively impacting the water quality and macro invertebrate community in Wabash Creek. They include the Newkirk Tunnel and Reevesdale No. 1 Drift that drain the mine pool located beneath the surface of Sharp Mountain on the south side of Wabash Valley. The Reevesdale No. 2 Drift, Churn Holes and Combined Flows drain the deep mine pool from Locust Mountain on the north side of Wabash Valley.

Two seep areas also negatively impact the water quality of the Wabash Creek. They include the sites of the former Reevesdale Colliery located south of Reevesdale and the Newkirk Breaker located at the mouth of the Newkirk Tunnel.

Upstream of the mine discharges, in the headwaters of Wabash Creek, the water is alkaline with low concentrations of iron, aluminum and manganese. Downstream in Tamaqua the pH is depressed and precipitated iron and aluminum coat the bottom of the stream. Other current usage of the watershed includes hunting and hiking.

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 applicable 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 (LAs) 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 the water quality standards must be met 99% of the time. The iron TMDLs are expressed as total recoverable as the iron data used for this analysis was reported as total recoverable. The following table shows the applicable water-quality criteria for the selected parameters.

Table 3. 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
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, load allocation and a margin of safety. The wasteload allocation is the portion of the load assigned to point sources. The load allocation is the portion of the load assigned to nonpoint sources. The margin of safety is applied to account for uncertainties in the computational process. The margin of safety may be expressed implicitly (documenting conservative processes in the computations) or explicitly (setting aside a portion of the allowable load).

TMDL Allocations Summary

Analyses of data for metals at Wabash Creek sample points indicated that there was no single critical flow condition for pollutant sources, and further, that there was no significant correlation between source flows and pollutant concentrations (Table 3).

Analysis of the remaining monitoring points in this TMDL did not have enough paired flow/parameter data to calculate correlations.

Table 4. Correlation Between Metals and Flow for Selected Points

Point Identification	***Flow vs.***			***Number of Samples***
	Iron	***Manganese***	***Aluminum***	
2WB	0.399396	0.347169	0.35676	17
4WB	0.045262	0.014258	0.009062	27
8WB	0.203605	0.209245	0.127579	51

***there were not enough sample values collected for these metals to allow an accurate correlation**

Allocation Summary

These TMDLs will focus remediation efforts on the identified numerical reduction targets for each watershed. As changes occur in the watershed, the TMDLs may be re-evaluated to reflect current conditions. Table 4 presents the estimated reductions identified for all points in the watershed. Attachment D gives detailed TMDLs by segment analysis for each allocation point.

Table 5. Summary Table–Wabash Creek Watershed

		Measured				*Reduction*
		Sample Data		*Allowable*		*Identified*
Station	*Parameter*	*Conc.*	*Load*	*LTA Conc. (Mg/l)*	*Load*	
		(Mg/l)	*(Lb/day)*		*(Lb/day)*	*Percent %*
1WB						
	Al	0.20	0.4	0.20	0.4	0
	Fe	1.31	2.6	0.38	0.7	71
	Mn	0.86	1.7	0.10	0.2	88
	Acidity	0.00	0.0	0.00	0.0	0
	Alkalinity	25.60	50.2			
2WB	**Al**	1.27	6.2	0.36	1.7	72
	Fe	3.51	17.1	0.49	2.4	86
	Mn	1.50	7.3	0.15	0.7	90
	Acidity	16.49	80.3	0.66	3.2	96
	Alkalinity	1.95	9.5			
4WB	**Al**	0.72	1.1	0.07	0.1	90
	Fe	3.97	5.8	0.40	0.6	90
	Mn	1.28	1.9	0.55	0.8	57
	Acidity	12.55	18.3	1.13	1.6	91
	Alkalinity	7.94	11.6			
8WB	**Al**	7.80	70.7	0.39	3.5	95
	Fe	3.83	34.7	0.96	8.7	75
	Mn	1.94	17.6	0.41	3.7	79
	Acidity	75.45	684.0	2.26	20.5	97
	Alkalinity	4.33	39.3			
11AWB	**Al**	3.29	43.6	0.36	4.8	NA
	Fe	0.67	8.9	0.67	8.9	NA
	Mn	1.15	15.3	0.50	6.6	NA
	Acidity	42.27	561.0	0.00	0.0	NA
	Alkalinity	0.00	0.0			
11WB	**Al**	2.66	46.3	0.35	6.0	NA
	Fe	0.56	9.8	0.56	9.8	NA

	Mn	1.07	18.6	0.55	9.7	NA
	Acidity	21.16	368.2	0.63	11.0	NA
	Alkalinity	1.77	30.7			

Recommendations

Two primary programs that provide reasonable assurance for maintenance and improvement of water quality in the watershed are in effect. The PADEP's efforts to reclaim abandoned mine lands, coupled with its duties and responsibilities for issuing NPDES permits, will be the focal points in water quality improvement.

Additional opportunities for water quality improvement are both ongoing and anticipated. Historically, a great deal of research into mine drainage has been conducted by PADEP's Bureau of Abandoned Mine Reclamation, which administers and oversees the Abandoned Mine Reclamation Program in Pennsylvania, the United States Office of Surface Mining, the National Mine Land Reclamation Center, the National Environmental Training Laboratory, and many other agencies and individuals. Funding from EPA's 319 Grant program, and Pennsylvania's Growing Greener program have been used extensively to remedy mine drainage impacts. These many activities are expected to continue and result in water quality improvement.

The PA DEP Bureau of Mining and Reclamation administers an environmental regulatory program for all mining activities, mine subsidence regulation, mine subsidence insurance, and coal refuse disposal; conducts a program to ensure safe underground bituminous mining and protect certain structures form subsidence; administers a mining license and permit program; administers a regulatory program for the use, storage, and handling of explosives; provides for training, examination, and certification of applicants for blaster's licenses; and 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 Operators Assistance Program (ROAP).

Reclaim PA is DEP's initiative designed to maximize reclamation of the state's quarter million acres of abandoned mineral extraction lands. Abandoned mineral extraction lands in Pennsylvania constituted a significant public liability – more than 250,000 acres of abandoned surface mines, 2,400 miles of streams polluted with mine drainage, 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.

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 DEP's Brownfields program. Since the 1960's, Pennsylvania has been a national leader in establishing laws and regulations to ensure reclamation and plugging occur after active operation is completed.

Pennsylvania is striving for complete reclamation of its abandoned mines and plugging of its orphaned wells. Realizing this task is no small order, DEP has developed concepts to make abandoned mine reclamation easier. These concepts, collectively called Reclaim PA, include legislative, policy land management initiatives designed to enhance mine operator, volunteer land DEP 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.

The coal industry, through DEP-promoted remining efforts, can help to eliminate some sources of AMD and conduct some the remediation identified in the above recommendations through the permitting, mining, and reclamation of abandoned and disturbed mine lands. Special consideration should be given to potential remining projects within these areas, as the environmental benefit versus cost ratio is generally very high.

In the Wabash Creek Watershed, numerous areas have been identified that could benefit from remediation. The goal would be to prevent or reduce AMD from reaching the Wabash Creek. This remediation would include: removal of abandoned high walls, filling abandoned pits, grading, processing refuse piles, revegetating and passively treating discharges.
Abandoned high wall removal in conjunction with back filling strip mine pits and revegetation is recommended because these practices reduce the diversion of surface water into the deep mines. This in turn reduces the AMD discharges from the mine pools and the runoff helps to buffer the remaining AMD discharge from the mine pools. Ancillary benefits include the elimination of a safety hazard and reduction of the size of a passive treatment system required to treat the remaining mine pool discharges.

Specific areas where this is recommended is north of the village of Newkirk on Locust Mountain at the former location of the Newkirk Colliery and on Sharp Mountain from the Newkirk Tunnel west to the Reevesdale No. 1 Drift. This would reduce the infiltration of runoff into the mine pools and reduce the AMD outflows from the Newkirk Colliery, Newkirk Tunnel, Reevesdale No. 1 and Reevesdale No. 2 Drift.

Passive treatment systems are recommended for the Reevesdale No. 1, Reevesdale No. 2, Newkirk Colliery, Newkirk Tunnel and Newkirk Breaker outflows. Assessments would have to be conducted for each discharge to determine whether passive treatment is practical or, if it is, which type is best suited for a specific discharge. Considerations would be given to water chemistry, topographical setting, and upfront and long-term costs, including maintenance.

The reprocessing of refuse piles and remining of remaining coal reserves in the watershed by the coal mining industry would also assist in the remediation effort.

The Pennsylvania Department of Environmental Protection, Bureau of Abandoned Mine Reclamation, through the Abandoned Mine Lands Program, has completed the six projects listed below which reclaimed a total of 472 acres at a total cost in excess of $11,500,000.00.

Contract No.	Name	Construction Cost	Acres Reclaimed	Completion Date
OSM54(1536)101.	Reevesdale	$ 4,077,798.59	204	1992
OSM54(1540)101.	South End Tamaqua	$ 2,526,785.16	64	1994
OSM54(1540)202.	South End Tamaqua 2	$ 1,406,382.49	31	2001
OSM54(3240)101.	Ashton Strip Pits	$ 411,475.35	29	1991
OSM54(3692)101.	Tuscarora 1	$ 1,549,056.26	68	1993
OSM54(3692)102.	Tuscarora 2	$ 1,538,736.57	76	1994
	TOTALS	**$11,510,234.42**	472	

Project No. AMD 54(1813)101.1, Newkirk Mine, funded through the Growing Greener Program and a 319 Grant from the Eastern Schuylkill Recreation Commission is under construction in the watershed. It includes construction of a passive treatment system at the mouth of the Newkirk Tunnel. The system is designed to treat 300 gpm with an estimated construction cost of $150,000.00.

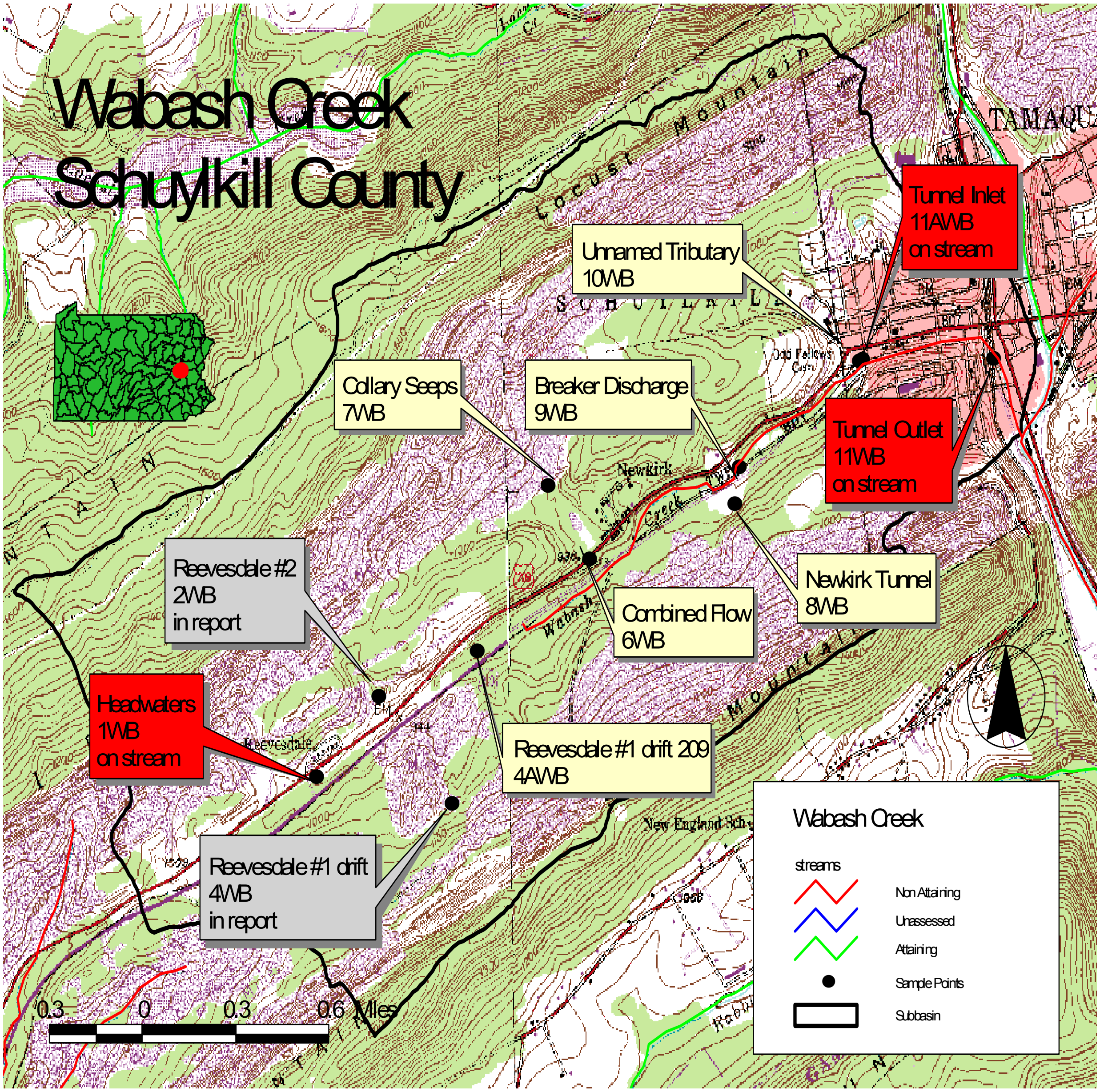
Future mine reclamation projects in the Wabash Creek Watershed are proposed but funding must be available and property owners must be willing to participate.

Public Participation

Notice of the draft TMDLs were published in the *PA Bulletin* and local newspapers with a 60 day comment period provided. A public meeting with watershed residents was held on January 22, 2003 to discuss the TMDLs. Notice of final TMDL approval will be posted on the Department website.

Attachment A

Wabash Creek Watershed Map


Wabash Creek
Schuylkill County
Tunnel Inlet 11AWB on stream
Unnamed Tributary 10WB
Collary Seeps 7WB
Breaker Discharge 9WB
Tunnel Outlet 11WB on stream
Reevesdale #2 2WB in report
Newkirk Tunnel 8WB
Combined Flow 6WB
Headwaters 1WB on stream
Reevesdale #1 drift 209 4AWB
Reevesdale #1 drift 4WB in report
Locust Mountain
TAMAQUA
Newkirk
Wabash Creek
Reevesdale
New England Sch
Wabash Creek
streams
Non Attaining
Unassessed
Attaining
Sample Points
Subbasin
0.3 0 0.3 0.6 Miles

Attachment B

AMD Methodology, The pH Method, And Surface Mining Control and Reclamation Act

AMD Methodology

Two approaches are used for the TMDL analysis of AMD-affected stream segments. Both of these approaches use the same statistical method for determining the instream allowable loading rate at the point of interest. The difference between the two is based on whether the pollution sources are defined as discharges that are permitted or have a responsible party, which are considered point sources. 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 only point-source impacts or a combination of point and 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.

TMDLs and load allocations for each pollutant were determined using Monte Carlo simulation. 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 any required percent reduction so that the water quality criteria will be met instream at least 99 percent of the time. For each iteration, the required percent reduction is:

$$PR = \text{maximum}\ \{0, (1 - Cc/Cd)\} \qquad \text{where} \qquad (1)$$

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

$$Cd = \text{RiskLognorm}(\text{Mean, Standard Deviation}) \qquad \text{where} \qquad (1a)$$

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:

$$LTA = \text{Mean} * (1 - PR99) \qquad \text{where} \qquad (2)$$

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

LTA = allowable LTA source concentration in mg/l

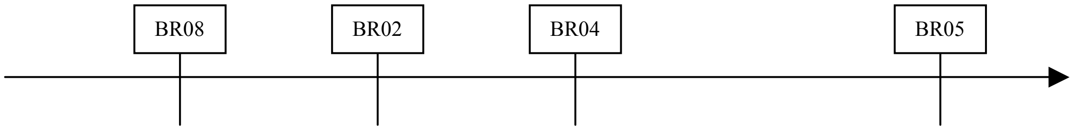
Once the required percent reduction for each pollutant source was determined, a second series of Monte Carlo simulations were performed to determine if the cumulative loads from multiple sources allow instream water quality criteria to be met at all points at least 99 percent of the time. The second series of simulations combined the flows and loads from individual sources in a step-wise fashion, so that the level of attainment could be determined immediately downstream of each source. Where available data allowed, pollutant-source flows used were the average flows. Where data were insufficient to determine a source flow frequency distribution, the average flow derived from linear regression was used.

In general, these cumulative impact evaluations indicate that, if the percent reductions determined during the first step of the analysis are achieved, water quality criteria will be achieved at all upstream points, and no further reduction in source loadings is required.

Where a stream segment is listed on the Section 303(d) list for pH impairment, the evaluation is the same as that discussed above; the pH method is fully explained in this Attachment. An example calculation from the Swatara Creek TMDL, including detailed tabular summaries of the Monte Carlo results, is presented for the Lorberry Creek TMDL in Attachment C. Information for the TMDL analysis performed using the methodology described above is contained in the TMDLs by segment section of this report in Attachment D.

Accounting for Upstream Reductions in AMD TMDLs

In AMD TMDLs, sample points are evaluated in headwaters (most upstream) to stream mouth (most downstream) order. As the TMDL evaluation moves downstream the impact of the previous, upstream, evaluations must be considered. The following examples are from the Beaver Run AMD TMDL (2003):



In the first example BR08 is the most upstream sample point and BR02 is the next downstream sample point. The sample data, for both sample points, are evaluated using @Risk (explained above) to calculate the existing loads, allowable loads, and a percentage reduction for aluminum, iron, manganese, and acidity (when flow and parameter data are available).

Any calculated load reductions for the upstream sample point, BR08, must be accounted for in the calculated reductions at sample point BR02. To do this (see table A) the allowable load is subtracted from the existing load, for each parameter, to determine the total load reduction.

Table A	Alum.	Iron	Mang.	Acidity
BR08	(#/day)	(#/day)	(#/day)	(#/day)
existing load=	3.8	2.9	3.5	0.0
allowable load=	3.8	2.9	3.5	0.0
Total Load Reduction=	**0.0**	**0.0**	**0.0**	**0.0**

In table B the Total Load Reduction BR08 is subtracted from the Existing loads at BR02 to determine the Remaining Load. The Remaining Load at BR02 has the previously calculated Allowable Loads at BR02 subtracted to determine any load reductions at sample point BR02. This results in load reductions for aluminum, iron and manganese at sample point BR02.

Table B. Necessary Reductions at Beaver Run BR02

	Al (#/day)	Fe (#/day)	Mn (#/day)	Acidity (#/day)
Existing Loads at BR02	13.25	38.44	21.98	6.48
Total Load Reduction BR08	0.00	0.00	0.00	0.00
Remaining Load (Existing Load at BR02 - BR08)	13.25	38.44	21.98	6.48
Allowable Loads at BR02	2.91	9.23	7.03	6.48
Percent Reduction	78.0%	76.0%	68.0%	NA
Additional Removal Required at BR02	10.33	29.21	14.95	0.00

At sample point BR05 this same procedure is also used to account for calculated reductions at sample points BR08 and BR02. As can be seen in Tables C and D this procedure results in additional load reductions for iron, manganese and acidity at sample point BR04.

At sample point BR05 (the most downstream) no additional load reductions are required, see Tables E and F.

Table C	Alum.	Iron	Mang.	Acidity
BR08 & BR02	(#/day)	(#/day)	(#/day)	(#/day)
Total Load Reduction=	**10.33**	**29.21**	**14.95**	**0.0**

Table D. Necessary Reductions at Beaver Run BR04				
	Al (#/day)	Fe (#/day)	Mn (#/day)	Acidity (#/day)
Existing Loads at BR04	12.48	138.80	54.47	38.76
Total Load Reduction BR08 & BR02	10.33	29.21	14.95	0.00
Remaining Load (Existing Load at BBR04 - TLR Sum	2.15	109.59	39.53	38.76
Allowable Loads at BR04	8.99	19.43	19.06	38.46
Percent Reduction	NA	82.3%	51.8%	0.8%
Additional Removal Required at BR04	0.00	90.16	20.46	0.29

Table E	Alum.	Iron	Mang.	Acidity
BR08 BR02 &BR04	(#/day)	(#/day)	(#/day)	(#/day)
Total Load Reduction=	10.3	29.2	14.9	0.0

Table F. Necessary Reductions at Beaver Run BR05				
	Al (#/day)	Fe (#/day)	Mn (#/day)	Acidity (#/day)
Existing Loads at BR05	0.0	31.9	22.9	4.1
Total Load Reduction BR08, BR02 & BR04	10.3	119.4	35.4	0.3
Remaining Load (Existing Load at BBR05 - TLR Sum	NA	NA	NA	3.8
Allowable Loads at BR05	0.0	20.4	15.1	4.1
Percent Reduction	NA	NA	NA	NA
Additional Removal Required at BR05	0.0	0.0	0.0	0.0

Although the evaluation at sample point BR05 results in no additional removal this does not mean there are no AMD problems in the stream segment BR05 to BR04. The existing and allowable loads for BR05 show that iron and manganese exceed criteria and, any abandoned mine discharges in this stream segment will be addressed.

Method for Addressing Section 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 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 Section 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 Section 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 added to the acidity of the polluted portion in question. 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 (added to the acidity of the polluted 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 reduce the acid load so the net alkalinity is greater than zero 99% of time.

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.*

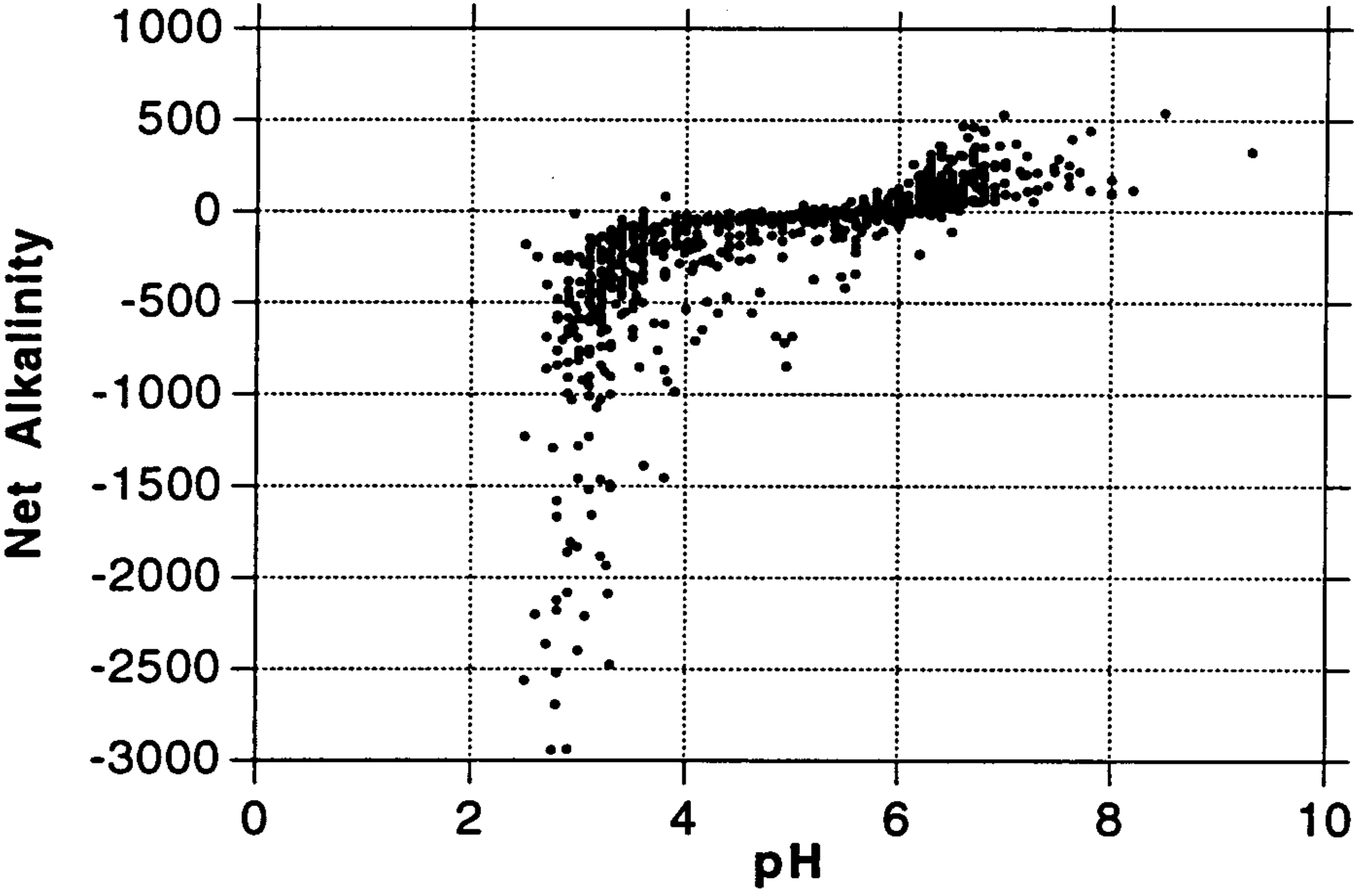


Figure 1. Net Alkalinity vs. pH. Taken from Figure 1.2 Graph C, pages 1-5, of Coal Mine Drainage Prediction and Pollution Prevention in Pennsylvania

Surface Mining Control and Reclamation Act

The Surface Mining Control and Reclamation Act of 1977 (SMCRA, Public Law 95-87) and its subsequent revisions were enacted to established a nationwide program to, among other things, protect the beneficial uses of land or water resources, and pubic health and safety from the adverse effects of current surface coal mining operations, as well as promote the reclamation of mined areas left without adequate reclamation prior to August 3, 1977. SMCRA requires a permit for the development of new, previously mined, or abandoned sites for the purpose of surface mining. Permittees are required to post a performance bond that will be sufficient to ensure the completion of reclamation requirements by the regulatory authority in the event that the applicant forfeits. Mines that ceased operating by the effective date of SMCRA, (often called "pre-law" mines) are not subject to the requirements of SMCRA.

Title IV of the Act is designed to provide assistance for reclamation and restoration of abandoned mines, while Title V states that any surface coal mining operations shall be required to meet all applicable performance standards. Some general performance standards include:

- Restoring the affected land to a condition capable of supporting the uses which it was capable of supporting prior to any mining,

- Backfilling and compacting (to insure stability or to prevent leaching of toxic materials) in order to restore the approximate original contour of the land with all highwalls being eliminated, and topsoil replaced to allow revegetation, and

- Minimizing the disturbances to the hydrologic balance and to the quality and quantity of water in surface and ground water systems both during and after surface coal mining operations and during reclamation by avoiding acid or other toxic mine drainage.

For purposes of these TMDLs, point sources are identified as NPDES-permitted discharge points, and nonpoint sources include discharges from abandoned mine lands, including but not limited to, tunnel discharges, seeps, and surface runoff. Abandoned and reclaimed mine lands were treated in the allocations as nonpoint sources because there are no NPDES permits associated with these areas. In the absence of an NPDES permit, the discharges associated with these land uses were assigned load allocations.

The decision to assign load allocations to abandoned and reclaimed mine lands does not reflect any determination by EPA as to whether there are, in fact, unpermitted point source discharges within these land uses. In addition, by establishing these TMDLs with mine drainage discharges treated as load allocations, EPA is not determining that these discharges are exempt from NPDES permitting requirements.

Related Definitions

Pre-Act (Pre-Law) - Mines that ceased operating by the effective date of SMCRA and are not subject to the requirements of SMCRA.

Bond – An instrument by which a permittee assures faithful performance of the requirements of the acts, this chapter, Chapters 87-90 and the requirements of the permit and reclamation plan.

Postmining pollution discharge – A discharge of mine drainage emanating from or hydrologically connected to the permit area, which may remain after coal mining activities have been completed, and which does not comply with the applicable effluent requirements described in Chapters 87.102, 88.92, 88.187, 88.292, 89.52 or 90.102. The term includes minimal-impact postmining discharges, as defined in Section of the Surface Mining Conservation and Reclamation Act.

Forfeited Bond – Bond money collected by the regulatory authority to complete the reclamation of a mine site when a permittee defaults on his reclamation requirements.

Attachment C

Example Calculation: Lorberry Creek

Lorberry Creek was evaluated for impairment due to high metals contents in the following manner: the analysis was completed in a stepwise manner, starting at the headwaters of the stream and moving to the mouth. The Rowe Tunnel (Swat-04) was treated as the headwaters of Lorberry Creek for the purpose of this analysis.

1. A simulation of the concentration data at point Swat-04 was completed. This estimated the necessary reduction needed for each metal to meet water quality criteria 99 percent of the time as a long-term average daily concentration. Appropriate concentration reductions were made for each metal.

2. A simulation of the concentration data at point Swat-11 was completed. It was determined that no reductions in metals concentrations are needed for Stumps Run at this time. Therefore, no TMDL for metals in Stumps Run is required at this time.

3. A mass balance of loading from Swat-04 and Swat-11 was completed to determine if there was any need for additional reductions as a result of combining the loads. No additional reductions were necessary.

4. The mass balance was expanded to include the Shadle Discharge (L-1). It was estimated that best available technology (BAT) requirements for the Shadle Discharge were adequate for iron and manganese. There is no BAT requirement for aluminum. A wasteload allocation was necessary for aluminum at point L-1.

There are no other known sources below the Shadle Discharge. However, there is additional flow from overland runoff and one unnamed tributary not impacted by mining. It is reasonable to assume that the additional flow provides assimilation capacity below point L-1, and no further analysis is needed downstream.

The calculations are detailed in the following section (Tables 1-8). Table 9 shows the allocations made on Lorberry Creek.

1. A series of four equations was used to determine if a reduction was needed at point Swat-04, and, if so the magnitude of the reduction.

Table 1. Equations Used for Rowe Tunnel Analysis (SWAT 04)

	Field Description	Equation	Explanation
1	Swat-04 Initial Concentration Value (Equation 1A)	= Risklognorm (Mean, St Dev)	This simulates the existing concentration of the sampled data.
2	Swat-04 % Reduction (from the 99th percentile of percent reduction)	= (Input a percentage based on reduction target)	This is the percent reduction for the discharge.
3	Swat-04 Final Concentration Value	= Sampled Value x (1-percent reduction)	This applies the given percent reduction to the initial concentration.
4	Swat-04 Reduction Target (PR)	= Maximum (0, 1- Cd/Cc)	This computes the necessary reduction, if needed, each time a value is sampled. The final reduction target is the 99th percentile value of this computed field.

2. The reduction target (PR) was computed taking the 99th percentile value of 5,000 iterations of the equation in row four of Table 1. The targeted percent reduction is shown, in boldface type, in the following table.

Table 2. Swat-04 Estimated Target Reductions

Name	Swat-04 Aluminum	Swat-04 Iron	Swat-04 Manganese
Minimum =	0	0.4836	0
Maximum =	0.8675	0.9334	0.8762
Mean =	0.2184	0.8101	0.4750
Std. Deviation =	0.2204	0.0544	0.1719
Variance =	0.0486	0.0030	0.0296
Skewness =	0.5845	-0.8768	-0.7027
Kurtosis =	2.0895	4.3513	3.1715
Errors Calculated =	0	0	0
Targeted Reduction % =	**72.2**	**90.5**	**77.0**
Target #1 (Perc%)=	99	99	99

3. This PR value was used as the percent reduction in the equation in row three of Table 1. Testing was done to see that the water quality criterion for each metal was achieved at least 99 percent of the time. This verified the estimated percent reduction necessary for each metal. Table 3 shows, in boldface type, the percent of the time criteria for each metal was achieved during 5,000 iterations of the equation in row three of Table 1.

Table 3. Swat-04 Verification of Target Reductions

Name	Swat-04 Aluminum	Swat-04 Iron	Swat-04 Manganese
Minimum =	0.0444	0.2614	0.1394
Maximum =	1.5282	2.0277	1.8575
Mean =	0.2729	0.7693	0.4871
Std Deviation =	0.1358	0.2204	0.1670
Variance =	0.0185	0.0486	0.0279
Skewness =	1.6229	0.8742	1.0996
Kurtosis =	8.0010	4.3255	5.4404
Errors Calculated =	0	0	0
Target #1 (value) (WQ Criteria)=	0.75	1.5	1
Target #1 (Perc%)=	**99.15**	**99.41**	**99.02**

4. These same four equations were applied to point Swat-11. The result was that no reduction was needed for any of the metals. Tables 4 and 5 show the reduction targets computed for, and the verification of, reduction targets for Swat-11.

Table 4. Swat-11 Estimated Target Reductions			
Name	Swat-11 Aluminum	Swat-11 Iron	Swat-11 Manganese
Minimum =	0.0000	0.0000	0.0000
Maximum =	0.6114	0.6426	0.0000
Mean =	0.0009	0.0009	0.0000
Std Deviation =	0.0183	0.0186	0.0000
Variance =	0.0003	0.0003	0.0000
Skewness =	24.0191	23.9120	0.0000
Kurtosis =	643.4102	641.0572	0.0000
Errors Calculated =	0	0	0
Targeted Reduction % =	**0**	**0**	**0**
Target #1 (Perc%) =	99	99	99

Table 5. Swat-11 Verification of Target Reductions			
Name	Swat-11 Aluminum	Swat-11 Iron	Swat-11 Manganese
Minimum =	0.0013	0.0031	0.0246
Maximum =	1.9302	4.1971	0.3234
Mean =	0.0842	0.1802	0.0941
Std Deviation =	0.1104	0.2268	0.0330
Variance =	0.0122	0.0514	0.0011
Skewness =	5.0496	4.9424	1.0893
Kurtosis =	48.9148	48.8124	5.1358
Errors Calculated =	0	0	0
WQ Criteria =	**0.75**	**1.5**	**1**
% of Time Criteria Achieved =	**99.63**	**99.60**	**100**

5. Table 6 shows variables used to express mass balance computations.

Table 6. Variable Descriptions for Lorberry Creek Calculations	
Description	**Variable Shown**
Flow from Swat-04	Q_{swat04}
Swat-04 Final Concentration	C_{swat04}
Flow from Swat-11	Q_{swat11}
Swat-11 Final Concentration	C_{swat11}
Concentration below Stumps Run	C_{stumps}
Flow from L-1 (Shadle Discharge)	Q_{L1}
Final Concentration From L-1	C_{L1}
Concentration below L-1	C_{allow}

6. Swat-04 and Swat-11 were mass balanced in the following manner:

   The majority of the sampling done at point Swat-11 was done in conjunction with point Swat-04 (20 matching sampling days). This allowed for the establishment of a significant correlation between the two flows (the R-squared value was 0.85). Swat-04 was used as the base flow, and a regression analysis on point Swat-11 provided an equation for use as the flow from Swat-11.

The flow from Swat-04 (Q_{swat04}) was set into an @RISK function so it could be used to simulate loading into the stream. The cumulative probability function was used for this random flow selection. The flow at Swat-04 is as follows (Equation 1):

$$Q_{swat04} = \text{RiskCumul(min,max,bin range, cumulative percent of occurrence)} \quad (1)$$

The RiskCumul function takes four arguments: minimum value, maximum value, the bin range from the histogram, and cumulative percent of occurrence.

The flow at Swat-11 was randomized using the equation developed through the regression analysis with point Swat-04 (Equation 2).

$$Q_{swat11} = Q_{swat}04 \text{ x } 0.142 + 0.088 \quad (2)$$

The mass balance equation is as follows (Equation 3):

$$C_{stumps} = ((Q_{swat04} * C_{swat04}) + (Q_{swat11} * C_{swat11}))/(Q_{swat04}+Q_{swat11}) \quad (3)$$

This equation was simulated through 5,000 iterations, and the 99th percentile value of the data set was compared to the water quality criteria to determine if standards had been met. The results show there is no further reduction needed for any of the metals at either point. The simulation results are shown in Table 7.

Table 7. Verification of Meeting Water Quality Standards Below Stumps Run

Name	Below Stumps Run Aluminum	Below Stumps Run Iron	Below Stumps Run Manganese
Minimum =	0.0457	0.2181	0.1362
Maximum =	1.2918	1.7553	1.2751
Mean =	0.2505	0.6995	0.4404
Std Deviation =	0.1206	0.1970	0.1470
Variance =	0.0145	0.0388	0.0216
Skewness =	1.6043	0.8681	1.0371
Kurtosis =	7.7226	4.2879	4.8121
Errors Calculated =	0	0	0
WQ Criteria =	**0.75**	**1.5**	**1**
% of Time Criteria Achieved =	**99.52**	**99.80**	**99.64**

7. The mass balance was expanded to determine if any reductions would be necessary at point L-1.

The Shadle Discharge originated in 1997, and very few data are available for it. The discharge will have to be treated or eliminated. It is the current site of a USGS test remediation project. The data that were available for the discharge were collected at a point prior to a settling pond. Currently, no data for effluent from the settling pond are available.

Modeling for iron and manganese started with the BAT-required concentration value. The current effluent variability based on limited sampling was kept at its present level. There was no BAT value for aluminum, so the starting concentration for the modeling was arbitrary. The BAT values for iron and manganese are 6 mg/l and 4 mg/l, respectively. Table 8 shows the BAT-adjusted values used for point L-1.

Table 8. L-1 Adjusted BAT Concentrations

Parameter	**Measured Value**		**BAT adjusted Value**	
	Average Conc.	*Standard Deviation*	*Average Conc.*	*Standard Deviation*
Iron	538.00	19.08	6.00	0.21
Manganese	33.93	2.14	4.00	0.25

The average flow (0.048 cfs) from the discharge will be used for modeling purposes. There were not any means to establish a correlation with point Swat-04.

The same set of four equations used for point Swat-04 was used for point L-1. The equation used for evaluation of point L-1 is as follows (Equation 4):

$$C_{allow} = ((Q_{swat04} * C_{swat04}) + (Q_{swat11} * C_{swat11}) + (Q_{L1} * C_{L1}))/(Q_{swat04} + Q_{swat11} + Q_{L1}) \qquad (4)$$

This equation was simulated through 5,000 iterations, and the 99th percentile value of the data set was compared to the water quality criteria to determine if standards had been met. It was estimated that an 81 percent reduction in aluminum concentration was needed for point L-1.

8. Table 9 shows the simulation results of the equation above.

Table 9. Verification of Meeting Water Quality Standards Below Point L-1			
Name	**Below L-1 Aluminum**	**Below L-1 Iron**	**Below L-1 Manganese**
Minimum =	0.0815	0.2711	0.1520
Maximum =	1.3189	2.2305	1.3689
Mean =	0.3369	0.7715	0.4888
Std Deviation =	0.1320	0.1978	0.1474
Variance =	0.0174	0.0391	0.0217
Skewness =	1.2259	0.8430	0.9635
Kurtosis =	5.8475	4.6019	4.7039
Errors Calculated =	0	0	0
WQ Criteria=	**0.75**	**1.5**	**1**
Percent of time achieved=	**99.02**	**99.68**	**99.48**

9. Table 10 presents the estimated reductions needed to meet water quality standards at all points in Lorberry Creek.

Table 10. Lorberry Creek Summary						
		Measured Sample Data		**Allowable**		**Reduction Identified**
Station	Parameter	Conc. (mg/l)	Load (lbs/day)	LTA Conc. (mg/l)	Load (lbs/day)	%
Swat 04						
	Al	1.01	21.45	0.27	5.79	73%
	Fe	8.55	181.45	0.77	16.33	91%
	Mn	2.12	44.95	0.49	10.34	77%
Swat 11						
	Al	0.08	0.24	0.08	0.24	0%
	Fe	0.18	0.51	0.18	0.51	00%
	Mn	0.09	0.27	0.09	0.27	00%
L-1						
	Al	34.90	9.03	6.63	1.71	81%
	Fe	6.00	1.55	6.00	1.55	0%
	Mn	4.00	1.03	4.00	1.03	0%

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

The TMDL for Lorberry Creek requires that a load allocation be made to the Rowe Tunnel Discharge (Swat-04) for the three metals listed, and that a wasteload allocation is made to the Shadle Discharge (L-1) for aluminum. There is no TMDL for metals required for Stumps Run (Swat-11) at this time.

Margin of Safety

For this study, the margin of safety is applied implicitly. The allowable concentrations and loadings were simulated using Monte Carlo techniques and employing the @Risk software. Other margins of safety used for this TMDL analysis include the following:

- None of the data sets were filtered by taking out extreme measurements. Because the 99 percent level of protection is designed to protect for the extreme event, it was pertinent not to filter the data set.

- Effluent variability plays a major role in determining the average value that will meet water quality criteria over the long term. This analysis maintained that the variability at each point would remain the same. The general assumption can be made that a treated discharge would be less variable than an untreated discharge. This implicitly builds in another margin of safety.

Attachment D

TMDLs By Segment

WABASH CREEK

Wabash Creek, a cold water fishery (CWF) is tributary to Little Schuylkill River, which flows into the Schuylkill River. Wabash Creek (stream code 02251) is identified as Segment 6185 under State Water Plan 3-A. The headwaters of the Wabash Creek is alkaline and exhibits low concentrations of iron, manganese and aluminum commonly associated with acid mine drainage. However five (5) discharges from deep mine pools and two seep areas located at former coal processing facilities negatively impact the water quality and macro invertebrate community in Wabash Creek.

TMDL calculations- 1WB – Wabash Creek Headwaters

The TMDL for sample point 1WB consists of a load allocation to all of the area above the point shown in Attachment A. The load allocation for this segment was computed using water-quality sample data collected at point 1WB. The flow for sampling point 1WB (0.24 MGD) was calculated using the unit area method.

There currently is no entry for this segment on the Pa Section 303(d) list for impairment due to pH. Sample data at point 1WB shows pH ranging between 6.3 and 6.6, and ph will be addressed in this TMDL. The objective is to reduce acid loading to the stream, which will in turn raise the pH to the desired range and keep a net alkalinity above zero, 99% of the time. 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 B.

An allowable long-term average in-stream concentration was determined at point 1WB for aluminum, iron, manganese and acidity. The analysis is designed to produce an average value that, when met, will be protective of the water-quality criterion for that parameter 99% 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% of the time. The simulation was run assuming the data set was lognormally distributed. Using the mean and standard deviation of the data set, 5000 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% of the time. The mean value from this data set represents the long-term average concentration that needs to be met to achieve water-quality standards. The following table shows the load allocations for this stream segment.

	Table D1. Load Allocations at Point 1WB				
	Measured Sample Data		Allowable		Reduction Identified
Parameter	Conc. (mg/l)	Load (lbs/day)	LTA conc. (mg/l)	Load (lbs/day)	%
Al	0.20	0.4	0.20	0.4	0
Fe	1.31	2.6	0.38	0.7	71
Mn	0.86	1.7	0.10	0.2	88
Acidity	0.00	0.0	0.00	0.0	0
Alkalinity	25.60	50.2			

The allowable loading values shown in Table D1 represent load allocations made at point 1WB.

<u>TMDL Calculation – 2WB – Reevesdale No. 2 Drift</u>

The TMDL for sample point 2WB consists of a load allocation to all of the area above the point shown in Attachment A. The load allocation for this segment was computed using water-quality sample data collected at point 2WB. The average flow, measured at the sampling point 2WB (0.59 MGD), is used for these computations.

There currently is not an entry for this segment on the Pa Section 303(d) list for impairment due to pH. For this reason pH will be addressed as part of this TMDL. Sample data at point 2WB shows pH ranging between 3.8 and 5.8. The objective is to reduce acid loading and/or increase alkalinity loading to the stream, which will in turn raise the pH and keep a net alkalinity above zero, 99% of the time. 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 B.

An allowable long-term average in-stream concentration was determined at point 2WB for aluminum, iron, manganese. The analysis is designed to produce an average value that, when met, will be protective of the water-quality criterion for that parameter 99% 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% of the time. The simulation was run assuming the data set was lognormally distributed. Using the mean and standard deviation of the data set, 5000 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% of the time. The mean value from this data set represents the long-term average concentration that needs to be met to achieve water-quality standards. The following table shows the load allocations for this stream segment.

	Table D2. Load Allocations at Point 2WB				
	Measured Sample Data		Allowable		Reduction Identified
Parameter	Conc. (mg/l)	Load (lbs/day)	LTA conc. (mg/l)	Load (lbs/day)	%
Al	1.27	6.2	0.36	1.7	72
Fe	3.51	17.1	0.49	2.4	86
Mn	1.50	7.3	0.15	0.7	90
Acidity	16.49	80.3	0.66	3.2	96
Alkalinity	1.95	9.5			

The allowable loading values shown in Table D2 represent load allocations made at point 2WB.

<u>TMDL calculations- 4WB – Reevesdale No. 1 Drift</u>

The TMDL for sample point 4WB consists of a load allocation to all of the area above the point shown in Attachment A. The load allocation for this segment was computed using water-quality sample data collected at point 4WB. The average flow, measured at the sampling point 4WB (0.18 MGD), is used for these computations.

There currently is no entry for this segment on the Pa Section 303(d) list for impairment due to pH. Sample data at point 4WB shows pH ranging between 3.2 and 6.3, and ph will be addressed in this TMDL. The objective is to reduce acid loading to the stream, which will in turn raise the pH to the desired range and keep a net alkalinity above zero, 99% of the time. 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 B.

An allowable long-term average in-stream concentration was determined at point 4WB for aluminum, iron, manganese and acidity. The analysis is designed to produce an average value that, when met, will be protective of the water-quality criterion for that parameter 99% 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% of the time. The simulation was run assuming the data set was lognormally distributed. Using the mean and standard deviation of the data set, 5000 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% of the time. The mean value from this data set represents the long-term average concentration that needs to be met to achieve water-quality standards. The following table shows the load allocations for this stream segment.

	Table D3. Load Allocations at Point 4WB				
	Measured Sample Data		Allowable		Reduction Identified
Parameter	Conc. (mg/l)	Load (lbs/day)	LTA conc. (mg/l)	Load (lbs/day)	%
Al	0.72	1.1	0.07	0.1	90
Fe	3.97	5.8	0.40	0.6	90
Mn	1.28	1.9	0.55	0.8	57
Acidity	12.55	18.3	1.13	1.6	91
Alkalinity	7.94	11.6			

The allowable loading values shown in Table D3 represent load allocations made at point 4WB.

<u>TMDL Calculation – 8WB– Newkirk Tunnel Outflow</u>

The TMDL for sample point 8WB consists of a load allocation to all of the area above the point shown in Attachment A. The load allocation for this segment was computed using water-quality sample data collected at point 8WB. The average flow, measured at the sampling point 8WB (1.09 MGD), is used for these computations.

There currently is no entry for this segment on the Pa Section 303(d) list for impairment due to pH. Sample data at point 59 shows pH ranging between 3.2 and 6.2, and ph will be addressed in this TMDL. The objective is to reduce acid loading to the stream, which will in turn raise the pH to the desired range and keep a net alkalinity above zero, 99% of the time. 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 B.

An allowable long-term average in-stream concentration was determined at point 8WB for aluminum, iron, manganese and acidity. The analysis is designed to produce an average value that, when met, will be protective of the water-quality criterion for that parameter 99% 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% of the time. The simulation was run assuming the data set was lognormally distributed. Using the mean and standard deviation of the data set, 5000 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% of the time. The mean value from this data set represents the long-term average concentration that needs to be met to achieve water-quality standards. The following table shows the load allocations for this stream segment.

	Table D4. Load Allocations at Point 8WB				
	Measured Sample Data		Allowable		Reduction Identified
Parameter	Conc. (mg/l)	Load (lbs/day)	LTA conc. (mg/l)	Load (lbs/day)	%
Al	7.80	70.7	0.39	3.5	95
Fe	3.83	34.7	0.96	8.7	75
Mn	1.94	17.6	0.41	3.7	79
Acidity	75.45	684.0	2.26	20.5	97
Alkalinity	4.33	39.3			

The allowable loading values shown in Table D4 represent load allocations made at point 8WB.

TMDL Calculation – 11AWB – Inlet to tunnel under Tamaqua

The TMDL for sample point 11AWB on Wabash Creek consists of a load allocation to the area above the point shown in Attachment A. The load allocation for this segment was computed using water-quality sample data collected at point 11AWB. Since there were no measured flow values at point 11AWB, the flow used for calculations (1.59 MGD) was determined using the unit area method.

There currently is not an entry for this segment on the Pa Section 303(d) list for impairment due to pH. For this reason pH will be addressed as part of this TMDL. Sample data at point 11AWB shows pH ranging between 4.1 and 4.3. The objective is to reduce acid loading to the stream, which will in turn raise the pH and keep a net alkalinity above zero, 99% of the time. 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 B.

The existing and allowable loading for point 11AWB for all parameters was computed using water-quality sample data collected at the point. This was based on the sample data for the point and did not account for any load reductions already specified from upstream sources. The load reduction from the above points was subtracted from the existing load at point 11AWB. This was compared to the allowable load at 11AWB for each parameter to determine if any further reductions were needed at this point.

An allowable long-term average in-stream concentration was determined at point 11AWB for aluminum, iron, manganese and acidity. The analysis is designed to produce an average value that, when met, will be protective of the water-quality criterion for that parameter 99% 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% of the time. The simulation was run assuming the data set was lognormally distributed. Using the mean and standard deviation of the data set, 5000 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% of the time. The mean value from this data set represents the long-term average concentration that needs to be met to achieve water-quality standards. The following table shows the load allocations for this stream segment.

Table D5 shows the load allocations for this stream segment.

Table D5. Load Allocations at Point 11AWB

	Measured Sample Data		Allowable	
Parameter	Conc. (mg/l)	Load (lbs/day)	LTA Conc. (mg/l)	Load (lbs/day)
Al	3.29	43.6	0.36	4.8
Fe	0.67	8.9	0.67	8.9
Mn	1.15	15.3	0.50	6.6
Acidity	42.27	561.0	0.00	0.0
Alkalinity	0.00	0.0		

The loading reduction for points 1WB, 2WB, 4WB and 8WB represent the total load that was removed from upstream sources. This value was then subtracted from the existing load at point 11AWB. This value was then compared to the allowable load at point 11AWB. Reductions at point 11AWB are necessary for any parameter that exceeded the allowable load at this point. Table D6 shows a summary of the load that affects point 11AWB. Table D7 illustrates the necessary reductions at point 11AWB.

Table D6. Summary of Load that Affects Point 11AWB

	Al (#/day)	Fe (#/day)	Mn (#/day)	Acidity (#/day)	Alkalinity (#/day)
Sum of 1WB,2WB,4WB,8WB					
load reduction=	72.7	47.8	23.1	757.3	0.0

Table D7. Necessary Reductions at Sample Point 11AWB

	Al (#/day)	Fe (#/day)	Mn (#/day)	Acidity (#/day)	Alkalinity (#/day)
Existing Loads at 11AWB	43.6	8.9	15.3	561.0	0.0
Total Load Reduction (Sum of 1WB,2WB,4WB, 8WB)	72.7	47.8	23.1	757.3	0.0
Remaining Load (Existing Loads at 11AWB-TLR Sum)	NA	NA	NA	NA	NA
Allowable Loads at 11AWB	4.8	8.9	6.6	0.0	NA

Percent Reduction	NA	NA	NA	NA	NA
Additional Removal Required at 11AWB	NA	NA	NA	NA	NA

The calculated flow, measured at sample point 11AWB, is used for these computations. The TMDL for 11AWB consists of no load allocations to all of the area upstream of 11AWB as shown in Attachment A. The percent reduction was calculated using below equation.

$$\left[1-\left(\frac{\text{Allowable Loads at 11AWB}}{\text{Remaining Load (Existing Loads at 11AWB - TLR Sum}}\right)\right]\times 100\%$$

No additional loading reductions were necessary for aluminum, iron, manganese or acidity.

TMDL Calculation – 11WB – Exit of tunnel under Tamaqua

The TMDL for sample point 11WB on Wabash Creek consists of a load allocation of the area above the point shown in Attachment A. The load allocation for this segment was computed using water-quality sample data collected at point 11WB. The average flow, measured at the sampling point 11WB (2.1MGD), is used for these computations.

There currently is not an entry for this segment on the Pa 303(d) list for impairment due to pH. For this reason pH will be addressed as part of this TMDL. Sample data at point 11WB shows pH ranging between 4.1 and 5.0. The objective is to reduce acid loading to the stream, which will in turn raise the pH and keep a net alkalinity above zero, 99% of the time. 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 B.

The existing and allowable loading for point 11WB for all parameters was computed using water-quality sample data collected at the point. This was based on the sample data for the point and did not account for any load reductions already specified from upstream sources. The load reduction from the above points was subtracted from the existing load at point 11WB. This was compared to the allowable load at 11WB for each parameter to determine if any further reductions were needed at this point.

An allowable long-term average in-stream concentration was determined at point 11WB for aluminum, iron, manganese and acidity. The analysis is designed to produce an average value that, when met, will be protective of the water-quality criterion for that parameter 99% 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% of the time. The simulation was run assuming the data set was lognormally distributed. Using the mean and standard deviation of the data set, 5000 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% of the time. The mean value from this data set represents the long-term average concentration that needs to be met to achieve water-quality standards. The following table shows the load allocations for this stream segment.

Table D8 shows the load allocations for this stream segment.

Table D8. Load Allocations at Point 11WB				
	Measured Sample Data		Allowable	
Parameter	Conc. (mg/l)	Load (lbs/day)	LTA Conc. (mg/l)	Load (lbs/day)
Al	2.66	46.3	0.35	6.0
Fe	0.56	9.8	0.56	9.8
Mn	1.07	18.6	0.55	9.7
Acidity	21.16	368.2	0.63	11.0
Alkalinity	1.77	30.7		

The loading reduction for points 1WB, 2WB, 4WB, 8WB and 11AWB represent the total load that was removed from upstream sources. This value was then subtracted from the existing load at point 11WB. This value was then compared to the allowable load at point 11WB. Reductions at point 11WB are necessary for any parameter that exceeded the allowable load at this point. Table D9 shows a summary of the load that affects point 11WB. Table D10 illustrates the necessary reductions at point 11WB.

Table D9. Summary of Load that Affects Point 11WB					
	Al (#/day)	**Fe (#/day)**	**Mn (#/day)**	**Acidity (#/day)**	**Alkalinity (#/day)**
Sum of 1WB,2WB,4WB,8WB 11AWB					
load reduction=	121.7	43.4	32.8	1464.0	31.1

Table D10. Necessary Reductions at Sample Point 11WB					
	Al (#/day)	**Fe (#/day)**	**Mn (#/day)**	**Acidity (#/day)**	**Alkalinity (#/day)**
Existing Loads at 11WB	46.3	9.8	18.6	368.2	30.7
Total Load Reduction (Sum of 1WB,2WB,4WB 8WB,11AWB)	111.5	47.8	31.8	1318.3	0.0
Remaining Load (Existing Loads at 11WB-TLR Sum)	NA	NA	NA	NA	30.7
Allowable Loads at 11WB	6.0	9.8	9.7	11.0	NA
Percent Reduction	NA	NA	NA	NA	NA

Additional Removal Required at 11WB	NA	NA	NA	NA	NA

The calculated flow, measured at sample point 11WB, is used for these computations. The TMDL for 11WB consists of no load allocations to all of the area upstream of 11WB as shown in Attachment A. The percent reduction was calculated using below equation.

$$\left[1-\left(\frac{\text{Allowable Loads at 11WB}}{\text{Remaining Load (Existing Loads at 11WB - TLR Sum}}\right)\right]\times 100\,\%$$

No additional loading reductions were necessary for aluminum, iron, manganese or acidity

Margin of Safety

PADEP used an implicit MOS in these TMDLs derived from the Monte Carlo statistical analysis. The Water Quality standard states that water quality criteria must be met at least 99% of the time. All of the @Risk analyses results surpass the minimum 99% level of protection. Another margin of safety used for this TMDL analysis results from:

- 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 these TMDLs because the data used represents all seasons.

Critical Conditions

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

Attachment E

Excerpts Justifying Changes Between the 1996, 1998, Draft 2000 and Draft 2002 Section 303(d) Lists

The following are excerpts from the Pennsylvania DEP 303(d) narratives that justify changes in listings between the 1996, 1998, draft 2000, and Draft 2002 list. 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 EPA 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 most notable difference between the 1998 and Draft 2000 303(d) lists are the listing of unnamed tributaries in 2000. In 1998, the GIS stream layer was coded to the named stream level so there was no way to identify the unnamed tributary records. As a result, the unnamed tributaries were listed as part of the first downstream named stream. The GIS stream coverage used to generate the 2000 list had the unnamed tributaries coded with the DEP's five-digit stream code. As a result, the unnamed tributary records are now split out as separate records on the 2000 303(d) list. This is the reason for the change in the appearance of the list and the noticeable increase in the number of pages. After due consideration of comments from EPA and PADEP on the Draft 2000 Section 303(d) list, the Draft 2002 Pa Section 303(d) list was written in a manner similar to the 1998 Section 303(d) list.

Attachment F

Water Quality Data Used In TMDL Calculations

Wabash Creek Headwaters - Point (1WB)									
	Test			00403	00410	70508	01045A	01055A	01105A
						Hot	Total	Total	Total
COLL #	Date	Days	Flow	PH	Alk.	Acidity	Fe	Mn	Al
			gpm	Units	mg/l	mg/l	mg/l	mg/l	mg/l
7191864	8/27/1997		-	6.4	24.0	0.0	0.46	0.15	0.200
7321336	10/19/2000		-	6.6	28.0	0.0	0.48	0.09	0.201
7321181	5/17/2001		15	6.6	26.0	0.0	2.59	0.12	0.202
7316024	6/27/2002		-	6.5	26.0	0.0	1.75	3.81	<.2
	7/17/2002		-	6.3	24.0	16.2	1.25	0.15	<.200
	Avg.		163.18	6.5	25.6	3.2	1.31	0.86	0.20
	Std. Dev.		#DIV/0!	0.1	1.7	7.2	0.90	1.65	0.00

Reevesdale No. 2 Drift - Point (2WB)									
	Test			00403	00410	70508	01045A	01055A	01105A
						Hot	Total	Total	Total
COLL #	Date	Days	Flow	PH	Alk.	Acidity	Fe	Mn	Al
			gpm	Units	mg/l	mg/l	mg/l	mg/l	mg/l
7191863	8/27/1997		250	4.7	2.0	46.0	4.34	0.90	1.230
7321032	7/14/1988		N/A	3.8	0.0	34.0	4.19	1.16	2.110
7191304	8/25/1998		145	4.4	0.0	16.0	5.58	1.16	1.030
7321670	12/22/1998		23	5.8	20.0	3.2	1.54	1.21	0.394
7321027	1/27/1999		1058	4.4	0.0	13.2	1.32	9.57	1.400
7321066	2/23/1999		795	4.5	0.0	16.8	1.78	0.96	1.500
7321116	3/30/1999		629	4.6	0.8	12.4	2.43	1.00	1.280
7321168	4/29/1999		545	4.4	0.0	11.2	2.69	0.74	1.180
7321198	5/26/1999		419	4.3	0.0	19.2	2.87	0.90	1.270
7321239	6/23/1999		236	4.3	0.0	18.4	4.11	0.93	1.210
7321282	7/28/1999		88	4.6	1.2	11.2	4.90	0.99	1.050
7321304	8/25/1999		19	5.3	9.2	6.8	9.74	1.13	0.344
7321338	9/28/1999		391	4.4	0.0	14.0	2.38	0.91	1.970
7321359	10/26/1999		417	4.5	0.0	16.8	2.58	0.95	1.490
7321409	12/20/1999		537	4.6	0.0	12.4	2.93	0.95	1.330
7321027	1/25/2000		522	4.4	0.0	13.4	2.87	0.83	1.300
7321175	5/17/2001		415	4.5	0.0	15.4	3.39	1.13	1.56
	Avg.		406	4.6	2.0	16.5	3.51	1.50	1.27
	Std. Dev.		282.3	0.4	5.2	9.9	1.99	2.08	0.44

Reevesdale No. 1 Drift - Point (4WB)									
	Test			00403	00410	70508	01045A	01055A	01105A
						Hot	Total	Total	Total

COLL #	Date	Days	Flow gpm	PH Units	Alk. mg/l	Acidity mg/l	Fe mg/l	Mn mg/l	Al mg/l
54980101	8/12/1997		43	4.7	2.1	42.0	3.10	1.17	0.33
54980101	9/3/1997		51	4.1	<1.0	40.0	1.76	1.20	0.49
54980101	10/30/1997		61	5.8	4.9	5.1	3.62	1.69	0.12
54980101	11/15/1997		84	5.6	3.6	5.2	3.65	1.50	0.14
54980101	12/14/1997		97	5.5	3.1	5.2	3.68	1.48	0.16
54980101	1/30/1998		376	5.5	2.8	<0.40	3.72	1.45	0.17
54980101	2/25/1998		72	6.1	2.9	<0.40	7.37	1.25	0.41
54980101	3/13/1998		72	5.9	7.8	<0.40	9.55	1.41	0.22
54980101	4/23/1998		84	5.3	4.0	0.9	5.50	1.38	0.36
54980101	5/28/1998		142	6.0	9.2	<0.40	6.24	1.30	0.3
54840204	6/8/1998		-	6.0	9.6	7.4	1.03	0.95	<.500
54980101	6/29/1998		97	5.5	3.0	<0.40	5.47	1.36	<0.10
54980101	7/30/1998		72	4.8	60.4	4.0	6.29	1.38	0.3
54840204	9/9/1998		-	4.7	7.4	3.8	0.44	1.08	<.500
54840204	12/3/1998		-	4.9	7.6	6.6	<.300	1.20	<.500
54840204	6/8/1999		-	5.1	9.8	4.2	2.07	0.84	<.500
54980101	11/24/1999		200	6.3	5.0	11.5	5.67	1.55	0.160
54840204	12/17/1999		-	5.3	7.8	5.0	0.57	1.00	<.500
54980101	12/17/1999		-	5.4	10.0	7.2	0.62	1.10	<.500
54980101	12/29/1999		158	5.5	6.6	3.8	5.35	1.48	0.200
54980101	1/27/2000		139	5.5	3.2	4.5	0.44	0.96	0.410
54980101	2/23/2000		139	6.1	5.4	12.3	2.23	1.49	0.140
54980101	4/29/2000		106	6.3	3.0	8.1	4.58	1.34	0.640
54980101	5/30/2000		80	5.9	5.0	<.40	5.34	1.52	0.160
54980101	6/26/2000		200	5.4	2.0	6.1	0.17	0.03	0.420
54980101	7/18/2000		158	3.2	<.40	78.1	3.56	1.75	8.570
7321	5/17/2001			5.7	12.2	2.6	11.10	1.81	<.200
	Avg.		121.55	5.41	7.94	12.55	3.97	1.28	0.72
	Std. Dev.		75.71	0.69	11.30	18.56	2.82	0.35	1.91

Newkirk Tunnel Outflow - Point (8WB)

Latitude: Longitude:

COLL #	Test Date	Days	Flow gpm	00403 PH Units	00410 Alk. mg/l	70508 Hot Acidity mg/l	01045A Total Fe mg/l	01055A Total Mn mg/l	01105A Total Al mg/l
N/A	8/8/1995		280	3.6	0.0	82.0	4.24	2.26	8.020
N/A	8/17/1995		N/A	3.5	0.0	80.0	4.67	2.60	8.863
7321148	5/14/1997		250	3.7	0.0	86.0	3.42	1.65	7.410

N/A	6/16/1997	310	3.6	0.0	70.0	3.43	1.74	7.810
N/A	8/12/1997	176	3.6	0.0	84.0	4.30	2.41	9.280
7191859	8/27/1997	200	3.5	0.0	108.0	4.53	2.00	10.500
7321389	9/24/1997	250	3.5	0.0	104.0	4.72	2.13	9.810
7321510	12/4/1997	<200	3.3	0.0	90.0	4.02	1.95	8.880
7321045	1/29/1998	728	3.7	0.0	76.0	3.51	1.44	7.590
7321077	2/23/1998	1107	3.6	0.0	74.0	3.80	1.37	7.900
7321132	3/25/1998	1003	3.6	0.0	76.0	4.22	1.53	8.360
7321193	4/28/1998	812	3.7	0.0	70.0	4.05	1.50	7.890
7321217	5/14/1998	1583	3.5	0.0	86.0	4.79	1.48	10.300
7321300	6/23/1998	342	3.6	0.0	78.0	3.97	1.89	7.780
7321379	7/23/1998	263	3.5	0.0	74.0	4.20	2.26	7.430
7321397	8/10/1998	<175	3.6	0.0	66.0	3.75	2.04	6.630
7191305	8/25/1998	220	3.6	0.0	82.0	4.51	2.43	9.530
7321503	9/24/1998	209	3.5	0.0	78.0	4.43	2.40	9.270
7321555	10/26/1998	276	3.5	0.0	86.0	4.56	2.28	9.760
7321615	11/23/1998	195	3.6	0.0	80.0	4.25	2.35	8.490
7321669	12/22/1998	182	3.6	0.0	76.0	3.66	2.13	7.420
7321026	1/27/1999	1289	3.5	0.0	84.0	3.77	1.27	10.400
7321065	2/23/1999	614	3.7	0.0	64.0	2.93	1.51	6.860
7321115	3/30/1999	627	3.7	0.0	11.8	3.34	1.54	7.660
7321167	4/29/1999	480	3.5	0.0	70.0	3.46	1.93	7.860
7321197	5/26/1999	373	3.5	0.0	70.0	3.36	1.74	7.230
7321238	6/23/1999	279	3.6	0.0	64.0	3.50	1.85	6.680
7314245	6/30/1999	-	3.6	0.0	82.0	3.50	1.92	6.960
7314247	7/6/1999	-	3.7	0.0	68.0	3.50	1.93	7.000
7314249	7/8/1999	-	3.6	0.0	68.0	3.59	2.00	7.500
7191859	8/27/1997	-	3.5	0.0	108.0	4.53	2.00	10.500
7191305	8/25/1998	220	3.6	0.0	82.0	4.51	2.43	9.530
7314255	7/12/1999	-	3.6	0.0	70.0	4.50	1.93	7.020
7314257	7/15/1999	-	3.6	0.0	64.0	4.35	2.02	7.250
7314275	7/20/1999	-	3.6	0.0	66.0	3.24	1.82	6.260
7321281	7/28/1999	180	3.6	0.0	66.0	3.63	7.29	2.090
7321303	8/25/1999	142	3.6	0.0	70.0	3.66	2.20	7.470
7321337	9/28/1999	342	3.4	0.0	98.0	4.78	2.08	13.900
7321353	10/26/1999	303	3.6	0.0	84.0	4.20	1.84	9.260
7321408	12/20/1999	656	3.5	0.0	76.0	4.02	1.74	9.000
7321022	1/25/2000	401	3.6	0.0	66.0	3.31	1.57	6.940
54980101	11/24/1999	2003	3.2	<.40	106.0	4.36	1.55	9.44
54980101	12/8/1999	-	3.7	0.0	80.0	3.44	1.49	8.27
54980101	12/29/1999	2003	3.5	<.40	92.6	2.85	1.45	7.81
54980101	1/27/2000	1515	3.7	<.40	60.2	2.66	1.58	6.43
54980101	2/23/2000	1831	5.7	192.0	67.9	3.26	1.78	5.44
54980101	4/29/2000	1831	3.6	<.40	85.1	3.25	1.59	7.41
54980101	5/30/2000	1874	3.7	<.40	66.4	3.62	1.68	7.77
54980101	6/26/2000	2575	6.2	<.40	77.6	0.09	0.01	0.18
54980101	7/18/2000	1515	5.3	2.9	6.3	5.28	1.44	0.56

7321	5/17/2001		-	3.6	0.0	68.0	3.78	1.88	8.25
	Avg		755	3.7	4.3	75.4	3.83	1.94	7.80
	Std. Dev.		683	0.5	28.62	17.9	0.78	0.87	2.25

WABASH CREEK UPSTREAM OF STONE DRAINAGEWAY UNDER TAMAQUA 11AWB

Latitude: Longitude:

	Test			00403	00410	70508	01045A	01055A	01105A
						Hot	Total	Total	Total
COLL #	Date	Days	Flow	PH	Alk.	Acidity	Fe	Mn	Al
			mgd	Units	mg/l	mg/l	mg/l	mg/l	mg/l
	8/27/1997		-	4.1	0.0	42.0	0.81	1.32	4.250
	4/30/1998		-	4.3	0.0	26.0	0.83	0.71	2.130
7321314	10/2/2000			4.2	0.0	-	0.63	1.41	3.690
	7/17/2002		-	4.1	0.0	58.8	0.42	1.18	3.080
	Avg.			4.2	0.0	42.3	0.67	1.15	3.29
	Std. Dev.			0.1	0.0	16.4	0.19	0.31	0.91

Flow……1105.25

Wabash Creek Downstream - Point (11WB)

	Test			00403	00410	70508	01045A	01055A	01105A
						Hot	Total	Total	Total
COLL #	Date	Days	Flow	PH	Alk.	Acidity	Fe	Mn	Al
			gpm	Units	mg/l	mg/l	mg/l	mg/l	mg/l
7191857	8/27/1997			4.1	0	42.0	0.81	1.32	4.25
	4/30/1998		-	4.6	1.6	20.0	0.57	0.59	1.73
7191300	8/25/1998		1119	4.8	2.6	16.2	0.52	1.37	3.00
7321315	10/2/2000		-	4.8	2.2	-	0.41	1.21	2.90
7321331	10/19/2000		-	5.0	2.8	14.0	0.51	0.94	1.73
1732179	5/17/2001		1779	4.7	1.4	13.6	0.57	0.97	2.34
	Avg.		1449	4.7	1.8	21.2	0.56	1.07	2.66
	Std. Dev.			0.3	1.0	11.9	0.13	0.29	0.95

The following points did not have enough flow data to be included in the allocations for Wabash Creek.

Reevesdale Colliery Seeps - Point (3WB)

Latitude: Longitude:

COLL #	Test Date	Days	Flow gpm	00403 PH Units	00410 Alk. mg/l	70508 Hot Acidity mg/l	01045A Total Fe mg/l	01055A Total Mn mg/l	01105A Total Al mg/l
7321334	10/19/2000		-	3.5	0.0	50.0	0.37	1.07	3.080
	Avg.			3.5	0.0	50.0	0.37	1.07	3.08
	st dev			#DIV/0!					

4AWB Reevesdale No. 1 Drift - at Route 209 Crossing

Latitude: Longitude:

COLL #	Test Date	Days	Flow gpm	00403 PH Units	00410 Alk. mg/l	70508 Hot Acidity mg/l	01045A Total Fe mg/l	01055A Total Mn mg/l	01105A Total Al mg/l
7321335	10/19/2000		75	3.6	0.0	6.8	0.91	0.95	1.67
7321182	5/17/2001			5.6	3.2	5.4	0.33	1.06	0.20
7316025	6/27/2002			5.4	2.8	46.8	3.11	0.80	2.47
	7/17/2002		-	5.0	2.2	32.6	0.48	0.65	0.79
	average		75.0	4.9	2.1	22.9	1.2	0.9	1.3
	st dev		#DIV/0!	0.9	1.4	20.3	1.3	0.2	1.0

Churn holes 5WB

Longitude:

Test Date	Days	Flow gpm	00403 PH Units	00410 Alk. mg/l	70508 Total Acidity mg/l	01045A Total Fe mg/l	01055A Total Mn mg/l	01105A Total Al mg/l
1/27/1999			6.0	24.0	0.0	7.69	1.25	<.200

2/23/1999	6.0	22.0	0.0	5.70	1.13	0.237
3/30/1999	6.0	20.0	0.0	6.25	1.17	0.201
4/29/1999	5.9	22.0	0.0	6.19	1.45	<.200
5/26/1999	5.8	24.0	0.0	6.77	1.14	<.200
6/23/1999	6.0	26.0	0.0	7.63	1.18	<200
7/28/1999	5.9	24.0	0.0	8.76	1.28	<.200
8/25/1999	5.9	26.0	0.0	8.08	1.20	<.200
9/28/1999	6.0	24.0	0.0	8.28	1.25	<.200
10/26/1999	6.0	26.0	0.0	7.33	1.17	<.200
12/20/1999	6.0	26.0	0.0	7.55	1.22	<.200
1/25/2000	6.0	24.0	0.0	6.80	1.12	<.200
Avg.	6.0	24.0	0.0	7.25	1.21	0.22
Std. Dev.	0.1	1.9	0.0	0.93	0.09	0.03

COMBINED FLOW (6WB)

Latitude: Longitude:

COLL #	Test Date	Days	Flow gpm	00403 PH Units	00410 Alk. mg/l	70508 Hot Acidity mg/l	01045A Total Fe mg/l	01055A Total Mn mg/l	01105A Total Al mg/l
7321029	1/27/1999			6.1	15.8	0.0	1.45	0.42	0.200
7221068	2/23/1999			6.2	13.6	0.0	0.50	0.15	0.200
7321118	3/30/1999			6.1	15.0	0.0	0.92	0.21	0.200
7321170	4/29/1999			6.2	16.4	0.0	1.28	0.25	0.200
7321200	5/26/1999			6.0	17.6	0.0	1.02	0.41	0.200
7321241	6/23/1999			6.1	20.0	0.0	1.48	0.61	0.200
7321284	7/28/1999			6.1	24.0	0.0	1.58	0.81	<.200
7321306	8/25/1999			6.1	22.0	0.0	1.53	0.80	<.200
7321340	9/28/1999			6.0	17.0	0.0	1.84	0.65	<.200
7321361	10/26/1999			6.1	19.0	0.0	1.38	0.47	<.200
7321411	12/20/1999			6.2	15.2	0.0	0.84	0.25	<.200
7321029	1/25/2000			6.2	17.4	0.0	1.42	0.28	<.200
	Avg.			6.1	17.8	0.0	1.27	0.44	0.20
	Std. Dev.			0.1	3.0	0.0	0.38	0.23	0.00
			406						

Newkirk Colliery Pipe Discharge - Point (7WB)

Latitude: Longitude:

		00403	00410	70508	01045A	01055A	01105A

COLL #	Teast Date	`	Flow gpm	PH UNITS	Alk. mg/l	Hot Acidity mg/l	Total Fe mg/l	Total Mn mg/l	Total Al mg/l
7321030	1/27/1999			5.9	4.8	0	0.291	0.164	0.200
7321069	2/23/1999			6.6	9.4	0	0.199	0.114	0.200
7321119	3/30/1999			6.2	7.4	0	0.136	0.096	0.200
7321171	4/29/1999			6.2	7.4	0	1.340	0.067	0.200
7321201	5/26/1999			6.1	7.2	0	0.076	0.038	0.200
7321242	6/23/1999			5.7	4.2	1.6	0.067	0.082	0.200
7321285	7/28/1999			6.2	6.8	0	0.124	0.021	0.309
7321307	8/25/1999			6.2	6.6	0	0.062	0.01	0.200
7321341	9/28/1999			6.0	5.6	0	0.504	0.061	0.209
7321362	10/26/1999			6.3	6.8	0	0.023	0.025	0.200
7321412	12/20/1999			6.4	7.4	0	0.162	0.111	0.200
7321030	1/25/2000			6.2	9.0	0	0.120	0.082	0.200
7321176	5/17/2001		406	6.2	11.4	0	0.11	0.065	0.200
	7/17/2002								
	Avg.		406.0	6.2	7.2	0.1	0.25	0.07	0.209
	Std. Dev.			0.2	1.9	0.4	0.35	0.04	0.030

NEWKIRK BREAKER PIPE DISCHARGE (9WB)

Latitude: Longitude:

COLL #	Test Date	Days	Flow gpm	00403 PH Units	00410 Alk. mg/l	70508 Hot Acidity mg/l	01045A Total Fe mg/l	01055A Total Mn mg/l	01105A Total Al mg/l
7191861	8/27/1997		-	4.7	2.0	64.0	5.67	3.63	5.100
7191303	8/25/1998		-	4.8	3.0	28.0	6.28	4.72	3.620
7321	5/17/2001		20.0	4.3	0.0	42.0	2.79	2.13	6.010
7316028	7/17/2002		-	4.5	0.0	75.6	3.38	2.14	5.45
	Avg.		20.0	4.6	1.3	52.4	4.5	3.2	5.0
	Std. Dev.		#DIV/0!	0.2	1.5	21.4	1.7	1.3	1.0

UNNAMED TRIBUTARY (10WB)

Latitude: Longitude:

COLL #	Test Date	Days	Flow gpm	00403 PH Units	00410 Alk. mg/l	70508 Hot Acidity mg/l	01045A Total Fe mg/l	01055A Total Mn mg/l	01105A Total Al mg/l
7191858	8/27/1997			6.6	44.0	0.0	0.18	0.07	0.200
7321177	5/17/2001		80.0	6.8	46.0	0.0	0.26	0.04	0.199
	7/17/2002		-	7.0	64.0	0.0	0.33	0.08	<.200
	Avg.		80.00	6.80	51.33	0.00	0.26	0.06	0.20
	st dev		#DIV/0!	0.2	11.0	0.0	0.1	0.0	0.0

Attachment G

Comment and Response

Environmental Protection Agency, Region III

Comment

It is not obvious why Sampling Points 1WB, 2WB, 4WB and 5WB were selected as requiring reductions in loads when the spreadsheet calculations indicate Sampling Points 4AWB, 6WB, 9WB, and the unnamed tributary, 10WB, also require load reductions. Please explain.

Response

These points were not included in the TMDL because they lacked sufficient flow data. Points 4AWB, 9WB and 10WB each had only one flow reading, whereas point 6WB had no measurement. Without more data, there cannot be a true representation of flow and therefore an accurate measure of load reductions is impossible.

Comment

Table 5, Summary Table – Wabash Creek Watershed indicates reductions at Sample Points 11 AWB and 11WB, the upstream and downstream points of a stone tunnel under Tamaqua, while *Tables D7* and *D10* in *Attachment D* no reductions are necessary at these points when considering upstream reductions. The percent reductions shown in *Table 5* are reductions required without upstream reductions.

Considering that treatment will not take place at Sample Points 11AWB or 11WB, EPA recommends that upstream Sample Points 4AWB, 6WB, 9WB, and 10WB required reductions be included in *Table 5*, and that the required reduction in pounds/day at Sample Point 11AWB be determined such that instream water quality standards at Sample Point 11AWB and 11WB are achieved. *Table 5* should then be followed by a paragraph explaining that the required pounds/day reductions may be taken at any point or combinations of points in the watershed. Reductions taken in the watershed should compensate for any loads entering the tunnel via storm sewers or groundwater.

Response

Because of the lack of flow data available for points 4AWB, 6WB, 9WB and 10WB, it is felt that these points should remain out of the TMDL and not be included in *Table 5*.

Comment

Should it be decided not to include the other sampling points in *Table 5*, the required percent reductions at Sample Points 11AWB and 11WB should match the calculation in *Attachment D*.

Response

This has been corrected in this TMDL.

Comment

It should be noted that these TMDLs only address metals for which the stream is included on the 1996 and 1998 Section 303(d) lists of impaired waters, while the 2002 Section 303(d) list on your web site includes siltation and flows resulting from mining as causes of impairments. Therefore, the stream will need to stay on the list of impaired waters and more TMDLs be developed.

Response

The tentative 2002 Section 303(d) listing has been placed in Table 1 of this TMDL. Wabash Creek will have to remain on the list of impaired waters if the 2002 303(d) tentative listings become finalized with these new listings included.