FINAL

FOWLER RUN WATERSHED TMDL

Butler County

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Pennsylvania Department of Environmental Protection

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[1]TMDL
Fowler Run Watershed
Butler County, Pennsylvania

Introduction

This Total Maximum Daily Load (TMDL) calculation has been prepared for the impairments noted on the 1996 Pennsylvania 303(d) list, required under the Clean Water Act and covers stream segments in the Fowler Run watershed. High levels of metals, in some areas depressed pH, and other inorganics caused these impairments. All impairments resulted from acid drainage from abandoned coal mines. The TMDL addresses the three primary metals associated with acid mine drainage (iron, manganese, aluminum), pH and sulfate

Table 1. Section 303(d) Sub-List

State Water Plan (SWP) Subbasin: 17-C Redbank Creek Basin

Year	Miles	Segment ID	DEP Stream Code	Stream Name	Designated Use	Data Source	Source	EPA 305(b) Cause Code
1996	1.8	5453	51125	Fowler Run	CWF	305(b) Report	RE	PH, Metals, & Other Inorganics
1998	3.35	5453	51125	Fowler Run	CWF	SWMR	AMD	PH, Metals, & Other Inorganics
2000	No further survey work reported for the 2000 update.			Fowler Run				
2002	6.3	20000705-1445-JJM	51125	Fowler Run	CWF	SWAP	AMD	Metals

CWF = Cold Water Fishes
RE= Resource Extraction
SWMR= Source Water Monitoring Report
Swap = Surface Water Assessment Program
AMD = Acid Mine Drainage
The use designations for the stream segments in this TMDL can be found in PA Title 25 Chapter 93.
The 2002 303(d) list is at this time a proposed document and has not been finalized.

[1] Pennsylvania's 1996 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.*

Directions to the Fowler Run Watershed

Fowler Run is located in Allegheny Township, Butler County, and can be found on the Emlenton 7½ Minute USGS Quadrangle. From Exit 6, I-80, take Route 478 approximately two miles south to St. Petersburg. At the intersection of Route 478 and Route 58, turn right on Route 58. Take Route 58 west for approximately 2.5 miles to Foxburg and cross the bridge. Where Route 58 intersects with Route 268 turn right on Route 268 and head north for approximately 400 feet. Route 268 crosses the mouth of Fowler Run. The upper reaches of Fowler Run can be accessed by crossing Route 268 and following Route 58. A location map is attached.

Segments addressed in this TMDL

There are no active mining operations in the watershed. All 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 Section 303(d) list will be addressed as a separate TMDL. These TMDLs will be expressed as long-term, average loadings. 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 Attachment D.

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 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 PA 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 (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 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.

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

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.

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 Fowler Run Watershed TMDL.

Watershed History

There are no active mining operations within the watershed. None of the companies that mined in this watershed are actively pumping and/or treating water. All of the discharges in this watershed are from abandoned mining operations 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. Most of the mining is pre-Act with no historical information to identify the mine operators. Known companies which have mined within this watershed include Black Fox Mining Permit Nos. 10810123 and 10830111, and Glacial Minerals Permit No. 10890101.

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 93.5(b) 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
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).

Other Inorganics

The cause of inorganic impairment as listed on the 1996 Section 303(d) list is sulfates. Due to Title 25 Chapter 96.3(d) a TMDL to address sulfates is not necessary.[3] The nearest potable water withdrawal to Fowler Run occurs approximately 3 miles downstream of the mouth at Parker Area Water Authority (#5030011). Sulfate data from WQN0803, located on the Allegheny River near the Rt. 368 bridge approximately 150 meters upstream of the water supply intake, shows that the sulfate criteria of 250 mg/L is not exceeded. The average sulfate concentration calculated from 13 years of WQN data (Table 4 Appendix F) is 30.52 mg/L. A map of the water supply intake, WQN Station, and USGS Gage Station is located in Appendix A and sulfate and flow data for the WQN station is located in Appendix F.

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 for points 5 and 6 indicated that there was no single critical flow condition for pollutant sources, and further, that there was no significant correlation between

[3] Based on the supposition that the EQB will approve the addition of sulfates to §96.3(d).

source flows and pollutant concentrations (Table 3). The other point in this TMDL did not have enough paired flow/parameter data to calculate correlations (fewer than 10 paired observations).

Table 3. Correlation Between Metals and Flow for Selected Points

Point Identification	Flow vs.			Number of Samples
	Aluminum	Iron	Manganese	
5	*	0.013943	0.133361	16
6		0.0341368	0.0081851	13

*There was not enough paired flow and aluminum data for either Fowler 5 or 6 to perform the correlation.

Allocation Summary

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 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 4. Summary Table–Fowler Run Watershed

Station	Parameter	Measured Sample Data		Allowable		Reduction Identified
		Conc. (mg/l)	Load (lb/day)	LTA Conc. (mg/l)	Load (lb/day)	Percent
5						
	Aluminum	1.32	4.0	0.11	0.3	92%
	Iron	5.37	16.1	0.22	0.6	96%
	Manganese	3.99	11.9	0.40	1.2	90%
	Acidity	12.89	38.6	0.24	0.7	98%
	Alkalinity	15.76	47.1			
6						
	Aluminum	0.52	2.1	0.52	2.1	0%
	Iron	4.36	17.7	0.48	1.9	89%
	Manganese	3.67	14.9	0.48	1.9	87%
	Acidity	3.25	13.2	0.0	0.0	100%
	Alkalinity	29.80	120.8			
1						
	Aluminum	0.79	4.7	0.25	1.5	0%
	Iron	5.71	34.2	0.69	4.1	0%
	Manganese	3.84	23.0	0.65	3.9	0%
	Acidity	8.72	52.2	0.40	2.4	0%
	Alkalinity	20.91	125.2			

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.

To date, there have been no remediation projects within the Fowler Run watershed. There are no local environmental or watershed groups active in this stream segment. If additional mining is pursued within Fowler Run watershed, the mining company will be required to meet the percent reduction, noted in Table 5 for discharges from the mine site.

When remediation efforts are undertaken, each project will have "before and after" monitoring done to determine the efficiency of the remediation strategy.

Water quality improvement may be achieved by employing various remediation techniques that may include a combination of any of the following. Reclamation and revegetation of un-reclaimed pits would create positive drainage by eliminating impoundments that promote mine drainage formation. Capping disturbed areas with fly ash can further reduce surface water infiltration. Promoting surface run-off would lead to a decrease in loading from the discharges.

There are several areas where the pre-Act mining occurred through stream channels. These sections of the streams would benefit greatly from stream reconstruction.

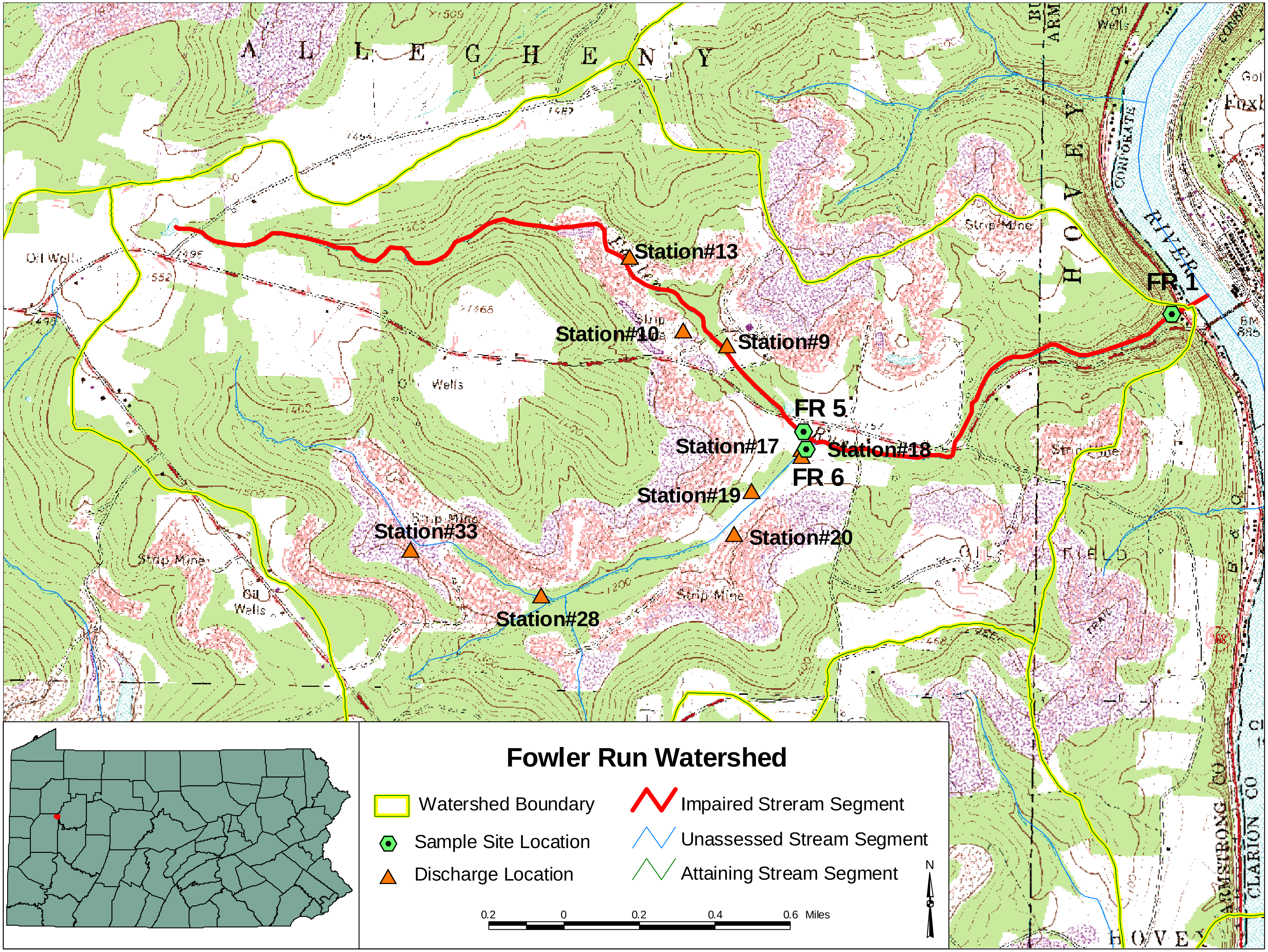
The deep mine discharges may be treated via Successive Alkalinity Producing (SAP) vertical flow treatment systems in conjunction with the construction of wetland treatment systems. In the absence of analyses for ferric iron and dissolved oxygen, anoxic limestone drains (ALD) may not be viable as a treatment option.

Several discharge locations are from naturally formed wetlands that may or may not have existed prior to the development of the discharges. Enhancement and / or enlargement of these wetlands would further aid in decreasing the metal concentrations in Fowler Run.

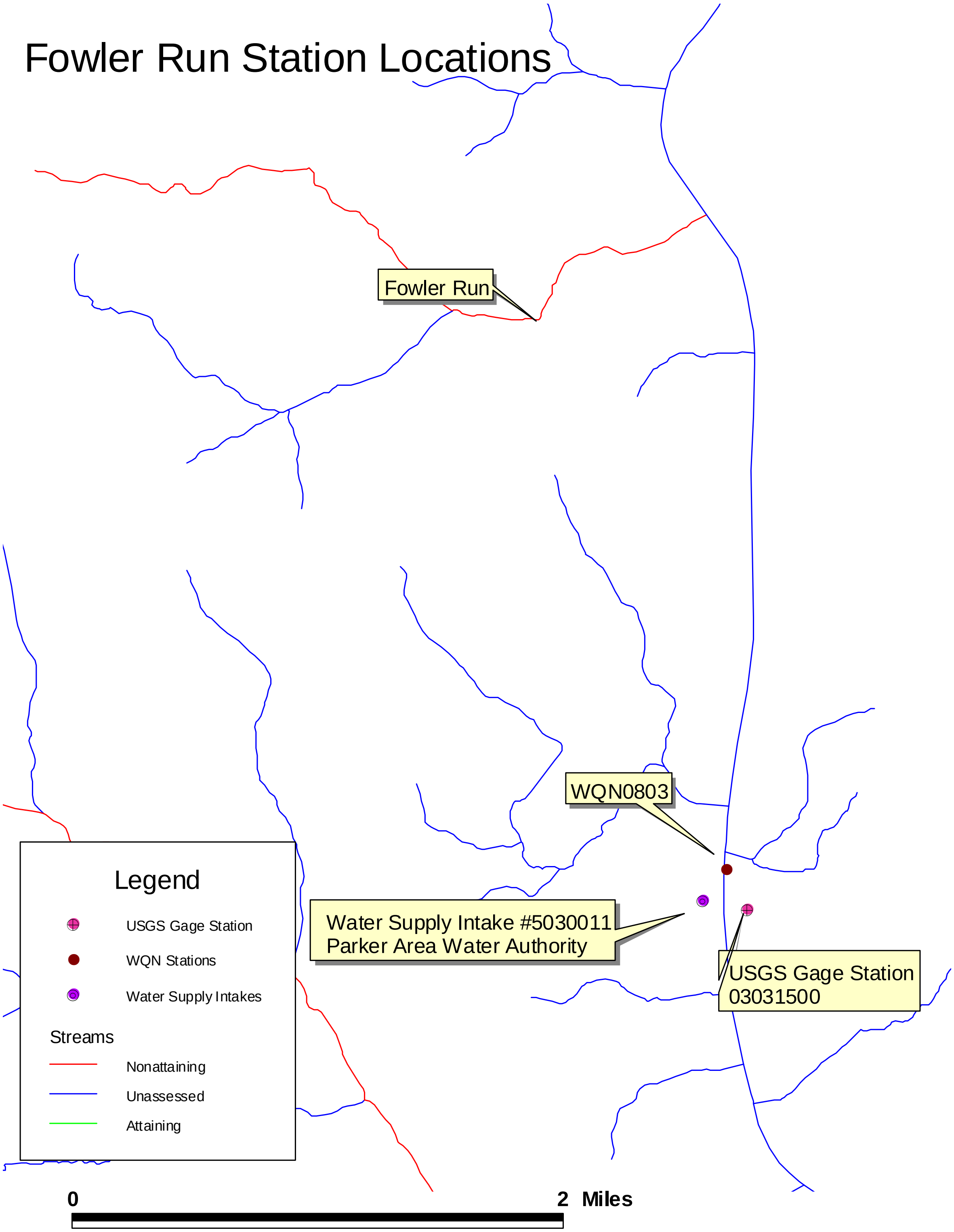
Public Participation

Public notice of the draft TMDL was published in the *Pennsylvania Bulletin,* on December 14, 2002, and the Butler Eagle on December 27, 2002 to foster public comment on the allowable loads calculated. A public meeting was held on January 13,2002, at the Jefferson County Conservation District Office in Jefferson County, Pa , to discuss the proposed TMDL.

Attachment A


Fowler Run Watershed
Watershed Boundary
Sample Site Location
Discharge Location
Impaired Strerm Segment
Unassessed Stream Segment
Attaining Stream Segment
0.2 0 0.2 0.4 0.6 Miles
N
Station#13
Station#10
Station#9
FR 5
Station#17
Station#18
FR 6
Station#19
Station#20
Station#33
Station#28
FR 1
A L L E G H E N Y
Strip Mine
Oil Wells
RIVER
ARMSTRONG CO
CLARION CO

Fowler Run Station Locations



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[4] 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 = 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)

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

LTA = allowable LTA source concentration in mg/l

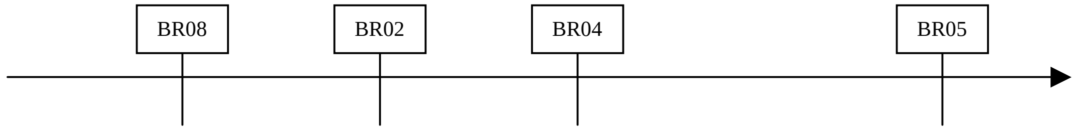
Once the required percent reduction for each pollutant source was determined, a second series of Monte Carlo simulations were performed to determine if the cumulative loads from multiple sources allow instream water quality criteria to be met at all points at least 99 percent of the time. The second 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 303(d) list for pH impairment, the evaluation is the same as that discussed above; the pH method is fully explained in Attachment C. 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 E. Information for the TMDL analysis performed using the methodology described above is contained in the TMDLs by segment section of this report in Attachment F.

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.*

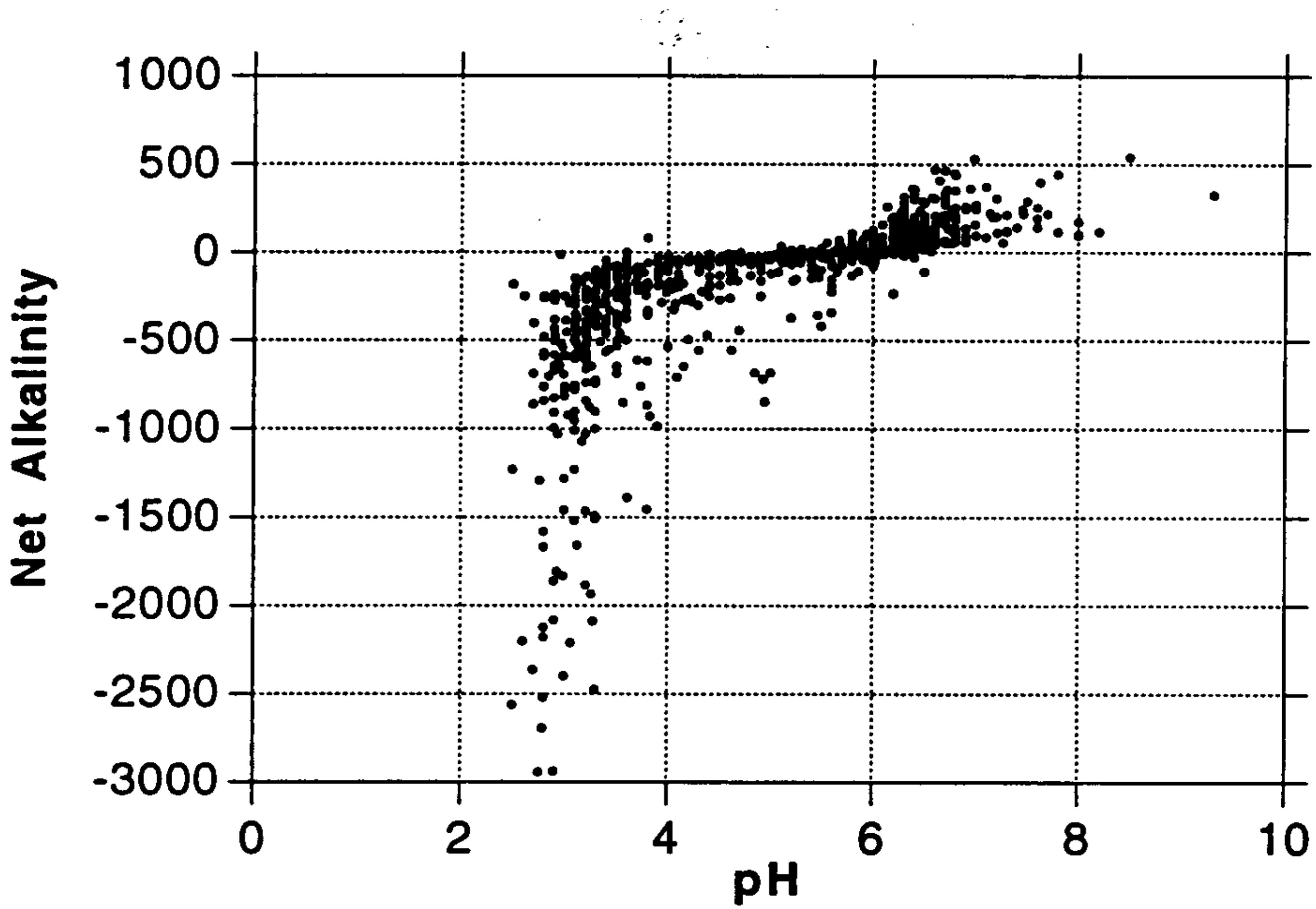


Figure 1. Net Alkalinity vs. pH. Taken from Figure 1.2 Graph C, pages 1-5, of Coal Mine Drainage Prediction and Pollution Prevention in Pennsylvania

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 – A 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).

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

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

TMDL Calculations for Fowler Run No. 5

Fowler Run # 5 has the influence of several seeps and discharges found upstream of this point.

Station 9 (#FR-9): The north side of Fowler Run is approximately 1,200 feet upstream from the culvert crossing at Route 58, just above the Fowler 5 sample location. This seep is heavily iron stained with flow >10 gpm.

Station 10 (#FR-10): Approximately 200 feet upstream of Station 9, this is a heavily iron stained seep flowing from a wetland area. Flow is >5 gpm.

Station 13 (#FR-13): Approximately 2,000 feet upstream of Station 9, this is an old deep mine discharge from a pond on Black Fox Mining & Development Corp.'s Permit No. 10810123.

The TMDL for the watershed above Fowler Run #5 consists of a load allocation to all of the area above sampling point Fowler Run #5 (Attachment A). Addressing the mining impacts above this point addresses the impairment for the entire stream segment to its confluence with the unnamed tributary at point Fowler Run #6.

Fowler Run is currently on the Section Pa 303(d) list for impairment due to pH, and sample data at point Fowler Run #5 shows pH ranging between 3.9 and 6.4; pH will be addressed as part of this TMDL because of the mining impacts No upstream samples were available for comparison. 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 load allocation for this stream segment was computed using water-quality sample data collected at point Fowler Run #5. The average flow, measured at sampling point Fowler Run #5 (0.36 MGD), is used for these computations.

An allowable long-term average in-stream concentration was determined at point Fowler Run #5 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. Fowler Run #5					
	Measured Sample Data		Allowable		Reduction Identified
Parameter	Conc (mg/l)	Load (lbs/day)	Conc (mg/l)	load (lbs/day)	%
Aluminum	1.32	4.0	0.11	0.3	92%
Iron	5.37	16.1	0.22	0.6	96%
Manganese	3.99	11.9	0.40	1.2	90%
Acidity	12.89	38.6	0.24	0.7	98%
Alkalinity	15.76	47.1			

The allowable loading values shown in Table D1 represent load allocations made at Fowler Run # 5.

TMDL Calculations for Fowler Run No. 6

Fowler Run # 6 is at the mouth of the unnamed tributary to Fowler Run. Seeps and Discharges impacting this point include:

Station 17 (#FR-17): There is water flowing from a wetland area into the north side of the unnamed tributary just upstream of the Fowler 6 sample location.

Station 18 (#FR-18): This is a discharge from old mine spoil into the unnamed tributary, located on the south side of the unnamed tributary approximately 300 feet upstream of Fowler 6. There is iron staining at the source and it has a light gray precipitate where it enters the stream. The flow is >10 gpm.

Station 19 (#FR-19): This is a discharge flowing from wetlands into the unnamed tributary, along the north side approximately 1,100 feet upstream of Fowler 6. There is heavy iron staining with a flow >10 gpm.

Station 20 (#FR-20): This is a discharge from old spoil into the unnamed tributary, along the south side approximately 1,300 feet upstream of Fowler 6. There is no staining and flow is >10 gpm.

Station 28 (#FR-28): This is a seep from old spoil into an unnamed tributary, along the north side of the stream approximately 4,400 feet upstream of Fowler 6. There is heavy iron staining and flow is >20 gpm.

Station 33 (#FR-33): This is a seep from the toe of spoil flowing directly into the unnamed tributary, approximately 6,400 feet upstream of Fowler 6. There is heavy iron staining and flow is >15 gpm.

The TMDL for the watershed above Fowler Run #6 consists of a load allocation to all of the area above sampling point Fowler Run #6 (Attachment A). Addressing the mining impacts above this point addresses the impairment for the entire stream segment to its confluence Fowler Run near point Fowler Run #5.

Fowler Run is currently on the Section Pa 303(d) list for impairment due to Ph. Sample data at point fowler 6 shows pH ranging between 5.4 and 6.5; pH will be addressed as part of this TMDL because of the mining impacts. 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 load allocation for this stream segment was computed using water-quality sample data collected at point Fowler Run #6. The average flow, measured at sampling point Fowler Run #6 (0.49 MGD), is used for these computations.

An allowable long-term average in-stream concentration was determined at point Fowler Run #6 for 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 D2. Fowler Run # 6

	Measured Sample Data		Allowable		Reduction Identified
Parameter	Conc (mg/l)	Load (lbs/day)	Conc (mg/l)	load (lbs/day)	%
Aluminum	0.52	2.1	0.52	2.1	0%
Iron	4.36	17.7	0.48	1.9	89%
Manganese	3.67	14.9	0.48	1.9	87%
Acidity	3.25	13.2	0.0	0.0	100%
Alkalinity	29.80	120.8			

The allowable loading values shown in Table D2 represent load allocations made at Fowler Run # 6.

TMDL Calculations for Fowler Run No. 1

The existing and the allowable loading for point Fowler Run #1 for all parameters was determined. This was based on the sample data for this point and did not account for any load reductions already specified from upstream sources. The load reductions from points Fowler Run # 5 and #6 were summed and represent the upstream load reductions. The upstream load reduction was subtracted from the existing load at point Fowler Run #1, and was compared to the allowable load at Fowler Run #1 for each parameter, to determine if any further reductions were needed at this point.

The existing and allowable loading values for this stream segment were computed using water-quality sample data collected at sampling point Fowler Run #1. The average flow, measured at sampling point Fowler Run #1 (0.72 MGD), is used for these computations.

Fowler Run is currently on the Pa Section 303(d) list for impairment due to pH, and sample data at point Fowler Run #1 shows pH ranging between 5.8 and 6.3; pH will be addressed as part of this TMDL because of the mining impacts. 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 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.

Table D3. Fowler #1

	Measured Sample Data		Allowable	
Parameter	Conc (mg/l)	Load (lbs/day)	Conc (mg/l)	load (lbs/day)
Aluminum	0.79	4.7	0.25	1.5
Iron	5.71	34.5	0.69	4.1
Manganese	3.84	23.0	0.65	3.9
Acidity	8.72	52.2	0.40	2.4
Alkalinity	20.91	125.2		

The area of Fowler Run watershed upstream of Fowler Run #1 is adversely affected by AMD and one or more allocations may be necessary at Fowler Run #1. In an effort to determine if there is a need for any allocations at this point the following procedure was used.

The loading reductions for points Fowler Run #5 and #6 were summed to show the total load that was removed from upstream sources. This value, for each parameter was then subtracted from the existing load at point Fowler Run #1. This value was then compared to the allowable load at point Fowler Run #1. Reductions at point Fowler Run #1 are necessary for any parameter that exceeded the allowable load at this point. Table D4. shows a summary of all loads that affect point Fowler Run #1. Table D5. illustrates the necessary reductions at point Fowler Run #1. The results of this analysis show that no reductions for aluminum, iron, manganese or acidity are necessary at this point.

Table D4. Summary of All Loads that Affect Fowler Run #1				
	Aluminum (#/day)	Iron (#/day)	Manganese (#/day)	Acidity (#/day)
Fowler Run No. 5				
load reduction=	3.63	15.42	10.74	37.84
Fowler Run No. 6				
load reduction=	0.0	15.7	13.0	13.2

Table D5. Necessary Reductions at Fowler Run #1				
	Aluminum (lbs/day)	Iron (lbs/day)	Manganese (lbs/day)	Acidity (lbs/day)
Existing Loads at Fowler Run No. 1	4.7	34.2	23.0	52.2
Total Load Reduction SUM @ (Fowler Run No. 5 + No 6)	3.6	31.2	23.7	51.0
Remaining Load (Existing Loads at Fowler Run No. 1 – TLR SUM)	1.1	3.0	NA	1.2
Allowable Loads at Fowler Run No. 1	1.5	4.1	3.9	2.4
Percent Reduction	NA	NA	NA	NA
Additional Removal Required at Fowler Run No. 1	0.0	0.0	0.0	0.0

The load allocation for this stream segment was computed using water-quality sample data collected at point Fowler Run #1 and the allowable loads from Fowler Run #5 and #6. The average flow, measured at sample point Fowler Run # 1, is used for these computations. The Percent Reduction in Table 5, above, is calculated (refer to Table 5):

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

Margin of Safety

For this study the margin of safety is applied implicitly. A MOS is built in because the allowable concentrations and loadings were simulated using Monte Carlo techniques and employing the @Risk software. 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. In addition, the five thousand @Risk iterations would be equivalent to daily sample collection for a thirteen-year period.

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. The average flow, measured at sample point Fowler Run #1, is used for these computations.

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 Section 303(d) narratives that justify changes in listings between the 1996, 1998, draft 2000, and Draft 2002 Section 303(d) list. The Section 303(d) listing process has undergone an evolution in Pennsylvania since the development of the 1996 list.

In the 1996 Section 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 Section 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 Section 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 Section 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 Section 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 2000 Section 303(d) list, the 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

Table 1. Fowler Run Sample Site 5											
DATE	FLOW gpm	pH	ALK mg/l	HOT A mg/l	IRON mg/l	MN mg/l	AL mg/l	SO4	TSS	NET ALK	Net Acidity
1/21/1982	125.00	4.10	0.00	38.00	5.34	3.87	6.30	160		-38	38.00
8/14/1987	100.00	3.90	0.90	56.00	7.50	7.50		255	1	-55.1	55.10
5/2/1988	350.00	4.43	5.10	46.20	7.81	6.10		305	1	-41.1	41.10
2/16/1989	500.00	4.85	3.10	6.70	3.81	3.40		215	1	-3.6	3.60
11/13/1990	350.00	6.60	14.80	0.90	31.25	0.50		335	1	13.9	-13.90
7/22/1991	100.00	6.10	10.20	9.80	7.81	7.11		241	1	0.4	-0.40
7/27/1992	550.00	5.62	4.20	4.60	3.13	3.52		330	8	-0.4	0.40
11/18/1993	300.00	6.24	15.60	10.40	1.15	1.54		156	1	5.2	-5.20
9/30/1994	250.00	6.40	18.00	0.80	2.30	3.86	0.49	470	3	17.2	-17.20
3/29/1995	110.00	6.20	22.00	6.40	4.75	4.59	1.20	568	4	15.6	-15.60
6/15/1995	375.00	6.40	22.00	2.60	3.04	3.50	0.72	487	6	19.4	-19.40
8/30/1995	175.00	6.40	38.00	0.00	0.82	3.81	0.49	756	3	38	-38.00
10/25/1995	290.00	6.30	22.00	1.20	1.59	4.74	0.49	773	14	20.8	-20.80
3/27/1996	50.00	6.10	18.20	8.00	2.88	3.58	1.24	519	3	10.2	-10.20
8/28/1996	135.00	6.20	36.00	0.00	1.33	3.54	0.49	824	8	36	-36.00
10/22/1996	225.00	6.40	22.00	14.60	1.44	2.72	0.49	389	3	7.4	-7.40
Avg	249.06	5.77	15.76	12.89	5.37	3.99	1.32	423.94	3.87	2.87	-2.87
StDev	148.75	0.91	11.49	17.62	7.30	1.80	1.89	217.14	3.72	26.48	26.48

COLL	DATE	FLOW gpm	pH	ALK mg/l	HOT A mg/l	IRON mg/l	MN mg/l	AL mg/l	SO4	TSS
	8/14/1987	350.00	6.07	8.30	17.60	9.53	6.40		680	1
	5/2/1988	714.00	6.35	17.20	10.80	7.75	3.60		325	1
	5/1/1989	50.00	6.40	15.60	8.70	6.53	5.00		605	1
	8/9/1990	250.00	6.22	10.10	4.20	0.18	1.10		680	1
	2/6/1991	700.00	6.29	18.20	0.90	3.31	2.90		228	1
4242-981	9/30/1994	415.00	6.50	30.00	0.00	5.18	4.46	0.49	456	8
4242-312	3/29/1995	215.00	6.40	38.00	0.00	3.81	3.44	0.54	456	3
4242-506	6/15/1995	375.00	6.50	44.00	0.00	2.24	2.68	0.49	430	10
679	8/30/1995	325.00	6.30	46.00	0.00	3.68	4.86	0.49	651	3
4242-815	10/25/1995	325.00	5.40	38.00	0.00	5.87	4.34	0.49	555	26
4242-160	3/27/1996	175.00	6.40	46.00	0.00	3.61	3.02	0.69	459	5
4242-619	8/28/1996	145.00	6.20	44.00	0.00	3.01	3.54	0.49	614	12
4242-813	10/22/1996	350.00	6.50	32.00	0.00	1.93	2.31	0.49	339	3
avg=		337.62		29.80	3.25	4.36	3.67	0.52		
stdev=					5.65	2.55	1.36	0.07		

Table 3. Fowler Run Sample Site 1											
DATE	FLOW gpm	pH	ALK mg/l	HOT A mg/l	IRON mg/l	MN mg/l	AL mg/l	SO4	TSS	NET ALK	Net Acidity
9/30/1994	675.00	6.20	14.20	0.00	6.28	4.57	0.50	481	3	14.2	-14.20
3/29/1995	325.00	6.20	22.00	9.60	5.36	3.83	1.10	491	3	12.4	-12.40
6/15/1995	715.00	6.20	22.00	0.00	3.04	2.86	0.70	465	22	22	-22.00
8/30/1995	535.00	6.20	17.40	24.00	7.97	4.34	0.50	782	3	-6.6	6.60
10/25/1995	630.00	6.10	24.00	10.30	10.00	5.27	0.50	709	10	13.7	-13.70
3/19/1996	230.00	6.30	26.00	5.80	5.15	3.76	1.84	484	12	20.2	-20.20
6/26/1996	475.00	6.30	20.00	2.20	3.68	3.35	0.86	471	4	17.8	-17.80
8/28/1996	310.00	6.30	28.00	9.60	6.49	3.64	0.50	921	24	18.4	-18.40
10/22/1996	590.00	5.80	14.60	17.00	3.39	2.98	0.60	403	3	-2.4	2.40
Avg	498.33	6.18	20.91	8.72	5.71	3.84	0.79	578.56	9.33	12.19	-12.19
StDev	174.39	0.16	4.82	7.98	2.28	0.78	0.44	179.26	8.46	10.02	10.02

Table 4. WQN0803 Sulfate and Flow Data

WQN0803 ~3 miles downstream of Fowler Run
Allegheny River - Rt 368 Br near Parkers Landing
150 Meters upstream of USGS Gaging Station
~ 150 meters upstream Water Supply Intake #503001
Parker Area Water Authority

Date	Sulfate Concentration	Mean Daily Flow	Instantaneous Flow
	mg/L	cfs	cfs
1/16/1985	18	10900	
2/25/1985	37	79700	84000
3/20/1985	20	29500	27500
4/17/1985	18	13400	11600
5/16/1985	26	3470	2880
6/12/1985	51	4590	4000
7/10/1985	26	13100	11900
8/6/1985	21	2280	2110
9/23/1985	68	4080	4090
10/8/1985	48	6310	6190
11/15/1985		40400	
11/20/1985	35	34100	32820
12/11/1985	54	33600	33310
1/8/1986	28	8000	8000
2/20/1986	68	33800	19300
3/13/1986	26	21000	18580
4/8/1986	18	10200	9980
5/8/1986	22	10300	8540
6/30/1986	62	7440	7700
7/16/1986	57	11000	12500
8/18/1986	22	6490	6280
9/16/1986	23	3880	3700
10/15/1986	27	17600	16900
11/6/1986	35	6380	6010
12/8/1986		31900	
12/11/1986	39	43600	42970
1/8/1987	24	8000	8000
2/5/1987	29	6800	7030
3/9/1987	22	31200	31070
4/7/1987	20	46000	46440
5/7/1987	22	9060	7150
6/2/1987	31	7010	5650
7/22/1987	28	4970	4780
8/4/1987		10100	9620
8/5/1987	19	8520	
9/23/1987	33	30700	312800
10/14/1987	21	15200	

Table 4. WQN0803 Sulfate and Flow Data			
Date	Sulfate Concentration	Mean Daily Flow	Instantaneous Flow
	mg/L	cfs	cfs
11/4/1987	10	9920	10100
11/27/1987		13600	
12/15/1987	20	2400	21600
8/13/1998	14.4		
9/10/1998	24.9		
10/19/1998	20.1		
11/19/1998	29.7		
12/16/1998	34.4		
AVG	30.52	17262.50	24855.88
STDEV	14.47	16127.90	53538.59

Attachment G

Comment and Response

Comment 1: In the *Watershed History* segment, please provide the current status of the post-act mining permits. While no companies "are actively pumping and/or treat water," please clarify whether or not any of the named permittees are potentially liable for treating mine discharge by providing the permit's status, *e.g.*, bond release, etc.

Response: When it is stated in an AMD TMDL "All of the discharges in this watershed are from abandoned mining operations…" there are no potentially liable entities. There are no active mines in the Fowler Run watershed. The mining permits mentioned in Watershed History on page 6, Black Fox Mining Permit Nos. 10810123 and 10830111, and Glacial Minerals Permit No. 10890101, have had their bonds released.

Comment 2: The values in *Table 3* should be identified.

Response: Correlation values are unit less.

Comment 3: On page 4, *Clean Water Act Requirements* section, please change the third bullet to read that the Section 303(d) list of impaired waters is required every *two* years under the current, applicable regulations.

Response: Changed

Comment 4: The values in *Table 4*, the values in the tables in *Attachment D*, and the spreadsheet do not always agree with respect to percent reduction required or allowable loads. Please review and correct as necessary.

Response: Corrected

Comment 5: In the *Recommendations* section the following comment is made: "If additional mining is pursued within Fowler Run watershed, the mining company will be required to meet the percent reduction, noted in Table 5 for discharges from the mine site." Please note that to permit future discharges under the Clean Water Act, this TMDL will need to be revised to convert load allocations (LAs) to waste load allocations (WLAs).

Response: Noted

Comment 6: In *Attachment F, Water Quality Data Used in TMDL Calculations, Table 2. Fowler Run Sample Site 6*, contains the same data as *Table 1. Fowler Run Sample 5.* Please correct.

Response: Corrected