FINAL

UNT 26641 West Branch Susquehanna River TMDL

Clearfield County

For Acid Mine Drainage Affected Segments

Prepared by:

Pennsylvania Department of Environmental Protection

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TABLE OF CONTENTS

FIGURES

TABLES

ATTACHMENTS

[1]TMDL

UNT 26641 West Branch Susquehanna River Watershed
Clearfield County, Pennsylvania

Table 1. 303(d) Sub-List								
State Water Plan (SWP) Subbasin: 8-B UNT 26641 West Branch Susquehanna River								
Year	**Miles**	**Segment ID Assessment ID**	**DEP Stream Code**	**Stream Name**	**Designated Use**	**Data Source**	**Source**	**EPA 305(b) Cause Code**
1996	1.5	7190	26641	UNT 26641 West Branch Susquehanna River	CWF	RE	AMD	pH
1998	1.53	7190	26641	UNT 26641 West Branch Susquehanna River	CWF	SWMP	AMD	pH
2002	1.5	7190	26641	UNT 26641 West Branch Susquehanna River	CWF	SWMP	AMD	pH
2004	1.5	7190	26641	UNT 26641 West Branch Susquehanna River	CWF	SWMP	AMD	pH

Resource Extraction = RE
Cold Water Fishery = CWF
Resource Extraction = RE
Surface Water Monitoring Program = SWMP
Abandoned Mine Drainage = AMD
See Attachment D, *Excerpts Justifying Changes Between the 1996, 1998, 2002 and 2004 Section 303(d) Lists.*
The use designations for the stream segments in this TMDL can be found in PA Title 25 Chapter 93

Introduction

This Total Maximum Daily Load (TMDL) calculation has been prepared for one segment in the UNT 26641 West Branch Susquehanna River (Attachment A). It was done to address the impairments noted on the 1996 Pennsylvania 303(d) list, required under the Clean Water Act, and covers one segment on this list (shown in Table 1). Depressed pH and in some areas, high levels of metals caused these impairments. Impairments resulted due to acid drainage from abandoned coalmines. The TMDL addresses the three primary metals associated with acid mine drainage (iron, manganese, aluminum) and pH.

Directions to the UNT 26641 West Branch Susquehanna River Watershed

Unnamed Tributary 26641 Watershed is located in North Central Pennsylvania, occupying a northwestern portion of Clearfield County in Lawrence and Pike Townships. The watershed area

[1] Pennsylvania's 1996, 1998, 2002 and 2004 Section 303(d) lists were approved by the Environmental Protection Agency (EPA). 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.*

is found on United States Geological Survey maps covering Clearfield, Curwensville, Elliot Park and Glen Richey 7.5-Minute Quadrangles. Land uses within the watershed include an active mining operation, abandoned mine lands, forestlands and homes scattered throughout.

Unnamed Tributary 26641 can be easily reached from Clearfield or Curwensville. The small community of Bailey Settlement is located in Unnamed Tributary 26641 drainage basin. Bailey Settlement is easily reached by traveling on State Route 879 from Clearfield or Curwensville. State Route 879 passes over Unnamed Tributary 26641 just before its confluence with the West Branch of the Susquehanna River.

Hydrology of Unnamed Tributary 26641 Watershed

The area within the watershed consists of 1.5 square miles. Unnamed Tributary 26641 flows from an elevation of 1500 feet above sea level in its headwaters to an elevation of 1100 feet above sea level at its confluence with the West Branch of the Susquehanna River. The tributary flows from the north to the south.

Geology of Unnamed Tributary 26641 Watershed

Unnamed Tributary 26641 watershed lies within the Appalachian Plateaus Physiographic Province. Regionally, broad, gentle, northeast striking folds are imposed on this well dissected plateau. Locally, the Chestnut ridge anticline lies to the northwest and the Clearfield syncline lies to the southeast of the watershed. The stream valleys are relatively broad, shallow and flat bottomed with narrow well-rounded interfluvial areas. All surface drainage flows to the south to the West Branch of the Susquehanna River.

Segments addressed in this TMDL

UNT 26641 West Branch Susquehanna River is affected by pollution from AMD. This pollution has caused high levels of metals and depressed pH in the watershed. There is one active mining operation in this watershed (Waroquier Coal Company). 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 Table 3 for TMDL calculations and see Attachment C for TMDL explanations.

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 (EPA) 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 EPA 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 non-point sources; and

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

Despite these requirements, states, territories, authorized tribes, and EPA had not developed many TMDLs. Beginning in 1986, organizations in many states filed lawsuits against the EPA for failing to meet the TMDL requirements contained in the federal Clean Water Act and its implementing regulations. While EPA 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 EPA to backstop TMDL development, track TMDL development, review state monitoring programs, and fund studies on issues of concern (e.g., AMD, implementation of non-point 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 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 EPA, the states have developed methods for assessing the waters within their respective jurisdictions.

The primary method adopted by the Pennsylvania Department of Environmental Protection (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

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

process. DEP is now using the Statewide Surface Waters Assessment Protocol (SSWAP), a modification of the EPA's 1989 Rapid Bioassessment Protocol II (RBP-II), as the primary mechanism to assess Pennsylvania's waters. The SSWAP 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 macroinvertebrates, habitat surveys, and measurements of pH, temperature, conductivity, dissolved oxygen, and alkalinity. Benthic macroinvertebrates are identified to the family level in the field.

After the survey is completed, the biologist determines the status of the stream segment. The decision is based on the performance of the segment using a series of biological metrics. If the stream is determined to be impaired, the source and cause of the impairment is documented. An impaired stream must be listed on the state's Section 303(d) list with the source and cause. A TMDL must be developed for the stream segment and each pollutant. 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. Calculating TMDL for the waterbody using EPA approved methods and computer models;
3. Allocating pollutant loads to various sources;
4. Determining critical and seasonal conditions;
5. Public review and comment period on draft TMDL;
6. Submittal of final TMDL to EPA.
7. EPA approval of the TMDL.

Watershed History

Portions of Unnamed Tributary 26641 watershed have been heavily mined by pre-law operations. Many of these mine sites were limited in extent and consisted of simple crop cut operations that seldom established a 60-foot highwall height. Following coal removal, the exposed coal seams were covered by backfilling. Generally, the highwalls were never reclaimed and spoil banks were left in an unregraded manner.

The watershed witnessed an intense build up of coal mining activities during the 1970's. From 1972 to 1980 six mine drainage permits were issued within the watershed (see completed mining for details). The combined acreage of the drainage permits comprised 70 percent of the Unnamed Tributary 26641 surface watershed. Coal mining activities were conducted on the Lower Kittanning, Middle Kittanning, and Upper Kittanning and Lower Freeport coal seams. Also the coal rider seams associated with the Lower and Middle Kittanning formations were mined where it was economically profitable.

COMPLETED MINING

The CA Ogden, Ogden #6 Operation (MDP#4572SM6) was issued in May of 1972. The total permit area was 131 acres with 42.5 acres affected. The Middle Kittanning coal seam was mined. Mining was completed in 1975.

The Benjamin Coal Company, Hartman Operation (MDP#4572SM13) was issued in June of 1973. The total permit area was 198 acres and then amended to a final total acreage of 252 acres. The coal seams mined were the Lower Kittanning and Lower Kittanning rider coal seams. Mining commenced in August of 1973 and was completed in October of 1978.

The Shawville Coal Company, Carr Hill #1 Operation (MDP#4576SM5) was issued in April of 1976. The total permit area was 131 acres with approximately 70 acres affected. The Lower Kittanning, Middle Kittanning, Upper Kittanning and Lower Freeport coal seams were mined. Mining commenced in December of 1976 and was completed in June of 1981.

The McDonald Land and Mining Company, Smay Operation (MDP#45A76SM3) was issued in October of 1976. The total permit area was 247 acres with 110 acres affected. The coal seams mined were the Lower Kittanning, Middle Kittanning and Upper Kittanning coal seams. Mining commenced in November of 1978 and was completed in March of 1982.

The Sky Haven Coal, Inc., Smay #1 Operation (MDP#45A77SM5) was issued in February of 1978. The total permit area was 109 acres with 54 acres affected. The coal seams mined were the Lower Kittanning, Middle Kittanning, Middle Kittanning rider and Upper Kittanning coal seams. Mining commenced in November of 1978 and was completed in March of 1982.

The Sky Haven Coal, Inc., Walker Operation (MDP#17800105) was issued in July of 1980. The total permit area was 194 acres with 137 acres affected. The coal seams mined were the Lower and Middle Kittanning coal seams. Mining commenced in February of 1981 and was completed in October of 1986.

ACTIVE MINNG

The Waroquier Coal Company, Lawrence #1 Operation (17980118) (41-00-09/78-29-00) was issued on October 3, 2000. The total permit area is 193.3 acres with 60.3 acres affected. The coal seams being mined are the Upper Freeport (17.8 acres) and Lower Freeport rider (42.5 acres). Mining commenced on the site in the fall of 2001 and continues today (December 2005).

AMD Methodology

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

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

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

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

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

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

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

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:

$$LTA = Mean * (1 – PR99) \text{ where} \tag{2}$$

LTA = allowable LTA source concentration in mg/l

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

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

There are two basic rules that are applied in load tracking; rule one is that if the sum of the measured loads that directly affect the downstream sample point is less than the measured load at the downstream sample point it is indicative that there is an increase in load between the points being evaluated, and this amount (the difference between the sum of the upstream and downstream loads) shall be added to the allowable load(s) coming from the upstream points to give a total load that is coming into the downstream point from all sources. The second rule is that if the sum of the measured loads from the upstream points is greater than the measured load at the downstream point this is indicative that there is a loss of instream load between the evaluation points, and the ratio of the decrease shall be applied to the load that is being tracked (allowable load(s)) from the upstream point.

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

In low pH TMDLs, acidity is compared to alkalinity as described in Attachment B. Each sample point used in the analysis of pH by this method must have measurements for total alkalinity and total acidity. Statistical procedures are applied, using the average value for total alkalinity at that point as the target to specify a reduction in the acid concentration. By maintaining a net alkaline stream, the pH value will be in the range between six and eight. This method negates the need to specifically compute the pH value, which for streams affected by low pH may not represent a true reflection of acidity. This method assures that Pennsylvania's standard for pH is met when the acid concentration reduction is met.

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

Method to Quantify Treatment Pond Pollutant Load

Calculating Waste Load Allocations for Active Mining in the TMDL Stream Segment.

The end product of the TMDL report is to develop Waste Load Allocations (WLA) and Load Allocations (LA) that represent the amount of pollution the stream can assimilate while still achieving in-stream limits. The LA is the load from abandoned mine lands where there is no NPDES permit or responsible party. The WLA is the pollution load from active mining that is permitted through NPDES.

In preparing the TMDL, calculations are done to determine the allowable load. The actual load measured in the stream is equal to the allowable load plus the reduced load.

Total Measured Load = Allowed Load + Reduced Load

If there is active mining or anticipated mining in the near future in the watershed, the allowed load must include both a WLA and a LA component.

Allowed Load (lbs/day) = WLA (lbs/day) + LA (lbs/day)

The following is an explanation of the quantification of the potential pollution load reporting to the stream from permitted pit water treatment ponds that discharge water at established effluent limits.

Surface coalmines remove soil and overburden materials to expose the underground coal seams for removal. After removal of the coal the overburden is replaced as mine spoil and the soil is replaced for revegetation. In a typical surface mining operation the overburden materials is removed and placed in the previous cut where the coal has been removed. In this fashion, an active mining operation has a pit that progresses through the mining site during the life of the mine. The pit may have water reporting to it, as it is a low spot in the local area. Pit water can be the result of limited shallow groundwater seepage, direct precipitation into the pit, and surface runoff from partially regarded areas that have been backfilled but not yet revegetated. Pit water is pumped to nearby treatment ponds where it is treated to the required treatment pond effluent limits. The standard effluent limits are as follows, although stricter effluent limits may be applied to a mining permit's effluent limits to insure that the discharge of treated water does not cause in-stream limits to be exceeded.

Standard Treatment Pond Effluent Limits:
Alkalinity > Acidity
6.0 <= pH <= 9.0
Fe < 3.0 mg/l
Mn < 2.0 mg/l
Al < 2.0 mg/l

Discharge from treatment ponds on a mine site is intermittent and often varies as a result of precipitation events. Measured flow rates are almost never available. If accurate flow data are available, they can be used to quantify the WLA. The following is an approach that can be used to determine a waste load allocation for an active mining operation when treatment pond flow rates are not available. The methodology involves quantifying the hydrology of the portion of a surface mine site that contributes flow to the pit and then calculating waste load allocation using NPDES treatment pond effluent limits.

The total water volume reporting to ponds for treatment can come from two primary sources: direct precipitation to the pit and runoff from the unregraded area following the pit's progression through the site. Groundwater seepage reporting to the pit is considered negligible compared to the flow rates resulting from precipitation.

In an active mining scenario, a mine operator pumps pit water to the ponds for chemical treatment. Pit water is often acidic with dissolved metals in nature. At the treatment ponds, alkaline chemicals are added to increase the pH and encourage dissolved metals to precipitate and settle. Pennsylvania averages 41.4 inches of precipitation per year (Mid-Atlantic River Forecast Center, National Weather Service, State College, PA, 1961-1990, http://www.dep.state.pa.us/dep/subject/hotopics/drought/PrecipNorm.htm). A maximum pit dimension without special permit approval is 1500 feet long by 300 feet wide. Assuming that 5 percent of the precipitation evaporates and the remaining 95 percent flows to the low spot in the active pit to be pumped to the treatment ponds, results in the following equation and average flow rates for the pit area.

41.4 in. precip./yr x 0.95 x 1 ft./12/in. x 1500'x300'/pit x 7.48 gal/ft^3 x 1yr/365days x 1day/24hr. x 1hr./60 min. =

= 21.0 gal/min average discharge from direct precipitation into the open mining pit area.

Pit water can also result from runoff from the unregraded and revegetated area following the pit. In the case of roughly backfilled and highly porous spoil, there is very little surface runoff. It is estimated that 80 percent of precipitation on the roughly regarded mine spoil infiltrates, 5 percent evaporates, and 15 percent may run off to the pit for pumping and potential treatment (Jay Hawkins, Office of Surface Mining, Department of the Interior, Personal Communications 2003). Regrading and revegetation of the mine spoil is conducted as the mining progresses. DEP encourages concurrent backfilling and revegetation through its compliance efforts and it is in the interest of the mining operator to minimize the company's reclamation bond liability by keeping the site reclaimed and revegetated. Experience has shown that reclamation and revegetation is accomplished two to three pit widths behind the active mining pit area. DEP uses three pit widths as an area representing potential flow to the pit when reviewing the NPDES permit application and calculating effluent limits based on best available treatment technology and insuring that in-stream limits are met. The same approach is used in the following equation, which represents the average flow reporting to the pit from the unregraded and unrevegetated spoil area.

41.4 in. precip./yr x 3 pit areas x 1 ft./12/in. x 1500'x300'/pit x 7.48 gal/ft^3 x 1yr/365days x 1day/24hr. x 1hr./60 min. x 15 in. runoff/100 in. precipitation =

= 9.9 gal./min. average discharge from spoil runoff into the pit area.

The total average flow to the pit is represented by the sum of the direct pit precipitation and the water flowing to the pit from the spoil area as follows:

Total Average Flow = Direct Pit Precipitation + Spoil Runoff

Total Average Flow = 21.0 gal./min + 9.9 gal./min. = 30.9 gal./min.

The resulting average waste load from a permitted treatment pond area is as follows.

Allowable Iron Waste Load Allocation:
30.9 gal./min. x 3 mg/l x 0.01202 = 1.1 lbs./day

Allowable Manganese Waste Load Allocation:
30.9 gal./min. x 2 mg/l x 0.01202 = 0.7 lbs./day

Allowable Aluminum Waste Load Allocation:
30.9 gal./min. x 2 mg/l x 0.01202 = 0.7 lbs./day

(Note: 0.01202 is a conversion factor to convert from a flow rate in gal/min. and a concentration in mg/l to a load in units of lbs./day.)

There is little or no documentation available to quantify the actual amount of water that is typically pumped from active pits to treatment ponds. Experience and observations suggest that the above approach is very conservative and overestimates the quantity of water, creating a large margin of safety in the methodology. County specific precipitation rates can be used in place of the long-term state average rate, although the margin of safety is greater than differences from individual counties. It is common for many mining sites to have very "dry" pits that rarely accumulate water that would require pumping and treatment.

Also, it is the goal of DEP's permit review process to not issue mining permits that would cause negative impacts to the environment. As a step to insure that a mine site does not produce acid mine drainage, it is common to require the addition of alkaline materials (waste lime, baghouse lime, limestone, etc.) to the backfill spoil materials to neutralize any acid-forming materials that may be present. This practice of 'alkaline addition' or the incorporation of naturally occurring alkaline spoil materials (limestone, alkaline shale or other rocks) may produce alkaline pit water with very low metals concentrations that does not require treatment. A comprehensive study in 1999 evaluated mining permits issued since 1987 and found that only 2.2 percent resulted in a post-mining pollution discharge (Evaluation of Mining Permits

Resulting in Acid Mine Drainage 1987-1996: A Post Mortem Study, March 1999). As a result of efforts to insure that acid mine drainage is prevented, most mining operations have alkaline pit water that often meets effluent limits and requires little or no treatment.

While most mining operations are permitted and allowed to have a standard, 1500' x 300' pit, most are well below that size and have a corresponding decreased flow and load. Where pit dimensions are greater than the standard size or multiple pits are present, the calculations to define the potential pollution load can be adjusted accordingly. Hence, the above calculated Waste Load Allocation is very generous and likely high compared to actual conditions that are generally encountered. A large margin of safety is included in the WLA calculations.

The allowable load for the stream segment is determined by modeling of flow and water quality data. The allowable load has a potential Waste Load Allocation (WLA) component if there is active mining or anticipated future mining and a Load Allocation (LA). So, the sum of the Load Allocation and the Waste Load Allocation is equal to the allowed load. The WLA is determined by the above calculations and the LA is determined by the difference between the allowed load and the WLA.

Allowed Load = Waste Load Allocation + Load Allocation
Or
Load Allocation = Allowed Load – Waste Load Allocation

This is an explanation of the quantification of the potential pollution load reporting to the stream from permitted pit water treatment ponds that discharge water at established effluent limits. This allows for including active mining activities and their associated Waste Load in the TMDL calculations to more accurately represent the watershed pollution sources and the reductions necessary to achieve in-stream limits. When a mining operation is concluded its WLA is available for a different operation. Where there are indications that future mining in a watershed are greater than the current level of mining activity, an additional WLA amount may be included in the allowed load to allow for future mining.

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.

Most of the pollution sources in the watershed are nonpoint and are expressed as Load Allocations (LAs) in the TMDL equation. The one point source will be expressed as a Waste Load Allocation (WLA). All allocations will be specified as long-term average daily concentrations. These long-term average concentrations are expected to meet water-quality criteria 99% of the time as required in PA Title 25 Chapter 96.3(c). The following table shows the applicable 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	30-day average; Total
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)

TMDL = 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 non-point 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). The TMDL allocations in this report are based on available data. Other allocation schemes could also meet the TMDL. Table 3 contains the TMDL component summary for each point evaluated in the watershed. Refer to the maps in Attachment A.

Allocation Summary

These TMDLs will focus remediation efforts on the identified numerical reduction targets for each watershed. The reduction schemes in Table 3 for each segment are based on the assumption that all upstream allocations are achieved and also take into account all upstream reductions. Attachment C contains the TMDLs by segment analysis for each allocation point in a detailed discussion. As changes occur in the watershed, the TMDLs may be re-evaluated to reflect current conditions. An implicit margin of safety (MOS) based on conservative assumptions in the analysis is included in the TMDL calculations.

The allowable LTA concentration in each segment is calculated using Monte Carlo Simulation as described previously. The allowable load is then determined by multiplying the allowable concentration by the flow and a conversion factor at each sample point. The allowable load is the TMDL and each TMDL includes upstream loads.

Each permitted discharge in a segment is assigned a waste load allocation and the total waste load allocation for each segment is included in this table. There currently is one permitted discharge in the UNT 26641 West Branch Susquehanna River Watershed. The difference between the TMDL and the WLA is the load allocation (LA) at the point. The LA at each point includes all loads entering the segment, including those from upstream allocation points. The percent reduction is calculated to show the amount of load that needs to be reduced to the area upstream of the point in order for water quality standards to be met at the point.

In some instances, instream processes, such as settling, are taking place within a stream segment. These processes are evidenced by a decrease in measured loading between consecutive sample points. It is appropriate to account for these losses when tracking upstream loading through a segment. The calculated upstream load lost within a segment is proportional to the difference in the measured loading between the sampling points**.**

Table 3. UNT 26641 West Branch Susquehanna River Watershed Summary Table

Parameter	Existing Load (lbs/day)	TMDL Allowable Load (lbs/day)	WLA (lbs/day)	LA (lbs/day)	Load Reduction (lbs/day)	% Reduction
PR03- at T504 Bridge in headwaters						
Aluminum (lbs/day)	11.80	2.15	0	2.15	9.65	82%
Iron (lbs/day)	ND	NA	0	NA	NA	NA
Manganese(lbs/day)	23.70	2.55	0	2.55	21.15	89%
Acidity (lbs/day)	271.77	29.27	0	29.27	242.50	89%
PR02 - unnamed tributary 26642 at SR2040 bridge						
Aluminum (lbs/day)	ND	NA	0.5	NA	NA	NA
Iron (lbs/day)	ND	NA	1.1	NA	NA	NA
Manganese(lbs/day)	0.24	0.24	0.7	NA	NA	NA
Acidity (lbs/day)	9.53	9.53	0	NA	NA	NA
PR01 - at LR 17145 bridge before Susquehanna river						
Aluminum (lbs/day)	6.71	2.73	0	2.73	0.00	0%*
Iron (lbs/day)	ND	NA	0	NA	NA	NA
Manganese(lbs/day)	43.26	10.07	0	10.07	12.04	54%
Acidity (lbs/day)	526.94	83.43	0	83.43	201.01	71%

* Total of loads affecting this segment is less than the allowable load calculated at this point, therefore no reduction is necessary.
NA = not applicable

In the instance that the allowable load is equal to the measured load (e.g. manganese PR02, Table 3), the simulation determined that water quality standards are being met instream and therefore no TMDL is necessary for the parameter at that point. Although no TMDL is necessary, the loading at the point is considered at the next downstream point. This is denoted as "ND" and "NA" in the above table.

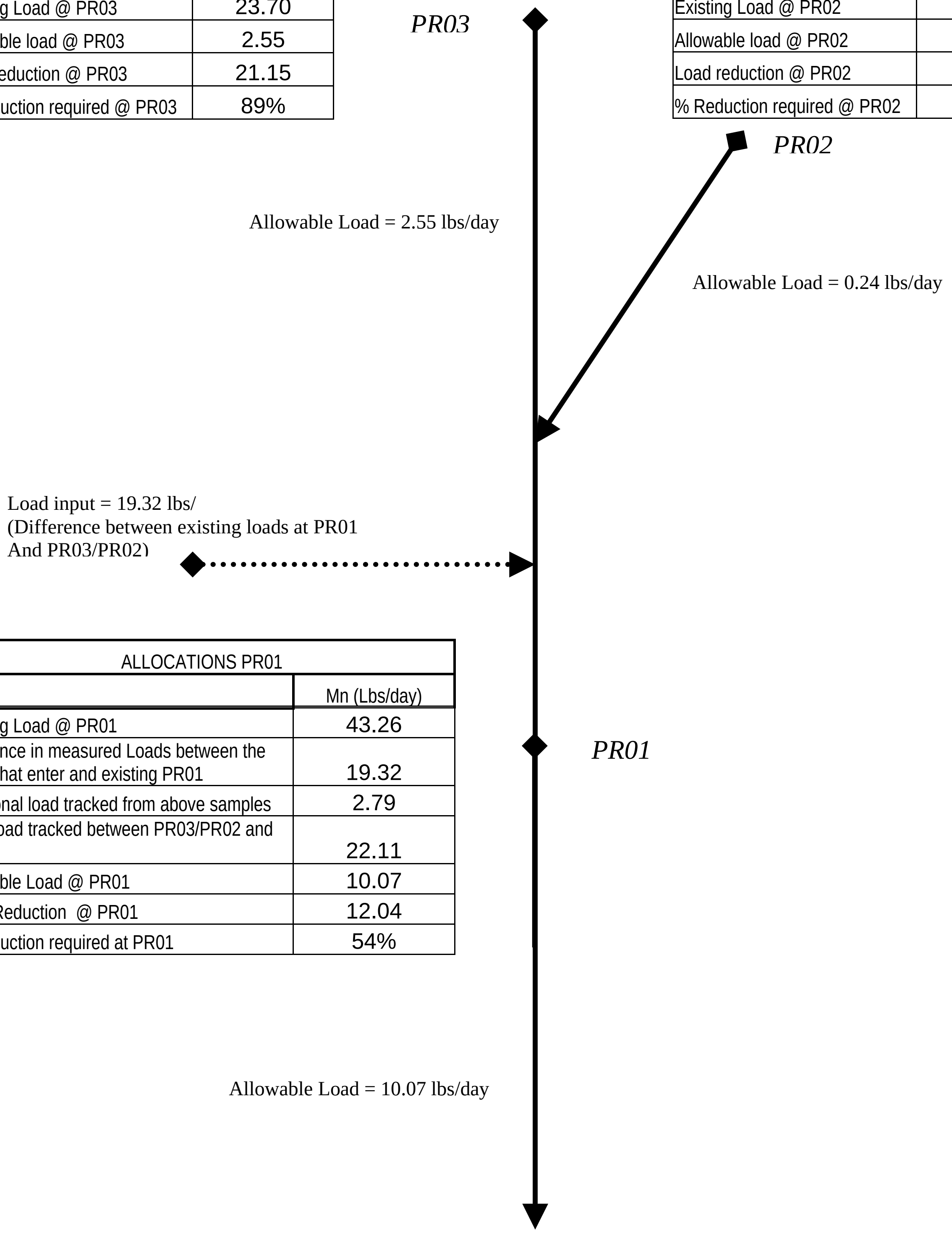
A Waste Load Allocation was assigned to the permitted mine drainage discharge contained in the UNT 26641 West Branch Susquehanna River Watershed. Waste load allocations are calculated using the method to quantify treatment pond pollutant load described in the above section. The WLA for the Waroquier Coal Co. discharge is being evaluated at sample point PR02 on UNT 26642. No required reductions of permit limits are needed at this time. All necessary reductions are assigned to non-point sources.

Table 4 Waste Load Allocations at WC1 Discharge			
Parameter	Monthly Avg. Allowable Conc. (mg/L)	Average Flow (MGD)	Allowable Load (lbs/day)
WAROQUIER COAL CO.			
Al	1.2	0.371418	0.5
Fe	3	0.371418	1.1
Mn	2	0.371418	0.7

On the following page is an example of how the allocations, presented in Table 3, for a stream segment are calculated. For this example, manganese allocations for PR01 of UNT 26641 West Branch Susquehanna River are shown. As demonstrated in the example, all upstream contributing loads are accounted for at each point. Attachment C contains the TMDLs by segment analysis for each allocation point in a detailed discussion. These analyses follow the example. Attachment A contains maps of the sampling point locations for reference.

ALLOCATIONS PR03	
PR03	Mn (Lbs/day)
Existing Load @ PR03	23.70
Allowable load @ PR03	2.55
Load reduction @ PR03	21.15
% Reduction required @ PR03	89%

ALLOCATIONS PR02	
PR02	Mn (Lbs/day)
Existing Load @ PR02	0.24
Allowable load @ PR02	0.24
Load reduction @ PR02	0.00
% Reduction required @ PR02	0%



ALLOCATIONS PR01	
PR01	Mn (Lbs/day)
Existing Load @ PR01	43.26
Difference in measured Loads between the loads that enter and existing PR01	19.32
Additional load tracked from above samples	2.79
Total load tracked between PR03/PR02 and PR01	22.11
Allowable Load @ PR01	10.07
Load Reduction @ PR01	12.04
% Reduction required at PR01	54%

The allowable load tracked from PR03 and PR02 was 2.79 lbs/day. The existing load at PR03 and PR02 was subtracted from the existing load at PR01 to show the actual measured increase of manganese load that has entered the stream between these two sample points (19.32 lbs/day).

This increased value was then added to the allowable loads from PR03 and PR02 to calculate the total load that was tracked between PR03 and PR02 and PR01 (allowable loads @ PR03 and PR02 + the difference in existing load between PR03 and PR02 and PR01). This total load tracked was then subtracted from the calculated allowable load at PR01 to determine the amount of load to be reduced at PR01. This total load value was found to be 22.11 lbs/day; it was 12.04 lbs/day greater then the PR01 allowable load of 10.07 lbs/day. Therefore, a 54% manganese reduction at PR01 is necessary.

Recommendations

Two primary programs provide maintenance and improvement of water quality in the watershed. DEP'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 BAMR, 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 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 and administers the EPA Watershed Assessment Grant Program, the Small Operator's Assistance Program (SOAP), and the Remining Operators Assistance Program (ROAP).

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

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.

The coal industry, through DEP-promoted remining efforts, can help to eliminate some sources of AMD and conduct some of 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.

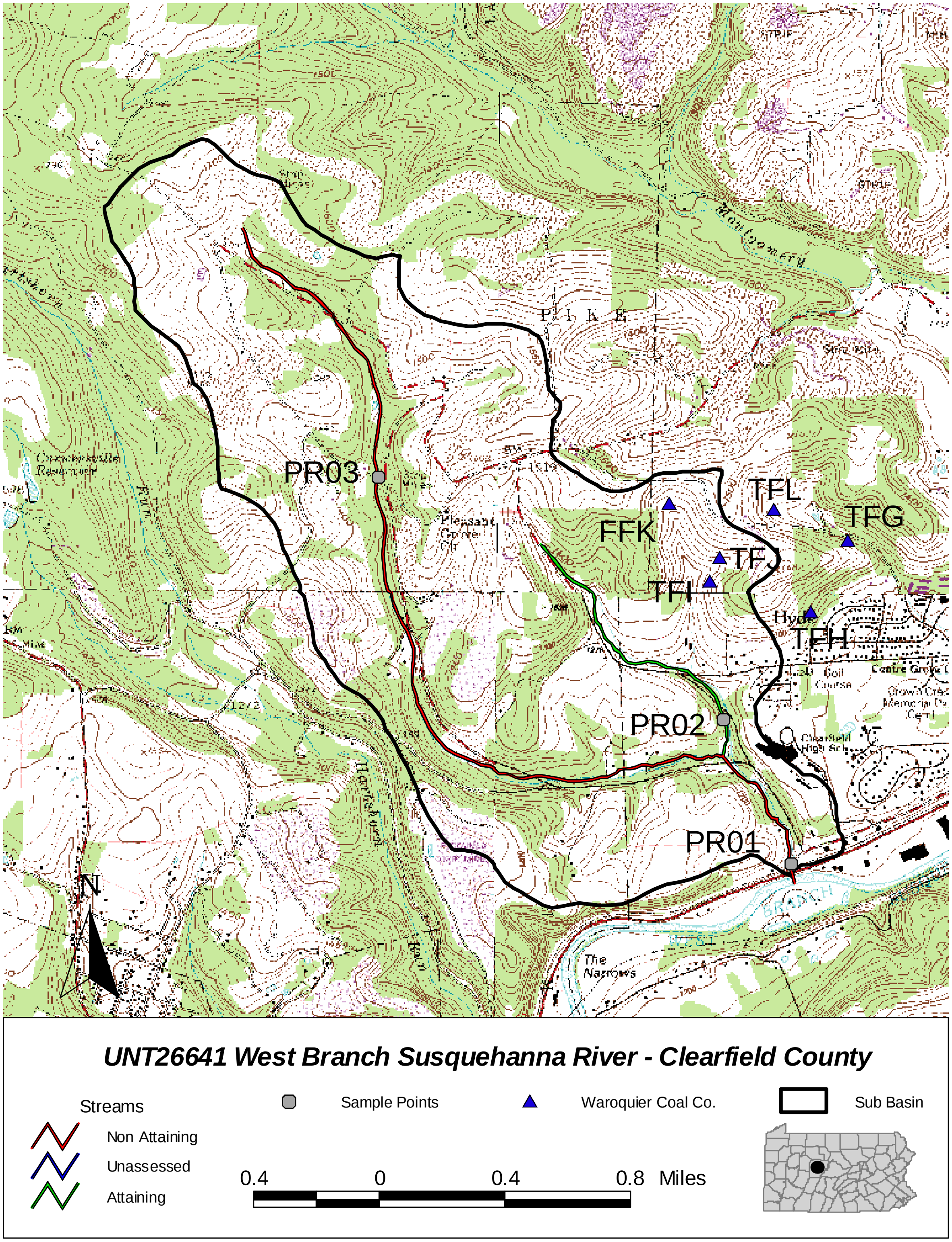
There is currently no watershed group focused on the Unnamed Tributary 26641 watershed area. It is recommended that agencies work with the recently formed watershed groups from adjacent watersheds to access this unnamed tributary. This watershed organization could then work to implement projects to achieve the reductions recommended in this TMDL document.

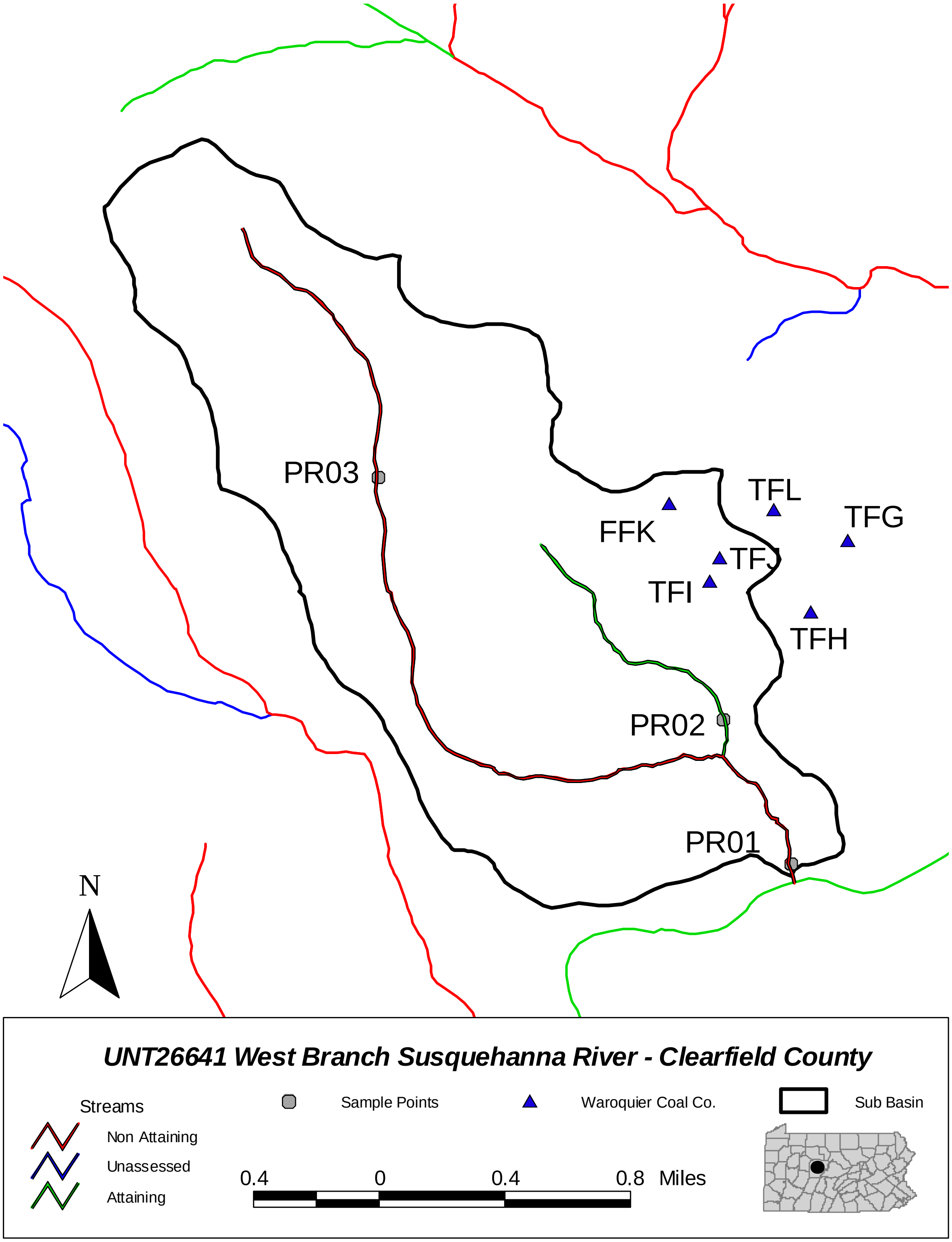
Public Participation

Public notice of the draft TMDL was published in the *Pennsylvania Bulletin* and *The Progress*, to foster public comment on the allowable loads calculated. A public meeting was held on May 17, 2006 at Moshannon District Mining Office in Philipsburg, to discuss the proposed TMDL.

Attachment A

UNT 26641 West Branch Susquehanna River Watershed Maps


UNT26641 West Branch Susquehanna River - Clearfield County
PR03
PR02
PR01
FFK
TFL
TFG
TFJ
TFI
TFH
N
Streams
Non Attaining
Unassessed
Attaining
Sample Points
Waroquier Coal Co.
Sub Basin
0.4
0
0.4
0.8
Miles


PR03
FFK
TFL
TFG
TFJ
TFI
TFH
PR02
PR01
N
UNT26641 West Branch Susquehanna River - Clearfield County
Streams
Non Attaining
Unassessed
Attaining
Sample Points
Waroquier Coal Co.
Sub Basin
0.4
0
0.4
0.8
Miles

Attachment B

Method for Addressing Section 303(d) Listings for pH and *Surface Mining Control and Reclamation Act*

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 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. 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. 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.

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

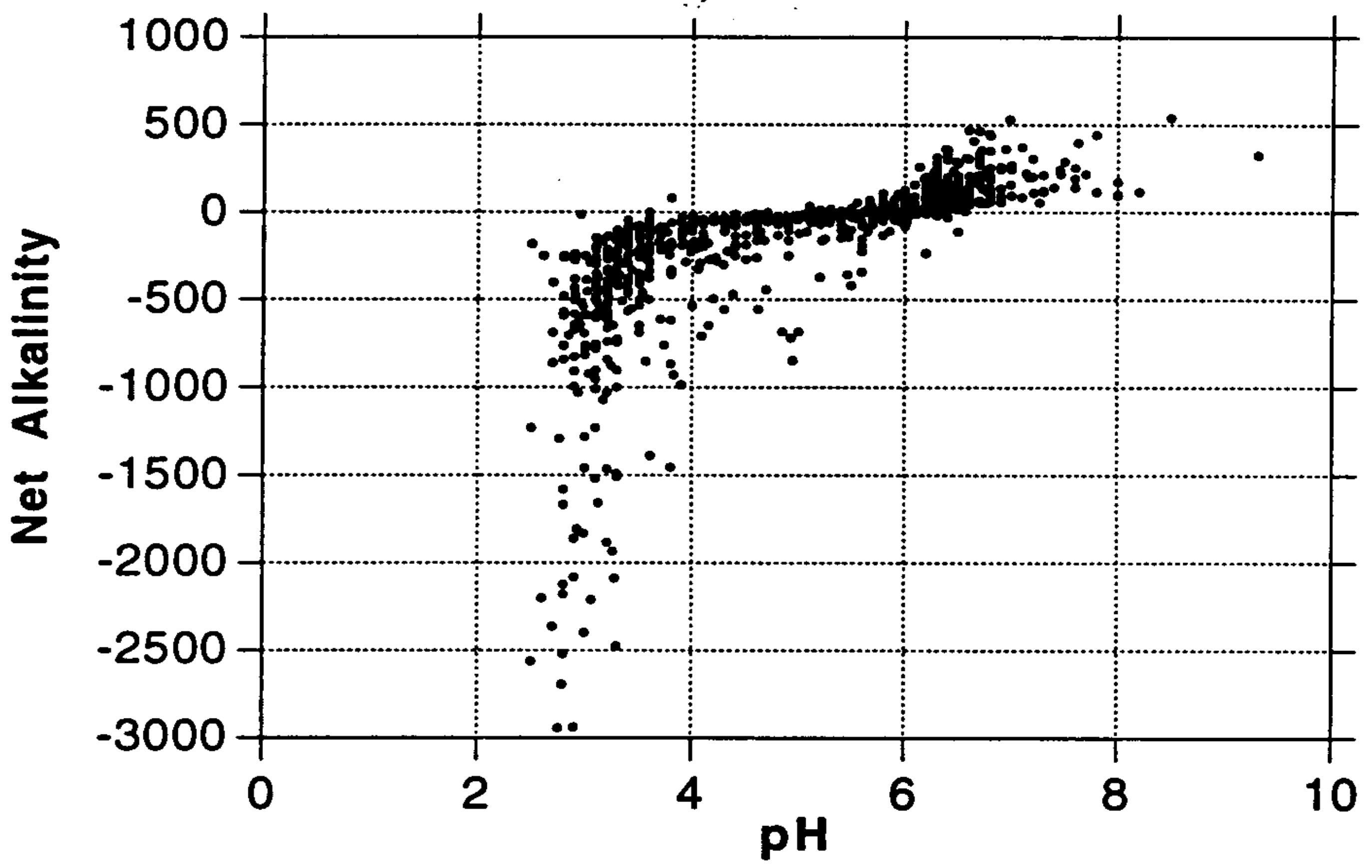


Figure 1. Net Alkalinity vs. pH. Taken from Figure 1.2 Graph C, pages 1-5, of Coal Mine Drainage Prediction and Pollution Prevention in Pennsylvania

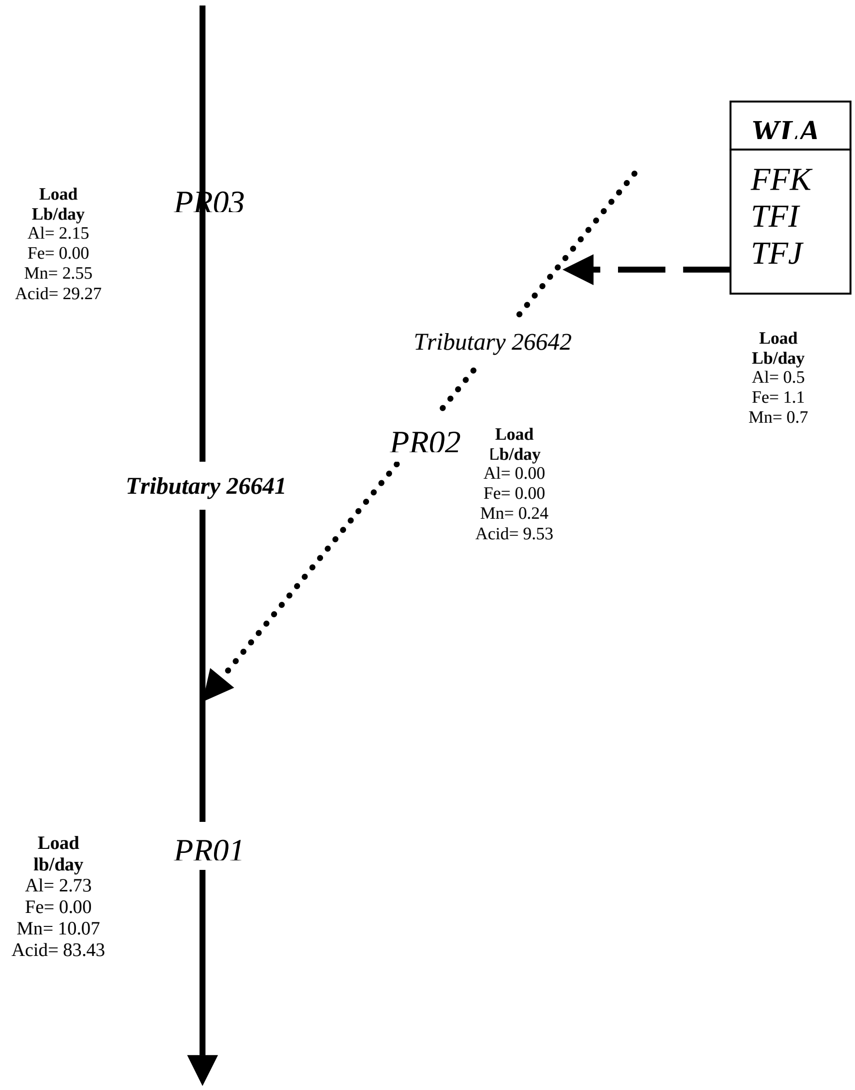
Attachment C
TMDLs By Segment

UNT 26641 West Branch Susquehanna River

The TMDL for UNT 26641 West Branch Susquehanna River consists of load allocations to two sampling sites along UNT 26641 West Branch Susquehanna River (PR03 and PR01) and one sampling site on the unnamed tributary of UNT 26641 West Branch Susquehanna River (PR02). Sample data sets were collected during 2004 and the early part of 2005. All sample points are shown on the maps included in Attachment A as well as on the loading schematic presented on the following page.

UNT 26641 West Branch Susquehanna River is listed on the 1996 PA Section 303(d) list for pH from AMD as being the cause of the degradation to this stream. This TMDL will focus on pH and reduced acid loading as well as metals analysis to the UNT 26641 West Branch Susquehanna River watershed. 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 each sample point for metals 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 log normally 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. Following is an explanation of the TMDL for each allocation point.



<u>TMDL calculations- PR03- UNT 26641 West Branch Susquehanna River at T504 Bridge in headwaters</u>

The TMDL for sample point PR03 consists of a load allocation to all of the area at and above this point shown in Attachment A. The load allocation for this uppermost segment (headwaters) of UNT 26641 West Branch Susquehanna River was computed using water-quality sample data collected at point PR03. The average flow, measured at sampling point PR03 (0.73 MGD), is used for these computations. This is the most upstream point of this segment and the allowable load allocations calculated at PR03 will directly affect the downstream point PR01.

Sample data at point PR03 shows that this headwaters section of UNT 26641 West Branch Susquehanna River has a pH ranging between 4.8 and 5.5. There currently is an entry for this segment on the Pa Section 303(d) list for impairment due to pH.

A TMDL for aluminum, manganese and acidity has been calculated. All measured sample data for iron was below detection limits. Because water quality standards are met, a TMDL for this parameter isn't necessary and is not calculated. The existing and allowable loads for the iron parameter at PR03 in Table C1 will be denoted as "NA". The concentrations will be denoted as "ND".

Table C1 shows the measured and allowable concentrations and loads at PR03. Table C2 shows the percent reduction for iron, manganese and acidity needed at PR03.

Table C1		Measured		Allowable	
Flow (gpm)=	506.25	Concentration	Load	Concentration	Load
		mg/L	lbs/day	mg/L	lbs/day
	Aluminum	1.94	11.8	0.35	2.2
	Iron	ND	NA	ND	NA
ND = non detection	Manganese	3.90	23.7	0.42	2.6
NA = not applicable	Acidity	44.70	271.8	4.81	29.3
	Alkalinity	9.10	55.3		

Table C2. Allocations PR03			
PR03	Al (Lbs/day)	Mn (Lbs/day)	Acidity (Lbs/day)
Existing Load @ PR03	11.80	23.70	271.77
Allowable Load @ PR03	2.15	2.55	29.27
Load Reduction @ PR03	9.65	21.15	242.50
% Reduction required @ PR03	82%	89%	89%

Waste Load Allocation – The Waroquier Coal Company, Lawrence #1 Operation (WC1)

The Waroquier Coal Co., SMP 17980118, NPDES permit no. PA 0238112 has a permitted discharge that is evaluated in the calculated allowable loads at PR02. Waste load allocations are calculated using a method to quantify treatment pond pollutant loads for aluminum, iron and manganese. The following table shows the waste load allocation for this discharge. This calculated load is evaluated at the downstream point PR02.

Table C3. Waste Load Allocations at Waroquier Coal Co. WC1			
Parameter	Monthly Avg. Allowable Conc. (mg/L)	Average Flow	Allowable Load
		(MGD)	(lbs/day)
Waroquier Coal Co..			
Al	1.2	0.371418	0.5
Fe	3	0.371418	1.1
Mn	2	0.371418	0.7

TMDL calculations- PR02- Unnamed tributary (26642) to UNT 26641 West Branch Susquehanna River at SR2040 bridge

The TMDL for sample point PR02 consists of a load allocation to all of the area at and above this point, including the waste load allocation WC1 shown in Attachment A. The load allocation for this tributary of UNT 26641 West Branch Susquehanna River was computed using water-quality sample data collected at point PR02. The average flow, measured at the sampling point PR02 (0.48 MGD), is used for these computations. The allowable loads calculated at PR02 will directly affect the downstream point PR01.

Sample data at point PR02 shows that this tributary of UNT 26641 West Branch Susquehanna River has a pH ranging between 7.3 and 7.7. There currently is not an entry for this segment on the Pa Section 303(d) list for impairment due to pH.

All measured sample data for aluminum and iron was below detection limits. Measured sample data for manganese as well as acidity was above detection limits but fell well below water quality standards. Because water quality standards are met, a TMDL for these parameters isn’t necessary and is not calculated. The existing and allowable loads for aluminum, iron manganese and acidity parameters at PR02 in Table C4 will be denoted as “NA”. The concentrations will be denoted as “ND”. This unimpaired tributary assimilates the discharge from the upstream waste load allocated discharge. Instream processes, such as settling, may be responsible for the lack of metals in the downstream sample data at sample point PR02.

Table C4 shows the measured and allowable concentrations and loads at PR02. Table C5 shows the percent reduction for acidity needed at PR02.

Table C4		Measured		Allowable	
Flow (gpm)=	330.50	Concentration	Load	Concentration	Load
		mg/L	lbs/day	mg/L	lbs/day
	Aluminum	ND	NA	ND	NA
	Iron	ND	NA	ND	NA
ND = non detection	Manganese	0.06	0.2	0.06	0.2
NA = not applicable	Acidity	2.40	9.5	2.40	9.5
	Alkalinity	37.30	148.1		

TMDL calculations- PR01- UNT 26641 West Branch Susquehanna River at LR 17145 bridge before West Branch Susquehanna River

The TMDL for sampling point PR01 consists of a load allocation to all of the area at and above this point shown in Attachment A. The load allocation for this segment was computed using water-quality sample data collected at point PR01. The average flow, measured at the sampling point PR01 (2.46 MGD), is used for these computations.

Sample data at point PR01 shows pH ranging between 6.7 and 7.2; pH will be addressed as part of this TMDL. There currently is an entry for this segment on the Section Pa 303(d) list for impairment due to pH.

The measured and allowable loading for point PR01 for aluminum, iron, manganese and acidity 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 loads already specified from upstream sources. The additional load from points PR03/ PR02 shows the total load that was permitted from upstream sources. This value was added to the difference in existing loads between points PR02/ PR03 and PR01 to determine a total load tracked for the segment of stream between PR01 and PR02/ PR03. This load will be compared to the allowable load to determine if further reductions are needed to meet the calculated TMDL at PR01.

A TMDL for aluminum, manganese and acidity at PR01 has been calculated. Some sample data for iron was found to be above detection limits but still below water quality standards. Because water quality standards are met, a TMDL for these parameters isn't necessary and is not calculated. The existing and allowable loads for the iron parameter at PR01 in Table C5 will be denoted as "NA". The concentrations will be denoted as "ND".

Table C5 shows the measured and allowable concentrations and loads at PR01. Table C6 shows the percent reductions for aluminum, manganese and acidity needed at PR01.

Table C5		Measured		Allowable	
Flow (gpm)=	1707.25	Concentration	Load	Concentration	Load
		mg/L	lbs/day	mg/L	lbs/day
	Aluminum	0.33	6.7	0.13	2.7
	Iron	ND	NA	ND	NA
ND = non detection	Manganese	2.11	43.3	0.49	10.1
NA = not applicable	Acidity	25.70	526.9	4.07	83.4
	Alkalinity	18.30	375.2		

Table C7. Allocations PR01			
PR01	Al (Lbs/day)	Mn (Lbs/day)	Acidity (Lbs/day)
Existing Load @ PR01	6.71	43.26	526.94
Difference in measured Loads between the loads that enter and existing PR01	-5.09	19.32	245.64
Percent loss due calculated at PR01	43.1%	NA	NA
Additional load tracked from above samples	2.15	2.79	38.80
Percentage of upstream loads that reach PR01	56.9%	NA	NA
Total load tracked between PR03/PR02 and PR01	1.22	22.11	284.44
Allowable Load @ PR01	2.73	10.07	83.43
Load Reduction @ PR01	-1.51	12.04	201.01
% Reduction required at PR01	0%	54%	71%

There is a 5.09 lbs/day decrease of aluminum at PR01 compared to the sum of measured loads from upstream segments. This decrease of aluminum loading in this segment of stream between PR03/PR02 and PR01 can be a result of dilution or other natural stream processes. The total aluminum load measured was 1.51 lbs/day less than the calculated allowable aluminum load of 2.73 lbs/day, resulting in a 0% aluminum reduction at this point. The total manganese load tracked at PR01 was 12.04 lbs/day greater than the calculated allowable manganese load of 10.07 lbs/day. Therefore a 54% reduction is required to achieve the calculated allowable manganese loading. The total acidic load tracked from upstream was 284.44 lbs/day, which was 201.01 lbs/day greater than the calculated allowable acidic load. A 71% acidic reduction is necessary to meet water quality standards at PR01.

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 D

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

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

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

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

1. mileage differences due to recalculation of segment length by the GIS;
2. slight changes in source(s)/cause(s) due to new 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).

Attachment E

Water Quality Data Used In TMDL Calculations

PR03	pH*	Alkalinity^	Acidity	Iron	Manganese	Aluminum	Flow
Date	**Lab**	**mg/l**	**mg/l**	**ug/l**	**ug/l**	**ug/l**	**gpm**
5/6/2004	4.8	7.6	51.80	<.300	3.92	2.37	530
7/7/2004	4.9	10.8	48.00	<.300	5.25	2.31	172
10/6/2004	4.9	9.6	54.00	<.300	4.88	2.19	140
3/24/2005	5.5	8.4	25.00	<.300	1.54	0.89	1183
AVERAGE	5.0	9.1	44.7	0.0	3.9	1.9	506.3
ST DEV	0.3	1.4	13.4	0.0	1.7	0.7	484.6

PR02	pH*	Alkalinity^	Acidity	Iron	Manganese	Aluminum	Flow
Date	**Lab**	**mg/l**	**mg/l**	**ug/l**	**ug/l**	**ug/l**	**gpm**
5/6/2004	7.6	27.4	5.20	<.300	<.050	<.500	227
7/7/2004	7.6	52.6	-20.60	<.300	0.08	<.500	70
10/6/2004	7.7	45.0	-5.40	<.300	0.11	<.500	125
3/24/2005	7.3	24.2	4.40	0.34	0.05	<.500	900
AVERAGE	7.6	37.3	-4.1	0.1	0.1	0.0	330.5
ST DEV	0.2	13.7	12.0	0.2	0.0	0.0	385.2

PR01	pH*	Alkalinity^	Acidity	Iron	Manganese	Aluminum	Flow
Date	**Lab**	**mg/l**	**mg/l**	**mg/l**	**mg/l**	**mg/l**	**gpm**
5/6/2004	6.7	12.6	57.00	<.300	2.57	0.74	1562
7/7/2004	7.2	22.4	0.40	<.300	1.81	<.500	544
10/6/2004	7.1	21.8	20.80	<.300	2.81	<.500	622
3/24/2005	7.0	16.4	24.60	0.43	1.25	0.57	4101
AVERAGE	7.0	18.3	25.7	0.1	2.1	0.3	1707.3
ST DEV	0.2	4.7	23.4	0.2	0.7	0.4	1661.5

Zero has been substituted for the less than detection values in the TMDL calculations

Attachment F
Comment and Response

No comments were received for UNT 26641 West Branch Susquehanna River