# POTATO GARDEN RUN WATERSHED FINALTMDL
## Allegheny County

Prepared for:

Pennsylvania Department of Environmental Protection

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**[1]Final TMDL**
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**Allegheny County, Pennsylvania**

## Introduction

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

| Table 1. Section 303(d) Sub-List | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| State Water Plan (SWP) Subbasin: 20-D Ohio River | | | | | | | | |
| **Year** | **Miles** | **Segment ID** | **DEP Stream Code** | **Stream Name** | **Designated Use** | **Data Source** | **Source** | **EPA 305(b) Cause Code** |
| 1996 | 3.6 | 4524 | 33756 | Potato Garden Run | WWF | 305(b) Report | RE | Metals |
| 1998 | 3.74 | 4524 | 33756 | Potato Garden Run | WWF | SWMP | AMD | Metals |
| 2000 | 3.75 | 990102-1120-TVP | 33756 | Potato Garden Run | WWF | SWMP | AMD | Metals & pH |
| 2002 | No additional assessment data collected | | | Potato Garden Run | WWF | SWMP | AMD | Metals & pH |
| 1996 | 0.8 | 4527 | 33764 | Unt Potato Garden Run | WWF | 305(b) Report | RE | Metals |
| 1998 | No additional assessment data collected | | | Unt Potato Garden Run | WWF | SWMP | AMD | Metals |
| 2000 | No additional assessment data collected | | | Unt Potato Garden Run | WWF | SWMP | AMD | Metals |
| 2002 | No additional assessment data collected | | | Unt Potato Garden Run | WWF | SWMP | AMD | Metals |

Warm Water Fishes=WWF
Surface Water Monitoring Program = SWMP
Abandoned Mine Drainage = AMD
Resource Extraction=RE
See Appendix E, *Excerpts Justifying Changes Between the 1996, 1998, and Draft 2000 Section 303(d) Lists*

[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.*

The use designations for the stream segments in this TMDL can be found in PA Title 25 Chapter 93.

## Directions to the Potato Garden Run Watershed

The main branch of Potato Garden Run is 7.5 miles long. The segment addressed in this report is 3.8 miles long plus a ¾ mile long segment of an unnamed tributary that flows from Clinton, PA south to Potato Garden Run. Potato Garden Run is located in the Ohio River Watershed. It flows to Raccoon Creek which runs into the Ohio River about 3 1/2 miles west of Beaver, PA. Potato Garden Run is in Findlay Township, Allegheny County. The watershed is about 7,000 acres and is bordered on the north and east by U.S. Route 30, on the south by U.S. Route 22, and on the west by Raccoon Creek. The eastern part of the stream runs along the eastern side of S.R. 3071. This road can be accessed by taking U.S. Route 22 west from Pittsburgh to the Champion Exit, and going north on S.R. 3071 about 1 mile. The western part of Potato Garden Run can be accessed by going west on Township Road 453 off of S.R. 3071.

## Segments addressed in this TMDL

There is one active mining operation in the watershed, but the NPDES permit points are located in the adjacent Montour Run watershed. All of the 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 Appendix D for TMDL calculations.

## Clean Water Act Requirements

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

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

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

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

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

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

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

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

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

**Section 303(d) Listing Process**

Prior to developing TMDLs for specific 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.

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

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 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.

**Watershed History**

The Potato Garden Run Watershed is contained within the Appalachian Plateau physiographic province, which is characterized by broad, dissected upland, underlain by horizontal sedimentary rocks, rounded ridges, and intervening valleys. The watershed is located within the Pennsylvanian System. The bedrock strata exposed are members of the Monongahela and Conemaugh groups. The Pittsburgh coal seam is the lowest bed in the Monongahela Group and rests unconformably on the Conemaugh Group. Below the Pittsburgh Coal is about 2 feet of dark to light gray brecciated limestone. The Pittsburgh coal seam is approximately 5 to 6 feet thick. The upper part of the Pittsburgh Coal consists of alternating bands of black carbonaceous shales and boney coal 6 inches to 2 feet in thickness for about 7 to 8 feet above the main seam. Iron sulfide minerals are generally associated with the coal and the black carbonaceous shales and sandstone overlying the coal bed. These minerals, upon oxidation, represent the principal source of acid from coal mining related activities (PADCNR, 1999).

The Pittsburgh coal seam in the Potato Garden Run Watershed has been extensively mined. All of the coal has been underground mined. Most of the coal ribs and stumps (remnants from the abandoned underground mine) have been surface mined. Only a few of the smaller hilltops located in the western part of the watershed have not been surface mined. Based on published data, it is estimated no more than 70 acres of abandoned underground mines have not been surface mined in this watershed. The extensive deep mining, which took place from the 1920's through the 1950's, has had a severe effect on groundwater and surface water in this watershed. Water quality data shows low pH and high concentrations of acid, iron, manganese, and aluminum in wells, springs, and streams. Surface mining conducted in the last 20 years has caused a significant improvement in the water quality. Closing the mine voids and mixing the alkaline overburden in the backfill has significantly raised alkalinity concentrations and raised pH levels. Iron, manganese, and aluminum concentrations remain elevated.

Currently the only active mining in the Potato Garden Run Watershed is associated with a Waste Management permit. A landfill operation is mining any coal encountered during excavations. All discharges from this operation are located in an adjacent watershed, therefore having no affect on Potato Garden Run. There is no active coal mining under a Surface Mining Permit with discharge limits in this watershed. Potato Garden Run is a rural watershed, which is mostly forested and agricultural in nature, with a few scattered homes throughout.

**TMDL Endpoints**

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

Because of the nature of the pollution sources in the watershed, the TMDLs component makeup will be load allocations that are specified above a point in the stream segment. All allocations will be specified as long-term average daily concentrations. These long-term average daily concentrations are expected to meet water quality criteria 99 percent of the time. Pennsylvania Title 25 Chapter 96.3(c) specifies that the water quality standards must be met 99% of the time. The iron TMDLs are expressed at total recoverable as the iron data used for this analysis was reported as total recoverable. The following table 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<br>0.3 | 30-day average<br>Total Recoverable<br>Dissolved |
| Manganese (Mn) | 1.00 | Total Recoverable |
| pH * | 6.0-9.0 | N/A |
| Sulfates | 250 | Total Recoverable |

*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

There currently is no entry for Potato Garden Run on the Pa Section 303(d) list for impairment due to sulfates. Although water quality data indicates high sulfate concentrations in Potato Garden Run, no TMDL will be completed for sulfates. The nearest potable water supply intake is located approximately 35 miles downstream of the mouth of Potato Garden Run at the Midland Borough Municipal Authority (PWSID #5040038), which intakes its water from the Ohio River. Water Quality data from WQN Station 901 located approximately 6.5 miles downstream of the water supply intake shows that sulfate criteria of 250 mg/L is not exceeded. The average sulfate concentration, calculated from 10 years of WQN sulfate data is 78.19 mg/L. Due to Title 25 Chapter 96.3(d) a TMDL to address sulfates is not necessary. A map of the water supply intake and WQN Station is located in Appendix A and sulfate 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).

## 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 3 presents the estimated reductions identified for all points in the watershed. Attachment D gives detailed TMDLs by segment analysis for each allocation point.

Table 3. Summary Table–Potato Garden Run Watershed

| Point | Parameter | Measured Sample Data | | Allowable | | Reduction Identified |
|---|---|---|---|---|---|---|
| | | Conc. (mg/l) | Load (lb/day) | LTA Conc. (mg/l) | Load (lb/day) | Percent |
| 161 | | Potato Garden Run near headwaters | | | | |
| | Al | 6.31 | 31.0 | 0.25 | 1.2 | 96 |
| | Fe | 10.93 | 53.7 | 0.55 | 2.7 | 95 |
| | Mn | 6.40 | 31.5 | 0.77 | 3.8 | 88 |
| | Acidity | 34.00 | 167.2 | 34.00 | 167.2 | 0 |
| | Alkalinity | 179.55 | 883.0 | | | |
| 162 | | Mouth of Unnamed Tributary 33766 | | | | |
| | Al | 0.40 | 1.0 | 0.12 | 0.3 | 71 |
| | Fe | 7.18 | 18.2 | 0.72 | 1.8 | 90 |
| | Mn | 3.05 | 7.7 | 0.49 | 1.2 | 84 |
| | Acidity | 23.50 | 59.6 | 15.04 | 38.2 | 36 |
| | Alkalinity | 46.62 | 118.3 | | | |
| | | Potato Garden Run above confluence w/ Tributary 33764 | | | | |
| 163 | Al | 0.02 | 0.36 | 0.02 | 0.36 | 0 |
| | Fe | 0.88 | 15.87 | 0.36 | 6.51 | 0 |
| | Mn | 2.09 | 37.75 | 0.48 | 8.68 | 0 |
| | Acidity | 9.25 | 166.86 | 9.25 | 166.86 | 0 |
| | Alkalinity | 89.24 | 1609.81 | | | |
| 164 | | Mouth of Unnamed Tributary 33764 | | | | |
| | Al | 3.23 | 8.36 | 0.16 | 0.42 | 95 |
| | Fe | 1.01 | 2.62 | 0.43 | 1.10 | 58 |
| | Mn | 0.96 | 2.49 | 0.80 | 2.07 | 17 |
| | Acidity | 20.75 | 53.64 | 12.45 | 32.18 | 40 |
| | Alkalinity | 41.54 | 107.39 | | | |
| | | Potato Garden Run above confluence w/ Tributary 33759 | | | | |
| 165 | Al | 2.31 | 45.48 | 0.09 | 1.82 | 74 |
| | Fe | 2.11 | 41.68 | 0.21 | 4.17 | 0 |
| | Mn | 3.40 | 66.99 | 0.17 | 3.35 | 90 |
| | Acidity | 24.75 | 488.40 | 14.11 | 278.39 | 38 |
| | Alkalinity | 82.33 | 1624.60 | | | |
| 166 | | Mouth of Unnamed Tributary 33759 | | | | |
| | Al | 4.98 | 24.31 | 0.15 | 0.73 | 97 |
| | Fe | 6.16 | 30.07 | 0.31 | 1.50 | 95 |
| | Mn | 4.97 | 24.28 | 0.25 | 1.21 | 95 |
| | Acidity | 19.59 | 95.62 | 6.66 | 32.51 | 66 |
| | Alkalinity | 31.97 | 156.06 | | | |
| 167 | | Mouth of Potato Garden Run | | | | |
| | Al | 0.02 | 0.52 | 0.02 | 0.52 | 0 |
| | Fe | 0.35 | 9.09 | 0.35 | 9.09 | 0 |
| | Mn | 1.04 | 27.07 | 0.33 | 8.66 | 0 |
| | Acidity | 10.25 | 266.17 | 10.25 | 266.17 | 0 |
| | Alkalinity | 75.62 | 1963.75 | | | |

**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.

Acid mine drainage has had a severe impact on Potato Garden Run. Surface mining ribs and stumps left from the abandoned underground mines has significantly neutralized AMD discharges in this stream. Surface mining neutralizes discharges by mixing in the alkaline overburden and filling the mine voids, thereby slowing recharge to the discharges. Reduction of metals loading in Potato Garden Run could be accomplished through passive treatment with wetlands. Large aerobic wetlands could effectively treat loading problems because the water in the stream is mostly alkaline. Riffles or small waterfalls in the stream prior to the wetlands would greatly increase the effectiveness of the passive treatment. The size of the wetlands can be determined by the iron, manganese, and aluminum loading reduction that is required.

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.

Acid mine drainage has had a severe impact on Potato Garden Run. Surface mining ribs and stumps left from the abandoned underground mines has significantly neutralized AMD discharges in this stream. Surface mining neutralizes discharges by mixing in the alkaline overburden and filling the mine voids, thereby slowing recharge to the discharges. Reduction of metals loading in Potato Garden Run could be accomplished through passive treatment with wetlands. Large aerobic wetlands could effectively treat loading problems because the water in the stream is mostly alkaline. Riffles or small waterfalls in the stream prior to the wetlands would greatly increase the effectiveness of the passive treatment. The size of the wetlands can be determined by the iron, manganese, and aluminum loading reduction that is required.

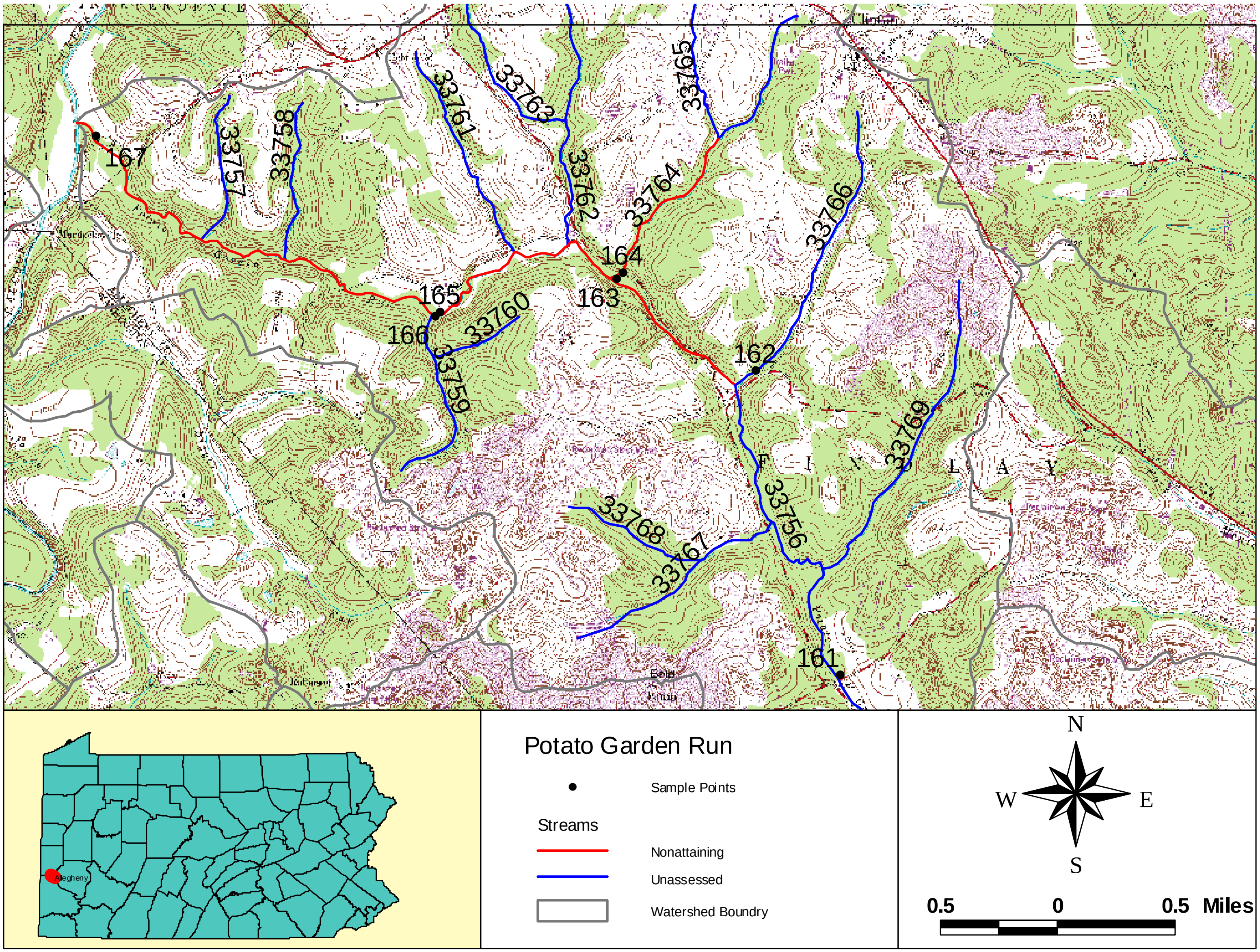
The Raccoon Creek Watershed Association is active in the Potato Garden Run Watershed. Efforts are underway to treat the Hamilton discharge which flows into an unnamed tributary to Potato Garden Run just upstream from sampling point 162. The Hamilton discharge is a major source of AMD in the watershed. It has an average flow of approximately 75 gpm and an average iron concentration of 45 mg/l. Over seven tons per year of iron is introduced to the watershed by this discharge. Project partners are the Pennsylvania Turnpike Commission, Penns Corner Conservancy Charitable Trust (PCCCT), Federal Office of Surface Mining, Washington County Conservation District, Raccoon Creek Watershed Association, and the PA DEP, Bureau of Abandoned Mine Reclamation (BAMR). On October 1, 2001 the PCCCT was awarded a Round 2 Growing Greener Grant (ME#351523) for the construction of a passive treatment system to treat the Hamilton discharge. The passive treatment system is being designed by BAMR. This project will reduce the iron loading and help to clean up three miles of stream in the Potato Garden Run Watershed.

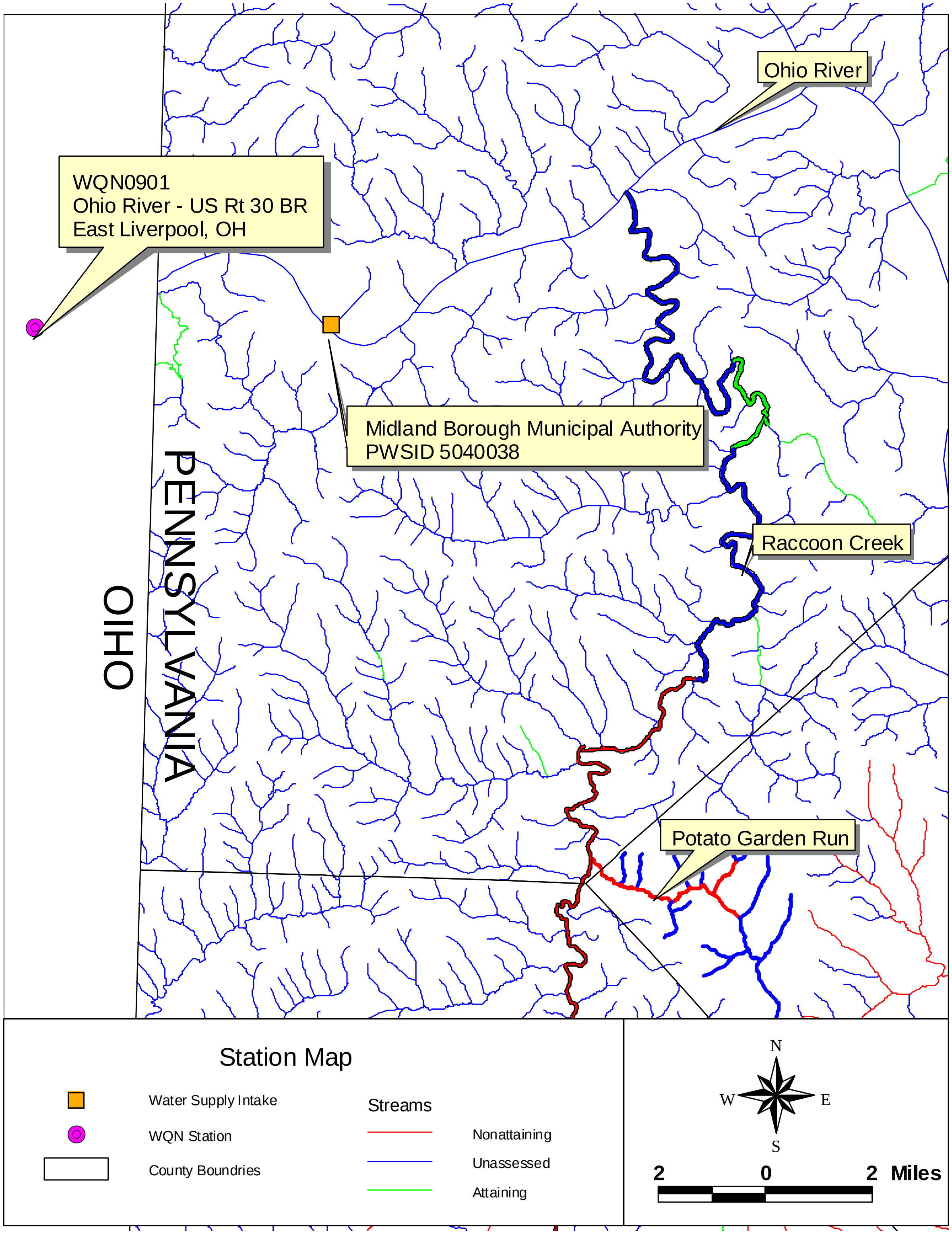
## Public Participation

Public notice of the draft TMDL was published in the *Pennsylvania Bulletin* on December 21, 2002 and the *Pittsburgh Post-Gazette* on January 23, 2003 to foster public comment on the allowable loads calculated. A public meeting was held on January 28, 2003 at the Raccoon Creek State Park Main Office Building at 5:30 pm to discuss the proposed TMDL.

# Attachment A

## Potato Garden Run Watershed Map


167
33757
33758
33761
33763
33765
33762
33764
164
163
165
166
33760
33759
33766
162
33769
33756
33768
33767
161
Allegheny
Potato Garden Run
Sample Points
Streams
Nonattaining
Unassessed
Watershed Boundry
N
W
E
S
0.5
0
0.5 Miles


Ohio River
WQN0901
Ohio River - US Rt 30 BR
East Liverpool, OH
Midland Borough Municipal Authority
PWSID 5040038
PENNSYLVANIA
OHIO
Raccoon Creek
Potato Garden Run
Station Map
Water Supply Intake
WQN Station
County Boundries
Streams
Nonattaining
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Attaining
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2
Miles

# Attachment B

## AMD Methodology, the pH Method, and Surface Mining Control and Reclamation Act

# AMD Methodology

Two approaches are used for the TMDL analysis of AMD-affected stream segments. Both of these approaches use the same statistical method for determining the instream allowable loading rate at the point of interest. The difference between the two is based on whether the pollution sources are defined as discharges that are permitted or have a responsible party, which are considered point sources. Nonpoint sources are then any pollution sources that are not point sources.

For situations where all of the impact is due to nonpoint sources, the equations shown below are applied using data for a point in the stream. The load allocation made at that point will be for all of the watershed area that is above that point. For situations where there are only point-source impacts or a combination of point and nonpoint sources, the evaluation will use the point-source data and perform a mass balance with the receiving water to determine the impact of the point source.

TMDLs and load allocations for each pollutant were determined using Monte Carlo simulation. Allocations were applied uniformly for the watershed area specified for each allocation point. For each source and pollutant, it was assumed that the observed data were log-normally distributed. Each pollutant source was evaluated separately using @Risk[3] by performing 5,000 iterations to determine any required percent reduction so that the water quality criteria will be met instream at least 99 percent of the time. For each iteration, the required percent reduction is:

PR = 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 99$^{th}$ 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)

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

LTA = allowable LTA source concentration in mg/l

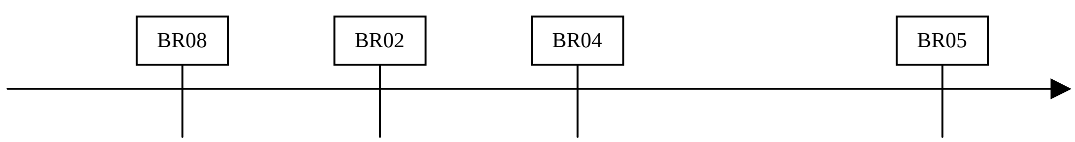
Once the required percent reduction for each pollutant source was determined, a second series of Monte Carlo simulations were performed to determine if the cumulative loads from multiple sources allow instream water quality criteria to be met at all points at least 99 percent of the time. The second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

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

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

# Accounting for Upstream Reductions in AMD TMDLs

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




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

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

| Table A | Alum. | Iron | Mang. | Acidity |
|---|---|---|---|---|
| BR08 | (#/day) | (#/day) | (#/day) | (#/day) |
| existing load= | 3.8 | 2.9 | 3.5 | 0.0 |
| allowable load= | 3.8 | 2.9 | 3.5 | 0.0 |
| **TOTAL LOAD REDUCTION=** | **0.0** | **0.0** | **0.0** | **0.0** |

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

**Table B. Necessary Reductions at Beaver Run BR02**

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

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

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

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

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

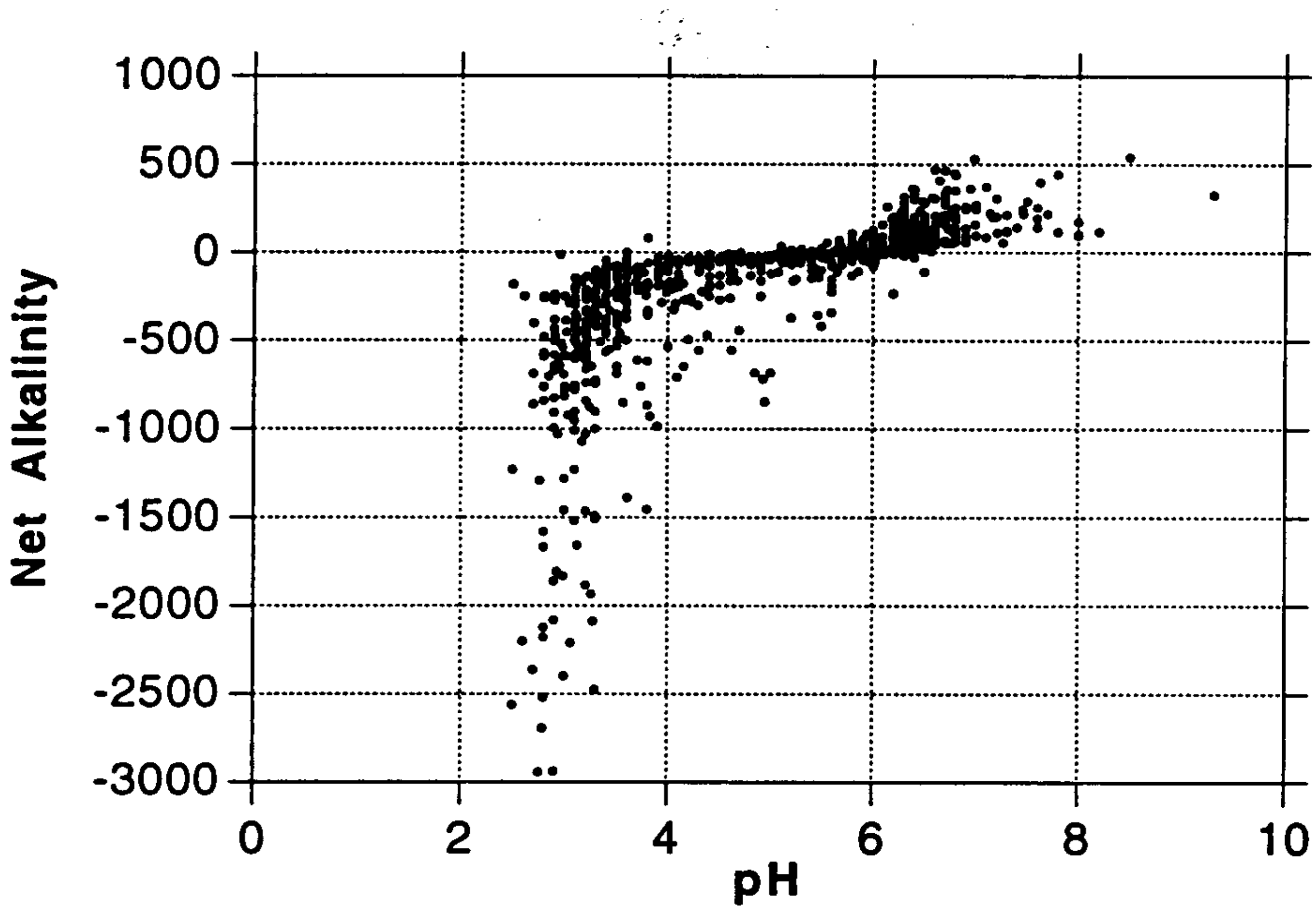



**Figure 1**. Net Alkalinity vs. pH. Taken from Figure 1.2 Graph C, pages 1-5, of Coal Mine Drainage Prediction and Pollution Prevention in Pennsylvania

## 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 99$^{th}$ 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 99$^{th}$ percentile value of this computed field. |

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

| Table 2. Swat-04 Estimated Target Reductions | | | |
|---|---|---|---|
| **Name** | **Swat-04 Aluminum** | **Swat-04 Iron** | **Swat-04 Manganese** |
| Minimum = | 0 | 0.4836 | 0 |
| Maximum = | 0.8675 | 0.9334 | 0.8762 |
| Mean = | 0.2184 | 0.8101 | 0.4750 |
| Std. Deviation = | 0.2204 | 0.0544 | 0.1719 |
| Variance = | 0.0486 | 0.0030 | 0.0296 |
| Skewness = | 0.5845 | -0.8768 | -0.7027 |
| Kurtosis = | 2.0895 | 4.3513 | 3.1715 |
| Errors Calculated = | 0 | 0 | 0 |
| **Targeted Reduction % =** | **72.2** | **90.5** | **77.0** |
| Target #1 (Perc%)= | 99 | 99 | 99 |

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

| Table 3. Swat-04 Verification of Target Reductions | | | |
|---|---|---|---|
| **Name** | **Swat-04 Aluminum** | **Swat-04 Iron** | **Swat-04 Manganese** |
| Minimum = | 0.0444 | 0.2614 | 0.1394 |
| Maximum = | 1.5282 | 2.0277 | 1.8575 |
| Mean = | 0.2729 | 0.7693 | 0.4871 |
| Std Deviation = | 0.1358 | 0.2204 | 0.1670 |
| Variance = | 0.0185 | 0.0486 | 0.0279 |
| Skewness = | 1.6229 | 0.8742 | 1.0996 |
| Kurtosis = | 8.0010 | 4.3255 | 5.4404 |
| Errors Calculated = | 0 | 0 | 0 |
| Target #1 (value) (WQ Criteria)= | 0.75 | 1.5 | 1 |
| **Target #1 (Perc%)=** | **99.15** | **99.41** | **99.02** |

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

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

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

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

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

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

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

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

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

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

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

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

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

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

This equation was simulated through 5,000 iterations, and the $99^{th}$ 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):

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

This equation was simulated through 5,000 iterations, and the 99$^{th}$ 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

**Potato Garden Run near headwaters, Sample Point 161**

TMDL calculations

The TMDL for Potato Garden Run consists of a load allocation to all of the area above sampling point 161 (Attachment A). Addressing the mining impacts above this point addresses the impairment for the entire stream segment from the point to the headwaters of the stream.

The load allocation for this stream segment was computed using water-quality sample data collected at point 161. The average flow measurement (0.59 MGD) for point 161 is used for these computations.

There currently is no entry for this segment on the Pa 303(d) list for impairment due to pH. Sample data at point 161 shows pH ranging between 6.92 and 7.24, pH will not be addressed in this TMDL.

An allowable long-term average in-stream concentration was determined at point 161 for aluminum, iron, and manganese. The analysis is designed to produce an average value that, when met, will be protective of the water-quality criterion for that parameter 99% of the time. An analysis was performed using Monte Carlo simulation to determine the necessary long-term average concentration needed to attain water-quality criteria 99% of the time. The simulation was run assuming the data set was lognormally distributed. Using the mean and standard deviation of the data set, 5000 iterations of sampling were completed, and compared against the water-quality criterion for that parameter. For each sampling event a percent reduction was calculated, if necessary, to meet water-quality criteria. A second simulation that multiplied the percent reduction times the sampled value was run to insure that criteria were met 99% of the time. The mean value from this data set represents the long-term average concentration that needs to be met to achieve water-quality standards. The following table shows the load allocations for this stream segment.

**Table D1. Potato Garden Run above 161**

| | | Measured Sample Data | | Allowable | | Reduction Identified |
|---|---|---|---|---|---|---|
| Point | Parameter | Conc (mg/l) | Load (lbs/day) | LTA Conc (mg/l) | Load (lbs/day) | % |
| 161 | Potato Garden Run, near headwaters | | | | | |
| | Al | 6.31 | 31.0 | 0.25 | 1.2 | 96 |
| | Fe | 10.93 | 53.7 | 0.55 | 2.7 | 95 |
| | Mn | 6.40 | 31.5 | 0.77 | 3.8 | 88 |
| | Acidity | 34.00 | 167.2 | 34.00 | 167.2 | 0 |
| | Alkalinity | 179.55 | 883.0 | | | |

**Mouth of Unnamed Tributary, Stream Code 33766, Sample Point 162**

TMDL Calculations

The TMDL for the unnamed tributary consists of a load allocation to all of the area above the point 162 shown in Attachment A. Addressing the mining impacts above this point addresses the impairment for the entire stream segment from the point to the stream headwaters.

The load allocation for this stream segment was computed using water-quality sample data collected at the point 162. The average flow measurement (0.30 MGD) for point 162 was used.

There is currently no entry for this segment on the Section Pa 303(d) list for impairment due to pH. Sample data at point 162 shows pH ranging between 6.68 and 7.69; pH will be addressed as part of this TMDL. The objective is to reduce acid loading to the stream, which will in turn raise the pH. The method and rationale for addressing pH is contained in Attachment B.

An allowable long-term average in-stream concentration was determined at point 162 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 D2. **Potato Garden Run above 162**

| | | Measured Sample Data | | Allowable | | Reduction Identified |
|---|---|---|---|---|---|---|
| Point | Parameter | Conc (mg/l) | Load (lbs/day) | LTA Conc (mg/l) | Load (lbs/day) | % |
| 162 | Mouth of Tributary 33766 | | | | | |
| | Al | 0.40 | 1.0 | 0.12 | 0.3 | 71 |
| | Fe | 7.18 | 18.2 | 0.72 | 1.8 | 90 |
| | Mn | 3.05 | 7.7 | 0.49 | 1.2 | 84 |
| | Acidity | 23.50 | 59.6 | 15.04 | 38.2 | 36 |
| | Alkalinity | 46.62 | 118.3 | | | |

**Potato Garden Run – Upstream Confluence with Unnamed Tributary 33764, Sample Point 163**

TMDL Calculations

The TMDL for Potato Garden Run, sampling point 163, consists of a load allocation to all of the area between stream monitoring points 161, 162, and 163. The load allocation for this stream segment was computed using water-quality sample data collected at point 163. The average flow (2.16 mgd) is used for these computations.

There is currently no entry for this segment on the Pa Section 303(d) list for impairment due to pH. Sample data at point 163 shows pH ranging between 7.40 and 7.75; pH will not be addressed as part of this TMDL.

An allowable long-term average in-stream concentration was determined at point 163 for aluminum, iron, and manganese. The analysis is designed to produce an average value that, when met, will be protective of the water-quality criterion for that parameter 99% of the time. An analysis was performed using Monte Carlo simulation to determine the necessary long-term average concentration needed to attain water-quality criteria 99% of the time. The simulation was run assuming the data set was lognormally distributed. Using the mean and standard deviation of the data set, 5000 iterations of sampling were completed, and compared against the water-quality criterion for that parameter. For each sampling event a percent reduction was calculated, if necessary, to meet water-quality criteria. A second simulation that multiplied the percent reduction times the sampled value was run to insure that criteria were met 99% of the time. The mean value from this data set represents the long-term average concentration that needs to be met to achieve water-quality standards. The following table shows the load allocations for this stream segment.

**Table D3. Potato Garden Run**

| 163 | Measured Sample Data | | Allowable | |
|---|---|---|---|---|
| Parameter | Conc (mg/l) | Load (lbs/day) | LTAConc (mg/l) | Load (lbs/day) |
| Al | 0.02 | 0.4 | 0.02 | 0.4 |
| Fe | 0.88 | 15.9 | 0.36 | 6.5 |
| Mn | 2.09 | 37.7 | 0.48 | 8.7 |
| Acidity | 9.25 | 166.9 | 9.25 | 166.9 |
| Alkalinity | 89.24 | 1609.8 | | |

The loading reductions for points 161 and 162, 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 163. This value was then compared to the allowable load at point 163. Reductions at point 163 are necessary for any parameter that exceeded the allowable load at this point. Table D4 shows a summary of all loads that affect point 163. Table D5 illustrates the necessary reductions at point 163. The results of this analysis show that no reductions are necessary at this point.

| Table D4. Summary of All Loads that Affect 163 | | | | |
|---|---|---|---|---|
| | **Al (#/day)** | **Fe (#/day)** | **Mn (#/day)** | **Acidity** (#/day) |
| **Potato Garden Run (161)** | | | | |
| load reduction= | 29.8 | 51.0 | 27.7 | 0.0 |
| **Un Trib to Potato Garden Run (162)** | | | | |
| load reduction= | 0.7 | 16.4 | 6.5 | 21.5 |

| Table D5. Necessary Reductions at Sample Point 163 | | | | |
|---|---|---|---|---|
| | **Al (#/day)** | **Fe (#/day)** | **Mn (#/day)** | **Acidity (#/day)** |
| **Existing Loads at 163** | 0.4 | 15.9 | 37.7 | 166.9 |
| **Total Load Reduction (Sum of 161 &162)** | 30.5 | 67.4 | 34.2 | 21.5 |
| **Remaining Load (Existing Loads at 163 – TLR Sum)** | 0.0 | 0.0 | 3.5 | 145.4 |
| **Allowable Loads at 163** | 0.4 | 6.5 | 8.7 | 166.9 |
| **Percent Reduction** | NA | NA | NA | NA |
| **Additional Removal Required at 163** | NA | NA | NA | NA |

The average flow, measured at sample point 163, is used for these computations. There are no necessary load allocations for the TMDL at 163. The percent reduction was calculated using the below equation.

$$\left[1-\left(\frac{\text{Allowable Loads at 163}}{\text{Remaining Load (Existing Loads at 163 - TLR Sum}}\right)\right]\times 100\,\%$$

No additional loading reductions were necessary.

**Mouth of Unnamed Tributary 33764, Sample Point 164**

TMDL calculations

The TMDL for Potato Garden Run consists of a load allocation to all of the area above the point 164 shown in Attachment A. The load allocation for this stream segment was computed using water-quality sample data collected at point 164. The average flow measurement (0.31 MGD) for point 164 is used for these computations.

There is currently an entry for this segment on the Pa Section 3030(d) list for impairment due to pH. Sample data at point 164 shows pH ranging between 6.96 and 7.63; pH will be addressed as part of this TMDL. The objective is to reduce acid loading to the stream, which will in turn raise the pH. The method and rationale for addressing pH is contained in Attachment B.

An allowable long-term average in-stream concentration was determined at point 164 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 D**6**. **Unnamed Tributary to Potato Garden Run above 164** | | | | |
|---|---|---|---|---|---|---|
| | | Measured Sample Data | | Allowable | | Reduction Identified |
| Point | Parameter | Conc (mg/l) | Load (lbs/day) | LTA Conc (mg/l) | Load (lbs/day) | % |
| 164 | Mouth of Unnamed Tributary 33764 | | | | | |
| | Al | 3.23 | 8.4 | 0.16 | 0.4 | 95 |
| | Fe | 1.01 | 2.6 | 0.43 | 1.1 | 58 |
| | Mn | 0.96 | 2.5 | 0.80 | 2.1 | 17 |
| | Acidity | 20.75 | 53.6 | 12.45 | 32.2 | 40 |
| | Alkalinity | 41.54 | 107.4 | | | |

**Potato Garden Run upstream of confluence w/ Unnamed Tributary 33759, Sample Point 165**

<u>TMDL Calculations</u>

The TMDL for Potato Garden Run, sampling point 165, consists of a load allocation to all of the area between stream monitoring points 163, 164, and 165. The load allocation for this stream segment was computed using water quality sample data collected at point 165. The average flow (2.37 mgd), measured at the sampling point, is used for these computations.

There is currently an entry for this segment on the Pa 303(d) list for impairment due to pH. Sample data at point 165 shows pH ranging between 4.42 and 7.96; 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. The method and rationale for addressing pH is contained in Attachment B.

An allowable long-term average in-stream concentration was determined at point 165 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 D7. Potato Garden Run** | | | | |
|---|---|---|---|---|
| 165 | Measured Sample Data | | Allowable | |
| Parameter | Conc (mg/l) | Load (lbs/day) | LTAConc (mg/l) | Load (lbs/day) |
| Al | 2.31 | 45.5 | 0.09 | 1.8 |
| Fe | 2.11 | 41.7 | 0.21 | 4.2 |
| Mn | 3.40 | 67.0 | 0.17 | 3.3 |
| Acidity | 24.75 | 488.4 | 14.11 | 278.4 |
| Alkalinity | 82.33 | 1624.6 | | |

The loading reductions for points 163 and 164, 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 165. This value was then compared to the allowable load at point 165. Reductions at point 165 are necessary for any parameter that exceeded the allowable load at this point. Table D8 shows a summary of all loads that affect point 165. Table D9 illustrates the necessary reductions at point 165. The results of this analysis show that reductions for aluminum, manganese, and acidity are necessary at this point.

| Table D8. Summary of All Loads that Affect 165 | | | | |
|---|---|---|---|---|
| | **Al (#/day)** | **Fe (#/day)** | **Mn (#/day)** | **Acidity (#/day)** |
| **Potato Garden Run (163)** | | | | |
| load reduction= | 30.5 | 67.4 | 34.2 | 21.5 |
| **Unnamed Trib to Potato Garden Run (164)** | | | | |
| load reduction= | 7.9 | 1.5 | 0.4 | 21.5 |

| Table D9. Necessary Reductions at Sample Point 165 | | | | |
|---|---|---|---|---|
| | **Al (#/day)** | **Fe (#/day)** | **Mn (#/day)** | **Acidity (#/day)** |
| **Existing Loads at 165** | 45.5 | 41.7 | 67.0 | 488.4 |
| **Total Load Reduction (Sum of 163 &164)** | 38.5 | 68.9 | 34.6 | 42.9 |
| **Remaining Load (Existing Loads at 165 – TLR Sum)** | 7.0 | NA | 32.4 | 445.5 |
| **Allowable Loads at 165** | 1.8 | 4.2 | 3.3 | 278.4 |
| **Percent Reduction** | 74 | NA | 90 | 38 |
| **Additional Removal Required at E-4** | 5.2 | NA | 29.0 | 167.1 |

The average flow, measured at sample point 165, is used for these computations. The TMDL for 165 consists of load allocations for aluminum, manganese, and acidity to all of the area upstream of 165 shown in Attachment A. The percent reduction was calculated using the below equation.

$$\left[1-\left(\frac{\text{Allowable Loads at 165}}{\text{Remaining Load (Existing Loads at 165 - TLR Sum}}\right)\right]\times 100\,\%$$

No additional loading reductions were necessary for iron.

**Mouth of Unnamed Tributary 33759, Sample Point 166**

TMDL Calculations

The TMDL for the unnamed tributary to Potato Garden Run consists of a load allocation to all of the area above the point 166 shown in Attachment A. The load allocation for this stream segment was computed using water-quality sample data collected at point 166. The average flow, measured at the sampling point 166 (0.59 MGD), is used for these computations.

There is currently no entry for this segment on the Pa 303(d) list for impairment due to pH. However sample data at point 166 shows pH ranging between 5.24 and 7.70. For this reason pH will be addressed as part of this TMDL. The result of this analysis is an acid loading reduction that equates to meeting standards for pH (see Table 2). The method and rationale for addressing pH is contained in Attachment B.

An allowable long-term average in-stream concentration was determined at point 166 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 D**10**. **Unnamed Tributary to Potato Garden Run**

| | | Measured Sample Data | | Allowable | | Reduction Identified |
|---|---|---|---|---|---|---|
| Point | Parameter | Conc (mg/l) | Load (lbs/day) | LTA Conc (mg/l) | Load (lbs/day) | % |
| 166 | Mouth of Tributary 33759 | | | | | |
| | Al | 4.98 | 24.3 | 0.15 | 0.7 | 97 |
| | Fe | 6.16 | 30.1 | 0.31 | 1.5 | 95 |
| | Mn | 4.97 | 24.3 | 0.25 | 1.2 | 95 |
| | Acidity | 19.59 | 95.6 | 6.66 | 32.5 | 66 |
| | Alkalinity | 31.97 | 156.1 | | | |

**Mouth of Potato Garden Run, Sample Point 167**

TMDL Calculations

The TMDL for Potato Garden Run, sampling point 167, consists of a load allocation to all of the area between stream monitoring points 165, 166, and 167. The load allocation for this stream segment was computed using water-quality sample data collected at point 167. The average flow, measured at sampling point 167 (3.11 mgd), is used for these computations.

There is currently an entry for this segment on the Pa Section 303(d) list for impairment due to pH. Sample data at point 167 shows pH ranging between 7.51 and 7.77; pH will not be addressed as part of this TMDL.

An allowable long-term average in-stream concentration was determined at point 167 for aluminum, iron, and manganese. The analysis is designed to produce an average value that, when met, will be protective of the water-quality criterion for that parameter 99% of the time. An analysis was performed using Monte Carlo simulation to determine the necessary long-term average concentration needed to attain water-quality criteria 99% of the time. The simulation was run assuming the data set was lognormally distributed. Using the mean and standard deviation of the data set, 5000 iterations of sampling were completed, and compared against the water-quality criterion for that parameter. For each sampling event a percent reduction was calculated, if necessary, to meet water-quality criteria. A second simulation that multiplied the percent reduction times the sampled value was run to insure that criteria were met 99% of the time. The mean value from this data set represents the long-term average concentration that needs to be met to achieve water-quality standards. The following table shows the load allocations for this stream segment.

**Table D11. Potato Garden Run**

| 167 | Measured Sample Data | | Allowable | |
|---|---|---|---|---|
| Parameter | Conc (mg/l) | Load (lbs/day) | LTAConc (mg/l) | Load (lbs/day) |
| Al | 0.02 | 0.5 | 0.02 | 0.5 |
| Fe | 0.35 | 9.1 | 0.35 | 9.1 |
| Mn | 1.04 | 27.1 | 0.33 | 8.7 |
| Acidity | 10.25 | 266.2 | 10.25 | 266.2 |
| Alkalinity | 75.62 | 1963.7 | | |

The loading reductions for points 165 and 166, 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 167. This value was then compared to the allowable load at point 167. Reductions at point 167 are necessary for any parameter that exceeded the allowable load at this point. Table D12 shows a summary of all loads that affect point 167. Table D13 illustrates the necessary reductions at point 167. The results of this analysis show that no reductions are necessary at this point.

**Table D12. Summary of All Loads that Affect 167**

| | **Al (#/day)** | **Fe (#/day)** | **Mn (#/day)** | **Acidity (#/day)** |
|---|---|---|---|---|
| **Potato Garden Run (165)** | | | | |
| load reduction= | 43.7 | 68.9 | 63.6 | 210.0 |
| **Unnamed Trib to Potato Garden Run (166)** | | | | |
| load reduction= | 23.6 | 28.6 | 23.1 | 63.1 |

| Table D13. Necessary Reductions at Sample Point 167 | | | | |
|---|---|---|---|---|
| | **Al (#/day)** | **Fe (#/day)** | **Mn (#/day)** | **Acidity (#/day)** |
| **Existing Loads at 167** | 0.5 | 9.1 | 27.1 | 266.2 |
| **Total Load Reduction (Sum of 165 &166)** | 67.2 | 97.5 | 86.7 | 273.1 |
| **Remaining Load (Existing Loads at 167 – TLR Sum)** | NA | NA | NA | NA |
| **Allowable Loads at 167** | 0.5 | 9.1 | 8.7 | 266.2 |
| **Percent Reduction** | NA | NA | NA | NA |
| **Additional Removal Required at 167** | NA | NA | NA | NA |

The average flow, measured at sample point 167, is used for these computations. The percent reduction was calculated using the below equation.

$$\left[1-\left(\frac{\text{Allowable Loads at 167}}{\text{Remaining Load (Existing Loads at 167 - TLR Sum}}\right)\right]\times 100\,\%$$

No additional loading reductions were necessary at the location of point 167.

*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.

*Seasonal Variation*

Seasonal variation is implicitly accounted for in these TMDLs because the data used represents all seasons.

*Critical Conditions*

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

# Attachment E

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

*The following are excerpts from the Pennsylvania DEP Section 303(d) list narratives that justify changes in listings between the 1996, 1998, and draft 2002 lists. 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) list 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 Draft 2000 Section 303(d) list, the Draft 2002 Pa Section 303(d) list was written in a manner similar to the 1998 Section 303(d) list.

# Attachment F

## Water Quality Data Used In TMDL Calculations

| Table 1. Sample Site 161 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **DATE** | **FLOW** | **pH** | **Acidity** | **Alkalinity** | **TSS** | **Al** | **Fe** | **Mn** | **SO4** |
| | **gpm** | | **mg/L** | **mg/L** | **mg/L** | **mg/L** | **mg/L** | **mg/L** | **mg/L** |
| 06/30/00 | 428 | 7.13 | 40 | 152 | 47.5 | 9.8 | 4.8 | 6.5 | 1786 |
| 10/01/00 | 370 | 7.17 | 23 | 201 | 43.25 | 4.65 | 9.90 | 7.10 | 2210 |
| 01/13/01 | 307 | 7.24 | 51 | 206 | 56.25 | 3.6 | 18 | 6.4 | 2118 |
| 04/01/01 | 533 | 6.92 | 22 | 160 | 60 | 7.20 | 11.00 | 5.60 | 1552 |
| | | | | | | | | | |
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| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| Average | **409.50000** | **7.11500** | **34.00000** | **179.55051** | **51.75000** | **6.31250** | **10.92500** | **6.40000** | **1916.50000** |
| Stdev | **96.02257** | **0.13772** | **14.02379** | **27.80416** | **7.71632** | **2.77320** | **5.43530** | **0.61644** | **303.66374** |

| Table 2. Sample Site 162 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **DATE** | **FLOW** | **pH** | **Acidity** | **Alkalinity** | **TSS** | **Al** | **Fe** | **Mn** | **SO4** |
| | **gpm** | | **mg/L** | **mg/L** | **mg/L** | **mg/L** | **mg/L** | **mg/L** | **mg/L** |
| 06/30/00 | 213 | 7.69 | 15 | 37 | 23 | 1.2 | 9.8 | 3.5 | 629 |
| 10/01/00 | 129 | 6.95 | 20 | 40 | 7.5 | 0.12 | 4.80 | 4.30 | 524 |
| 01/13/01 | 55 | 7.10 | 44 | 60 | 18.00 | 0.02 | 5.30 | 2.20 | 447 |
| 04/01/01 | 448 | 6.68 | 15 | 49 | 22.5 | 0.27 | 8.80 | 2.20 | 338 |
| | | | | | | | | | |
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| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| Average | **211.25000** | **7.10500** | **23.50000** | **46.61590** | **17.75000** | **0.40250** | **7.17500** | **3.05000** | **484.50000** |
| Stdev | **170.52150** | **0.42697** | **13.86843** | **10.15864** | **7.19375** | **0.54150** | **2.49583** | **1.03441** | **122.89426** |

| Table 3. Sample Site 163 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **DATE** | **FLOW** | **pH** | **Acidity** | **Alkalinity** | **TSS** | **Al** | **Fe** | **Mn** | **SO4** |
| | **gpm** | | **mg/L** | **mg/L** | **mg/L** | **mg/L** | **mg/L** | **mg/L** | **mg/L** |
| 06/30/00 | 1486 | 7.75 | 5 | 82 | 0 | 0.02 | 0.27 | 1.27 | 1134 |
| 10/01/00 | 742 | 7.56 | 8 | 94 | 2 | 0.02 | 0.35 | 1.90 | 1446 |
| 01/13/01 | no data | 7.61 | 10 | 110 | 9.00 | 0.02 | 1.10 | 3.00 | 1318 |
| 04/01/01 | 2278 | 7.40 | 14 | 71 | 7 | 0.02 | 1.8 | 2.2 | 707 |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| Average | **1502.00000** | **7.58000** | **9.25000** | **89.24348** | **4.50000** | **0.02000** | **0.88000** | **2.09250** | **1151.25000** |
| Stdev | **768.12499** | **0.14445** | **3.77492** | **16.81861** | **4.20317** | **0.00000** | **0.71828** | **0.71849** | **322.66533** |

| Table 4. Sample Site 164 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **DATE** | **FLOW** | **pH** | **Acidity** | **Alkalinity** | **TSS** | **Al** | **Fe** | **Mn** | **SO4** |
| | **gpm** | | **mg/L** | **mg/L** | **mg/L** | **mg/L** | **mg/L** | **mg/L** | **mg/L** |
| 06/30/00 | 157 | 7.35 | 14 | 28 | 54.5 | 5 | 1.9 | 1.1 | 430 |
| 10/01/00 | 102 | 7.63 | 40 | 61 | 8 | 0.03 | 0.27 | 0.90 | 240 |
| 01/13/01 | 129 | 7.40 | 20 | 52 | 22.00 | 2.30 | 0.68 | 0.90 | 225 |
| 04/01/01 | 473 | 6.96 | 9 | 25 | 36.5 | 5.60 | 1.20 | 0.95 | 220 |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| Average | **215.25000** | **7.33500** | **20.75000** | **41.54234** | **30.25000** | **3.23250** | **1.01250** | **0.96250** | **278.75000** |
| Stdev | **173.29431** | **0.27815** | **13.59841** | **17.80482** | **19.91858** | **2.57259** | **0.70349** | **0.09465** | **101.19083** |

| Table 5. Sample Site 165 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **DATE** | **FLOW** | **pH** | **Acidity** | **Alkalinity** | **TSS** | **Al** | **Fe** | **Mn** | **SO4** |
| | **gpm** | | **mg/L** | **mg/L** | **mg/L** | **mg/L** | **mg/L** | **mg/L** | **mg/L** |
| 06/30/00 | 1768 | 7.96 | 7 | 77 | 0.25 | 0.02 | 0.24 | 0.78 | 1009 |
| 10/01/00 | 133 | 4.42 | 69 | | 10.5 | 9.00 | 6.80 | 9.30 | 1693 |
| 01/13/01 | no data | 7.57 | 20 | 102 | 5.00 | 0.02 | 0.51 | 2.00 | 1016 |
| 04/01/01 | 3028 | 7.61 | 3 | 68 | 7.5 | 0.18 | 0.90 | 1.50 | 518 |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| Average | **1643.00000** | **6.88875** | **24.75191** | **82.33414** | **5.81250** | **2.30500** | **2.11250** | **3.39500** | **1059.00000** |
| Stdev | **1451.54228** | **1.65488** | **30.38325** | **17.23072** | **4.33674** | **4.46397** | **3.13672** | **3.96839** | **482.69590** |

| Table 6. Sample Site 166 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **DATE** | **FLOW** | **pH** | **Acidity** | **Alkalinity** | **TSS** | **Al** | **Fe** | **Mn** | **SO4** |
| | **gpm** | | **mg/L** | **mg/L** | **mg/L** | **mg/L** | **mg/L** | **mg/L** | **mg/L** |
| 06/30/00 | 128 | 5.53 | 32 | 4 | 44.5 | 8.4 | 10 | 8 | 1458 |
| 10/01/00 | 1197 | 7.70 | 6 | 90 | 0 | 0.02 | 0.14 | 0.79 | 1125 |
| 01/13/01 | 47 | 5.24 | 40 | 3 | 44.50 | 8.40 | 11.00 | 7.40 | 1446 |
| 04/01/01 | 254 | 6.86 | 1 | 31 | 23 | 3.10 | 3.50 | 3.70 | 748 |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| Average | **406.50000** | **6.33250** | **19.58688** | **31.96637** | **28.00000** | **4.98000** | **6.16000** | **4.97250** | **1194.25000** |
| Stdev | **533.83799** | **1.15266** | **18.97708** | **40.70216** | **21.24068** | **4.14443** | **5.21176** | **3.37496** | **335.10036** |

| Table 7. Sample Site 167 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **DATE** | **FLOW** | **pH** | **Acidity** | **Alkalinity** | **TSS** | **Al** | **Fe** | **Mn** | **SO4** |
| | **gpm** | | **mg/L** | **mg/L** | **mg/L** | **mg/L** | **mg/L** | **mg/L** | **mg/L** |
| 06/30/00 | 2170 | 7.77 | 8 | 71 | 0 | 0.02 | 0.22 | 0.62 | 825 |
| 10/01/00 | 1171 | 7.56 | 6 | 74 | 0.5 | 0.02 | 0.06 | 0.55 | 1085 |
| 01/13/01 | 1510 | 7.51 | 22 | 91 | 13.50 | 0.02 | 0.50 | 1.80 | 966 |
| 04/01/01 | 3798 | 7.62 | 5 | 67 | 5 | 0.02 | 0.62 | 1.2 | 483 |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| Average | **2162.25000** | **7.61500** | **10.25000** | **75.62246** | **4.75000** | **0.02000** | **0.35000** | **1.04250** | **839.75000** |
| Stdev | **1166.72544** | **0.11269** | **7.93200** | **10.66838** | **6.25167** | **0.00000** | **0.25586** | **0.58300** | **260.49616** |

Table 8. WQN0901
Ohio River - US Rt. 30 BR
East Liverpool, OH

| | |
|---|---|
| Date | Sulfates |
| | mg/L |
| 1/24/1989 | 58 |
| 2/27/1989 | 61 |
| 3/23/1989 | 69 |
| 4/24/1989 | 104 |
| 5/22/1989 | 57 |
| 6/20/1989 | 58 |
| 7/24/1989 | 103 |
| 8/14/1989 | 134 |
| 9/25/1989 | 124 |
| 10/23/1989 | 84 |
| 11/20/1989 | 69 |
| 12/20/1989 | 61 |
| 1/23/1990 | 59 |
| 2/27/1990 | 65 |
| 3/20/1990 | 82 |
| 4/30/1990 | 79 |
| 5/22/1990 | 52 |
| 6/26/1990 | 109 |
| 7/24/1990 | 60 |
| 8/27/1990 | 107 |
| 9/25/1990 | 78 |
| 10/25/1990 | 59 |
| 11/26/1990 | 71 |
| 12/27/1990 | 52 |
| 1/29/1991 | 81 |
| 2/25/1991 | 56 |
| 3/25/1991 | 67 |
| 4/24/1991 | 71 |
| 5/20/1991 | 90 |
| 6/17/1991 | 119 |
| 7/24/1991 | 133 |
| 8/26/1991 | 191 |
| 9/25/1991 | 149 |
| 10/22/1991 | 140 |
| 11/21/1991 | 136 |
| 12/3/1991 | 54 |
| 12/30/1991 | 80 |
| 1/22/1992 | 71 |
| 2/19/1992 | 91 |
| 3/19/1992 | 71 |

| Date | Sulfates (mg/L) |
|---|---|
| 4/29/1992 | 60 |
| 5/11/1992 | 66 |
| 6/1/1992 | 106 |
| 7/8/1992 | 130 |
| 8/10/1992 | 52 |
| 9/7/1992 | 76 |
| 10/19/1992 | 68 |
| 11/17/1992 | 56 |
| 1/4/1993 | 41 |
| 2/9/1993 | 77 |
| 3/3/1993 | 74 |
| 4/8/1993 | 48 |
| 5/13/1993 | 84 |
| 6/3/1993 | 136 |
| 7/20/1993 | 115 |
| 8/5/1993 | 139 |
| 9/13/1993 | 93 |
| 10/7/1993 | 118 |
| 11/9/1993 | 80 |
| 12/9/1993 | 43 |
| 1/10/1994 | 86 |
| 2/16/1994 | 75 |
| 3/28/1994 | 49 |
| 4/14/1994 | 49 |
| 5/19/1994 | 77 |
| 6/21/1994 | 42 |
| 7/20/1994 | 135 |
| 8/22/1994 | 78 |
| 9/20/1994 | 91 |
| 10/20/1994 | 82 |
| 11/14/1994 | 56 |
| 12/15/1994 | 56 |
| 1/12/1995 | 79 |
| 2/16/1995 | 83 |
| 3/14/1995 | 48 |
| 4/20/1995 | 56 |
| 5/18/1995 | 69 |
| 6/7/1995 | 66 |
| 7/24/1995 | 107 |
| 8/21/1995 | 127 |
| 9/19/1995 | 121 |
| 10/11/1995 | 123 |
| 11/13/1995 | 82 |
| 12/18/1995 | 62 |
| 1/17/1996 | 74 |
| 2/13/1996 | 75 |

| Date | Sulfates (mg/L) |
|---|---|
| 3/19/1996 | 76 |
| 4/22/1996 | 67 |
| 5/8/1996 | 42 |
| 6/4/1996 | 87 |
| 7/16/1996 | 10 |
| 8/26/1996 | 91 |
| 9/19/1996 | 70 |
| 10/16/1996 | 61 |
| 11/13/1996 | 39 |
| 12/4/1996 | 39 |
| 1/21/1997 | 60 |
| 2/12/1997 | 52 |
| 3/17/1997 | 30 |
| 4/15/1997 | 27 |
| 5/7/1997 | 74 |
| 6/23/1997 | 72 |
| 7/24/1997 | 89 |
| 8/18/1997 | 107 |
| 9/22/1997 | 97 |
| 10/21/1997 | 74 |
| 11/24/1997 | 54 |
| 12/16/1997 | 45 |
| 1/20/1998 | 40 |
| 2/19/1998 | 82 |
| 3/9/1998 | 49 |
| 4/20/1998 | 50 |
| 5/18/1998 | 54 |
| 6/3/1998 | 91 |
| 7/13/1998 | 40 |
| 8/17/1998 | 98 |
| 10/21/1998 | 87 |
| 12/15/1998 | 107 |
| | |
| Average | 78.18644 |
| St Dev | 29.98260 |

# Attachment G
## Comment and Response

The following comments were submitted by the United States Environmental Protection Agency, Region 3 on January 31, 2003 in regards to the proposed TMDL for the Potato Garden Run Watershed.

1. Consider adding the 2002 Section 303(d) list information to Table 1. While Potato Garden Run is not listed for "other inorganics," provided monitoring at the mouth of Potato Garden Run is high in sulfates. The report should address this by showing there is no public drinking water intake downstream on Raccoon Creek.

   *The 2002 Section 303(d) list information was added to Table 1. Water Supply Intake information has been provided in the report.*

2. Table 1 identifies impaired segments by segment ID and DEP stream code and the impaired segments are in red on the watershed map. It should be noted that when the map is printed in black and white, it is not possible to identify the impaired segments, including the UNT. Please also identify the impaired segments in the text.

   *Stream Codes were added to the map in Attachment A to better help identify the impaired listed segments from Table 1.*

3. The Segments addressed in this TMDL section states there are no active mining operations while the Watershed History section states there is one active mining operation. The sections should be consistent.

   The active mining operation is a Waste Management permit and its NPDES discharges are located in an adjacent watershed. This information has been added to the report.

4. The Watershed History section states, "Water quality data shows low pH and high concentrations of acid, iron,..." However, the provided monitoring data shows one pH violation out of 28 samples. Please provide EPA with all monitoring data, whether or not it is included in the TMDL Report.

   *Any additional water quality monitoring data for the Potato Garden Run Watershed can be obtained from the PADEP Greensburg District Mining Office.*

5. In Attachment F, Water Quality Data Used in TMDL Calculations, shows most "acidity - mg/l" as negative values. EPA does not believe the negative values represent the results of an analytical method. Please review and correct as necessary.

   *The negative acidity values represent positive net alkalinity. The tables and calculations have been corrected as necessary.*

6. The Potato Garden Run Above 161 section states that point 161 is "the first stream monitoring point downstream of all mining impacts." Since this is an incorrect statement, please correct (or clarify).

*Statement corrected.*

7. The spreadsheets and Attachment F, Water Quality Data Used in TMDL Calculations, show acidity values as negative when they should be positive such that net alkalinity equals total alkalinity minus total acidity. Table D1 should show acidity as 146.83 so that net alkalinity equals 179.55 – 146.83 = 23.79, which is consistent with measured the pH of 7.12. Please verify.

   *The negative acidity values represented positive net alkalinity. Tables and calculations were corrected accordingly.*

8. Table 3 and tables in Attachment D show zero as the existing acidity concentration when both Attachment F and the spreadsheet show existing acidity in mg/l. Please correct.

   *Tables corrected.*

9. The presented data for UNT 33764, Sampling Point 164, does not indicate a pH impairment but the 2002 Section 303(d) list indicates a listing for pH impairment. Is there additional data supporting the listing? If so, it would be prudent to develop the pH TMDL now?

   *UNT 33764, Segment ID 4527 is not listed for pH impairments on the 2002 Section 303(d) list, however reductions in acidity are necessary at point 164 and therefore a TMDL for pH was completed.*

10. In both the spreadsheet and Attachment F, at Sample Point 165 for 6/30/00 the TSS is shown as –0.25 mg/l. In addition, two other TSS measurements are shown as negative. Please correct.

    *Tables corrected.*

11. It should be noted at Sampling Point 165 that the pH criterion is violated one of four samples. The mainstem may be borderline for pH listing on the Section 303(d) list.

    *PH was added as a cause of impairment to the 2002 Section 303(d) listing of the mainstem of Potato Garden Run (refer to Table 1).*

12. Although UNT 33759, Sampling Point 166, is not on the 2002 Section 303(d) list for pH impairment, the data in Attachment F show violations for two out of four pH measurements indicating it should be listed. It is unacceptable to state in Attachment D that pH will not be addressed because the segment is net alkaline based on the data provided.

    *A TMDL for pH at Sampling Point 166 has been completed.*