CATAWISSA CREEK WATERSHED TMDL

Carbon, Columbia, Luzerne, and Schuylkill Counties

Prepared for:

Pennsylvania Department of Environmental Protection

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INTRODUCTION

This Total Maximum Daily Load (TMDL) calculation has been prepared for segments in the Catawissa Creek Watershed (Attachment A). It was done to address the impairments noted on the 1996 and 1998 Pennsylvania Section 303(d) lists, the 2000 305(b) report required under the Clean Water Act, and the draft 2002 Pennsylvania Section 303(d) list. The TMDL covers six segments on these lists (Table 1). High levels of metals, and in some areas depressed pH, caused these impairments. All impairments are a result of acid drainage from abandoned coal mines. The TMDL addresses the three primary metals (iron, manganese, and aluminum) associated with acid mine drainage (AMD) and pH.

Table 1. Catawissa Creek Segments Addressed

State Water Plan (SWP) Subbasin: 05-A Susquehanna River								
Year	***Miles***	***Segment ID***	***DEP Stream Code***	***Stream Name***	***Designated Use***	***Data Source***	***Source***	***EPA 305(b) Cause Code***
1996	27.5	4177,4178	27529	Catawissa Creek	CWF , TSF	305(b) Report	RE	Metals
1998	17.6	4177	27529	Catawissa Creek	CWF	305(b) Report	AMD	Metals
2000	17.6	4177	27529	Catawissa Creek	CWF	SWMP	AMD	Metals
2002	17.5	4177	27529	Catawissa Creek	CWF	SWMP	AMD	Metals
1998	6.22	4178	27529	Catawissa Creek	TSF	305(b) Report	AMD	Metals
2000	6.23	4178	27529	Catawissa Creek	TSF	SWMP	AMD	Metals
2002	6.2	4178	27529	Catawissa Creek	TSF	SWMP	AMD	Metals
1996	14	7200	27529	Catawissa Creek	TSF	305(b) Report	AMD	Metals
1998	20.82	7200	27529	Catawissa Creek	TSF	SWMP	AMD	Metals
2000	20.83	7200	27529	Catawissa Creek	TSF	SWMP	AMD	Metals
2002	20.8	7200	27529	Catawissa Creek	TSF	SWMP	AMD	Metals
1996	5.5	4184	27571	Sugarloaf Creek	CWF	305(b) Report	RE	pH

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

State Water Plan (SWP) Subbasin: 05-A Susquehanna River								
Year	**Miles**	**Segment ID**	**DEP Stream Code**	**Stream Name**	**Designated Use**	**Data Source**	**Source**	**EPA 305(b) Cause Code**
1998	3.45	4184	27571	Sugarloaf Creek	CWF	SWMP	AMD	pH
2000	3.45	4184	27571	Sugarloaf Creek	CWF	SWMP	AMD	pH
2002	3.4	4184	27571	Sugarloaf Creek	CWF	SWMP	AMD	pH
1996	10.6	4182,4183	27567	Tomhickon Creek	CWF	305(b) Report	RE	pH
1998	2.11	4182	27567	Tomhickon Creek	CWF	SWMP	AMD	pH
1998	8.92	4183	27567	Tomhickon Creek	CWF	SWMP	AMD	pH
2000	2.11	4182	27567	Tomhickon Creek	CWF	SWMP	AMD	pH
2000	8.92	4183	27567	Tomhickon Creek	CWF	SWMP	AMD	pH
2002	2.1	4182	27567	Tomhickon Creek	CWF	SWMP	AMD	pH
2002	8.9	4183	27567	Tomhickon Creek	CWF	SWMP	AMD	pH

Attachment B includes a justification of differences between the 1996 and 1998 Section 303(d) Lists and the 2000 305(b) Report

EV = Exceptional Value
HQ = High Quality Water
CWF = Cold Water Fishes
TSF = Trout Stocked Fishery
RE = Resource Extraction
AMD = Abandoned Mine Drainage
SWMP = Surface Water Monitoring Program

LOCATION

The Catawissa Creek Watershed is approximately 153 square miles in area. The headwaters of Catawissa Creek are located along the boundary of Luzerne and Schuylkill Counties, a few miles southwest of Hazleton, Pennsylvania. The watershed can be located on the U. S. Geological Service (USGS) 7.5 minute quadrangles of Ashland, Catawissa, Conyngham, Delano, Hazleton, Nuremburg, Shenandoah, and Shumans, Pennsylvania. The stream flows northwest from northern Schuylkill County into Columbia County where it joins the Susquehanna River at the Borough of Catawissa, Pennsylvania. The Borough of McAdoo and the village of Kelayres lie at the eastern edge of the watershed. The villages of Sheppton and Oneida lie in the mid-region of the watershed. Catawissa Creek can be accessed from State Highways 924 and 339 that follow the creek along its length. Interstate 81 bisects the headwaters of Catawissa Creek between the McAdoo and Hazleton exits. Numerous township roads also provide access to Catawissa Creek and its tributaries.

SEGMENTS ADDRESSED IN THIS TMDL

The Catawissa Creek Watershed is affected by pollution from AMD. This pollution has caused high levels of metals and low pH in the mainstem of Catawissa Creek, Tomhickon Creek and Sugarloaf Run. The sources of the AMD are five drainage tunnels, completed in the 1930s, that dewater the anthracite coal fields in and to the east of the watershed. Four of these tunnels (Oneida #1, Oneida #3, Green Mountain, and Catawissa) dewater the North and South Green Mountain Coal Basins that lie in the mid-region of the Catawissa Creek Watershed. The North Green Mountain Coal Basin lies north of Oneida. The villages of Oneida and Sheppton lie on opposite sides of the South Green Mountain Coal Basin. The final tunnel, Audenried, drains the western portion of Jeansville Coal Basin that lies mainly to the east of the Catawissa Creek Watershed, between Hazleton and McAdoo, Pennsylvania. The Oneida #1 tunnel discharges into Sugarloaf Creek between the Lake Susquehanna and Lake Choctaw impoundments. The Catawissa Creek Restoration Association and their partners completed a treatment system on this discharge in July 2001. The Oneida #3 tunnel discharges into Tomhickon Creek after the confluence of Little Tomhickon Creek. The Catawissa, Audenried, and Green Mountain tunnels discharge into the Catawissa Creek in rapid succession.

Little Tomhickon Creek is also a source of AMD to Tomhickon Creek. The headwaters of Little Tomhickon Creek begin in the strip mined area of the South Green Mountain Coal Basin. Little Tomhickon Creek enters Tomhickon Creek upstream of the Oneida #3 tunnel discharge. The Pennsylvania Fish and Boat Commission (PFBC) examined the Catawissa Creek Watershed during the summer of 1997 and found that Little Tomhickon Creek is severely impacted by AMD. The PFBC study found no fish species and very acidic water chemistry values (Wnuk 1998).

The headwaters of Catawissa Creek also have been affected by the mining operations in the Jeansville Coal Basin. Deep mining, and the subsequent collapse of the underground workings, and extensive strip mining have destroyed the natural drainage patterns in the Jeansville Coal Basin (Gannett Fleming 1974). Catawissa Creek and its tributary Hunkydory Creek both lose their entire surface flow into the deep mines. Their flows infiltrate through the broken strata or strip pits and are then conveyed as AMD by the Audenried drainage tunnel into the Catawissa Creek. An unnamed tributary to Catawissa Creek has also had its flow altered by the mining operations. The tributary began north of Beaver Brook before the mining operations altered its flow. The tributary now reemerges at a strip pond just east of Interstate 81 and is piped into a series of ponds on the western side of Interstate 81. These ponds are all interconnected and flow into Catawissa Creek below the Mount Pleasant Reservoirs. The owner of the ponds states that there are abundant fish living in the ponds and one of them is a registered backup water supply for the Hazelton Water Company (Bonner 2002).

CLEAN WATER ACT REQUIREMENTS

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

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

- States to develop lists of impaired waters for which current pollution controls are not stringent enough to meet water quality standards (the list is used to determine which streams need TMDLs);
- States to establish priority rankings for waters on the lists based on severity of pollution and the designated use of the waterbody; states must also identify those waters for which TMDLs will be developed and a schedule for development;
- States to submit the list of waters to USEPA every two years (April 1 of the even numbered years);
- States to develop TMDLs, specifying a pollutant budget that meets state water quality standards and allocate pollutant loads among pollution sources in a watershed, e.g., point and nonpoint sources; and
- USEPA to approve or disapprove state lists and TMDLs within 30 days of final submission.

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

In the cases that have been settled to date, the consent agreements require USEPA to backstop TMDL development, track TMDL development, review state monitoring programs, and fund studies on issues of concern (e.g., AMD, implementation of nonpoint source Best Management Practices (BMPs), etc.). These TMDLs were developed in partial fulfillment of the 1996 lawsuit settlement of *American Littoral Society and Public Interest Group of 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 303(d) lists.

Prior to 1998, data used to list streams were in a variety of formats, collected under differing protocols. Information also was gathered through the Section 305(b)[2] reporting process. Pa. DEP is now using the Unassessed Waters Protocol (UWP), a modification of the USEPA Rapid Bioassessment Protocol II (RPB-II), as the primary mechanism to assess Pennsylvania's waters. The UWP provides a more consistent approach to assessing Pennsylvania's streams.

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

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

BASIC STEPS FOR DETERMINING A TMDL

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

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

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

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

WATERSHED BACKGROUND

The Catawissa Creek Watershed lies within the Appalachian Mountain Section of the Ridge and Valley Province. There is a vertical drop in the watershed of 1,548 feet from its headwaters to its mouth. The topography of the headwaters is characteristic of the northern sandstone ridge and anthracite regions. These areas have sharp ridges and narrow valleys. The rest of the watershed downstream from Mainville is characterized by rolling valleys and isolated hills. Soils throughout the Catawissa Creek Watershed are usually well drained and acidic (Wnuk 1998). The surficial geology is mainly interbedded sedimentary (93 percent) with a small amount of sandstone (7 percent).

Coal mining was the primary industry in the eastern portion of the watershed from the mid-1800s to the early 1970s. Large tracts of land in the eastern portion of the watershed are unreclaimed strip pits and subsidence areas from the abandoned underground mine workings. Forested land now makes up 78.4 percent of the watershed. Agriculture makes up 17.4 percent of the land use. Disturbed land (abandoned coal mines, quarries, etc.) make up approximately two percent of the watershed. The watershed is thinly populated, with only one percent developed lands.

Catawissa Creek, from its source to Rattling Run, is classified as cold-water fishes (CWF) by the PA Code, Title 25 Chapter 93 Water Quality Standards. It is classified as trout stocked fishery (TSF) from Rattling Run to its mouth. The unnamed tributaries are all classified as CWF. Some of the named tributaries to Catawissa Creek are designated HQ-CWF, such as Messers Run, Davis Run, Dark Run, and Little Catawissa Creek. The PFBC has surveyed the mainstem of Catawissa Creek three times. In 1957, the first survey concluded that Catawissa Creek has excellent physical characteristics and water temperatures for trout management but that AMD had made the stream devoid of aquatic life. Chemical surveys of the stream in 1966 and 1976 found that it was still severely degraded by AMD. In the summer of 1997, the PFBC studied the Catawissa Creek Watershed to assess the level of management the streams in the watershed needed and their potential as fisheries, since they had never been documented. The study found substantial wild trout populations in the streams where water quality had not been severely impacted by AMD. The PFBC states that Catawissa Creek would have a tremendous potential for coldwater management if AMD pollution can be remedied (Wnuk 1998).

Mining in the Eastern Middle Anthracite fields where the Jeansville and Green Mountain Coal Basins lie began in the mid-1800s. To alleviate groundwater pumping problems in the deep mines, the drainage tunnels were driven through the enclosing ridges of the coal fields. The tunnels were completed in the early 1930s. Mining was the major industry in the eastern portion of the Catawissa Creek Watershed until the early 1970s. Major deep mining was then discontinued because of dwindling coal reserves, reduced markets, and rising production costs. Strip mining continued after 1970, and additional coal is being reclaimed from the refuse banks in the basin. There are five current mining permits in the Catawissa Creek Watershed (Table 2).

Table 2. Mining Permits in the Catawissa Creek Watershed

Permit No.	NPDES No.	Effective Dates	Company Name	Status
13743002R2	none	1986- 2001	Pagnotti Coal Company: Spring Mt Colliery	Stage 2 Bond Release
40850201R3	none	1985-2005	Beaver Brook Coal Company: Beaver Brook	Active
54980201	PA023930	1998-2003	A/C Fuels Company: Audenried Mine	Active
54840103R2	none	1985-2000	Shepco Coal Company: Oneida Mine	Complete
54960201-01	none		Northeastern Power Company: Honeybrook	Active

Gannett Fleming, Coddry, and Carpenter, Inc. (1974) completed a report entitled "Mine Drainage Abatement Measures for the Jeansville Basin" under the Pa. Department of Environmental Resources Scarlift program. The study looked at the possible interconnections of the mining complexes in the Jeansville Basin that contribute water to the Audenried tunnel and the possibility of plugging the tunnel to stop the discharge and inundate the mine workings. Gannett Fleming concluded that all of the mine workings in the western portion of the Jeansville Basin are connected and drain to the Audenried tunnel, as well as water lost from the surface. They also decided that no conclusion could be made about sealing the tunnel. Reports from the construction of Audenried indicate a large fracture that might cause a seal to leak and poor rock conditions in the portions of the tunnel studied did not allow for a suitable site.

In 1982, GEO-Technical Services conducted a study for the PA. Department of Environmental Resources and published a report entitled "Design Criteria and a Conceptual Plan for the Abatement of AMD Discharges from Five Water Level Tunnels." The study was undertaken to investigate the AMD in the Catawissa Creek Watershed and to develop design criteria and a conceptual plan for abating the tunnel discharges. The findings indicate that Audenried tunnel contributes up to 80 percent of the acid load to Catawissa Creek. GEO-Technical Services recommended neutralizing the discharges with limestone beds and revolving drums. The drums are essentially water wheels partially filled with limestone. The acid in the water is neutralized by the discharges flow driving the wheel and grinding the limestone. The limestone fines then mix into the water, neutralizing it. The limestone beds force the water through aggregate limestone in order to neutralize the acid (GEO 1982).

The Catawissa Creek Restoration Association (CCRA) has been active in the watershed since 1998. The group has done several projects to improve the water quality in the Catawissa Creek and its tributaries, as well as monitoring water quality in Catawissa, Tomhickon, and Sugarloaf Creeks since their formation. For two years the group added limestone sand to Catawissa Creek to try to reduce the acidity and raise the alkalinity, but the sand had little effect and hauling fees became too expensive. In July 2001, the Oneida #1 treatment system came online through the efforts of the CCRA and its partners. The treatment system has effectively neutralized the AMD pollution entering Sugarloaf Creek. The water flows through an oxic limestone drain that neutralizes the acidity and raises the pH and alkalinity of the water. The CCRA thinks that a similar treatment system would work at the Green Mountain tunnel. CCRA also has been working on building a passive treatment system for the Oneida #3 tunnel. The design and planning stage of the treatment system is being funded with USEPA 319 funds. CCRA also is planning a test project on the Audenried tunnel. With the help of a Technical Assistance Grant

(TAG) from Hedin Environmental and the NRCS, CCRA hopes to build a treatment system out of storage tanks filled with limestone to neutralize the acid (Wyotovich 2002).

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 percent of the time. The iron TMDLs are expressed as total recoverable as the iron data used for this analysis was reported as total recoverable. Table 2 shows the water quality criteria for the selected parameters.

Table 3. Applicable Water Quality Criteria

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

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

TMDL ELEMENTS (WLA, LA, MOS)

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

TMDL ALLOCATIONS SUMMARY

Analyses of data for metals for the points below indicated that there was no single critical flow condition for pollutant sources. A few of the points show a correlation between source flows and concentrations; however, the Pa. TMDL program has shown repeatedly that there is no significant correlation between source flows and pollutant concentrations (Table 4). The other points in this TMDL did not have enough paired flow/parameter data to calculate correlations (fewer than 10 paired observations).

Table 4. Correlation Between Metals and Flow for Selected Points

Point Identification	Flow vs.			Number of Samples
	Iron	Manganese	Aluminum	
C Tunnel	0.251	0.299	0.152	26, 26, 25
A Tunnel	0.072	0.557	0.436	28
GM Tunnel	0.008	0.48	0.046	29
CC6	0	0.606	0.585	19
O3 Tunnel	0.009	0.036	0.06	32

Methodology for dealing with metal and pH impairments is discussed in Attachment C. An example calculation from the Swatara Creek TMDL, including detailed tabular summaries of the Monte Carlo results, is presented for the Lorberry Creek TMDL in Attachment D. Information for the TMDL analysis using the methodology described above is contained in the TMDLs by segment section in Attachment E.

This TMDL will focus remediation efforts on the identified numerical reduction targets for each watershed. As changes occur in the watershed, the TMDL may be reevaluated to reflect current conditions. Table 5 presents the estimated reductions identified for all points in the watershed. Attachment E gives detailed TMDLs by segment analysis for each allocation point.

Table 5. Summary Table–Catawissa Creek Watershed

Station	Parameter	Measured Sample Data		Allowable		Reduction Identified
		Conc. (mg/l)	Load (lb/day)	LTA Conc. (mg/l)	Load (lb/day)	Percent
CC1	Fe	0.34	-	0.34	-	0
	Mn	1.74	-	0.001	-	99.9
	Al	3.20	-	0.38	-	88
	Acidity	34.50	-	0.03	-	99.9
	Alkalinity	0.17	-			
C Tunnel	Fe	1.01	6.9	0.58	4.0	43
	Mn	0.31	2.1	0.31	2.1	0
	Al	1.27	8.7	0.39	2.7	69
	Acidity	18.44	126.1	1.84	12.6	90
	Alkalinity	4.11	28.1			

Station	Parameter	Measured Sample Data		Allowable		Reduction Identified
		Conc. (mg/l)	Load (lb/day)	LTA Conc. (mg/l)	Load (lb/day)	Percent
A Tunnel	Fe	0.70	71.3	0.56	57.1	21
	Mn	2.28	232.4	0.61	62.2	73
	Al	7.93	808.2	0.40	40.8	95
	Acidity	68.08	6938.4	0.68	69.3	99
	Alkalinity	2.31	235.4			
GM Tunnel	Fe	0.44	5.3	0.23	2.8	49
	Mn	0.64	7.7	0.62	7.4	3
	Al	2.97	35.7	0.33	4.0	89
	Acidity	28.06	337.0	2.25	27.0	92
	Alkalinity	3.29	39.5			
CC6	Fe	0.25	46.8	0.25	46.8	0*
	Mn	1.05	196.5	0.40	74.9	0*
	Al	3.62	677.5	0.29	54.3	0*
	Acidity	33.26	6224.6	0.10	18.7	0*
	Alkalinity	0.41	76.7			
CC7	Fe	0.22	46.7	0.22	46.7	0*
	Mn	0.93	197.4	0.34	72.2	0*
	Al	3.28	696.2	0.23	48.8	0*
	Acidity	28.58	6066.2	0.60	127.4	0*
	Alkalinity	1.24	263.2			
CC8	Fe	1.51	507.9	0.09	30.3	94*
	Mn	0.85	285.9	0.12	40.4	65*
	Al	1.97	662.6	0.18	60.5	0*
	Acidity	16.77	5640.6	0.34	114.4	0*
	Alkalinity	2.78	935.1			
TC5	Fe	0.50	4.8	0.40	3.9	21
	Mn	0.08	0.8	0.08	0.8	0
	Al	0.69	6.7	0.07	0.7	90
	Acidity	0.83	8.0	0.82	7.9	0
	Alkalinity	23.37	226.1			
O3 Tunnel	Fe	0.18	5.7	0.18	5.7	0
	Mn	0.59	18.8	0.12	3.8	79
	Al	1.59	50.7	0.46	14.7	71
	Acidity	17.35	552.8	1.91	60.9	89
	Alkalinity	7.40	235.8			
TC1	Fe	0.15	19.3	0.15	19.3	0*
	Mn	0.17	21.8	0.17	21.8	0*
	Al	0.42	53.9	0.30	38.5	0*
	Acidity	10.92	1401.6	1.31	168.1	82*
	Alkalinity	6.04	775.2			

Station	Parameter	Measured Sample Data		Allowable		Reduction Identified
		Conc. (mg/l)	Load (lb/day)	LTA Conc. (mg/l)	Load (lb/day)	Percent
CC9	Fe	0.10	48.8	0.10	48.8	0*
	Mn	0.53	258.7	0.40	195.2	0*
	Al	1.30	634.5	0.27	131.8	0*
	Acidity	23.88	11654.8	0.24	117.1	96*
	Alkalinity	2.16	1054.2			
CC10	Fe	0.11	82.2	0.11	82.2	0
	Mn	0.33	246.6	0.33	246.6	0
	Al	0.85	635.2	-	-	-
	Acidity	12.80	9,565.0	-	-	-
	Alkalinity	18.16	13,570.3			

*The percent reduction for CC6, CC7, CC8, TC1, CC9 are found in Attachment E Tables: E7, E10, E13, E18, E21

RECOMMENDATIONS

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

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

The CCRA was formed in 1998. Since that time, CCRA has been very active planning and completing projects to restore the water quality in Catawissa Creek. The CCRA monitors pH, acidity, and alkalinity at 11 sites in the Catawissa Creek Watershed on a monthly basis. The group also has completed a passive treatment system on the Oneida #1 tunnel in July of 2001. Designs and plans for a passive treatment system for the Oneida #3 tunnel are in their final stages. The CCRA applied for a Growing Greener grant to construct the system in February 2003. If the project is funded the treatment system could be online by 2005. The CCRA also has preliminary plans to treat the Green Mountain tunnel and they have been working with Hedin Environmental to design a test project on the Audenried tunnel. If the Audenried tunnel were treated, an estimated 80 percent of the AMD in Catawissa Creek could be eliminated.

Pa. DEP BAMR have completed at least two restorations of abandoned mine land in the Catawissa Creek Watershed and have been taking water quality samples at 12 sites in the watershed since 1996. It is recommended that these actions continue to encourage the further improvement of water quality in Catawissa Creek. Furthermore, land reclamation and the restoration of stream channels for Hunkydory Creek and two unnamed tributaries to Catawissa Creek, in the Jeansville Coal Basin, would help reduce the flow in the Audenried tunnel. Land reclamation in the Green Mountain Coal Basin would help reduce the flow to the Oneida #1 and #3 tunnels as well, particularly in the headwaters of Tomhickon Creek that reportedly lose waters to the deep mine voids.

PUBLIC PARTICIPATION

Public notice of the draft TMDL was published in the *Pennsylvania Bulletin* on December 7, 2002, and the Hazelton Standard-Speaker on December 15, 2002, to foster public comment on the allowable loads calculated. A public meeting was held on December 18, 2002, at the Catawissa Creek Restoration Association's bi-monthly meeting in the Beaver Township Fire Company, Columbia County, to discuss the proposed TMDL.

REFERENCES

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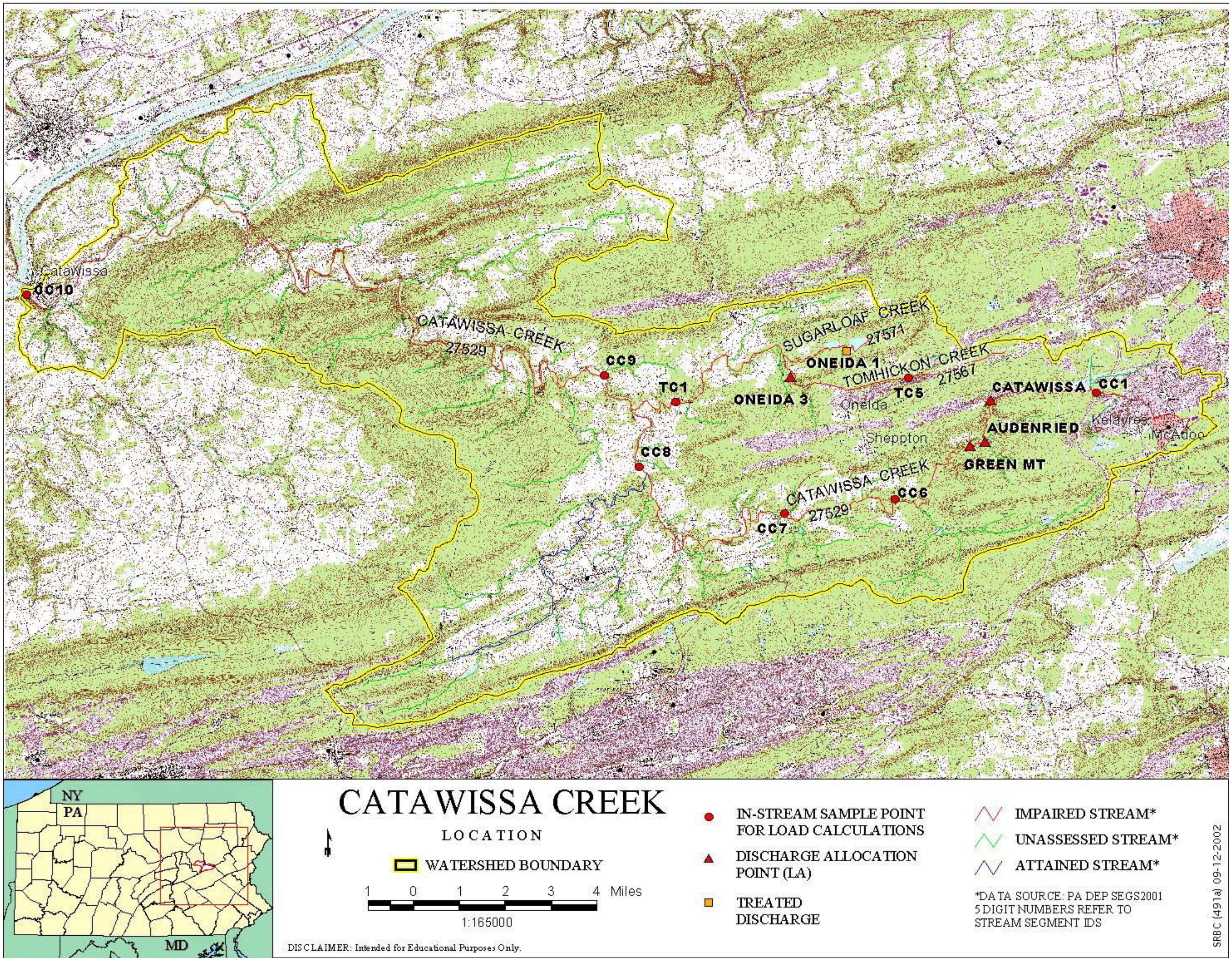
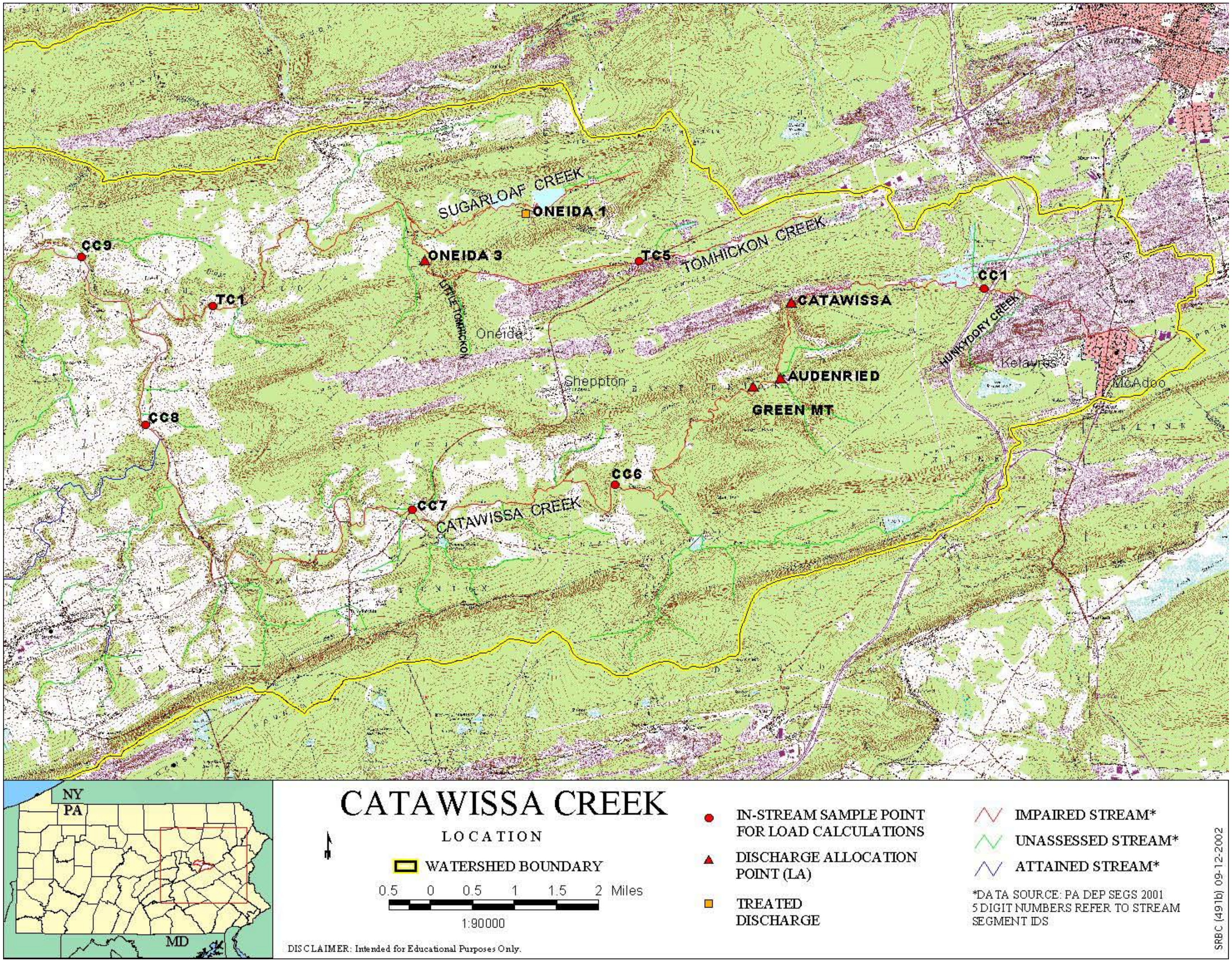
Attachment A

Catawissa Creek Watershed Maps


Catawissa
CC10
CATAWISSA CREEK
27529
CC9
TC1
CC8
SUGARLOAF CREEK
27571
ONEIDA 1
ONEIDA 3
TOMHICKON CREEK
27567
TC5
Oneida
Sheppton
CATAWISSA
CC1
AUDENRIED
Kelayres
McAdoo
GREEN MT
CATAWISSA CREEK
27529
CC6
CC7
NY
PA
MD
CATAWISSA CREEK
LOCATION
WATERSHED BOUNDARY
1 0 1 2 3 4 Miles
1:165000
IN-STREAM SAMPLE POINT FOR LOAD CALCULATIONS
DISCHARGE ALLOCATION POINT (LA)
TREATED DISCHARGE
IMPAIRED STREAM*
UNASSESSED STREAM*
ATTAINED STREAM*
*DATA SOURCE: PA DEP SEGS2001
5 DIGIT NUMBERS REFER TO STREAM SEGMENT IDS
SRBC (491a) 09-12-2002
DISCLAIMER: Intended for Educational Purposes Only.


SUGARLOAF CREEK
ONEIDA 1
CC9
ONEIDA 3
TC5
TOMHICKON CREEK
CC1
TC1
CATAWISSA
LITTLE TOMHICKON
Oneida
HUNKYDORY CREEK
Kelayres
Sheppton
AUDENRIED
McAdoo
GREEN MT
CC8
CC6
CC7
CATAWISSA CREEK
NY
PA
MD
CATAWISSA CREEK
LOCATION
WATERSHED BOUNDARY
0.5 0 0.5 1 1.5 2 Miles
1:90000
IN-STREAM SAMPLE POINT FOR LOAD CALCULATIONS
DISCHARGE ALLOCATION POINT (LA)
TREATED DISCHARGE
IMPAIRED STREAM*
UNASSESSED STREAM*
ATTAINED STREAM*
*DATA SOURCE: PA DEP SEGS 2001
5 DIGIT NUMBERS REFER TO STREAM SEGMENT IDS
DISCLAIMER: Intended for Educational Purposes Only.
SRBC (491b) 09-12-2002

Attachment B

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

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

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

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

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

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

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

Attachment C

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

LTA = Mean * (1 – PR99)   where   (2)
LTA = allowable LTA source concentration in mg/l

---

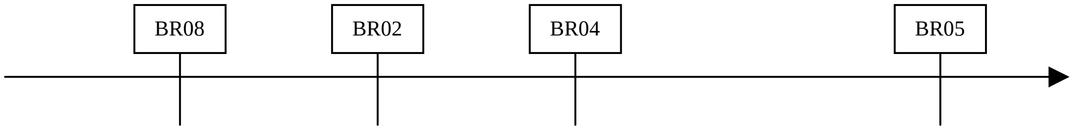
[3] @Risk – Risk Analysis and Simulation Add-in for Microsoft Excel, Palisade Corporation, Newfield, NY, 1990-1997.

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.

Accounting for Upstream Reductions in AMD TMDLs

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



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

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

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

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

Table B. Necessary Reductions at Beaver Run BR02

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

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

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

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

Table D. Necessary Reductions at Beaver Run BR04

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

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

Table F. Necessary Reductions at Beaver Run BR05

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

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

Method for Addressing 303(d) Listings for pH

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

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

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

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

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

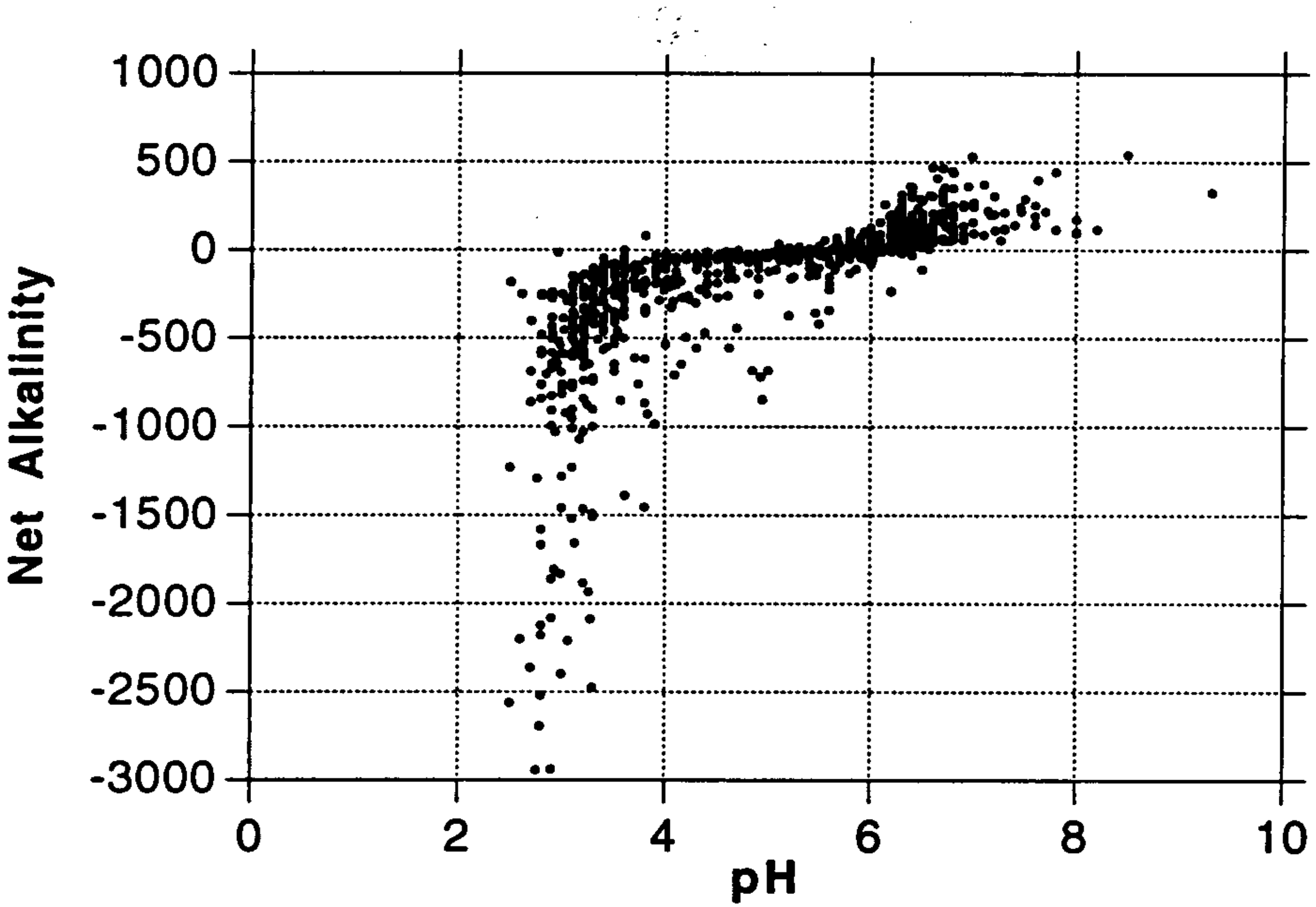


Figure 1. Net Alkalinity vs. pH. Taken from Figure 1.2 Graph C, pages 1-5, of Coal Mine Drainage Prediction and Pollution Prevention in Pennsylvania.

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 non-point 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 non-point 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 D

Example Calculation: Lorberry Creek

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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).

$$Q_{swat11} = Q_{swat04} \text{ x } 0.142 + 0.088 \tag{2}$$

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

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

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

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

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

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

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

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

Table 8. L-1 Adjusted BAT Concentrations

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

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

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

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

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

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

Table 9. Verification of Meeting Water Quality Standards Below Point L-1

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

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

Table 10. Lorberry Creek Summary

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

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

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

Margin of Safety

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

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

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

Attachment E

TMDLs By Segment

Catawissa Creek Above CC1

The headwaters of Catawissa Creek began outside of McAdoo, Pennsylvania. Outside of Kelayres, Pennsylvania, an unnamed tributary to Catawissa Creek and Hunkydory Creek joined with Catawissa Creek and it proceeded to flow west. Anthracite mining in the Jeansville Coal Basin severely disturbed the land surface and underground structure. The surface waters in this portion of the watershed now seep into the deep mine pools through abandoned strip pits or fractures in the strata caused by the deep mines subsiding. Catawissa Creek no longer flows in this area. In fact, the streambed has almost been completely destroyed. Likewise, Hunkydory Creek and the unnamed tributary to Catawissa Creek lose all of their flow in the abandoned mine lands outside of Kelayres. It is believed that most of this flow later joins Catawissa Creek through the Audenried drainage tunnel (Gannett Fleming 1974).

The point CC1 is located where Catawissa Creek reemerges in an iron stained pool on the west side of Interstate 81. Flow measurements were not available for CC1; therefore loading values could not be calculated at this point. The concentrations of metals and acidity indicate that the stream is not meeting water quality standards at this station.

An allowable long-term average instream concentration was determined at point CC1 for iron, manganese, aluminum, and acidity. The analysis is designed to produce a long-term average value that, when met, will be protective of the water quality criterion for that parameter 99 percent of the time. An analysis was performed using Monte Carlo simulation to determine the necessary long-term average concentration needed to attain water quality criteria 99 percent of the time. The simulation was run assuming the data set was lognormally distributed. Using the mean and the standard deviation of the data set, 5,000 iterations of sampling were completed and compared against the water quality criterion for that parameter. For each sampling event a percent reduction was calculated, if necessary, to meet water quality criteria. A second simulation that multiplied the percent reduction times the sampled value was run to insure that criteria were met 99 percent of the time. The mean value from this data set represents that long-term daily average concentration that needs to be met to achieve water quality standards. The concentrations of metals and acidity at point CC1 for this stream segment are presented in Table E1.

Table E1. Water Quality Data for Catawissa Creek at CC1

Station CC1	***Measured Sample Data***	***Allowable***
	Conc. (mg/l)	***LTA Conc. (mg/l)***
Fe	0.34	0.34
Mn	1.74	0.001
Al	3.20	0.38
Acidity	34.50	0.03
Alkalinity	0.17	-

Catawissa Tunnel

The Catawissa drainage tunnel was driven approximately 840 feet northward from the Catawissa Creek valley into the deep coal mines of the adjacent South Green Mountain Coal Basin to dewater the mines by gravity. The drainage tunnels were completed in the early 1930s. The Catawissa tunnel is the most upstream tunnel to discharge into the Catawissa Creek. It lies approximately one mile upstream of the Audenried tunnel.

The TMDL for this discharge consists of a load allocation to Catawissa Tunnel. Addressing the mining impacts at this discharge addresses the impairments. An average flow measurement was calculated from available flow data for point Catawissa Tunnel (0.82 mgd).

There is currently no entry for this discharge on the Pennsylvania Section 303(d) list for impairment due to pH. Sample data for point Catawissa Tunnel shows pH ranging between 3.8 and 4.5, with an average pH of 4.17; therefore, pH will be addressed in this TMDL. The objective is to reduce acid loading to the stream, which will in turn raise the pH to the desired range and keep a net alkalinity above zero 99 percent of the time. The result of this analysis is an acid loading reduction that equates to meeting standards for pH (see Table 3). The method and rationale for addressing pH is contained in Attachment C.

An allowable long-term average instream concentration was determined at point Catawissa Tunnel for iron, manganese, aluminum, and acidity. The analysis is designed to produce a long-term average value that, when met, will be protective of the water quality criterion for that parameter 99 percent of the time. An analysis was performed using Monte Carlo simulation to determine the necessary long-term average concentration needed to attain water quality criteria 99 percent of the time. The simulation was run assuming the data set was lognormally distributed. Using the mean and the standard deviation of the data set, 5,000 iterations of sampling were completed and compared against the water quality criterion for that parameter. For each sampling event a percent reduction was calculated, if necessary, to meet water quality criteria. A second simulation that multiplied the percent reduction times the sampled value was run to insure that criteria were met 99 percent of the time. The mean value from this data set represents that long-term daily average concentration that needs to be met to achieve water quality standards. The load allocations made at point Catawissa Tunnel for this discharge are presented in Table E2.

Table E2. Reductions for the Catawissa Drainage Tunnel

Station Catawissa Tunnel	***Measured Sample Data***		***Allowable***		***Reduction Identified***
	Conc. (mg/l)	***Load (lb/day)***	***LTA Conc. (mg/l)***	***Load (lb/day)***	***Percent***
Fe	1.01	6.9	0.58	4.0	43
Mn	0.31	2.1	0.31	2.1	0
Al	1.27	8.7	0.39	2.7	69
Acidity	18.44	126.1	1.84	12.6	90
Alkalinity	4.11	28.1			

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

The TMDL for the Catawissa tunnel requires that a load allocation be made for total iron, total aluminum, and acidity. A load allocation does not need to be made for total manganese.

Audenried Tunnel

The Audenried drainage tunnel is the largest of the AMD discharges into Catawissa Creek. The tunnel was driven from the Audenried Mine, in the Jeansville Coal Basin, in a westerly direction for approximately 16,150 feet to the Catawissa Creek Watershed. The Audenried tunnel drains the western portion of the Jeansville Coal Basin that lies between Hazleton and McAdoo, Pennsylvania. Previous studies have shown that the Audenried tunnel contributes up to 84 percent of the acid load to Catawissa Creek (GEO 1982).

The TMDL for the Audenried drainage tunnel consists of a load allocation to point Audenried Tunnel. Addressing the mining impacts at this point addresses the impairment for the discharge. An average flow measurement was calculated from available flow data for point Audenried Tunnel (12.22 mgd).

There is currently no entry for this discharge on the Pennsylvania Section 303(d) list for impairment due to pH. Sample data for point Audenried Tunnel shows pH ranging between 3.8 and 4.1, with an average pH of 4.03; therefore, pH will be addressed in this TMDL. The objective is to reduce acid loading to the stream, which will in turn raise the pH to the desired range and keep a net alkalinity above zero 99 percent of the time. The result of this analysis is an acid loading reduction that equates to meeting standards for pH (see Table 3). The method and rationale for addressing pH is contained in Attachment C.

An allowable long-term average instream concentration for iron, manganese, aluminum, and acidity was determined at point Audenried Tunnel. The analysis is designed to produce a long-term average value that, when met, will be protective of the water quality criterion for that parameter 99 percent of the time. An analysis was performed using Monte Carlo simulation to determine the necessary long-term average concentration needed to attain water quality criteria 99 percent of the time. The simulation was run assuming the data set was lognormally distributed. Using the mean and the standard deviation of the data set, 5,000 iterations of sampling were completed and compared against the water quality criterion for that parameter. For each sampling event a percent reduction was calculated, if necessary, to meet water quality criteria. A second simulation that multiplied that percent reduction times that sampled value was run to insure that criteria were met 99 percent of the time. The mean value from this data set represents that long-term daily average concentration that needs to be met to achieve water quality standards. The load allocations made at point Audenried Tunnel for this discharge are presented in Table E3.

Table E3. Reductions for the Audenried Drainage Tunnel

Station Audenried Tunnel	***Measured Sample Data***		***Allowable***		***Reduction Identified***
	Conc. (mg/l)	***Load (lb/day)***	***LTA Conc. (mg/l)***	***Load (lb/day)***	***Percent***
Fe	0.70	71.3	0.56	57.1	21
Mn	2.28	232.4	0.61	62.2	73
Al	7.93	808.2	0.40	40.8	95
Acidity	68.08	6,938.4	0.68	69.3	99
Alkalinity	2.31	235.4			

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

The TMDL for the Audenried tunnel requires a load allocation for total iron, total manganese, total aluminum, and acidity.

Green Mountain Tunnel

The Green Mountain drainage tunnel is the last discharge on the mainstem of Catawissa Creek. The tunnel was driven approximately 4,100 feet to the north to intercept a low point in order to dewater the deep mines of the eastern portion of the South Green Mountain Coal Basin. The drainage tunnels were completed in the early 1930s.

The TMDL for the Green Mountain tunnel consists of a load allocation to point Green Mountain Tunnel. Addressing the mining impacts at this point addresses the impairment for the discharge. An average flow measurement was calculated from available flow data for point Green Mountain Tunnel (1.44 mgd).

There is currently no entry for this discharge on the Pennsylvania Section 303(d) list for impairment due to pH. Sample data for point Green Mountain Tunnel shows pH ranging between 3.6 and 4.2, with an average pH of 4.05; therefore, pH will be addressed in this TMDL. The objective is to reduce acid loading to the stream, which will in turn raise the pH to the desired range and keep a net alkalinity above zero 99 percent of the time. The result of this analysis is an acid loading reduction that equates to meeting standards for pH (see Table 3). The method and rationale for addressing pH is contained in Attachment C.

An allowable long-term average instream concentration was determined at point Green Mountain Tunnel for iron, manganese, aluminum, and acidity. The analysis is designed to produce a long-term average value that, when met, will be protective of the water quality criterion for that parameter 99 percent of the time. An analysis was performed using Monte Carlo simulation to determine the necessary long-term average concentration needed to attain water quality criteria 99 percent of the time. The simulation was run assuming the data set was lognormally distributed. Using the mean and the standard deviation of the data set, 5,000 iterations of sampling were completed and compared against the water quality criterion for that parameter. For each sampling event a percent reduction was calculated, if necessary, to meet water quality criteria. A second simulation that multiplied the percent reduction times the sampled value was run to insure that criteria were met 99 percent of the time. The mean value from this data set represents that long-term daily average concentration that needs to be met to achieve water quality standards. The load allocations made at Green Mountain Tunnel for this discharge are presented in Table E4.

Table E4. Reductions for the Green Mountain Drainage Tunnel

Station Green Mountain Tunnel	***Measured Sample Data***		***Allowable***		***Reduction Identified***
	Conc. (mg/l)	***Load (lb/day)***	***LTA Conc. (mg/l)***	***Load (lb/day)***	***Percent***
Fe	0.44	5.3	0.23	2.8	49
Mn	0.64	7.7	0.62	7.4	3
Al	2.97	35.7	0.33	4.0	89
Acidity	28.06	337.0	2.25	27.0	92
Alkalinity	3.29	39.5			

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

The TMDL for the Green Mountain tunnel requires that a load allocation be made for total iron, total manganese, total aluminum, and acidity.

Catawissa Creek at Point CC6

Catawissa Creek at point CC6 represents the stream after the three tunnel discharges to the mainstem have entered and after the confluence of Messers Run, a HQ-CWF stream.

The TMDL for this section of Catawissa Creek consists of a load allocation to the watershed area between CC6 and CC1. Addressing the mining impacts between these points addresses the impairment for the stream segment. An average instream flow measurement was calculated from available flow data for point CC6 (22.44 mgd).

There is currently no entry for this segment on the Pennsylvania Section 303(d) list for impairment due to pH. Sample data for point CC6 shows pH ranging between 4.1 and 6.2, with an average pH of 4.45; therefore, pH will be addressed in this TMDL. The objective is to reduce acid loading to the stream, which will in turn raise the pH to the desired range and keep a net alkalinity above zero 99 percent of the time. The result of this analysis is an acid loading reduction that equates to meeting standards for pH (see Table 3). The method and rationale for addressing pH is contained in Attachment C.

An allowable long-term average instream concentration for iron, manganese, aluminum, and acidity was determined at CC6. The analysis is designed to produce a long-term average value that, when met, will be protective of the water quality criterion for that parameter 99 percent of the time. An analysis was performed using Monte Carlo simulation to determine the necessary long-term average concentration needed to attain water quality criteria 99 percent of the time. The simulation was run assuming the data set was lognormally distributed. Using the mean and the standard deviation of the data set, 5,000 iterations of sampling were completed and compared against the water quality criterion for that parameter. For each sampling event a percent reduction was calculated, if necessary, to meet water quality criteria. A second simulation that multiplied the percent reduction times the sampled value was run to insure that criteria were met 99 percent of the time. The mean value from this data set represents that long-term daily average concentration that needs to be met to achieve water quality standards. The load allocations made at point CC6 for this stream segment are presented in Table E5.

Table E5. Long Term Average (LTA) Concentrations for Catawissa Creek at CC6				
Station CC6	***Measured Sample Data***		***Allowable***	
	Conc. (mg/l)	***Load (lb/day)***	***LTA Conc. (mg/l)***	***Load (lb/day)***
Fe	0.25	46.8	0.25	46.8
Mn	1.05	196.5	0.40	74.9
Al	3.62	677.5	0.29	54.3
Acidity	33.26	6,224.6	0.10	18.7
Alkalinity	0.41	76.7		

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

The loading reductions for the points C Tunnel, A Tunnel, and GM Tunnel were used to show the total load that was removed from upstream sources. For each parameter, the total load that was removed upstream was subtracted from the existing load at point CC6. This value was compared to the allowable load at point CC6. Reductions at point CC6 are necessary for any parameter that exceeds the allowable load at this point. A summary of all loads that affect point CC6 is shown in Table E6. Necessary reductions at point CC6 are shown in Table E7.

Table E6. Summary of Loads Affecting Point CC6				
	Iron (lb/day)	***Manganese (lb/day)***	***Aluminum (lb/day)***	***Acidity (lb/day)***
C Tunnel				
Load Reduction	2.9	0	6.0	113.5
A Tunnel				
Load Reduction	14.2	170.2	767.4	6,869.1
GM Tunnel				
Load Reduction	2.5	0.3	31.7	310.0

Table E7. Reductions Necessary at Point CC6				
	Iron (lb/day)	***Manganese (lb/day)***	***Aluminum (lb/day)***	***Acidity (lb/day)***
Existing Loads at CC6	46.8	196.5	677.5	6,224.6
Total Load Reduction (Sum of C, A, and GM Tunnels)	19.6	170.5	805.1	7,292.6
Remaining Load	27.2	26.0	0	0
Allowable Loads at CC6	46.8	74.9	54.3	18.7
Percent Reduction	0	0	0	0
Load Reduction	0	0	0	0

The TMDL for point CC6 does not require a load allocation for total iron, total manganese, total aluminum, and acidity. All necessary reductions have been made upstream of this point.

Catawissa Creek Between Points CC6 and CC7

Catawissa Creek at point CC7 represents the stream after the confluence of Davis Run, a HQ-CWF stream.

The TMDL for Catawissa Creek at point CC7 consists of a load allocation to the watershed area between points CC6 and CC7. Addressing the mining impacts between these point addresses the impairment for the segment. An instream flow measurement was not available for point CC7; the flow was calculated by the unit area method (25.45 mgd).

The watershed area contributing[4] to the stream flow above point CC7 is 60,333,853.56 square meters. The known flow point at CC6 had an average flow of 15,575.03 GPM. The average flows from the tunnel discharges were subtracted from the flow at CC6 to yield an average flow, based on the contributing land area, of 5,522.70 GPM. The contributing watershed area for CC6 is 43,801,375.93 square meters. The flow at CC7 is calculated by cross multiplication as 7,607.20 GPM. Addition of the average flow from the tunnel discharges yields 17,659.53 GPM, which converts to 25.45 mgd.

There is currently no entry for this segment on the Pennsylvania Section 303(d) list for impairment due to pH. Sample data for point CC7 shows pH ranging between 4.5 and 4.9, with an average pH of 4.64; therefore, pH will be addressed in this TMDL. The objective is to reduce acid loading to the stream, which will in turn raise the pH to the desired range and keep a net alkalinity above zero 99 percent of the time. The result of this analysis is an acid loading reduction that equates to meeting standards for pH (see Table 3). The method and rationale for addressing pH is contained in Attachment C.

An allowable long-term average instream concentration for iron, manganese, aluminum, and acidity was determined at point CC7. The analysis is designed to produce a long-term average value that, when met, will be protective of the water quality criterion for that parameter 99 percent of the time. An analysis was performed using Monte Carlo simulation to determine the necessary long-term average concentration needed to attain water quality criteria 99 percent of the time. The simulation was run assuming the data set was lognormally distributed. Using the mean and the standard deviation of the data set, 5,000 iterations of sampling were completed and compared against the water quality criterion for that parameter. For each sampling event a percent reduction was calculated, if necessary, to meet water quality criteria. A second simulation that multiplied the percent reduction times the sampled value was run to insure that criteria were met 99 percent of the time. The mean value from this data set represents that long-term daily average concentration that needs to be met to achieve water quality standards. The long-term average concentrations at point CC7 for this stream segment are presented in Table E8.

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[4] The watershed area in the Jeansville Coal Basin north of McAdoo no longer contributes direct stream flow to Catawissa Creek. Therefore, this land area was not used in the determination of flow by the unit area method.

Table E8. Long Term Average (LTA) Concentrations for Catawissa Creek at CC7				
Station CC7	***Measured Sample Data***		***Allowable***	
	Conc. (mg/l)	***Load (lb/day)***	***LTA Conc. (mg/l)***	***Load (lb/day)***
Fe	0.22	46.7	0.22	46.7
Mn	0.93	197.4	0.34	72.2
Al	3.28	696.2	0.23	48.8
Acidity	28.58	6,066.2	0.60	127.4
Alkalinity	1.24	263.2		

The loading reductions for points C Tunnel, A Tunnel, GM Tunnel, and CC6 were used to show the total load that was removed from upstream sources. For each parameter, the total load that was removed upstream was subtracted from the existing load at point CC7. This value was compared to the allowable load at point CC7. Reductions at point CC7 are necessary for any parameter that exceeds the allowable load at this point. A summary of all loads that affect point CC7 is shown in Table E9. Necessary reductions at point CC7 are shown in Table E10.

Table E9. Summary of Loads Affecting Point CC7				
	Iron (lb/day)	***Manganese (lb/day)***	***Aluminum (lb/day)***	***Acidity (lb/day)***
C Tunnel				
Load Reduction	2.9	0	6.0	113.5
A Tunnel				
Load Reduction	14.2	170.2	767.4	6,869.1
GM Tunnel				
Load Reduction	2.5	0.3	31.7	310.0
CC6				
Load Reduction	0	0	0	0

Table E10. Reductions Necessary at Point CC7				
	Iron (lb/day)	***Manganese (lb/day)***	***Aluminum (lb/day)***	***Acidity (lb/day)***
Existing Loads at CC7	46.7	197.4	696.2	6,066.2
Total Load Reduction (Sum of C, A, and GM Tunnels and CC6)	19.6	170.5	805.1	7,292.6
Remaining Load	27.1	26.9	0	0
Allowable Loads at CC7	46.7	72.2	48.8	127.4
Percent Reduction	0	0	0	0
Load Reduction	0	0	0	0

The TMDL for point CC7 does not require a load allocation for total iron, total manganese, total aluminum, and acidity. All necessary reductions have been made upstream of this point.

Catawissa Creek Between Points CC7 and CC8

Catawissa Creek at point CC8 represents Catawissa Creek after the confluence of Rattling Run, Dark Run, and Little Catawissa Creek, but before the confluence of Tomhickon Creek.

The TMDL for this section of Catawissa Creek consists of a load allocation to all of the watershed area between points CC7 and CC8. Addressing the mining impacts between these points addresses the impairment for the segment. An instream flow measurement was not available for point CC8; the average flow was derived using the unit area method (40.33 mgd).

The watershed area contributing to the stream flow above point CC8 is 142,233,219.16 square meters. The known flow point at CC6 had an average flow of 15,575.03 GPM. The average flows from the tunnel discharges were subtracted from the flow at CC6 to yield an average flow, based on the contributing land area, of 5,522.70 GPM. The contributing watershed area for CC6 is 43,801,375.93 square meters. The flow at CC8 is calculated by cross multiplication as 17,933.49 GPM. Addition of the average flow from the tunnel discharges yields 27,985.82 GPM, which converts to 40.33 mgd.

There is currently no entry for this segment on the Pennsylvania Section 303(d) list for impairment due to pH. Sample data for point CC8 shows pH ranging between 3.2 and 6.4, with an average pH of 4.96; therefore, pH will be addressed in this TMDL. The objective is to reduce acid loading to the stream, which will in turn raise the pH to the desired range and keep a net alkalinity above zero 99 percent of the time. The result of this analysis is an acid loading reduction that equates to meeting standards for pH (see Table 3). The method and rationale for addressing pH is contained in Attachment C.

An allowable long-term average instream concentration for iron, manganese, aluminum, and acidity was determined at point CC8. The analysis is designed to produce a long-term average value that, when met, will be protective of the water quality criterion for that parameter 99 percent of the time. An analysis was performed using Monte Carlo simulation to determine the necessary long-term average concentration needed to attain water quality criteria 99 percent of the time. The simulation was run assuming the data set was lognormally distributed. Using the mean and the standard deviation of the data set, 5,000 iterations of sampling were completed and compared against the water quality criterion for that parameter. For each sampling event, a percent reduction was calculated, if necessary, to meet water quality criteria. A second simulation that multiplied the percent reduction times the sampled value was run to insure that criteria were met 99 percent of the time. The mean value from this data set represents that long-term daily average concentration that needs to be met to achieve water quality standards. The long-term average concentrations at point CC8 for this stream segment are presented in Table E11.

Table E11. Long Term Average (LTA) Concentrations for Catawissa Creek CC8				
Station CC8	***Measured Sample Data***		***Allowable***	
	Conc. (mg/l)	***Load (lb/day)***	***LTA Conc. (mg/l)***	***Load (lb/day)***
Fe	1.51	507.9	0.09	30.3
Mn	0.85	285.9	0.12	40.4
Al	1.97	662.6	0.18	60.5
Acidity	16.77	5,640.6	0.34	114.4
Alkalinity	2.78	935.1		

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

The loading reductions for points C Tunnel, A Tunnel, GM Tunnel, CC6, and CC7 were used to show the total load that was removed from upstream sources. For each parameter, the total load that was removed upstream was subtracted from the existing load at point CC8. This value was compared to the allowable load at point CC8. Reductions at point CC8 are necessary for any parameter that exceeds the allowable load at this point. A summary of all loads that affect point CC8 are shown in Table E12. Necessary reductions at point CC8 are shown in Table E13.

Table E12. Summary of Loads Affecting Point CC8				
	Iron (lb/day)	***Manganese (lb/day)***	***Aluminum (lb/day)***	***Acidity (lb/day)***
C Tunnel				
Load Reduction	2.9	0	6.0	113.5
A Tunnel				
Load Reduction	14.2	170.2	767.4	6,869.1
GM Tunnel				
Load Reduction	2.5	0.3	31.7	310.0
CC6				
Load Reduction	0	0	0	0
CC7				
Load Reduction	0	0	0	0

Table E13. Reductions Necessary at Point CC8				
	Iron (lb/day)	***Manganese (lb/day)***	***Aluminum (lb/day)***	***Acidity (lb/day)***
Existing Loads at CC8	507.9	285.9	662.6	5,640.6
Total Load Reduction (Sum of C, A, and GM Tunnels, CC6, and CC7)	19.6	170.5	805.1	7,292.6
Remaining Load	488.3	115.4	0	0
Allowable Loads at CC8	30.3	40.4	60.5	114.4
Percent Reduction	94	65	0	0
Load Reduction	458.0	75.0	0	0

The TMDL for Catawissa Creek at point CC8 requires a load reduction for all areas between CC7 and CC8 for total iron and total manganese. A load reduction is not necessary for total aluminum and acidity. All necessary reductions have been made upstream from this point.

Tomhickon Creek above TC5

The headwaters of Tomhickon Creek begin north of the mainstem of Catawissa Creek and flow to the west joining Catawissa Creek below point CC8. Point TC5 represents Tomhickon Creek before the confluence of Little Tomhickon Creek, the Oneida #3 tunnel, and Sugarloaf Creek. The headwaters of Tomhickon Creek flow through a small amount of abandoned mine lands reclaimed by Pa. DEP BAMR.

The TMDL for the headwaters of Tomhickon Creek consists of a load allocation to all of the watershed area above point TC5. Addressing the mining impacts above this point addresses the impairment for the segment. An instream flow measurement was not available for point TC5; the average flow was derived using the unit area method (1.16 mgd).

The watershed area contributing to the stream flow above point TC5 is 6,582,584.41 square meters. The known flow point at TC1 had an average flow of 10,681.50 GPM. The average flows from the tunnel discharges were subtracted from the flow at TC1 to yield an average of 6,456.21 GPM. The contributing watershed area for TC1 is 52,857,476.19 square meters. The flow at TC5 is calculated by cross multiplication as 804.02 GPM, which converts to 1.16 mgd

An allowable long-term average instream concentration for iron, manganese, aluminum and acidity was determined at point TC5. The analysis is designed to produce a long-term average value that, when met, will be protective of the water quality criterion for that parameter 99 percent of the time. An analysis was performed using Monte Carlo simulation to determine the necessary long-term average concentration needed to attain water quality criteria 99 percent of the time. The simulation was run assuming the data set was lognormally distributed. Using the mean and the standard deviation of the data set, 5,000 iterations of sampling were completed and compared against the water quality criterion for that parameter. For each sampling event, a percent reduction was calculated, if necessary, to meet water quality criteria. A second simulation that multiplied the percent reduction times the sampled value was run to insure that criteria were met 99 percent of the time. The mean value from this data set represents that long-term daily average concentration that needs to be met to achieve water quality standards. The load allocations made at point TC5 for this stream segment are presented in Table E14.

Table E 14. Reductions for Tomhickon Creek at TC5

Station TC5	*Measured Sample Data*		*Allowable*		*Reduction Identified*
	Conc. (mg/l)	*Load (lb/day)*	*LTA Conc. (mg/l)*	*Load (lb/day)*	*Percent*
Fe	0.50	4.8	0.40	3.9	21
Mn	0.08	0.8	0.08	0.8	0
Al	0.69	6.7	0.07	0.7	90
Acidity	0.83	8.0	0.83	8.0	0
Alkalinity	23.37	226.1			

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

The TMDL for point TC5 requires that a load allocation be applied to all areas of Tomhickon Creek above TC5 for total iron and total aluminum. A load reduction is not necessary for total manganese and acidity at this point.

Oneida #3 Tunnel

The Oneida #3 tunnel drains potions of the mines in the South Green Mountain Coal Basin. The tunnel was driven approximately 7,000 feet north from the mine to discharge into Tomhickon Creek. The CCRA has received U.S. EPA 319 funding to begin engineering and design of a passive treatment system for this discharge.

The TMDL for the Oneida #3 tunnel consists of a load allocation to the discharge at point Oneida 3 Tunnel. Addressing the mining impacts at this point addresses the impairment for the discharge. An average flow measurement was calculated from available flow data for point Oneida 3 Tunnel (3.82 mgd).

There is currently no entry for this discharge on the Pennsylvania Section 303(d) list for impairment due to pH. Sample data for point Oneida 3 Tunnel shows pH ranging between 3.9 and 4.7, with an average pH of 4.57; therefore, pH will be addressed in this TMDL. The objective is to reduce acid loading to the stream, which will in turn raise the pH to the desired range and keep a net alkalinity above zero 99 percent of the time. The result of this analysis is an acid loading reduction that equates to meeting standards for pH (see Table 3). The method and rationale for addressing pH is contained in Attachment C.

An allowable long-term average instream concentration for iron, manganese, aluminum and acidity was determined at point Oneida 3 Tunnel. The analysis is designed to produce a long-term average value that, when met, will be protective of the water quality criterion for that parameter 99 percent of the time. An analysis was performed using Monte Carlo simulation to determine the necessary long-term average concentration needed to attain water quality criteria 99 percent of the time. The simulation was run assuming the data set was lognormally distributed. Using the mean and the standard deviation of the data set, 5,000 iterations of sampling were completed and compared against the water quality criterion for that parameter. For each sampling event, a percent reduction was calculated, if necessary, to meet water quality criteria. A second simulation that multiplied the percent reduction times the sampled value was run to insure that criteria were met 99 percent of the time. The mean value from this data set represents that long-term daily average concentration that needs to be met to achieve water quality standards. The load allocations made at point Oneida 3 Tunnel for this discharge are presented in Table E15.

Table E 15. Reductions for the Oneida #3 Discharge Tunnel

Station Oneida 3 Tunnel	***Measured Sample Data***		***Allowable***		***Reduction Identified***
	Conc. (mg/l)	***Load (lb/day)***	***LTA Conc. (mg/l)***	***Load (lb/day)***	***Percent***
Fe	0.18	5.7	0.18	5.7	0
Mn	0.59	18.8	0.12	3.8	79
Al	1.59	50.7	0.46	14.7	71
Acidity	17.35	552.8	1.91	60.9	89
Alkalinity	7.40	235.8			

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

The TMDL for the Oneida #3 tunnel requires a load reduction for total manganese, total aluminum, and acidity.

Oneida #1 Treated Tunnel

The Oneida #1 discharge tunnel drains the North Green Mountain Coal Basin. It is the only tunnel that drains the mine workings in that basin. The Oneida #1 tunnel drains into Sugarloaf Creek between the Lake Susquehanna and Lake Choctaw impoundments. The tunnel is the only addition of AMD to Sugarloaf Creek.

In July of 2001, a treatment system came online through the efforts of the CCRA and their partners, including the Schuylkill and Columbia County Conservation Districts, Natural Resource Conservation Service (NRCS), Office of Surface Mining (OSM), Eastern Pennsylvania Council on Abandoned Mine Reclamation (EPCAMR), Pa. DEP BAMR, the Eagle Rock Homeowner’s Association, and the landowners Double Diamond Development Corporation. The treatment system consists of three series of buried limestone cells where the acidity in the discharge water is neutralized and the pH and alkalinity are increased. Prior to treatment the discharge had low pH (3.6-4.2), no alkalinity, acidity (40-50 mg/1), negligible iron, and aluminum (1.4-4.9 mg/1). The discharge water requires relatively little detention time in order to successfully add the necessary alkalinity and raise the pH. The treated water now averages a pH of 6.5, alkalinity of 9-26 mg/1, and iron and acidity has been reduced to zero. The aluminum has also been reduced to two thirds of its prior levels to, on average, 0.70 mg/L. A final polishing pond and Lake Choctaw serve as oxidation/precipitation basins that remove the remaining aluminum from the water. Monitoring data from the spillway of Lake Choctaw shows very good water quality with a high pH, alkalinity, and virtually no acidity or aluminum. Final adjustments to the design and operation of the Oneida #1 treatment system are expected to improve the water quality even further and meet all the current standards.

Tomhickon Creek at Point TC1

Tomhickon Creek at point TC1 represents the stream at its mouth, after the confluence of Little Tomhickon Creek, Sugarloaf Creek, and the Oneida #3 tunnel.

The TMDL for this section of Tomhickon Creek consists of a load allocation to all of the watershed area between points TC5 and TC1. Addressing the mining impacts between these points addresses the impairment for the segment. An average instream flow measurement was calculated from available flow data for point TC1 (15.39 mgd).

An allowable long-term average instream concentration for iron, manganese, aluminum and acidity was determined at point TC1. The analysis is designed to produce a long-term average value that, when met, will be protective of the water quality criterion for that parameter 99 percent of the time. An analysis was performed using Monte Carlo simulation to determine the necessary long-term average concentration needed to attain water quality criteria 99 percent of the time. The simulation was run assuming the data set was lognormally distributed. Using the mean and the standard deviation of the data set, 5,000 iterations of sampling were completed and compared against the water quality criterion for that parameter. For each sampling event, a percent reduction was calculated, if necessary, to meet water quality criteria. A second simulation that multiplied the percent reduction times the sampled value was run to insure that criteria were met 99 percent of the time. The mean value from this data set represents that long-term daily average concentration that needs to be met to achieve water quality standards. The load allocations made at point TC1 for this stream segment are presented in Table E16.

Table E16. Long Term Average (LTA) Concentrations for Tomhickon Creek at TC1

Station TC1	*Measured Sample Data*		*Allowable*	
	Conc. (mg/l)	*Load (lb/day)*	*LTA Conc. (mg/l)*	*Load (lb/day)*
Fe	0.15	19.3	0.15	19.3
Mn	0.17	21.8	0.17	21.8
Al	0.42	53.9	0.30	38.5
Acidity	10.92	1,401.6	1.31	168.1
Alkalinity	6.04	775.2		

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

The loading reductions for points TC5 and O3 Tunnel were used to show the total load that was removed from upstream sources. For each parameter, the total load that was removed upstream was subtracted from the existing load at point TC1. This value was compared to the allowable load at point TC1. Reductions at point TC1 are necessary for any parameter that exceeds the allowable load at this point. A summary of all loads that affect point TC1 are shown in Table E17. Necessary reductions at point TC1 are shown in Table E18.

Table E17. Summary of Loads Affecting Point TC1

	Iron (lb/day)	*Manganese (lb/day)*	*Aluminum (lb/day)*	*Acidity (lb/day)*
TC5				
Load Reduction	0.9	0	6.0	0
O3 Tunnel				
Load Reduction	0	15.0	36.0	491.9

Table E18. Reductions Necessary at Point TC1				
	Iron (lb/day)	***Manganese (lb/day)***	***Aluminum (lb/day)***	***Acidity (lb/day)***
Existing Loads at TC1	19.3	21.8	53.9	1,401.6
Total Load Reduction (Sum of TC5 and O3 Tunnel)	0.9	15.0	42.0	491.9
Remaining Load	18.4	6.8	11.9	909.7
Allowable Loads at TC1	19.3	21.8	38.5	168.1
Percent Reduction	0	0	0	82
Load Reduction	0	0	0	741.6

The TMDL for the segment of Tomhickon Creek between TC5 and TC1 requires a load reduction for acidity. A load reduction is not necessary for total iron, total manganese, and total aluminum. All necessary reductions have been made upstream of this point.

Catawissa Creek at Point CC9

Catawissa Creek at point CC9 represents the stream after all of the tunnel discharges and the confluence of Tomhickon Creek. CC9 lies upstream of the unnamed tributary to Catawissa Creek 27565.

The TMDL for this section of Catawissa Creek consists of a load allocation to all of the watershed area between points CC9 and CC8. Addressing the mining impacts above this point addresses the impairment for the segment. An instream flow measurement was not available for point CC9; the average flow was derived using the unit area method (58.52 mgd).

The watershed area contributing to the stream flow above point CC9 is 208,874,606.73 square meters. The known flow point at CC6 had an average flow of 15,575.03 GPM. The average flows from the tunnel discharges were subtracted from the flow at CC6 to yield an average flow, based on the contributing land area, of 5,522.70 GPM. The contributing watershed area for CC6 is 43,801,375.93 square meters. The flow at CC9 is calculated by cross multiplication as 26,335.97 GPM. Addition of the average flow from the tunnel discharges yields 40,613.29 GPM, which converts to 58.52 mgd.

There is currently no entry for this segment on the Pennsylvania Section 303(d) list for impairment due to pH. Sample data for point CC9 shows pH ranging between 4.7 and 5.4, with an average pH of 4.57; therefore, pH will be addressed in this TMDL. The objective is to reduce acid loading to the stream, which will in turn raise the pH to the desired range and keep a net alkalinity above zero 99 percent of the time. The result of this analysis is an acid loading reduction that equates to meeting standards for pH (see Table 3). The method and rationale for addressing pH is contained in Attachment C.

An allowable long-term average instream concentration for iron, manganese, aluminum and acidity was determined at point CC9. The analysis is designed to produce a long-term average value that, when met, will be protective of the water quality criterion for that parameter 99 percent of the time. An analysis was performed using Monte Carlo simulation to determine the necessary long-term average concentration needed to attain water quality criteria 99 percent of the time. The simulation was run assuming the data set was lognormally distributed. Using the mean and the standard deviation of the data set, 5,000 iterations of sampling were completed and compared against the water quality criterion for that parameter. For each sampling event, a percent reduction was calculated, if necessary, to meet water quality criteria. A second simulation that multiplied the percent reduction times the sampled value was run to insure that criteria were met 99 percent of the time. The mean value from this data set represents that long-term daily average concentration that needs to be met to achieve water quality standards. The load allocations made at point CC9 for this stream segment are presented in Table E19.

Table E19. Long Term Average (LTA) Concentrations for Catawissa Creek at CC9

Station CC9	*Measured Sample Data*		*Allowable*	
	Conc. (mg/l)	*Load (lb/day)*	*LTA Conc. (mg/l)*	*Load (lb/day)*
Fe	0.10	48.8	0.10	48.8
Mn	0.53	258.7	0.40	195.2
Al	1.30	634.5	0.27	131.8
Acidity	23.88	11,654.8	0.24	117.1
Alkalinity	2.16	1,054.2		

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

The loading reductions for points C Tunnel, A Tunnel, GM Tunnel, CC6, CC7, CC8, TC5, O3 Tunnel, and TC1 were used to show the total load that was removed from upstream sources. For each parameter, the total load that was removed upstream was subtracted from the existing load at point CC9. This value was compared to the allowable load at point CC9. Reductions at point CC9 are necessary for any parameter that exceeds the allowable load at this point. A summary of all loads that affect point CC9 are shown in Table E20. Necessary reductions at point CC9 are shown in Table E21.

Table E20. Summary of Loads Affecting Point CC9

	Iron (lb/day)	*Manganese (lb/day)*	*Aluminum (lb/day)*	*Acidity (lb/day)*
C Tunnel				
Load Reduction	2.9	0	6.0	113.5
A Tunnel				
Load Reduction	14.2	170.2	767.4	6,869.1
GM Tunnel				
Load Reduction	2.5	0.3	31.7	310.0
CC6				
Load Reduction	0	0	0	0
CC7				
Load Reduction	0	0	0	0
CC8				
Load Reduction	458.0	75.0	0	0
TC5				
Load Reduction	0.9	0	6.0	0
O3 Tunnel				
Load Reduction	0	15.0	36.0	491.9

TC1				
Load Reduction	0	0	0	741.6

Table E21. Reductions Necessary at Point CC9

	Iron (lb/day)	***Manganese (lb/day)***	***Aluminum (lb/day)***	***Acidity (lb/day)***
Existing Loads at CC9	48.8	258.7	634.5	11,654.8
Total Load Reduction (Sum of C, A, GM, and O3 Tunnels, CC6, CC7, CC8, TC5, TC1)	478.5	260.5	847.1	8,526.1
Remaining Load	0	0	0	3,128.7
Allowable Loads at CC9	48.8	195.2	131.8	117.1
Percent Reduction	0	0	0	96.0
Load Reduction	0	0	0	3,011.6

The TMDL for Catawissa Creek at point CC9 requires a load reduction for acidity. A load reduction is not necessary for total iron, total manganese, and total aluminum. All necessary reductions have been made upstream of this point.

Catawissa Creek at Point CC10

Catawissa Creek at point CC10 represents the stream at its mouth before it joins the Susquehanna River.

The TMDL for this section of Catawissa Creek consists of a load allocation to all of the watershed area between points CC10 and CC9. Addressing the mining impacts between these points addresses the impairment for the segment. An instream flow measurement was not available for point CC10; the average flow was derived using the unit area method (89.60 mgd).

The watershed area contributing to the stream flow above point CC10 is 379,940,018.265 square meters. The known flow point at CC6 had an average flow of 15,575.03 GPM. The average flows from the tunnel discharges were subtracted from the flow at CC6 to yield an average flow, based on the contributing land area, of 5,522.70 GPM. The contributing watershed area for CC6 is 43,801,375.93 square meters. The flow at CC9 is calculated by cross multiplication as 47,904.77 GPM. Addition of the average flow from the tunnel discharges yields 62,182.10 GPM, which converts to 89.60 mgd.

There were fewer aluminum and acidity data than necessary for this segment to conduct Monte Carlo analysis; therefore, they were not evaluated for this TMDL. Text removed

An allowable long-term average instream concentration for iron and manganese[5] was determined at point CC10. The analysis is designed to produce a long-term average value that, when met, will be protective of the water quality criterion for that parameter 99 percent of the time. An analysis was performed using Monte Carlo simulation to determine the necessary long-term average concentration needed to attain water quality criteria 99 percent of the time. The

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[5] The data used for iron and manganese date before the Oneida #1 treatment system became operational. Any reductions taken at point CC10 will be protective of the watershed since the treatment system may remove some of the loading values upstream.

simulation was run assuming the data set was lognormally distributed. Using the mean and the standard deviation of the data set, 5,000 iterations of sampling were completed and compared against the water quality criterion for that parameter. For each sampling event, a percent reduction was calculated, if necessary, to meet water quality criteria. A second simulation that multiplied the percent reduction times the sampled value was run to insure that criteria were met 99 percent of the time. The mean value from this data set represents that long-term daily average concentration that needs to be met to achieve water quality standards. The load allocations made at point CC10 for this stream segment are presented in Table E22.

Table E22. Long Term Average (LTA) Concentrations for Catawissa Creek at CC10

Station CC10	***Measured Sample Data***		***Allowable***	
	Conc. (mg/l)	***Load (lb/day)***	***LTA Conc. (mg/l)***	***Load (lb/day)***
Fe	0.11	82.2	0.11	82.2
Mn	0.33	246.6	0.33	246.6
Al	0.85	635.2	-	-
Acidity	12.80	9,565.0	-	-
Alkalinity	18.16	13,570.3		

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

The loading reductions for points C Tunnel, A Tunnel, GM Tunnel, CC6, CC7, CC8, TC5, O3 Tunnel, TC1, and CC9 were used to show the total load that was removed from upstream sources. For each parameter, the total load that was removed upstream was subtracted from the existing load at point CC10. This value was compared to the allowable load at point CC10. Reductions at point CC10 are necessary for any parameter that exceeds the allowable load at this point. A summary of all loads that affect point CC10 are shown in Table E23. Necessary reductions at point CC10 are shown in Table E24.

Table E23. Summary of Loads Affecting Point CC10				
	Iron (lb/day)	***Manganese (lb/day)***	***Aluminum (lb/day)***	***Acidity (lb/day)***
C Tunnel				
Load Reduction	2.9	0	6.0	113.5
A Tunnel				
Load Reduction	14.2	170.2	767.4	6,869.1
GM Tunnel				
Load Reduction	2.5	0.3	31.7	310.0
CC6				
Load Reduction	0	0	0	0
CC7				
Load Reduction	0	0	0	0
CC8				
Load Reduction	458.0	75.0	0	0
TC5				
Load Reduction	0.9	0	6.0	0
O3 Tunnel				
Load Reduction	0	15.0	36.0	491.9
TC1				
Load Reduction	0	0	0	741.6
CC9				
Load Reduction	0	0	0	3,011.6

Table E24. Reductions Necessary at Point CC10				
	Iron (lb/day)	***Manganese (lb/day)***	***Aluminum (lb/day)***	***Acidity (lb/day)***
Existing Loads at CC10	82.2	246.6	635.2	13,570.3
Total Load Reduction (Sum of C, A, GM, and O3 Tunnels, CC6, CC7, CC8, TC5, TC1, and CC9)	478.5	260.5	847.1	11,537.7
Remaining Load	0	0	0	2,032.6
Allowable Loads at CC10	82.2	246.6	-	-
Percent Reduction	0	0	-	-
Load Reduction	0	0	-	-

The TMDL for Catawissa Creek at point CC10 does not require a load reduction for total iron and total manganese. All necessary reductions have been made upstream of this point.

Margin of Safety (MOS)

An implicit MOS was used in these TMDLs derived from the Monte Carlo statistical analysis. Pennsylvania Title 25 Chapter 96.3(c) states that water quality criteria must be met at least 99 percent of the time. All of the @Risk analyses results surprass the minimum 99 percent level of protection. Another MOS used for this TMDL analyses is:

- 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 MOS.

- An additional MOS is that the calculations were performed using a daily iron average, instead of the 30-day average.

Seasonal Variation

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

Critical Conditions

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

Attachment F

Water Quality Data Used In TMDL Calculations

TMDL Pt	Company	Permit #	Location	Date	Flow	pH (f)	pH (l)	Fe	Mn	Al	Acidity	Alk.	Sulfate
CC1	BAMR WB	*	CC1	2/13/1997	*	*	4.5	0.236	1.57	3.03	30	0	50
	BAMR WB	*	CC1	3/13/1997	*	*	4.4	0.18	1.46	2.84	28	0	50
	BAMR WB	*	CC1	3/27/1997	*	*	4.4	0.316	1.49	4.16	28	0	38
	BAMR WB	*	CC1	4/7/1997	*	*	4.2	0.205	1.15	3.24	26	0	34
	BAMR WB	*	CC1	4/23/1997	*	*	4.4	0.351	1.79	3.9	42	0	28
	BAMR WB	*	CC1	5/20/1997	*	*	4.5	0.398	1.72	3.18	28	0	45
	BAMR WB	*	CC1	6/24/1997	*	*	4.4	1.03	1.89	2.89	28	0	60
	BAMR WB	*	CC1	7/24/1997	*	*	4.4	0.662	1.6	1.82	28	0	39
	BAMR WB	*	CC1	8/21/1997	*	*	5.9	0.393	0.417	1.18	10.8	4.6	37
	BAMR WB	*	CC1	9/18/1997	*	*	4.4	0.338	1.92	2.5	26	0	54
	BAMR WB	*	CC1	10/16/1997	*	*	4.5	0.293	1.99	2.48	28	0	52
	BAMR WB	*	CC1	11/13/1997	*	*	4.2	0.031	2.59	2.79	46	0	49
	BAMR WB	*	CC1	1/21/1998	*	*	4.1	0.186	1.55	4.89	52	0	111
	BAMR WB	*	CC1	4/6/1998	*	*	4.2	0.43	1.64	4.58	42	0	15
	BAMR WB	*	CC1	7/6/1998	*	*	4.4	0.391	1.96	2.99	30	0	53
	BAMR WB	*	CC1	10/6/1998	*	*	4.5	0.229	2.01	1.95	16	0	36
	BAMR WB	*	CC1	2/2/1999	*	*	4.3	0.176	1.67	4.13	30	0	45
	BAMR WB	*	CC1	4/14/1999	*	*	4.1	0.243	1.63	4.98	44	0	68
	BAMR WB	*	CC1	11/4/1999	*	*	4.4	0.05	1.73	3.55	28	0	58
	BAMR WB	*	CC1	2/1/2000	*	*	4.5	0.42	1.66	2.91	24	0	47
	BAMR WB	*	CC1	4/13/2000	*	*	4.3	0.142	1.28	2.89	26	0	40
	BAMR WB	*	CC1	7/13/2000	*	*	4.4	0.501	1.92	3.6	34	0	53
	BAMR WB	*	CC1	1/11/2001	*	*	4.5	0.626	1.85	2.74	24	0	45
	BAMR WB	*	CC1	4/24/2001	*	*	4.4	0.235	1.91	3.87	28	0	68
	BAMR WB	*	CC1	7/17/2001	*	*	4.3	0.312	2.23	3.21	68.4	0	78.4
	BAMR WB	*	CC1	10/30/2001	*	*	4.4	0.252	2.44	3.02	67.6	0	73.2
	BAMR WB	*	CC1	2/25/2002	*	*	4.5	0.46	2.02	3.17	68.8	0	55.1
				Average	*****	*****	**4.43**	**0.34**	**1.74**	**3.20**	**34.50**	**0.17**	**51.17**
				St Dev	*****	*****	**0.32**	**0.21**	**0.41**	**0.89**	**14.94**	**0.89**	**18.28**
C Tunnel	BAMR WB	*	C Tunnel	7/25/96	*	*	4.2	0.915	0.298	1.35	22	4	21
	BAMR WB	*	C Tunnel	8/28/96	157.71	*	4	1.83	0.433	1.89	32	2.8	<20
	BAMR WB	*	C Tunnel	9/30/96	262.68	*	3.8	1.92	0.462	1.39	30	0	30
	BAMR WB	*	C Tunnel	11/26/96	530.74	*	4.4	1.01	0.289	1.46	20	7.8	36
	BAMR WB	*	C Tunnel	3/29/97	413.82	*	4.2	0.822	0.258	1.31	18.4	5.8	<20
	BAMR WB	*	C Tunnel	4/29/97	467.74	*	4.3	0.906	0.28	1.24	22	6.8	20
	BAMR WB	*	C Tunnel	5/31/97	410.96	*	4.4	0.749	0.227	1.12	18.2	7.4	<20

TMDL Pt	Company	Permit #	Location	Date	Flow	pH (f)	pH (l)	Fe	Mn	Al	Acidity	Alk.	Sulfate
	BAMR WB	*	C Tunnel	6/28/97	165.51	*	4.1	1.34	0.388	1.61	28	3.4	<20
	BAMR WB	*	C Tunnel	7/19/97	51	*	4	2.03	0.489	1.78	24	1.8	39
	BAMR WB	*	C Tunnel	9/13/97	157.2	*	4.2	0.815	0.283	0.919	16.4	3.8	<20
	BAMR WB	*	C Tunnel	10/25/97	911.23	*	4	1.71	0.545	1.51	30	2.8	23
	BAMR WB	*	C Tunnel	11/15/97	0	*		0	0	0	0	0	0
	BAMR WB	*	C Tunnel	12/20/97	283.86	*	4.2	0.915	0.28	0.953	15	4.2	<20
	BAMR WB	*	C Tunnel	2/21/98	1007.77	*	4.4	0.577	0.172	1.14	13.4	6.4	<20
	BAMR WB	*	C Tunnel	3/31/98	1414.1	*	4.3	0.681	0.211	1.11	14.6	5.8	<20
	BAMR WB	*	C Tunnel	4/25/98	2374.2	*	4.4	0.641	0.187	1.21	15	7.2	<20
	BAMR WB	*	C Tunnel	5/16/98	2716.44	*	4.4	0.526	0.183	1	13.4	7.2	<20
	BAMR WB	*	C Tunnel	6/20/98	280.97	*	4.1	0.983	0.318	1.3	18	3.4	<20
	BAMR WB	*	C Tunnel	7/19/98	247.59	*	4.1	1.09	0.37	1.58	18	3.4	42
	BAMR WB	*	C Tunnel	8/15/98	*	*	4	1.36	0.442	1.52	22	2.2	30
	BAMR WB	*	C Tunnel	9/19/98	108.7	*	3.9	1.55	0.532	1.83	18.8	0	23
	BAMR WB	*	C Tunnel	10/31/98	187.44	*	4.2	0.901	0.318	1.31	13.6	5	65
	BAMR WB	*	C Tunnel	11/21/98	165.9	*	4.1	1.17	0.381	1.49	18.6	3.4	23
	BAMR WB	*	C Tunnel	12/19/98	126.21	*	4.1	0.907	0.355	1.07	17	4.2	<20
	BAMR WB	*	C Tunnel	1/30/99	1000	*	4.5	0.446	0.17	1.1	13	6.6	20
	BAMR WB	*	C Tunnel	3/6/99	848.42	*	4.4	0.536	0.189	0.982	18.4	6.4	<20
	BAMR WB	*	C Tunnel	4/3/99	614.34	*	4.2	0.717	0.23	1.23	13.2	4	<20
	BAMR WB	*	C Tunnel	4/25/99	415.34	*	4.1	0.702	0.217	1.03	14	3.8	<20
	BAMR WB	*	C Tunnel	6/5/99	*	*	4.1	1.02	0.314	1.33	16.2	3.8	22
	BAMR WB	*	C Tunnel	7/31/99	109.96	*	3.9	1.58	0.422	*	20	0	41
				Average	**571.48**	*****	**4.17**	**1.01**	**0.31**	**1.27**	**18.44**	**4.11**	**29.00**
				St Dev	**668.69**	*****	**0.18**	**0.47**	**0.12**	**0.36**	**6.32**	**2.32**	**14.60**
A Tunnel	BAMR WB	*	A Tunnel	7/25/96	*	*	3.9	0.674	2.31	8.32	70	0	114
	BAMR WB	*	A Tunnel	8/28/96	4346.25	*	3.9	0.821	2.43	9.09	80	0	133
	BAMR WB	*	A Tunnel	9/30/96	4725.73	*	3.8	0.804	2.62	8.71	80	0	156
	BAMR WB	*	A Tunnel	11/26/96	12575.99	*	4.1	1.33	1.99	7.97	62	6.6	120
	BAMR WB	*	A Tunnel	12/27/96	16977.39	*	4.1	0.385	1.63	6.45	52	5	87
	BAMR WB	*	A Tunnel	3/29/97	9647.43	*	4.1	0.593	2	6.99	58	5	74
	BAMR WB	*	A Tunnel	4/29/97	8860.69	*	4.1	0.581	1.99	7.01	60	4.8	112
	BAMR WB	*	A Tunnel	5/31/97	5360.38	*	4	0.709	2.23	7.88	68	3.8	106
	BAMR WB	*	A Tunnel	6/28/97	4681.35	*	4	0.776	2.3	8.2	70	3	91
	BAMR WB	*	A Tunnel	7/19/97	3970	*	4	0.813	2.61	9.1	72	1.6	153
	BAMR WB	*	A Tunnel	9/13/97	6284.52	*	4	0.772	3.06	10.2	80	2	138

TMDL Pt	Company	Permit #	Location	Date	Flow	pH (f)	pH (l)	Fe	Mn	Al	Acidity	Alk.	Sulfate
	BAMR WB	*	A Tunnel	10/25/97	7133.14	*	4	2.45	2.88	10	80	2.6	119
	BAMR WB	*	A Tunnel	11/15/97	6706.54	*	4	0.807	2.81	9.61	74	3	113
	BAMR WB	*	A Tunnel	12/20/97	4870.48	*	3.9	0.651	2.25	7.72	72	0	112
	BAMR WB	*	A Tunnel	2/21/98	16384.33	*	4.1	0.559	1.74	6.67	50	3.8	56
	BAMR WB	*	A Tunnel	3/21/98	17119.05	*	4.1	0.605	1.9	7.51	50	3.6	92
	BAMR WB	*	A Tunnel	4/25/98	19723.26	*	4.1	0.549	1.82	6.58	50	3.8	109
	BAMR WB	*	A Tunnel	5/16/98	13742.26	*	4.1	0.479	1.78	6.31	46	5	110
	BAMR WB	*	A Tunnel	6/20/98	5140.9	*	4	0.731	2.5	9.21	68	1.8	134
	BAMR WB	*	A Tunnel	7/19/98	4707.54	*	3.9	0.755	2.67	9.57	74	0	152
	BAMR WB	*	A Tunnel	8/15/98	*	*	3.9	0.846	2.74	9.74	80	0	142
	BAMR WB	*	A Tunnel	9/19/98	4007.52	*	3.9	0.743	2.67	9.61	70	0	171
	BAMR WB	*	A Tunnel	10/31/98	4903.8	*	3.9	0.787	2.81	10.4	74	0	172
	BAMR WB	*	A Tunnel	11/21/98	4021.24	*	3.9	0.857	2.96	10.3	80	0	166
	BAMR WB	*	A Tunnel	12/19/98	3338.3	*	3.9	0.873	3.14	9.85	78	0	197.4
	BAMR WB	*	A Tunnel	1/30/99	19150.62	*	4	0.511	2	7.76	56	2.6	128
	BAMR WB	*	A Tunnel	3/6/99	8761.83	*	4	0.552	2.09	7.26	68	2.6	115
	BAMR WB	*	A Tunnel	4/3/99	8837.27	*	4.1	0.513	1.9	6.62	50	3	85
	BAMR WB	*	A Tunnel	4/25/99	7633.57	*	4	0.47	1.79	6.03	50	2.2	113
	BAMR WB	*	A Tunnel	6/5/99	*	*	4	1.21	2.22	7.09	56	3.2	117
	BAMR WB	*	A Tunnel	7/31/99	3784.91	*	3.8	0.819	2.62	8.95	68	0	174
	A/C Fuels	54980201	A Tunnel	9/13/1998	*	*	4.2	0.437	1.02	3.56	30	5	61.1
	A/C Fuels	54980201	A Tunnel	6/7/2000	*	3.57	3.94	0.63	2.5	*	48.4	<0.4	136
	A/C Fuels	54980201	A Tunnel	9/27/2000	*	3.4	3.84	0.67	2.54	*	84	<0.4	180
	A/C Fuels	54980201	A Tunnel	3/28/2001	*	3.36	3.89	0.43	1.8	*	43.9	<0.4	154
	N.Eastern	54960201-01	A Tunnel	3/20/2001	*	*	3.8	0.775	2.16	7.96	76	<1.0	176
	N.Eastern	54960201-01	A Tunnel	5/8/2001	*	*	3.85	0.428	1.94	6.91	76	<1.0	152
	N.Eastern	54960201-01	A Tunnel	5/23/2001	*	*	6.73	0.125	2.88	*	69	<1.0	400
	N.Eastern	54960201-01	A Tunnel	1/10/2000	*	*	3.8	0.58	2.2	*	124	<1.0	160
	N.Eastern	54960201-01	A Tunnel	4/18/2000	*	*	3.84	0.45	1.6	*	88	<1.0	126
	N.Eastern	54960201-01	A Tunnel	7/4/2000	*	*	3.93	0.35	1.8	0.66	76	<1.0	140
	N.Eastern	54960201-01	A Tunnel	10/2/2000	*	*	4	0.692	2.68	9.52	98	<1.0	176
				Average	**8478.44**	**3.44**	**4.03**	**0.70**	**2.28**	**7.93**	**68.08**	**2.31**	**136.25**
				St Dev	**5169.42**	**0.11**	**0.44**	**0.35**	**0.47**	**1.96**	**16.57**	**2.00**	**53.41**
GM Tunnel	BAMR WB	*	GM Tunnel	7/25/96	*	*	4	0.28	0.581	2.68	28	2.2	44
	BAMR WB	*	GM Tunnel	8/28/96	556.66	*	4	1.17	0.641	3.04	32	2.8	42
	BAMR WB	*	GM Tunnel	9/30/96	749.55	*	3.9	0.294	0.681	8.71	32	0	45

TMDL Pt	Company	Permit #	Location	Date	Flow	pH (f)	pH (l)	Fe	Mn	Al	Acidity	Alk.	Sulfate
	BAMR WB	*	GM Tunnel	11/26/96	1269.29	*	4.2	0.38	0.532	2.58	28	6.8	50
	BAMR WB	*	GM Tunnel	12/27/96	1954.94	*	4.2	0.377	0.435	2.28	22	5.6	26
	BAMR WB	*	GM Tunnel	3/29/97	1124.6	*	4.1	0.385	0.609	2.76	30	4.4	25
	BAMR WB	*	GM Tunnel	4/29/97	1315.46	*	4.1	0.305	0.511	2.28	26	4.8	34
	BAMR WB	*	GM Tunnel	5/31/97	577.7	*	4.1	0.273	0.517	2.22	24	5	22
	BAMR WB	*	GM Tunnel	6/28/97	661.13	*	4.1	0.285	0.585	2.49	30	3.6	<20
	BAMR WB	*	GM Tunnel	7/19/97	633	*	4.1	0.263	0.724	2.78	26	3.2	35
	BAMR WB	*	GM Tunnel	9/13/97	546.46	*	4	0.303	0.984	3.97	34	2.2	40
	BAMR WB	*	GM Tunnel	10/25/97	394.41	*	4.1	0.215	0.878	3.25	32	4.4	<20
	BAMR WB	*	GM Tunnel	11/15/97	355.14	*	4	0.217	0.81	3.17	30	3.2	39
	BAMR WB	*	GM Tunnel	12/20/97	725.37	*	4	0.208	0.556	2.32	28	2.2	31
	BAMR WB	*	GM Tunnel	2/21/98	2251.03	*	4.1	0.359	0.534	2.8	26	3.2	29
	BAMR WB	*	GM Tunnel	4/25/98	1724.99	*	4.1	0.398	0.488	2.5	26	3.8	32
	BAMR WB	*	GM Tunnel	3/21/98	2314	*	3.6	0.387	0.53	2.82	26	3.6	29
	BAMR WB	*	GM Tunnel	4/25/98	1724.99	*	4.1	0.398	0.488	2.5	26	3.8	32
	BAMR WB	*	GM Tunnel	5/16/98	2613.54	*	4.1	0.339	0.498	2.54	26	4.6	39
	BAMR WB	*	GM Tunnel	6/20/98	580.62	*	4	0.333	0.672	3.05	30	2	39
	BAMR WB	*	GM Tunnel	7/19/98	745.59	*	4	0.337	0.682	2.97	28	2.4	110
	BAMR WB	*	GM Tunnel	8/15/98	*	*	4	0.454	0.72	2.84	30	2.2	39
	BAMR WB	*	GM Tunnel	9/19/98	305.04	*	4	0.312	0.833	3.57	32	1.8	46
	BAMR WB	*	GM Tunnel	10/31/98	582.13	*	4.1	0.308	0.69	2.96	24	3.2	53
	BAMR WB	*	GM Tunnel	11/21/98	363.83	*	4.1	0.299	0.774	3.11	28	2.8	47
	BAMR WB	*	GM Tunnel	12/19/98	472.23	*	4.1	0.243	0.794	2.78	32	3.4	49.7
	BAMR WB	*	GM Tunnel	1/30/99	1615.65	*	4.1	0.235	0.502	2.72	24	3.8	29
	BAMR WB	*	GM Tunnel	3/6/99	1025.63	*	4.1	3.68	0.584	2.8	36	3.6	38
	BAMR WB	*	GM Tunnel	4/3/99	854.66	*	4.1	0.317	0.556	2.7	26	3.2	25
	BAMR WB	*	GM Tunnel	4/25/99	570.92	*	4	0.279	0.518	2.33	24	2.8	30
	BAMR WB	*	GM Tunnel	6/5/99	*	*	4.1	0.281	0.628	2.52	24	3.4	38
	BAMR WB	*	GM Tunnel	7/31/99	461.25	*	4	0.248	0.861	3.09	28	1.4	63
				Average	**1002.41**	*****	**4.05**	**0.44**	**0.64**	**2.97**	**28.06**	**3.29**	**40.02**
				St Dev	**661.52**	*****	**0.10**	**0.61**	**0.14**	**1.11**	**3.35**	**1.30**	**16.23**
CC6	BAMR WB	*	CC6	2/13/1997	*	*	4.3	0.263	0.909	3.53	32	0	47
	BAMR WB	*	CC6	3/13/1997	25339.25	*	4.5	0.177	0.712	2.48	24	0	43
	BAMR WB	*	CC6	3/27/1997	24868.01	*	4.5	0.181	0.702	2.62	22	0	32
	BAMR WB	*	CC6	4/7/1997	*	*	4.5	0.313	0.563	2.05	16.2	0	28
	BAMR WB	*	CC6	4/23/1997	14586.00	*	4.5	0.183	0.797	2.79	28	0	29

TMDL Pt	Company	Permit #	Location	Date	Flow	pH (f)	pH (l)	Fe	Mn	Al	Acidity	Alk.	Sulfate
	BAMR WB	*	CC6	5/20/1997	18127.03	*	4.5	0.24	0.667	2.36	18.6	0	38
	BAMR WB	*	CC6	6/24/1997	10869.94	*	4.3	0.222	1.14	3.98	30	0	66
	BAMR WB	*	CC6	7/24/1997	*	*	4.7	0.482	0.957	2.77	24	1.6	54
	BAMR WB	*	CC6	8/21/1997	16735.75	*	6.2	0.65	0.18	1.03	6.6	7.8	64
	BAMR WB	*	CC6	9/18/1997	6862.15	*	4.4	0.092	1.81	6.11	46	0	85
	BAMR WB	*	CC6	10/16/1997	5668.64	*	4.3	0.152	1.63	5.65	44	0	69
	BAMR WB	*	CC6	11/13/1997	6229.34	*	4.3	0.169	1.66	5.4	38	0	70
	BAMR WB	*	CC6	1/21/1998	30249.12	*	4.5	0.202	0.766	2.77	22	0	40
	BAMR WB	*	CC6	4/6/1998	25182.17	*	4.5	0.243	0.903	3.5	28	0	51
	BAMR WB	*	CC6	7/6/1998	5834.40	*	4.4	0.286	1.27	4.59	38	0	73
	BAMR WB	*	CC6	10/6/1998	4254.62	*	4.1	0.307	1.94	6.7	50	0	122
	BAMR WB	*	CC6	2/2/1999	*	*	4.6	0.381	0.606	2.35	16	1.2	31
	BAMR WB	*	CC6	4/14/1999	25357.20	*	4.6	0.286	0.629	2.25	18	0.8	37
	BAMR WB	*	CC6	11/4/1999	19118.88	*	4.3	0.274	1.17	4.32	34	0	82
	BAMR WB	*	CC6	2/1/2000	*	*	4.2	0.247	1.1	3.88	32	0	68
	BAMR WB	*	CC6	4/13/2000	*	*	4.5	0.181	0.618	2.24	26	0	37
	BAMR WB	*	CC6	7/13/2000	14393.02	*	4.3	0.222	1	3.33	28	0	51
	BAMR WB	*	CC6	10/3/2000	5915.18	*	4.1	0.307	1.93	6.78	48	0	90
	BAMR WB	*	CC6	1/11/2001	11161.66	*	4.3	0.213	1.01	3.15	26	0	50
	BAMR WB	*	CC6	4/24/2001	25173.19	*	4.5	0.17	0.66	2.13	16.4	0	46
	BAMR WB	*	CC6	7/17/2001	*	*	4.2	0.203	1.33	4.11	75.8	0	79.7
	BAMR WB	*	CC6	10/30/2001	*	*	4.1	0.305	1.78	5.69	83.6	0	80.2
	BAMR WB	*	CC6	2/25/2002	*	*	4.5	0.18	0.93	2.71	60	0	43.1
				Average	**15575.03**	*****	**4.45**	**0.25**	**1.05**	**3.62**	**33.26**	**0.41**	**57.36**
				St Dev	**8561.18**	*****	**0.38**	**0.11**	**0.47**	**1.53**	**17.78**	**1.50**	**22.53**
CC7	BAMR WB	*	CC7	3/13/1997	*	*	4.7	0.142	0.59	2.01	19	2	37
	BAMR WB	*	CC7	3/27/1997	*	*	4.7	0.134	0.57	2.27	18	1.6	31
	BAMR WB	*	CC7	4/7/1997	*	*	4.8	0.192	0.467	1.62	13.6	2	27
	BAMR WB	*	CC7	4/23/1997	*	*	4.8	0.151	0.711	2.49	26	2.2	28
	BAMR WB	*	CC7	5/20/1997	*	*	4.9	0.108	0.582	1.66	9.4	2.6	36
	BAMR WB	*	CC7	6/24/1997	*	*	4.5	0.142	0.962	3.23	24	0	58
	BAMR WB	*	CC7	7/24/1997	*	*	4.7	0.284	0.996	2.27	22	2	74
	BAMR WB	*	CC7	8/21/1997	*	*	4.5	1.63	2.62	10.1	76	0	116
	BAMR WB	*	CC7	9/18/1997	*	*	4.6	0.128	1.47	4.78	36	1.2	79
	BAMR WB	*	CC7	10/16/1997	*	*	4.6	0.167	1.44	4.79	34	1	63
	BAMR WB	*	CC7	11/13/1997	*	*	4.6	0.1	1.32	4.22	30	1.2	39

TMDL Pt	Company	Permit #	Location	Date	Flow	pH (f)	pH (l)	Fe	Mn	Al	Acidity	Alk.	Sulfate
	BAMR WB	*	CC7	1/21/1998	*	*	4.7	0.143	0.605	2.04	18.4	1.8	38
	BAMR WB	*	CC7	4/6/1998	*	*	4.7	0.149	0.734	2.57	19.2	2	49
	BAMR WB	*	CC7	7/6/1998	*	*	4.6	0.137	0.988	3.44	30	2	65
	BAMR WB	*	CC7	10/6/1998	*	*	4.5	0.164	0.148	5.08	36	0	95
	BAMR WB	*	CC7	2/2/1999	*	*	4.8	0.43	0.542	2.14	13.6	2.2	31
	BAMR WB	*	CC7	4/14/1999	*	*	4.7	N/A	N/A	N/A	12.6	2	38
	BAMR WB	*	CC7	11/4/1999	*	*	4.5	0.04	1.06	3.81	28	0	79
	BAMR WB	*	CC7	2/1/2000	*	*	4.7	0.153	0.725	2.54	17.8	1.4	52
	BAMR WB	*	CC7	4/13/2000	*	*	4.7	0.152	0.516	1.84	14.2	1.6	32
	BAMR WB	*	CC7	7/13/2000	*	*	4.6	0.159	0.897	2.95	24	1	56
	BAMR WB	*	CC7	10/3/2000	*	*	4.4	0.205	1.51	5.12	36	0	85
	BAMR WB	*	CC7	1/11/2001	*	*	4.6	0.187	0.855	2.64	22	1.2	47
	BAMR WB	*	CC7	4/24/2001	*	*	4.7	0.128	0.529	1.63	12.2	1.2	46
	BAMR WB	*	CC7	7/17/2001	*	*	4.5	0.157	1.14	3.42	59.8	0	75.9
	BAMR WB	*	CC7	10/30/2001	*	*	4.4	0.201	1.48	4.59	74.8	0	90.6
	BAMR WB	*	CC7	2/25/2002	*	*	4.7	0.1	0.74	2.14	45	1.4	42.6
				Average	*****	*****	**4.64**	**0.22**	**0.93**	**3.28**	**28.58**	**1.24**	**55.93**
				St Dev	*****	*****	**0.12**	**0.30**	**0.50**	**1.80**	**17.57**	**0.85**	**23.73**
CC8	BAMR WB	*	CC8W	3/13/1997	*	*	5	0.081	0.335	1.1	11.4	3.2	29
	BAMR WB	*	CC8W	3/27/1997	*	*	5.1	0.07	0.307	1.06	7.4	2.8	25
	BAMR WB	*	CC8W	4/7/1997	*	*	5.2	0.162	0.279	0.846	3.6	2.8	16
	BAMR WB	*	CC8W	4/23/1997	*	*	5.2	0.076	0.395	1.24	10.6	3.2	21
	BAMR WB	*	CC8W	5/20/1997	*	*	5.9	0.255	0.357	1	4.4	3.6	27
	BAMR WB	*	CC8W	6/24/1997	*	*	5.1	0.078	0.488	1.1	7.4	2.4	46
	BAMR WB	*	CC8W	7/24/1997	*	*	5.9	0.558	0.517	2.13	11.4	6.6	34
	BAMR WB	*	CC8W	8/21/1997	*	*	3.2	5.52	9.07	4.46	120	0	279
	BAMR WB	*	CC8W	9/18/1997	*	*	4.7	0.079	1.1	2.75	12.8	2	60
	BAMR WB	*	CC8W	10/16/1997	*	*	4.8	0.04	1.19	3.14	19.6	2.4	67
	BAMR WB	*	CC8W	11/13/1997	*	*	4.8	0.056	0.83	2.3	11	2.2	42
	BAMR WB	*	CC8W	1/21/1998	*	*	4.9	0.097	0.359	1.08	9.8	2.4	12
	BAMR WB	*	CC8W	4/6/1998	*	*	5.2	0.105	0.366	0.909	6.6	2.8	36
	BAMR WB	*	CC8W	7/6/1998	*	*	4.9	0.092	0.665	1.81	13.2	2.6	38
	BAMR WB	*	CC8W	10/6/1998	*	*	4.7	0.065	0.954	2.59	14.2	1.6	78
	BAMR WB	*	CC8W	2/2/1999	*	*	5	0.54	0.376	1.76	6.6	2.6	28
	BAMR WB	*	CC8W	4/14/1999	*	*	5.2	0.117	0.284	0.888	3.6	2.8	29
	BAMR WB	*	CC8W	11/4/1999	*	*	4.8	0.03	0.645	2.18	13.6	2	48

TMDL Pt	Company	Permit #	Location	Date	Flow	pH (f)	pH (l)	Fe	Mn	Al	Acidity	Alk.	Sulfate
	BAMR WB	*	CC8W	2/1/2000	*	*	4.8	0.223	0.534	2.27	13.6	1.8	38
	BAMR WB	*	CC8W	4/13/2000	*	*	5.4	0.133	0.272	0.953	3.6	3	28
	BAMR WB	*	CC8W	7/13/2000	*	*	4.8	0.103	0.586	1.75	12	2.6	46
	BAMR WB	*	CC8W	10/3/2000	*	*	4.8	0.094	0.829	2.43	12.4	2	60
	BAMR WB	*	CC8W	1/11/2001	*	*	4.8	0.135	0.525	1.77	10.4	2	35
	BAMR WB	*	CC8W	4/24/2001	*	*	5.1	0.115	0.32	0.86	2.6	2.4	30
	BAMR WB	*	CC8W	7/17/2001	*	*	4.7	0.075	0.728	1.76	33.2	1.8	48.9
	BAMR WB	*	CC8W	10/30/2001	*	*	4.2	0.081	1.08	3.04	48.4	0	64.5
	BAMR WB	*	CC8W	2/25/2002	*	*	4.9	0.07	0.48	2.05	48.8	2.2	34
	BAMR WB	*	CC8E	4/23/1997	*	*	5	0.08	0.447	1.41	11.4	3	22
	BAMR WB	*	CC8E	5/20/1997	*	*	6.4	0.263	0.362	1.06	1.6	13.4	24
	BAMR WB	*	CC8E	6/24/1997	*	*	5.1	0.082	0.485	0.965	6.4	2.4	42
	BAMR WB	*	CC8E	7/24/1997	*	*	6	0.753	0.525	3.05	8.8	7.2	59
	BAMR WB	*	CC8E	8/21/1997	*	*	3.8	7.09	6.91	11	78	0	230
	BAMR WB	*	CC8E	9/18/1997	*	*	4.7	62	1.06	2.59	17.8	2	63
	BAMR WB	*	CC8E	10/16/1997	*	*	4.8	0.056	1.17	3.03	20	2.6	48
	BAMR WB	*	CC8E	11/13/1997	*	*	4.8	0.057	0.817	2.27	12.2	2.2	47
	BAMR WB	*	CC8E	1/21/1998	*	*	5	0.098	0.334	1.02	9.8	2.4	26
	BAMR WB	*	CC8E	4/6/1998	*	*	5.2	0.113	0.388	1.1	7.8	2.6	35
	BAMR WB	*	CC8E	7/6/1998	*	*	4.8	0.098	0.684	1.8	15.6	2.6	45
	BAMR WB	*	CC8E	10/6/1998	*	*	4.7	0.072	0.943	2.53	15.4	1.6	69
	BAMR WB	*	CC8E	2/2/1999	*	*	5.1	0.546	0.38	1.75	4.4	2.8	29
	BAMR WB	*	CC8E	4/14/1999	*	*	5.2	0.125	0.277	0.872	5	2.8	29
	BAMR WB	*	CC8E	11/4/1999	*	*	4.8	0.03	0.606	2.03	12.4	2.2	60
	BAMR WB	*	CC8E	2/1/2000	*	*	4.9	0.11	0.586	1.71	12.4	2.4	48
	BAMR WB	*	CC8E	4/14/1999	*	*	5.2	0.125	0.277	0.872	5	2.8	29
	BAMR WB	*	CC8E	11/4/1999	*	*	4.8	0.03	0.606	2.03	12.4	2.2	60
	BAMR WB	*	CC8E	2/1/2000	*	*	4.7	0.241	0.54	2.32	16.4	1.6	40
	BAMR WB	*	CC8E	4/13/2000	*	*	5.2	0.101	0.271	0.892	4	2.8	32
	BAMR WB	*	CC8E	7/13/2000	*	*	4.9	0.11	0.586	1.71	12.4	2.4	48
	BAMR WB	*	CC8E	10/3/2000	*	*	4.9	0.099	0.828	2.38	11.6	2.2	63
	BAMR WB	*	CC8E	1/11/2001	*	*	4.9	0.158	0.527	1.76	10.8	2.4	40
	BAMR WB	*	CC8E	4/24/2001	*	*	5.2	0.1	0.307	0.818	3	2.6	33
	BAMR WB	*	CC8E	7/17/2001	*	*	4.8	0.073	0.724	1.61	33.6	1.8	49.8
	BAMR WB	*	CC8E	10/30/2001	*	*	4.7	0.086	1.08	2.98	48.8	9.2	68.5
	BAMR WB	*	CC8E	2/25/2002	*	*	4.9	0.06	0.49	1.33	36.6	2.2	34.7
				Average	*****	*****	**4.96**	**1.51**	**0.85**	**1.97**	**16.77**	**2.78**	**49.51**

TMDL Pt	Company	Permit #	Location	Date	Flow	pH (f)	pH (l)	Fe	Mn	Al	Acidity	Alk.	Sulfate
				St Dev	*****	*****	**0.47**	**8.47**	**1.45**	**1.48**	**20.14**	**2.07**	**43.55**
TC5	BAMR WB	*	TC5	3/13/1997	*	*	7.2	0.322	0.112	0.258	0	22	13
	BAMR WB	*	TC5	3/27/1997	*	*	6.4	0.197	0.127	0.277	0	12.6	15
	BAMR WB	*	TC5	4/7/1997	*	*	6.3	0.167	0.08	0.205	0	9.4	10
	BAMR WB	*	TC5	4/23/1997	*	*	6.6	0.142	0.041	0.135	0	20	10
	BAMR WB	*	TC5	5/20/1997	*	*	6.3	0.603	0.081	0.569	1.6	10.6	10
	BAMR WB	*	TC5	6/24/1997	*	*	6.5	0.809	0.085	0.369	0	19.6	21
	BAMR WB	*	TC5	6/25/1997	*	*	6.5	0.809	0.085	0.369	0	19.6	21
	BAMR WB	*	TC5	7/24/1997	*	*	6.8	1.57	0.127	0.9	0	36	13
	BAMR WB	*	TC5	8/21/1997	*	*	5.9	1.31	0.442	8.39	13	4.2	38
	BAMR WB	*	TC5	9/18/1997	*	*	6.6	0.261	0.033	0.2	0	56	65
	BAMR WB	*	TC5	10/16/1997	*	*	6.9	0.219	0.024	0.2	0	78	84
	BAMR WB	*	TC5	11/13/1997	*	*	6.5	0.339	0.034	0.24	0	24	21
	BAMR WB	*	TC5	1/21/1998	*	*	6.2	0.162	0.094	0.207	4.2	7.4	10
	BAMR WB	*	TC5	4/6/1998	*	*	6.3	0.59	0.071	0.427	3.2	7.2	54
	BAMR WB	*	TC5	7/6/1998	*	*	6.3	0.933	0.055	0.292	0	16.8	10
	BAMR WB	*	TC5	10/6/1998	*	*	6.7	0.702	0.002	0.2	0	34	20
	BAMR WB	*	TC5	2/2/1999	*	*	6.2	0.721	0.187	0.955	0	7.8	20
	BAMR WB	*	TC5	4/14/1999	*	*	6.4	0.363	0.075	0.233	0	13.6	20
	BAMR WB	*	TC5	11/4/1999	*	*	6.3	0.12	0.084	0.4	1.2	8.6	20
	BAMR WB	*	TC5	2/1/2000	*	*	6.9	0.24	0.066	0.2	0	46	24
	BAMR WB	*	TC5	4/13/2000	*	*	6.2	0.239	0.078	0.265	0	8.4	20
	BAMR WB	*	TC5	7/13/2000	*	*	6.4	0.671	0.039	0.2	0	19.2	23
	BAMR WB	*	TC5	10/3/2000	*	*	7.2	0.889	0.022	<0.200	0	38	29
	BAMR WB	*	TC5	1/11/2001	*	*	6.8	0.583	0.094	0.385	0	38	35
	BAMR WB	*	TC5	4/24/2001	*	*	6.4	0.247	0.09	<0.200	0	7.4	<20
	BAMR WB	*	TC5	7/17/2001	*	*	6.6	0.517	0.056	<0.200	0	24	20.5
	BAMR WB	*	TC5	10/30/2001	*	*	6.5	0.175	0.018	<0.200	0	40	46.8
	BAMR WB	*	TC5	2/25/2002	*	*	6.7	0.13	0.06	<0.200	0	26	20.3
				Average	*****	*****	**6.52**	**0.50**	**0.08**	**0.69**	**0.83**	**23.37**	**25.69**
				St Dev	*****	*****	**0.30**	**0.37**	**0.08**	**1.69**	**2.59**	**17.26**	**17.98**
O3 Tunnel	BAMR WB	*	O3 Tunnel	7/24/96	*	*	4.4	0.141	0.474	1.95	16.4	6	45
	BAMR WB	*	O3 Tunnel	8/12/96	*	*	4.5	0.119	0.427	1.64	14.6	6.4	36
	BAMR WB	*	O3 Tunnel	9/25/96	1398.95	*	4.6	0.093	0.479	1.63	16.2	8.2	30
	BAMR WB	*	O3 Tunnel	10/24/96	3429.51	*	4.4	0.142	0.362	2.05	24	6.6	95

TMDL Pt	Company	Permit #	Location	Date	Flow	pH (f)	pH (l)	Fe	Mn	Al	Acidity	Alk.	Sulfate
	BAMR WB	*	O3 Tunnel	11/25/96	3429.96	*	4.7	0.105	0.31	1.2	15.8	8.4	27
	BAMR WB	*	O3 Tunnel	12/30/96	7415.46	*	4.7	0.085	0.267	1.05	26	9.2	22
	BAMR WB	*	O3 Tunnel	1/30/97	2057.89	*	4.7	0.104	0.35	1.11	19.2	7.2	26
	BAMR WB	*	O3 Tunnel	2/25/97	2937.65	*	4.5	1.11	0.359	1.7	15.6	7.4	28
	BAMR WB	*	O3 Tunnel	3/26/97	1734.95	*	4.6	0.108	0.329	1.19	13	7.2	<20
	BAMR WB	*	O3 Tunnel	4/29/97	1953.7	*	4.7	0.098	0.4	1.24	14.8	9.8	25
	BAMR WB	*	O3 Tunnel	5/28/97	1374.18	*	4.6	0.101	0.348	1.21	12.6	7.2	*
	BAMR WB	*	O3 Tunnel	6/23/97	1183.79	*	4.7	0.12	0.394	1.34	12.2	8.2	20
	BAMR WB	*	O3 Tunnel	7/31/97	1452.16	*	4.7	0.512	0.485	1.58	13	8.4	<20
	BAMR WB	*	O3 Tunnel	8/25/97	1075.23	*	4.6	0.102	0.523	1.83	22	7.2	37
	BAMR WB	*	O3 Tunnel	9/23/97	484.51	*	4.6	0.1	0.63	2.09	19	8.2	<20
	BAMR WB	*	O3 Tunnel	11/4/97	781.3	*	4.7	0.088	0.622	2.21	15.2	8.4	26
	BAMR WB	*	O3 Tunnel	11/25/97	973.21	*	3.9	1.31	7.28	1.4	94	0	243
	BAMR WB	*	O3 Tunnel	1/5/98	968.52	*	4.4	0.198	0.485	2.19	18.4	7.6	29
	BAMR WB	*	O3 Tunnel	1/27/98	2384.58	*	4.4	0.123	0.387	1.92	13.6	7.4	23
	BAMR WB	*	O3 Tunnel	2/25/98	7486.48	*	4.4	0.156	0.336	1.68	19.4	7	<20
	BAMR WB	*	O3 Tunnel	3/31/98	5164.35	*	4.5	0.09	0.321	1.21	13.2	7.2	<20
	BAMR WB	*	O3 Tunnel	4/21/98	9014.19	*	4.6	0.131	0.316	1.55	14.8	10.4	24
	BAMR WB	*	O3 Tunnel	5/27/98	3806.25	*	4.7	0.09	0.319	1.17	11.4	8	31
	BAMR WB	*	O3 Tunnel	6/20/98	2455.77	*	4.6	0.11	0.37	1.33	12	7.8	<20
	BAMR WB	*	O3 Tunnel	7/19/98	1615.9	*	4.7	0.096	0.542	1.53	13.4	8.4	30
	BAMR WB	*	O3 Tunnel	8/15/98	*	*	4.7	0.078	0.476	1.52	16	8.6	36
	BAMR WB	*	O3 Tunnel	9/19/98	766.99	*	4.7	0.1	0.552	1.82	10.2	8	43
	BAMR WB	*	O3 Tunnel	10/31/98	1176.33	*	4.7	0.102	0.565	2.09	13.4	8.4	38
	BAMR WB	*	O3 Tunnel	11/21/98	837.29	*	4.7	0.091	0.541	1.83	16	8.6	33
	BAMR WB	*	O3 Tunnel	12/19/98	920.35	*	4.7	0.074	0.532	1.7	17.8	8.6	39.6
	BAMR WB	*	O3 Tunnel	1/30/99	7255.06	*	4.4	0.122	0.351	1.9	16.4	6.2	21
	BAMR WB	*	O3 Tunnel	3/6/99	4005.25	*	4.6	0.114	0.337	1.38	13	7.4	29
	BAMR WB	*	O3 Tunnel	4/3/99	2765.97	*	4.5	0.115	0.359	1.53	14.2	7.2	25
	BAMR WB	*	O3 Tunnel	4/25/99	1759.41	*	4.5	0.092	0.32	1.26	10.2	7.2	27
	BAMR WB	*	O3 Tunnel	6/5/99	*	*	4.7	0.08	0.401	1.29	10.6	8.8	29
	BAMR WB	*	O3 Tunnel	7/31/99	757.68	*	4.7	0.092	0.546	1.72	12	7.6	34
	Shepco	54840103R2	O3 Tunnel	6/15/2000	*	*	4.4	0.171	0.376	1.69	14.6	6	29
	Shepco	54840103R2	O3 Tunnel	9/20/2000	*	*	4.6	0.112	0.584	1.86	15.6	8.2	35
	Shepco	54840103R2	O3 Tunnel	1/18/1999	*	*	4.5	0.144	0.47	1.75	22	7.4	116
	Shepco	54840103R2	O3 Tunnel	5/24/1996	*	*	4.6	0.423	0.406	1.29	22	7.4	155.1
	Shepco	54840103R2	O3 Tunnel	8/3/1995	*	*	4.6	<0.3	0.47	1.55	13.2	7.6	31

TMDL Pt	Company	Permit #	Location	Date	Flow	pH (f)	pH (l)	Fe	Mn	Al	Acidity	Alk.	Sulfate
	Shepco	54840103R2	O3 Tunnel	5/18/1994	*	4.76	4.55	0.11	0.35	1.03	10	0	42.51
	Shepco	54840103R2	O3 Tunnel	3/28/1994	*	*	4.5	<0.3	0.428	2.13	19.2	7	29
				Average	**2650.71**	**4.76**	**4.57**	**0.18**	**0.59**	**1.59**	**17.35**	**7.40**	**44.14**
				St Dev	**2278.34**	*****	**0.15**	**0.25**	**1.05**	**0.33**	**12.55**	**1.89**	**43.67**
TC1	BAMR WB	*	TC1	1/11/2001	5632.44	*	5.8	0.119	0.266	0.563	2.4	3.4	29
	BAMR WB	*	TC1	4/24/2001	17404.46	*	5.9	0.123	0.188	0.486	2.8	3.4	21
	BAMR WB	*	TC1	7/17/2001	*	*	6.1	0.114	0.225	<0.200	15.6	5.6	26.3
	BAMR WB	*	TC1	10/30/2001	*	*	6	0.301	0.065	<0.200	8.6	10.6	49
	BAMR WB	*	TC1	2/25/2002	*	*	6.2	0.1	0.12	0.208	25.2	7.2	24.9
				Average	**11518.45**	*****	**6.00**	**0.15**	**0.17**	**0.42**	**10.92**	**6.04**	**30.04**
				St Dev	**8324.08**	*****	**0.16**	**0.08**	**0.08**	**0.19**	**9.61**	**3.01**	**10.99**
CC9	BAMR WB	*	CC9	1/11/2001	*	*	4.9	0.189	0.459	1.57	8.6	2.2	39
	BAMR WB	*	CC9	4/24/2001	*	*	5.4	0.136	0.292	0.785	2	2.6	23.6
	BAMR WB	*	CC9	7/17/2001	*	*	4.7	0.054	0.597	0.889	27	1.8	44.5
	BAMR WB	*	CC9	10/30/2001	*	*	4.7	0.061	0.898	2.26	43.2	1.8	58.9
	BAMR WB	*	CC9	2/25/2002	*	*	5	0.06	0.4	0.992	38.6	2.4	31
				Average	*****	*****	**4.94**	**0.10**	**0.53**	**1.30**	**23.88**	**2.16**	**39.40**
				St Dev	*****	*****	**0.29**	**0.06**	**0.23**	**0.62**	**18.11**	**0.36**	**13.48**
CC10	H_20 Auth	*	CC10	4/10/1990	*	*	5.6	0.09	0.3	*	*	20.4	*
	H_20 Auth	*	CC10	4/13/1990	*	*	5.7	0.15	0.2	*	*	13.6	*
	H_20 Auth	*	CC10	4/28/1990	*	*	5.6	0.09	0.3	*	*	20.4	*
	H_20 Auth	*	CC10	7/3/1990	*	*	5.7	0.17	0.431	*	*	13.6	*
	H_20 Auth	*	CC10	7/20/1990	*	*	5.6	0.17	0.366	*	*	20.4	*
	H_20 Auth	*	CC10	7/24/1990	*	*	5.4	0.05	0.357	*	*	20.4	*
	H_20 Auth	*	CC10	10/10/1990	*	*	4.8	0.15	0.345	*	*	13.6	*
	H_20 Auth	*	CC10	10/11/1990	*	*	4.5	0.09	0.478	*	*	13.6	*
	H_20 Auth	*	CC10	2/18/1997	*	*	6.22	*	0.31	*	*	20.4	*
	H_20 Auth	*	CC10	2/25/1997	*	*	5.97	*	*	*	*	20.4	*
	H_20 Auth	*	CC10	2/26/1997	*	*	5.98	*	*	*	*	13.6	*
	H_20 Auth	*	CC10	2/27/1997	*	*	5.85	*	*	*	*	13.6	*
	H_20 Auth	*	CC10	4/16/1997	*	*	6.2	0.08	0.238	*	*	20.4	*
	H_20 Auth	*	CC10	5/9/1997	*	*	6.77	*	*	*	*	20.4	*
	H_20 Auth	*	CC10	5/13/1997	*	*	6.67	*	*	*	*	20.4	*
	H_20 Auth	*	CC10	5/14/1997	*	*	6.63	*	*	*	*	20.4	*

TMDL Pt	Company	Permit #	Location	Date	Flow	pH (f)	pH (l)	Fe	Mn	Al	Acidity	Alk.	Sulfate
	H_20 Auth	*	CC10	10/23/1997	*	*		0.16	0.66	*	*	*	*
	H_20 Auth	*	CC10	11/6/1997	*	*	6.55	0.14	0.396	*	*	20.4	*
	H_20 Auth	*	CC10	11/13/1997	*	*	6.74	*	*	*	*	20.4	*
	H_20 Auth	*	CC10	11/14/1997	*	*	6.87	*	*	*	*	20.4	*
	H_20 Auth	*	CC10	11/17/1997	*	*	6.76	0.08	0.298	*	*	20.4	*
	H_20 Auth	*	CC10	11/18/1997	*	*	6.96	*	*	*	*	20.4	*
	H_20 Auth	*	CC10	11/24/1997	*	*	6.9	0.17	0.237	*	*	20.4	*
	H_20 Auth	*	CC10	11/26/1997	*	*	6.4	0.06	0.281	*	*	20.4	*
	H_20 Auth	*	CC10	2/16/1998	*	*	6.01	0	0.253	*	*	20.4	*
	H_20 Auth	*	CC10	2/17/1998	*	*	5.89	0.08	0.253	*	*	20.4	*
	H_20 Auth	*	CC10	2/18/1998	*	*	6.46	0.08	0.22	*	*	20.4	*
	H_20 Auth	*	CC10	2/19/1998	*	*	6.55	0.15	0.169	*	*	20.4	*
	H_20 Auth	*	CC10	2/20/1998	*	*	6.72	0.14	0.152	*	*	20.4	*
	H_20 Auth	*	CC10	3/9/1998	*	*	7.21	0.09	0.235	*	*	20.4	*
	H_20 Auth	*	CC10	3/10/1998	*	*	7	0.09	0.179	*	*	20.4	*
	H_20 Auth	*	CC10	9/22/1998	*	*	6.64	0.21	0.356	*	*	20.4	*
	H_20 Auth	*	CC10	2/18/1999	*	*	6.67	0.07	0.31	*	*	20.4	*
		*	CAT0.2	8/9/1993	16,693.12	4.8	4.7	0.042	0.685	1.44	12.8	2	58
		*	CAT0.2	8/16/2001	24,824.92	6	5.8	0.116	0.456	0.254	*	3.4	43.8
				Avg	20,759.02	5.40	6.18	0.11	0.33	0.85	12.80	18.16	50.90
				St Dev	5,750.05	0.85	0.68	0.05	0.13	0.84	*	4.72	10.04

Note: All flow data are shown in units of gallons per minute (gpm); all concentration data are shown in units of milligrams per liter (mg/L); pH(f)- field pH; pH(l)- laboratory pH

SRBC
SRBC

Attachment G

Comment and Response

Comments/Responses on Catawissa Creek Watershed TMDL

EPA Region III Comments

Comment:
In *Table 2. Mining Permits in the Catawissa Creek Watershed*, it is assumed that PADEP intends to supply information missing from this table. If a facility does not have a National Pollutant Discharge Elimination System (NPDES) permit, use “none” in that column. Any facility with a NPDES permit will require a waste load allocation (WLA). Should the Stage 2 Bond release and Bond Release facilities have NPDES permits, an appropriate WLA is equal to their present permit limits.

Response:
The appropriate text has been added to Table 2. Four of the mining facilities do not have NPDES permits since they do not produce a discharge. The fifth has an NPDES permit for a storm water erosion and sedimentation basin. The basin never receives water from a mine opening and has no record of ever discharging; therefore a waste load allocation is not necessary for this NPDES permit.

Comment:
Please modify the standard language in *Attachment E* that refers to “instream” concentrations for iron, manganese, aluminum and acidity in each tunnel discharge section to clarify that the tunnel discharge, in instream flow, has been monitored and that the TMDL is being developed for the tunnel discharge.

Response:
The word “instream” has been removed from the text. The text now reads, “An average flow measurement was calculated from available flow data for point…”

Comment:
It is unclear why an allocation for the Oneida 1 Tunnel has not been developed. The monitoring data indicates the average aluminum concentration is greater than 3 mg/l. An allocation for aluminum should be developed.

Response:
Text has been added to explain why a load allocation is not necessary for the Oneida #1 treatment system. The aluminum data referenced above is the amount found in the discharge before it is treated.

Comment:
In *Attachment E, sample point CC10*, EPA agrees that it is inappropriate to develop a TMDL based on totally inadequate data. However, the Catawissa Creek is listed for metals and failing to develop TMDLs for all metals could eliminate that segment as having TMDLs completed and counting toward the Consent Decree’s requirements, especially as “observations for aluminum and pH in the downstream segment of Catawissa Creek indicate that they also may be violating water quality standards.”

Appendix E states that BMPs used to reduce iron and manganese loads will also reduce aluminum and acidity loads. Should PADEP believe that these BMPs, together with upstream removal of aluminum and acidity, will achieve water quality standards at Sampling Point CC10, allocations could be equal to the water quality standard and then TMDLs would be complete for that segment.

Response:
This TMDL establishes that loading reductions are not necessary at point CC10. The available data for iron and manganese show that they are meeting the water quality standards, see data in Attachment F. The text, “observations for aluminum and pH in the downstream segment of Catawissa Creek indicate that they also may be violating water quality standards,” was included inadvertently and has been deleted. The Catawissa Water Authority has indicated that they do not experience any problems from aluminum and the average pH at their intake is 6.18.

Comment:
Due to the scale of the map, the actual location of Sampling Point CC9 is unclear. Please identify whether it is upstream or downstream of the junction of Catawissa Creek and tributary 27565.

Response:
Text has been added to explain that CC9 is above the confluence of unnamed tributary 27565.

Comment:
The following comments are basically editorial in nature:

On *Page 4*, the third bullet should be revised to read “every *two* years...”

On Page 7, the third paragraph should read, “For two years the group were *adding* limestone...”

In *Recommendations,* third paragraph, identify the expected date for the implementation of the Oneida #3 treatment system, if known.

In *Attachment A*, please consider increasing the label size because they are very difficult to read.

The terms “Catawissa Tunnel” and “C Tunnel” are used interchangeably. It would be helpful to state that C Tunnel means Catawissa Tunnel.

Response:
The following changes have been made in the text where appropriate.

Citizen’s for Pennsylvania’s Future (PennFuture) Comments

Comment:
“Abandoned” Mine Discharges

The draft TMDL report states that "[a]ll impairments are a result of acid drainage from abandoned coal mines" (p. 1), and later explains that only those "discharges that are permitted or have a responsible party… are considered point sources." (p. 20) The description of all of the sources of impairments as "abandoned" coal mines with no associated "responsible party" may be inaccurate or misleading in two respects.

First, the draft TMDL report identifies several regulated mining operations in the Catawissa Creek watershed. (pp. 6-7 & Table 2) From the description of the drainage tunnels in the "Watershed Background" section, it appears possible that some of these regulated mines are located in the recharge area for one of the drainage tunnels, or in other words, that the mine is hydrologically connected to the tunnel. If a regulated mine contributes to the discharge from a drainage tunnel, then the mine operator may be responsible for treating the discharge from the tunnel. See 35 P.S. 691.307(a), 691.316; C&K Coal Co. v. DER. 1987 EHB 786, 789 ("liability for the treatment or abatement of an off-permit, pre-existing discharge may be imposed under 315(a) of the Clean Streams Law where there is a hydrologic connection between the mining operation and the off-permit discharge"). To substantiate the classification of all the pollution sources as "abandoned" mines, the draft TMDL report should demonstrate that no hydrologic connection exists between any of the regulated mining operations and any of the drainage tunnels.

Second, the Department should not assume that the tunnels themselves are abandoned. It is possible than an existing company is the successor in interest to the person or entity that originally built a particular tunnel. There also may be an owner(s) of record of the tunnel itself or a larger interest in real property that includes the tunnel. Under the NPDES program and the Clean Streams Law, the owner or operator of a tunnel that adds pollutants to the waters of the Commonwealth must have a permit authorizing the discharge. See 33 U.S.C. 1311(a), (g)(2), 1342(a), (b), 1362(14); 35 P.S. 691.315(a), 691.316; 25 Pa. Code 92.3. See also Commonwealth v. Barnes & Tucker Co., 371 A.2d 461 (Pa. 1977). Again, the Department should conduct an exhaustive search for potentially responsible parties before characterizing all of these drainage tunnels as "abandoned."

Response:
The mines that are/were operating in the Catawissa Creek watershed do not have any mine drainage NPDES permits. These facilities do not produce any discharges. The term abandoned is used specifically for sources of pollution that are not controlled by the NPDES program. The mines that built and utilized the tunnels were closed before Pennsylvania's Clean Streams Law was passed. Therefore, the tunnel discharges are classified as nonpoint sources of pollution since there are no associated NPDES permits.

Comment:
Sugarloaf Creek / Oneida #1 Treated Tunnel

The draft TMDL report should either demonstrate that Sugarloaf Creek is no longer impaired or include a determination of the load reduction necessary to alleviate any continuing impairment. It does neither.

Because the treatment system for the Oneida #1 Tunnel did not go on line until July 2001, PennFuture suspects that a new stream survey assessing its impact could not be performed before DEP prepared the Section 303(d) list submitted to EPA in September 2002, which continues to list 3.4 miles of the creek as impaired by mine drainage. The discussion of Sugarloaf Creek and the "Oneida #1 Treated Tunnel" on page 44 of the draft TMDL does not directly state that the stream now meets all applicable water quality standards. If it does not, then the TMDL must include a determination of the load reductions that are necessary to achieve all of the applicable standards, but no such determination is provided in the draft TMDL report.

Although the net alkalinity in the effluent from the passive treatment system for the Oneida #1 tunnel discharge indicates that Sugarloaf Creek should be meeting the instream criterion for pH, the discussion of the creek and the treatment system never mentions iron or the system's iron removal efficiency. The description of the effluent suggests that the new passive treatment system may not be removing enough aluminum for the creek to satisfy the aluminum instream criterion at least 99 percent of the time. If that is true, then DEP must perform a load allocation or wasteload allocation for aluminum. In addition, if Sugarloaf Creek is not meeting the instream criterion for iron, DEP must also perform a similar allocation for iron.

Response:
Text has been added to the discussion of the Oneida #1 treatment system to address the comments on iron and aluminum reductions.

Comment:
Instream Water Quality Criteria for Iron

The "TMDL Endpoints" (p.8) appropriately include the instream water quality criteria for both total recoverable iron and dissolved iron. These two criteria are not substitutable, "either/or" standards. They are legally independent in that each of them must be satisfied at least 99 percent of the time. See 25 Pa. Code 93.7(a), 96.3(c). If a stream satisfies the total iron instream criterion but not the dissolved iron criterion, it is impaired, and the TMDL must determine the load reductions necessary to ensure compliance with the dissolved iron criterion.

DEP has reason to believe that some if not all of the impaired segments do not meet the instream criterion for dissolved iron. EPA's TMDL guidance provides that "[a] TMDL must identify the loading capacity of a waterbody for the applicable pollutant." (EPA "Guidelines for Reviewing TMDLs under Existing Regulations Issued in 1992, " May 20, 2002, p. 2) Nevertheless, the draft TMDL report does not address dissolved iron loads or indicate whether achieving the load reductions necessary to attain the total iron instream criterion also would result in attainment of the instream criterion for dissolved iron. The draft report explains that "[t]he iron TMDLs are expressed as total recoverable as the iron data used for this analysis was reported as total recoverable." (p. 8) In other words, because the monitoring data does not include dissolved iron concentrations, DEP is treating total recoverable iron as the one and only iron parameter and the one and only iron criterion that must be satisfied. The draft TMDL report therefore does not address dissolved iron or demonstrate that the instreeam criterion for dissolved iron will be achieved.

The shortcoming of the monitoring data, however, does not excuse DEP from addressing dissolved iron. The TMDL must demonstrate load reductions necessary to satisfy all applicable water quality criteria. By impermissibly eliding over the regulatory independence of the dissolved and total iron criteria, and by failing to demonstrate what load reductions are necessary to achieve the instream criterion for dissolved iron, the draft TMDL report does not adequately address all applicable water quality standards.

It may be that through other monitoring data or documented relationships between the concentrations of total and dissolved iron in mine drainage, DEP can demonstrate, with a reasonable degree of confidence, that the necessary reductions in total iron loads identified in the draft TMDL report will result in attainment of the dissolved iron instream criterion. Perhaps DEP cannot make this demonstration without further monitoring in the Catawissa Creek watershed that includes analysis of dissolved iron concentrations. One way or another, however, DEP must show what must be done in order to ensure that the impaired streams are no longer impaired by a well-known constituent of mine drainage, dissolved iron. As it stands, the draft TMDL report simply does not make this required showing.

Response:
The TMDL process uses existing and readily accessible data; it does not require further monitoring for the streams that have existing data. The total iron criteria is considered to be the most conservative, i.e. most protective, standard that can be used since it takes into account both dissolved and particulate iron concentrations. In addition, the water quality standards are based on a biological endpoint, the condition of the aquatic macroinvertebrate community. It is this endpoint that will indicate if the designated uses are being attained. Furthermore, the AMD discharges in the Catawissa Creek Watershed have low levels of total iron that is easily removed in treatment, as shown by the Oneida #1 treatment system. Since the concentration of total iron is not problematic in the watershed, it can be assumed that the concentration of dissolved iron is not problematic either.

Comment:
Lack of an Implementation Plan

What will produce the considerable load reductions that the draft TMDL report says are necessary to achieve water quality standards? The "[t]wo primary programs" cited in the "Recommendations" section of the draft TMDL report are the NPDES permitting program and DEP's "efforts to reclaim abandoned mine lands." (p. 11)

The draft report classifies all the tunnel discharges, and indeed all of the loading sources in the entire Catawissa Creek watershed, as nonpoint sources (p. 20), which is why all of the permissile wasteloads are allocated through a Load Allocation. The NPDES permitting program, however, is limited to point sources discharges. See 25 Pa. Code 92.3. It is incoungruous, is not disingenuious, to rely on a program that does not apply to nonpoint source discharges for the purpose of achieving reductions in loads from sources DEP has classified in the same document as nonpoint sources. Cf. EPA May 20, 2002 Guidelines, p. 4 ("When a TMDL is developed for waters impaired by point sources only, the issuance of a National Pollutant Elimination System

(NPDES) permit(s) provides the reasonable assurance that the wasteload allocation contained in the TMDL will be achieved.")(emphasis added)

As for the various efforts to reclaim abandoned mine lands, the draft TMDL report gives no assurance that the programs will be able to make a significant dent in the watershed's reclamation problem. The report states that DEP's Bureau of Abandoned Mine Reclamation has "completed at least two restorations of abandoned mine land in the Catawissa Creek Watershed" in the more than twenty years that program has been in operation. (p. 11) The report does not estimate the percentage of the abandoned mine lands in the watershed that those two projects reclaimed. It also does not indicate the number of abandoned mine lands in the watershed remaining in the watershed or the approximate cost of reclaiming those lands. It is well known that Pennsylvania annually receives about $20-25 million for reclamation of abandoned mine lands from the federal Abandoned Mine Land Fund, but needs about $15 million to complete all the remaining reclamation work in the state. Even when these projects are augmented with Growing Greener grants and funding from other sources, as well as reclamation being achieved through refuse bank reclamation operations or other remining activities, it seems likely that it will be a long time before the reclamation of the abandoned mine lands described in the draft TMDL report is completed. Again, this assessment may be incorrect. Reclamation projects with significant loading benefits through infiltration reduction or other mechanisms could be on the horizon. But given the intense competition for scarce AML funds statewide, the draft TMDL report does not demonstrate that the second "primary program" will be able to contribute in the foreseeable future to achieving the necessary load reductions.

This discussion points to the overall problem of the lack of an implementation plan in the draft TMDL report. Although EPA says that it cannot disapprove a TMDL for "waters impaired only by nonpoint sources" for failure to provide a "demonstration of reasonable assurance that [Load Allocations] will be achieved, " (EPA May 20, 2002 Guidelines, pp. 4-5), the TMDL process obviously is a more meaningful exercise if such "reasonable assurance" is provided. Moreover, if DEP determines that there is a responsible party (or parties) for one or more of the discharges addressed by the draft TMDL report, then the relevant waters would be impaired by both point and nonpoint sources as classified by DEP. In that situation, EPA's guidance states that : The TMDL should provide reasonable assurances that nonpoint source control measures will achieve expected load reductions in order for the TMDL to be approveable." (EPA May 20, 2002 Guidelines, p. 4).

PennFuture by no means intends to slight the tremendous efforts of the Catawissa Creek Restoration Association and its consultants. It is a testament to Mr. Hedin and his firm, Mr. Wytovich, and all of the Association's volunteers that they are undaunted by the flow and water quality measurements for the Audenried drainage tunnel discharge. But like the watershed's potential abandoned mine land reclamation projects, these volunteer mine drainage treatment projects are part of an intense statewide competition for funding. Moreover, as aluminum monitoring results for the Oneida #1 tunnel discharge appear to show, passive treatment systems may not achieve all of the load reductions that the draft TMDL report identifies as being necessary to achieve all applicable water quality standards.

Given all of the practical complications, it may be difficult for DEP to provide assurance that the necessary load reduction actually will be achieved. But it is misleading to suggest that the NPDES and abandoned mine land reclamation programs will take care of the contaminant loading problems in the Catawissa Creek watershed within any reasonable time frame. If the TMDL is to provide meaningful, workable solution for the watershed's pollution problems, it should include a workable implementation plan.

Response:
A preliminary schedule of reclamation and the resources necessary to complete the reclamation are considered to be part of an implementation plan. Based on current regulations, an implementation plan is not required for this TMDL, therefore; this comment will not be addressed.