TIOGA RIVER WATERSHED TMDL
Tioga County

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 Tioga River Watershed (Attachment A). It was done to address the impairments noted on the 1996, 1998, and draft 2002 Pennsylvania 303(d) lists required under the Clean Water Act. 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 resulted from 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. Tioga River Segments Addressed

State Water Plan (SWP) Subbasin: 04-A Tioga River								
Year	***Miles***	***Segment ID***	***DEP Stream Code***	***Stream Name***	***Designated Use***	***Data Source***	***Source***	***EPA 305(b) Cause Code***
1996	3	7214	30990	Tioga River	Basin: source to Mill Creek – CWF; Basin: Mill Creek to Crooked Creek – CWF; Basin: Crooked Creek to PA/NY border	305(b) Report	Resource Extraction	Metals
1998	0.98	7214	30990	Tioga River	Basin: source to Mill Creek – CWF; Basin: Mill Creek to Crooked Creek – CWF; Basin: Crooked Creek to PA/NY border	SWMP	AMD	Metals
2002	19.6	990811-1515-JLR	30990	Tioga River	Basin: source to Mill Creek – CWF; Basin: Mill Creek to Crooked Creek – CWF; Basin: Crooked Creek	SWAP	AMD	Metals pH

[1] Pennsylvania's 1996 and 1998 Section 303(d) lists were approved by the U.S. Environmental Protection Agency (USEPA). The 2000 Section 303(d) list was not required by 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: 04-A Tioga River								
Year	**Miles**	**Segment ID**	**DEP Stream Code**	**Stream Name**	**Designated Use**	**Data Source**	**Source**	**EPA 305(b) Cause Code**
					to PA/NY border			
1996	This segment not included on the 1996 Section 303(d) list.			Bear Creek				
1998	This segment not included on the 1998 Section 303(d) list.			Bear Creek				
2002	3.9	990810-1050-JLR	31442	Bear Creek	CWF	SWAP	AMD	Metals pH
1996	This segment not included on the 1996 Section 303(d) list.			Coal Creek				
1998	This segment not included on the 1998 Section 303(d) list.			Coal Creek				
2002	3.9	990810-1050-JLR	31476	Coal Creek	CWF	SWAP	AMD	Metals pH
1996	This segment not included on the 1996 Section 303(d) list.			Coal Creek, Unt				
1998	This segment not included on the 1998 Section 303(d) list.			Coal Creek, Unt				
2002	3.9	990810-1050-JLR	31477	Coal Creek, Unt	CWF	SWAP	AMD	Metals pH
1996	This segment not included on the 1996 Section 303(d) list.			Fellows Creek				
1998	This segment not included on the 1998 Section 303(d) list.			Fellows Creek				
2002	3.4	990728-1145-JLR	31534	Fellows Creek	CWF	SWAP	AMD	Metals pH
1996	This segment not included on the 1996 Section 303(d) list.			Johnson Creek				
1998	This segment not included on the 1998 Section 303(d) list.			Johnson Creek				
2002	5.2	20000619-1131-JLR	31443	Johnson Creek	CWF	SWAP	AMD	Metals pH
	2.8	20000619-1411-JLR				SWAP	AMD	Metals pH

Attachment B includes a justification of differences between the 1996, 1998, and draft 2002 303(d) lists.

CWF = Cold Water Fishes
RE = Resource Extraction
AMD = Abandoned Mine Drainage
SWMP = Surface Water Monitoring Program
SWAP = Surface Water Assessment Program

In addition to the segments listed, TMDLs were revised for the following segments because more recent data were available for the segments: Morris Run (stream code 31480), unnamed tributaries to Morris Run (stream codes 31481, 31483, 31484, 31485, 31486, 31487, 31488), Fall Brook (stream code 31506) and unnamed tributaries to Fall Brook (stream codes 31519, 31521, 31522, 31523). TMDLs for these stream codes were approved by EPA in 2001.

LOCATION

The Tioga River Watershed is located in Tioga and Bradford Counties about 35 miles north of Williamsport, Pennsylvania. It originates in Armenia Township, Bradford County and travels southwest towards the town of Blossburg. In Blossburg, the Tioga turns direction and flows north through Mansfield and into the Tioga/Hammond Dam Complex. The Tioga River can be accessed by traveling on US Route 15 north from Williamsport, Pennsylvania or south from Corning, New York.

SEGMENTS ADDRESSED IN THIS TMDL

The Tioga River Watershed is affected by pollution from AMD. This pollution has caused high levels of metals and low pH in the mainstem of Tioga River and in some of its tributaries. From historical records and field observations, it was determined that the majority of AMD degradation in the watershed is due to abandoned deep mines in the Morris Run, Fall Brook, Bear Creek, Coal Creek and Johnson Creek subwatersheds.

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

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

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 Tioga River Watershed TMDL.

WATERSHED BACKGROUND

Coal was discovered in the Tioga River Watershed in the "Peters Camp" area (now Blossburg) in 1792 by workers creating a road from Loyalsock, Pa. to Painted Post, NY (Blossburg Homepage). Between 1812 and 1815, the first mine was opened in the Bear Creek Watershed to supply markets in southern New York, Albany and Philadelphia (Blossburg Homepage). In September 1840, the first railroad was constructed to transport Tioga region coal (Blossburg Homepage). Coal mining was the primary land use in the upper section of the Tioga River Watershed throughout the 18- and 1900s. Deep mining was the predominant form of mining in the watershed until surface mining became predominant in the 1950s, a pattern similar to Pennsylvania coal mining as a whole. Active surface mining ceased in the 1980s in the watershed; however, there is one active permit in the Johnson Creek Watershed for removal of 3.3 acres of refuse in piles (Signor Brothers Berguson, Government Financed Construction Contract (GFCC) 6662-59-01-01). Many of the surface mined areas in the watershed have been reclaimed, but some pre-Act areas have not. The South Mountain area of the Johnson Creek Watershed, areas in the Bear Creek and Morris Run Watersheds and small areas scattered throughout the Tioga Watershed are still in need of some type of surface reclamation, from surface contouring and pit dewatering to vegetation establishment. Additionally, many of the deep mines now discharge large volumes of AMD into the surrounding waters, degrading them severely.

The Tioga River flows through the Northcentral Bituminous Coalfield in northcentral Pennsylvania. The bituminous coal region is characterized by strip and drift mining of coal seams that are horizontal in orientation. This often resulted in fairly level underground tunnels running for miles, as coal was mined along a particular seam. After the mine workings had been abandoned, the tunnels often collapsed, filled up with water, and some now discharge to the surface. Many of these discharges are very large and are responsible for much of the water quality impairment in the region. In the Tioga River Watershed, many of the tunnels were used to dewater the mines and to allow airflow into the mines. They were dug in an upslope direction, allowing gravity to dewater the mines. This type of drainage tunnel can be particularly difficult to treat because they often drain large volumes of water from a large underground area.

Forested land makes up a large percentage of the Tioga River watershed. Much of the watershed area upstream of Blossburg is forested, with forested lands occurring along some stream corridors, ridgetops, and scattered among agricultural lands. Agricultural lands make up approximately one third of the watershed, mostly occurring downstream of Blossburg. Disturbed land (abandoned coal mines, quarries, etc.) make up less than ten percent of the watershed. Major population centers in the watershed include the towns of Blossburg and Mansfield. Other smaller residential areas occur throughout the watershed. Many of the dwellings found in the upper section of the watershed are used as seasonal camps, with much of the land owned by absentee landowners, coal company trusts or the Commonwealth of Pennsylvania.

In addition to mined lands, forests, agriculture and residential uses, a few other uses in the watershed are important. A landfill, the Pine Hill Landfill & Reclamation Site, occurs in the mid-reaches of Fall Brook. It accepts sand dust, foundry sand, and stabilized slag and sludge from the Ward Manufacturing, Inc. The landfill does have a stormwater permit (PAR504806), but is not considered a source of downstream AMD impairment in that watershed as it does not discharge any parameters considered in the TMDL analysis (metals, acid). The Northern Tier Solid Waste Authority – Landfill #1 is located on the hill separating the Morris Run and Coal Creek Watersheds on reclaimed surface mine lands. This landfill formerly accepted solid waste, demolition waste, and residual wastes; however, currently, it only accepts construction/demolition waste and serves as a transfer station. As with the Pine Hill Landfill, it also has a stormwater permit (PAR504803) but is not considered a source of downstream AMD impairment in the watershed as it does not discharge any parameters considered in the TMDL analysis (metals, acid). One large industrial business is located in the upper watershed area in Blossburg, Ward Manufacturing. It maintains two plant areas in Blossburg. Ward has both a stormwater and an industrial waste discharge permit (PAR204816 and PA0111945); however, neither permit is considered as source of impairment as they do not discharge any parameters considered in the TMDL analysis (metals, acid). A public water supply for the town of Morris Run is located between MORR3 and MORR2 on the Morris Run mainstem; Bellman Run, a tributary to Johnson Creek, is a public water supply for the town of Blossburg. Two co-operative trout nurseries are located in the watershed: one, run by the Arnot Sportsmans Club, uses mine water in the upper Johnson Creek Watershed, the other is in Blossburg and is run by the Hillside Rod and Gun Club.

The headwaters of the Tioga River flow through the Tioga State Forest. Many of the tributaries in the headwaters area are intermittent; some originate in wetland areas. Many of these tributaries are listed as impaired by metals and low pH due to AMD (Fall Brook, Fellows Creek, Morris Run) due to their being grouped with mainstem impairments in a SWAP survey. However, the headwaters of Fall Brook, Morris Run and Fellows Creek, in addition to other tributaries in the headwaters of the Tioga River, are impacted by low pH due to tannic acids produced by extensive wetland areas in these watersheds. Often this tannic acid causes the stream water to take on a deep reddish hue that can easily be mistaken on visual inspection for iron precipitates. Chemically, however, these streams generally posses low levels of metals, low sulfates and low conductivity, the combination of which are generally elevated in cases where impairments are due to AMD. Supporting water quality data for these stream segments can be found in Attachment F. Therefore, the headwaters of Fall Brook, Morris Run and the entire Fellows Creek watershed will not be addressed with TMDLs.

Five major deep mine discharges are allocated to in this TMDL document. One abandoned mine discharge flows into Fall Brook in its lower reaches. This discharge occurs near benchmark 1899 on the Gleason quadrangle 7.5-minute series topographic map and was monitored at point DFB099. The Morris Run Watershed is impacted by three major deep mine discharges: the Lake Mine Discharge, the East Mine Discharge and the Tioga Mine Discharge. These three discharges were monitored at points DMR004, DMR001 and DMR003, respectively. The Lake Mine Discharge occurs downstream of a reclaimed area, completed in the 1980's using a Rural Abandoned Mine Program (RAMP) project, near the pallet factory in the town of Morris Run. The East Mine Discharge occurs behind St. Joseph's Catholic Church in Morris Run. It flows from a pipe in an area that was reclaimed in the mid-1980s with a RAMP project. The Tioga Mine Discharge occurs near the end of Tioga Street in Morris Run. It is the smallest in volume of the three discharges. The final large discharge drains to the Coal Creek Watershed. This discharge, monitored at point DCC005, is the largest single contributor of AMD pollution to the Tioga River Watershed. It drains from an opening at the end of a railroad spur into a deep, steeply-sided ravine. In periods of low flow, Coal Creek is entirely dry upstream of this discharge due to capture of the streamflow into the underlying mine pool through the fissured stream channel. According to historical reports, the underground watershed made up of mine passages for this discharge is almost twice that of the above ground topographical watershed (U.S. Army Corps of Engineers 1972). In addition to draining the upstream Coal Creek Watershed, it also drains a large portion of the upper Morris Run Watershed due to deep mine interception of groundwater infiltration. Several smaller deep mine, and to a lesser extent, surface mine discharges impact waters throughout the upper Tioga Watershed.

Many studies have been conducted to assess the biological community present in the Tioga River. Studies were done by either the Pennsylvania Department of Environmental Protection (Pa. DEP) (formerly Department of Environmental Resources, Pa. DER) or the PFBC in 1964, 1972, 1978, 1984 and 1995, all with the similar finding the Tioga River was being polluted with AMD (cited in Moase *et al*. 1999; Hughey 1993). In a 1993 aquatic biological investigation of the Tioga River headwaters by the Pa. DER, the macroinvertebrate community of the Tioga Watershed was found to be moderately impaired in the headwaters area and severely impaired in the downstream reaches due to AMD (Hughey 1993). The PFBC conducted an examination of the Upper Tioga River Basin in 1999 and found no fish in Fall Brook or Morris Run (Moase *et al*. 1999). As early as 1939, a Pennsylvania Fish and Boat Commission (PFBC) study noted that Morris Run contributed AMD to the Tioga River (Moase *et al*. 1999). The entire Tioga River Watershed and all of its tributaries (in Pennsylvania) are classified by the Pa. Code, Title 25 Chapter 93 Water Quality Standards as the cold water fishes designated use. However, the Fish and Boat Commission study noted that considerable recreational fisheries could be established in some of the tributaries of the Tioga River if AMD pollution were remediated. Additionally, a cold water fishery occurring in the upper section of the Tioga River upstream of TIOG6 could be expanded to downstream locations (Moase *et al*. 1999).

The mine drainage in the Tioga Watershed occurs in the upper one half of its length above the Tioga/Hammond Dam Complex. However, it impairs the Tioga River downstream to the Tioga Dam. The US Army Corps of Engineers operates the Tioga/Hammond Dam complex as a flood control and recreational project. Due to the degraded state of the water entering the Tioga impoundment, water from the Hammond impoundment must be mixed with the Tioga water through a connecting channel before being discharged downstream as the Tioga River. A detailed operations plan was created by staff at the complex to ensure that water quality standards were being met downstream of the dam. The Tioga River segment addressed in this TMDL document ends at the beginning of the Tioga impoundment. It is assumed that remediation of the mine drainage at its source would produce positive benefits for the operation of the Tioga/Hammond Complex and remove the source of impairment to the Tioga impoundment.

Currently, the Upper Tioga River Watershed, from its source to the Tioga/Hammond Dam complex, is being assessed by the Susquehanna River Basin Commission in cooperation with other project partners. This assessment is being funded by Pennsylvania's Growing Greener Program. The assessment will inventory all mining-associated problem areas in the watershed, will prioritize these areas for remediation, will recommend treatment technologies for treating selected discharges, will give cost estimates for each recommended treatment system and will recommend possible funding sources for implementation funding. There are currently many citizens groups, hunting clubs and a watershed organization that are interested in restoring the Tioga River Watershed.

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 at 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 2. Applicable Water Quality Criteria

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

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

TMDL ELEMENTS (WLA, LA, MOS)

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

TMDL ALLOCATIONS SUMMARY

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 re-evaluated to reflect current conditions. Table 3 presents the estimated reductions identified for all points in the watershed. Attachment E gives detailed TMDLs by segment analysis for each allocation point.

Table 3. Summary Table–Tioga River Watershed

Station	Parameter	Measured Sample Data		Allowable		Reduction Identified
		Conc. (mg/l)	Load (lb/day)	LTA Conc. (mg/l)	Load (lb/day)	Percent
TIOG4	Tioga River 0.5 miles upstream of confluence with Morris Run (downstream Fall Brook)					
	Fe	0.30	88.0	0.30	88.0	0*
	Mn	1.03	302.1	0.32	93.9	0*
	Al	0.74	217.1	0.22	64.5	0*
	Acidity	23.90	7010.3	2.15	630.6	84*
	Alkalinity	8.03	2355.3			
TIOG3	Tioga River immediately upstream of confluence with Johnson Creek					

Station	Parameter	Measured Sample Data		Allowable		Reduction Identified
		Conc. (mg/l)	Load (lb/day)	LTA Conc. (mg/l)	Load (lb/day)	Percent
	Fe	2.96	1330.4	0.39	175.3	28*
	Mn	3.96	1779.8	0.32	143.8	78*
	Al	5.75	2584.3	0.06	27.0	98*
	Acidity	69.97	31447.5	0.35	157.3	99*
	Alkalinity	1.27	570.8			
TIOG2	Tioga River at U.S. Route 15 crossing upstream of Marvin Creek					
	Fe	0.74	434.3	0.74	434.3	0*
	Mn	2.56	1502.4	0.31	181.9	0*
	Al	3.75	2200.8	004	23.5	0*
	Acidity	64.70	37971.5	0.65	381.5	92*
	Alkalinity	2.33	1367.4			
TIOG1	Near USGS gaging station on Brooklyn Rd. (T754)					
	Fe	0.58	450.7	0.52	404.1	0*
	Mn	2.02	1569.8	0.26	202.1	0*
	Al	2.87	2230.3	0.03	23.3	0*
	Acidity	47.00	36524.7	1.41	1095.7	0*
	Alkalinity	7.20	5595.3			
FALL2	Fall Brook upstream of SR2014 bridge (upstream DFB099)					
	Fe	0.70	26.8	0.41	15.7	41
	Mn	1.91	73.1	0.19	7.3	90
	Al	0.99	37.9	0.28	10.7	72
	Acidity	33.73	1291.2	1.69	64.7	95
	Alkalinity	4.27	163.5			
DFB099	Benchmark 1899 Discharge					
	Fe	1.58	10.5	0.90	6.0	43
	Mn	21.66	143.6	0.43	2.9	98
	Al	15.98	106.0	0.16	1.1	98
	Acidity	180.60	1197.4	0	0	100
	Alkalinity	0	0			
FALL1	Fall Brook at mouth					
	Fe	0.42	20.6	0.42	20.6	0*
	Mn	6.15	301.6	0.37	18.1	81*
	Al	4.36	213.8	0.05	2.5	97*
	Acidity	65.23	3198.8	0.65	31.9	96*
	Alkalinity	2.77	135.8			
DMR004	Lake Mine Discharge					
	Fe	8.20	104.6	0.90	11.5	89
	Mn	22.53	287.5	0.68	8.7	97
	Al	17.32	221.0	0.17	2.2	97
	Acidity	236.37	3016.1	0	0	100
	Alkalinity	0	0			
DMR003	Tioga Mine Discharge					
	Fe	3.78	9.4	1.25	3.1	67
	Mn	26.27	65.1	0.53	1.3	98
	Al	18.45	45.7	0.18	0.4	97
	Acidity	228.40	565.7	0	0	100
	Alkalinity	0	0			
DMR001	East Mine Discharge					
	Fe	9.05	49.3	1.27	6.9	86

Station	Parameter	Measured Sample Data		Allowable		Reduction Identified
		Conc. (mg/l)	Load (lb/day)	LTA Conc. (mg/l)	Load (lb/day)	Percent
	Mn	28.70	156.3	0.58	3.2	98
	Al	38.48	209.6	0.38	2.1	99
	Acidity	400.83	2182.9	0	0	100
	Alkalinity	0	0			
MORR2	Morris Run at SR2024 bridge					
	Fe	5.24	161.7	0.89	27.5	0*
	Mn	17.45	538.5	0.52	16.0	63*
	Al	15.85	489.1	0.16	4.9	72*
	Acidity	173.17	5343.7	0	0	0*
	Alkalinity	0	0			
MORR1	Morris Run at mouth					
	Fe	4.19	164.6	0.92	36.1	0*
	Mn	16.95	655.8	0.51	20.0	86*
	Al	15.55	610.8	0.16	6.3	95*
	Acidity	165.57	6503.8	0	0	100*
	Alkalinity	0	0			
DCC005	Coal Creek Discharge					
	Fe	40.30	951.2	0.81	19.1	98
	Mn	9.40	221.9	0.47	11.1	95
	Al	31.40	741.1	0.31	7.3	99
	Acidity	439.17	10365.4	0	0	100
	Alkalinity	0				
COAL2	Coal Creek at Mohawk Lane bridge (upstream DCC005)					
	Fe	0.35	0.5	0.35	0.5	0
	Mn	0.42	0.6	0.42	0.6	0
	Al	0.50	0.8	0.50	0.8	0
	Acidity	19.24	29.0	2.18	3.3	89
	Alkalinity	9.56	14.4			
COAL1	Coal Creek at mouth					
	Fe	34.32	864.4	0.69	17.4	0*
	Mn	7.61	191.7	0.54	13.6	0*
	Al	27.38	689.6	0.27	6.8	0*
	Acidity	392.30	9880.8	0	0	0*
	Alkalinity	0	0			
JOHN3	Johnson Creek Between Elm Street and Walnut Street bridges in Arnot					
	Fe	0.74	12.7	0.30	5.2	59
	Mn	0.47	8.1	0.39	6.7	18
	Al	0.51	8.8	0.51	8.8	0
	Acidity	13.37	229.7	13.37	229.7	0
	Alkalinity	16.33	280.6			
JOHN2	Johnson Creek At trail crossing bridge 1/3 mile upstream from new Rt. 15 overpass					
	Fe	0.36	20.2	0.36	20.2	0*
	Mn	0.38	21.3	0.38	21.3	0*
	Al	0.50	28.0	0.50	28.0	0*
	Acidity	20.40	1143.3	3.06	171.5	75*
	Alkalinity	13.83	775.1			
JOHN1	Johnson Creek at mouth					
	Fe	0.31	33.8	0.31	33.8	0*
	Mn	0.45	49.0	0.34	37.0	0*

Station	Parameter	Measured Sample Data		Allowable		Reduction Identified
		Conc. (mg/l)	Load (lb/day)	LTA Conc. (mg/l)	Load (lb/day)	Percent
	Al	0.53	57.7	0.53	57.7	0*
	Acidity	19.17	2088.0	3.07	334.4	50*
	Alkalinity	16.63	1811.3			
UNT7	Unnamed tributary to Johnson Creek at mouth (drains #5 Discharge)					
	Fe	0.60	13.3	0.60	13.3	0
	Mn	0.52	11.5	0.52	11.5	0
	Al	0.54	12.0	0.51	11.3	7
	Acidity	24.57	545.1	3.93	87.2	84
	Alkalinity	16.30	361.6			
UNT5	Unnamed tributary to Johnson Creek at mouth (drains South Mountain)					
	Fe	0.74	3.1	0.61	2.6	17
	Mn	9.05	38.0	0.45	1.9	95
	Al	10.22	43.0	0.10	0.4	97
	Acidity	107.76	453.0	0.32	1.3	99.7
	Alkalinity	0.92	3.9			
BEAR1	Bear Creek at mouth					
	Fe	6.54	22.6	0.92	3.2	86
	Mn	6.62	22.9	0.33	1.1	95
	Al	15.63	54.0	0.16	0.6	99
	Acidity	195.30	674.3	0	0	100
	Alkalinity	0	0			

* These percent reductions take into account reductions called for at points upstream.

RECOMMENDATIONS

Two primary programs 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 Bureau of Abandoned Mine Reclamation, 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.

Currently, the Upper Tioga River Watershed is being assessed by the Susquehanna River Basin Commission in cooperation with other project partners. This assessment is being funded by Pennsylvania's Growing Greener Program. The assessment will inventory all mining-associated problem areas in the watershed, will prioritize these areas for remediation, will recommend treatment technologies for treating selected discharges, will give cost estimates for each recommended treatment system and will recommend possible funding sources for implementation funding. The assessment will be completed in early summer 2003. There are currently many citizens groups, hunting clubs, and a watershed organization that are interested in restoring the Tioga River Watershed. It is recommended that Pa. DEP and other organizations work with these groups to implement the recommendations in the restoration plan.

PUBLIC PARTICIPATION

Public notice of the draft TMDL was published in the *Pennsylvania Bulletin* on December 14, 2002 and the Wellsboro Gazette on January 22, 2003 to foster public comment on the allowable loads calculated. A public meeting was held on January 28, 2003 at the Hillside Rod and Gun Club in Blossburg, Pa. to discuss the proposed TMDL.

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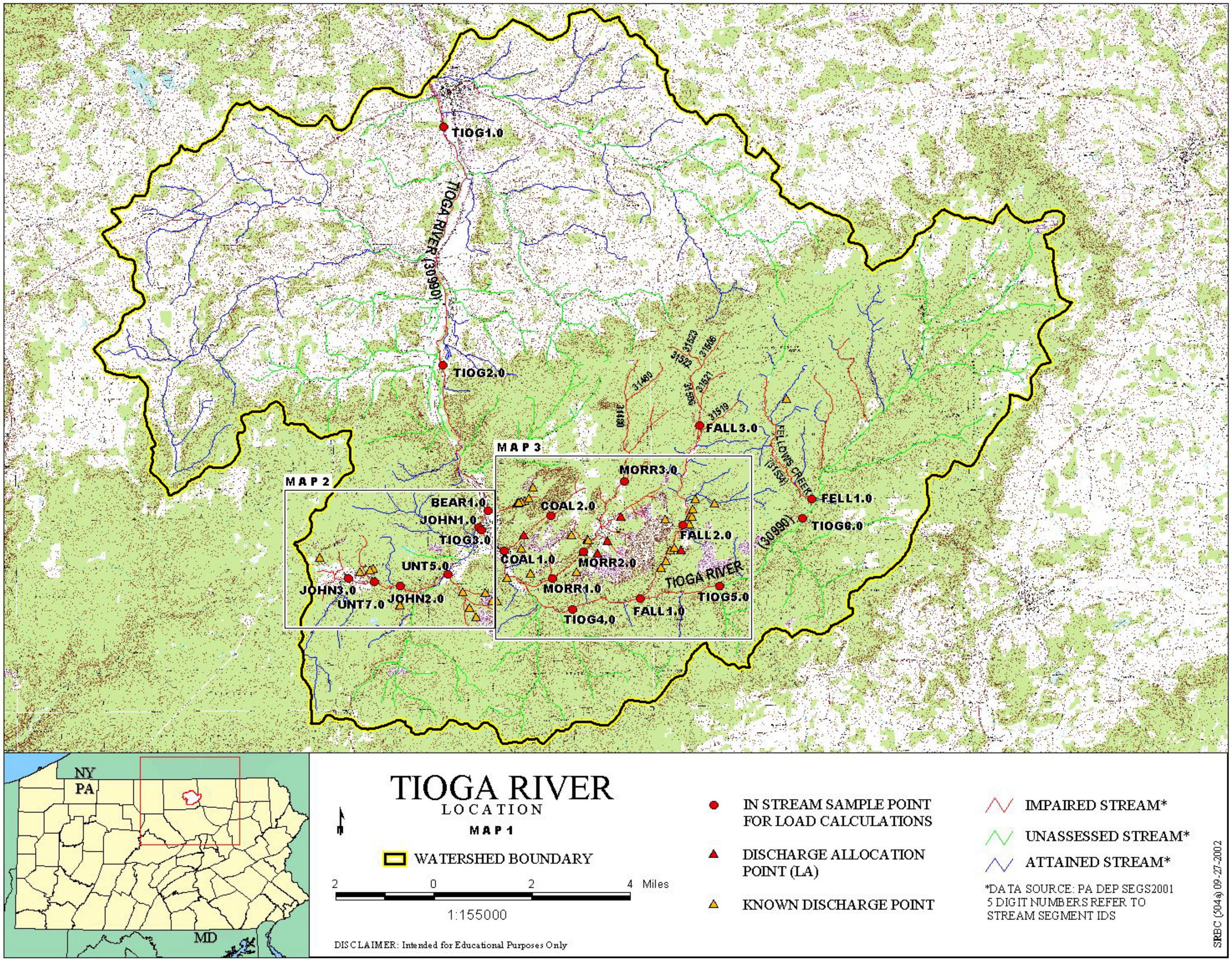
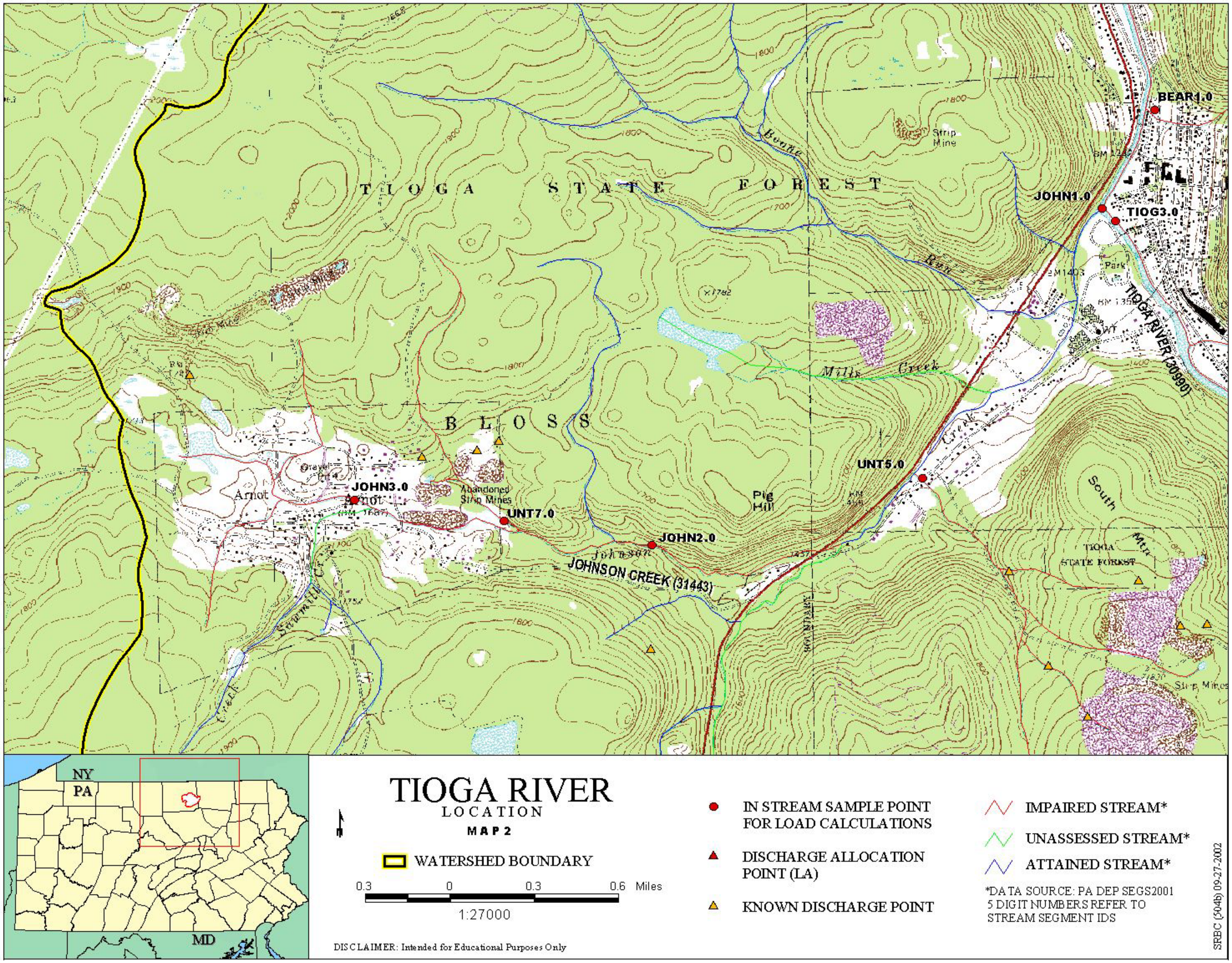
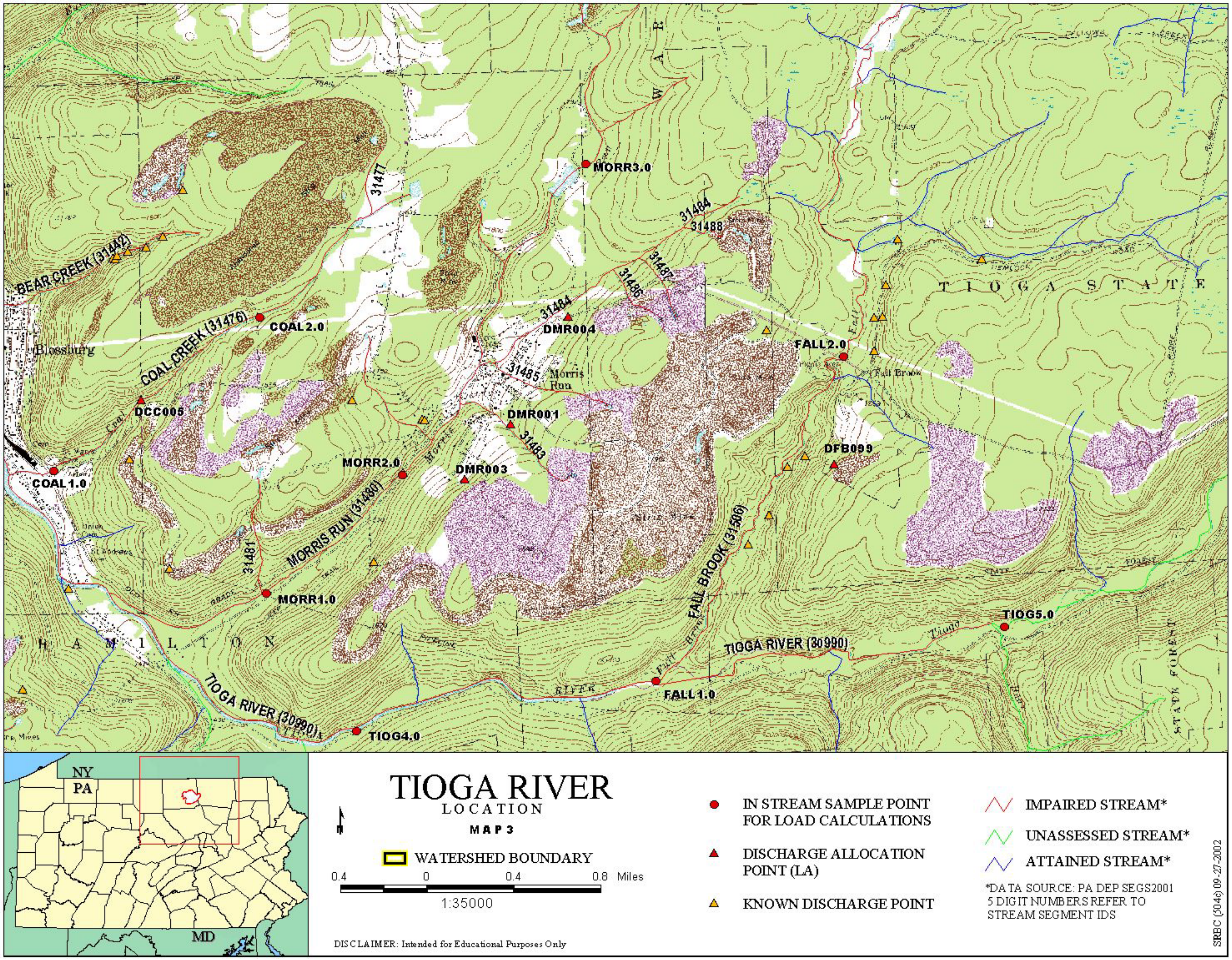
Attachment A

Tioga River Watershed Maps



TIOG1.0
TIOGA RIVER (30990)
TIOG2.0
FALL3.0
FELLOWS CREEK
MAP 3
MAP 2
MORR3.0
FELL1.0
TIOG6.0
(30990)
BEAR1.0
JOHN1.0
TIOG3.0
COAL2.0
FALL2.0
COAL1.0
MORR2.0
UNT5.0
TIOGA RIVER
JOHN3.0
UNT7.0
JOHN2.0
MORR1.0
TIOG5.0
FALL1.0
TIOG4.0
NY
PA
MD
TIOGA RIVER
LOCATION
MAP 1
WATERSHED BOUNDARY
2 0 2 4 Miles
1:155000
IN STREAM SAMPLE POINT FOR LOAD CALCULATIONS
DISCHARGE ALLOCATION POINT (LA)
KNOWN DISCHARGE POINT
IMPAIRED STREAM*
UNASSESSED STREAM*
ATTAINED STREAM*
*DATA SOURCE: PA DEP SEGS2001
5 DIGIT NUMBERS REFER TO
STREAM SEGMENT IDS
DISCLAIMER: Intended for Educational Purposes Only
SRBC (304a) 09-27-2002


TIOGA RIVER
LOCATION
MAP 2
WATERSHED BOUNDARY
IN STREAM SAMPLE POINT FOR LOAD CALCULATIONS
DISCHARGE ALLOCATION POINT (LA)
KNOWN DISCHARGE POINT
IMPAIRED STREAM*
UNASSESSED STREAM*
ATTAINED STREAM*
*DATA SOURCE: PA DEP SEGS2001
5 DIGIT NUMBERS REFER TO STREAM SEGMENT IDS
0.3 0 0.3 0.6 Miles
1:27000
DISCLAIMER: Intended for Educational Purposes Only
SRBC (504b) 09-27-2002
NY
PA
MD
TIOGA STATE FOREST
BLOSS
BEAR1.0
JOHN1.0
TIOG3.0
UNT5.0
JOHN3.0
UNT7.0
JOHN2.0
JOHNSON CREEK (31443)
TIOGA RIVER (20990)
Arnot
Pig Hill
Mills Creek
South Mtn
Abandoned Strip Mines


TIOGA RIVER
LOCATION
MAP 3
WATERSHED BOUNDARY
0.4 0 0.4 0.8 Miles
1:35000
IN STREAM SAMPLE POINT FOR LOAD CALCULATIONS
DISCHARGE ALLOCATION POINT (LA)
KNOWN DISCHARGE POINT
IMPAIRED STREAM*
UNASSESSED STREAM*
ATTAINED STREAM*
*DATA SOURCE: PA DEP SEGS2001
5 DIGIT NUMBERS REFER TO STREAM SEGMENT IDS
DISCLAIMER: Intended for Educational Purposes Only
SRBC (504c) 09-27-2002
NY
PA
MD
BEAR CREEK (31442)
COAL CREEK (31476)
MORRIS RUN (31480)
FALL BROOK (31586)
TIOGA RIVER (30990)
MORR3.0
MORR2.0
MORR1.0
COAL 2.0
COAL 1.0
DCC005
DMR004
DMR001
DMR003
FALL2.0
FALL1.0
DFB099
TIOG5.0
TIOG4.0
31477
31484
31488
31487
31486
31485
31483
31481
Blossburg
Morris Run
Fall Brook
HAMILTON
TIOGA STATE
STATE FOREST

Attachment B

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

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

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

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

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

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

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

Attachment 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

---

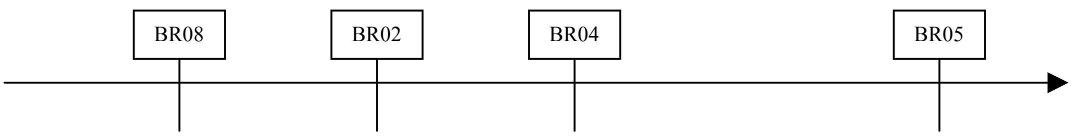
[3] @Risk – Risk Analysis and Simulation Add-in for Microsoft Excel, Palisade Corporation, Newfield, NY, 1990-1997.

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

Table D. Necessary Reductions at Beaver Run BR04

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

Table F. Necessary Reductions at Beaver Run BR05

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

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

Method for Addressing 303(d) Listings for pH

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

The pH, a measurement of hydrogen ion acidity presented as a negative logarithm, is not conducive to standard statistics. Additionally, pH does not measure latent acidity. For this reason, and based on the above information, Pennsylvania is using the following approach to address the stream impairments noted on the 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.*

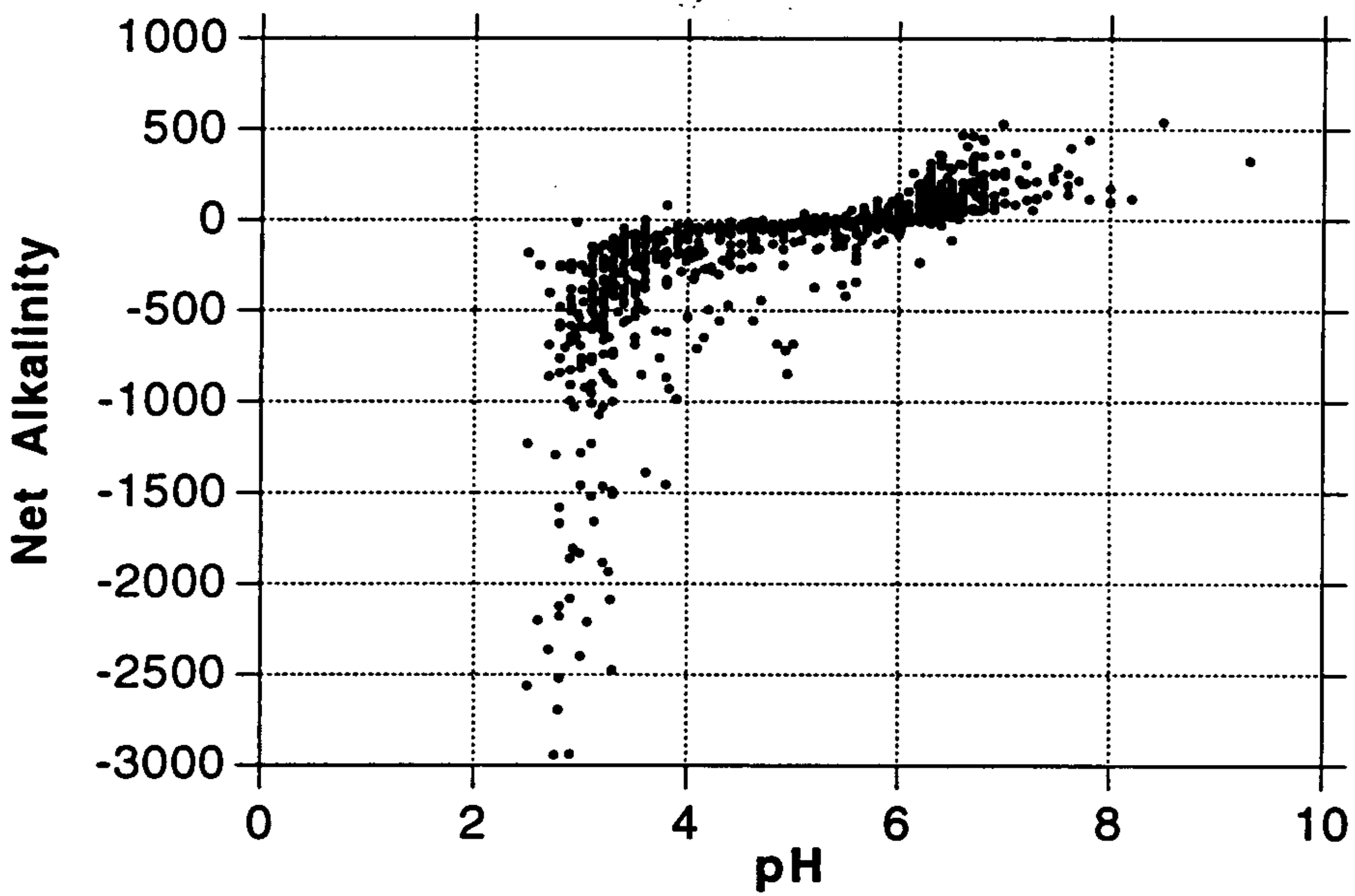


Figure 1. Net Alkalinity vs. pH. Taken from Figure 1.2 Graph C, pages 1-5, of Coal Mine Drainage Prediction and Pollution Prevention in Pennsylvania.

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):

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

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

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

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

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

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

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

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

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

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

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

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

Table 8. L-1 Adjusted BAT Concentrations

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

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

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

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

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

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

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

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

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

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

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

Margin of Safety

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

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

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

Attachment E
TMDLs By Segment

Fellows Creek

Fellows Creek is listed on the 2002 draft 303(d) list as impaired by AMD based on SWAP surveys of the watershed. While Fellows Creek does have pH that is below water quality standards (ranges between 4.6 and 4.9), it is not due to mining impacts. Very small areas of the watershed have been mined in the past. Field investigation of the watershed by walking all streams and tributaries found no water quality impacts in the watershed from mining. However, the headwaters of Fellows Creek consist of large wetland areas. Past studies have noted that the upper Tioga River and its tributaries are naturally low pH, low conductivity streams, sometimes with a deep orange color, especially during times of low flow (Hughey 1993). This condition was observed during the summer of 2002 when many streams visually appeared to be impacted by AMD due to their color but did not show the chemical characteristics of AMD (elevated levels of metals, elevated conductivity, elevated sulfates). This color is most likely due to tannic acids that are produced in the wetland areas of the watershed. Because AMD is not impairing the Fellows Creek Watershed, it is recommended that segments in the Fellows Creek watershed be changed on the draft 2002 Section 303(d) list to having naturally occurring low pH. Further, it is recommended that Fellows Creek not be listed on the next Section 303(d) list.

Tioga River above TIOG5

Tioga River above point TIOG5 is attaining its designated uses and is, therefore, not included on the 303(d) list. It is included as a reference point for all other points downstream. The Fellows Creek Watershed, located upstream of TIOG5, is listed as impaired by AMD; however, low pH levels in Fellows Creek are likely due to tannic acid production from many naturally occurring wetlands in the watershed. Fellows Creek will not be addressed in this document. Therefore, no impaired streams due to AMD are located upstream of TIOG5 in the Tioga River Watershed. Because the reach of Tioga River containing TIOG5 is not listed as impaired, a TMDL will not be done for Tioga River upstream of TIOG5.

Fall Brook Above FALL3

Fall Brook above FALL3 represents the headwaters of the Fall Brook Watershed. Surface mining was conducted in the Tanglewood area of the watershed, located upstream from FALL3; however, this area has been reclaimed and presents no water quality problems. The upper section of Fall Brook is a series of large wetlands with flow from one to the next. Some of the tributaries in this section of the watershed have naturally low pH due to tannic acid from wetlands. While this section of Fall Brook and its tributaries often appears reddish in color, it is due to tannic acids and not metals from mine drainage. Because this section of Fall Brook is meeting water quality standards except for pH that is due to tannic acids from natural sources (Attachment F), a TMDL will not be done for this segment of Fall Brook and its tributaries. Because AMD is not impairing the Fall Brook Watershed above FALL3, it is recommended that segments in this segment be changed in the 305(b) report to having naturally occurring low pH. Further, it is recommended that this segment not be listed on the next Section 303(d) list.

Fall Brook Between FALL3 and FALL2

Fall Brook between FALL3 and FALL2 receives drainage from several AMD discharges that negatively impact the stream. Point FALL2 represents Fall Brook upstream of the influence of the Benchmark 1899 Discharge.

The TMDL for this section of Fall Brook consists of a load allocation to all of the watershed area between points FALL3 and FALL2 computed using water quality data collected at point FALL2. Addressing the mining impacts between these points addresses the impairments. An average flow measurement was available for point FALL2 (4.59mgd).

Sample data at point FALL2 show pH ranging from 3.9 to 4.5; pH will be addressed as part of this TMDL because of the mining impacts. The objective is to reduce acid loading to the stream that will in turn raise the pH to the desired range. The result of this analysis is an acid loading reduction that equates to meeting water quality standards for pH (see Table 2). The method and rationale for addressing pH is contained in Attachment C.

An allowable long-term average instream concentration was determined at point FALL2 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 FALL2 for this stream segment are presented in Table E1.

Table E1. Reductions for Fall Brook Between FALL3 and FALL2

Station FALL2	*Measured Sample Data*		*Allowable*		*Reduction Identified*
	Conc. (mg/l)	*Load (lb/day)*	*LTA Conc. (mg/l)*	*Load (lb/day)*	*Percent*
Fe	0.70	26.8	0.41	15.7	41
Mn	1.91	73.1	0.19	7.3	90
Al	0.99	37.9	0.28	10.7	72
Acidity	33.73	1291.2	1.69	64.7	95
Alkalinity	4.27	163.5			

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

The TMDL for Fall Brook at point FALL2 requires that a load allocation be made for all areas between FALL3 and FALL2 for total iron, total manganese, total aluminum and total acidity.

Benchmark 1899 Discharge (DFB099)

The Benchmark 1899 Discharge is an abandoned deep mine discharge that drains areas of the lower eastern Fall Brook Watershed that were deep mined and later surface mined. It flows down a steep hill from its origin at a collapsed drift opening to join with Fall Brook below FALL2. DFB099 represents the discharge at its origin.

The TMDL for the Benchmark 1899 Discharge consists of a load allocation to the discharge computed using water quality data collected at point DFB099. Addressing the mining impacts at this point addresses the impairments. An instream flow measurement was available for point DFB099 (0.795mgd).

Sample data at point DFB099 show pH ranging from 3.3 to 3.4; pH will be addressed as part of this TMDL because of the mining impacts. The objective is to reduce acid loading to the stream that will in turn raise the pH to the desired range. The result of this analysis is an acid loading reduction that equates to meeting water quality standards for pH (see Table 2). The method and rationale for addressing pH is contained in Attachment C.

An allowable long-term average instream concentration was determined at point DFB099 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 DFB099 for the discharge are presented in Table E2.

Table E2. Reductions for the Benchmark 1899 Discharge

Station DFB099	***Measured Sample Data***		***Allowable***		***Reduction Identified***
	Conc. (mg/l)	***Load (lb/day)***	***LTA Conc. (mg/l)***	***Load (lb/day)***	***Percent***
Fe	1.58	10.5	0.90	6.0	43
Mn	21.66	143.6	0.43	2.9	98
Al	15.98	106.0	0.16	1.1	98
Acidity	180.60	1197.4	0	0	100
Alkalinity	0	0			

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

The TMDL for the Benchmark 1899 Discharge at point DFB099 requires that a load allocation be made for the discharge for total iron, total manganese, total aluminum and total acidity.

Fall Brook Between FALL2 and FALL1

Fall Brook between FALL2 and FALL1 is Fall Brook after the influence of the Benchmark 1899 Discharge. A few additional inputs of AMD, including some contaminated groundwater recharge to Fall Brook, flow into the stream in this reach. Point FALL1 represents Fall Brook at the mouth.

The TMDL for this section of Fall Brook consists of a load allocation to all of the watershed area between points FALL2 and FALL1 computed using water quality data collected at point FALL1. Addressing the mining impacts between these points addresses the impairments. An instream flow measurement was available for point FALL1 (5.88mgd).

Sample data at point FALL1 show pH ranging from 4 to 4.2; pH will be addressed as part of this TMDL because of the mining impacts. The objective is to reduce acid loading to the stream that will in turn raise the pH to the desired range. The result of this analysis is an acid loading reduction that equates to meeting water quality standards for pH (see Table 2). The method and rationale for addressing pH is contained in Attachment C.

An allowable long-term average instream concentration was determined at point FALL1 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 FALL1 for this stream segment are presented in Table E3.

Table E3. Long Term Average (LTA) for Fall Brook Between FALL2 and FALL1

Station FALL1	***Measured Sample Data***		***Allowable***	
	Conc. (mg/l)	***Load (lb/day)***	***LTA Conc. (mg/l)***	***Load (lb/day)***
Fe	0.42	20.6	0.42	20.6
Mn	6.15	301.6	0.37	18.1
Al	4.36	213.8	0.05	2.5
Acidity	65.23	3198.8	0.65	31.9
Alkalinity	2.77	135.8		

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

The loading reductions for points FALL2 and DFB099 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 FALL1. This value was compared to the allowable load at point FALL1. Reductions at point FALL1 are necessary for any parameter that exceeds the allowable load at this point. A summary of all loads that affect point FALL1 are shown in Table E4. Necessary reductions at point FALL1 are shown in Table E5.

Table E4. Summary of Loads Affecting Point FALL1				
	Iron (lb/day)	***Manganese (lb/day)***	***Aluminum (lb/day)***	***Acidity (lb/day)***
FALL2				
Load Reduction	11.1	65.8	27.2	1226.5
DFB099				
Load Reduction	4.5	140.7	104.9	1197.4

Table E5. Reductions Necessary at Point FALL1				
	Iron (lb/day)	***Manganese (lb/day)***	***Aluminum (lb/day)***	***Acidity (lb/day)***
Existing Loads at FALL1	20.6	301.6	213.8	3198.8
Total Load Reduction (FALL2, DFB099)	15.6	206.5	132.1	2423.9
Remaining Load	5.0	95.1	81.7	774.9
Allowable Loads at FALL1	20.6	18.1	2.5	31.9
Percent Reduction	0	81	97	96
Load Reduction	0	77.0	79.2	743.0

The TMDL for Fall Brook at point FALL1 requires that a load allocation be made for all areas between FALL2 and FALL1 for total manganese, total aluminum and total acidity.

Tioga River Between TIOG5 and TIOG4

The Tioga River between points TIOG5 and TIOG4 receives input from the Fall Brook watershed and other small watersheds. Fall Brook at its confluence with the Tioga River is impaired by AMD and causes the Tioga River downstream of their confluence to be impaired as well. The bottom substrate in Fall Brook at its mouth is stained orange from iron precipitates. When it mixes with the higher pH water of the Tioga River, it causes aluminum to precipitate, giving the Tioga River a white color downstream from Fall Brook to the confluence with Morris Run below point TIOG4. Point TIOG4 represents the Tioga River approximately one half mile upstream of the confluence with Morris Run.

The TMDL for this section of Tioga River consists of a load allocation to all of the watershed area between points TIOG4 and TIOG5 computed using water quality data collected at point TIOG4. Addressing the mining impacts between these points addresses the impairments. An instream flow measurement was available for point TIOG4 (35.17mgd).

Sample data at point TIOG4 show pH ranging from 4.8 to 6; pH will be addressed as part of this TMDL because of the mining impacts. The objective is to reduce acid loading to the stream that will in turn raise the pH to the desired range. The result of this analysis is an acid loading reduction that equates to meeting water quality standards for pH (see Table 2). The method and rationale for addressing pH is contained in Attachment C.

An allowable long-term average instream concentration was determined at point TIOG4 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 TIOG4 for this stream segment are presented in Table E6.

Table E6. Long Term Average (LTA) for Tioga River Between TIOG5 and TIOG4

Station TIOG4	***Measured Sample Data***		***Allowable***	
	Conc. (mg/l)	***Load (lb/day)***	***LTA Conc. (mg/l)***	***Load (lb/day)***
Fe	0.30	88.0	0.30	88.0
Mn	1.03	302.1	0.32	93.9
Al	0.74	217.1	0.22	64.5
Acidity	23.90	7010.3	2.15	630.6
Alkalinity	8.03	2355.3		

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

The loading reductions for all upstream points (FALL2, FALL1, DFB099) 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 TIOG4. This value was compared to the allowable load at point TIOG4. Reductions at point TIOG4 are necessary for any parameter that exceeds the allowable load at this point. A summary of all loads that affect point TIOG4 are shown in Table E7. Necessary reductions at point TIOG4 are shown in Table E8.

Table E7. Summary of Loads Affecting Point TIOG4

	Iron (lb/day)	***Manganese (lb/day)***	***Aluminum (lb/day)***	***Acidity (lb/day)***
FALL2,DFB099				
Load Reduction	15.6	206.5	132.1	2423.9
FALL1				
Load Reduction	0	77.0	79.2	743.0

Table E8. Reductions Necessary at Point TIOG4				
	Iron (lb/day)	***Manganese (lb/day)***	***Aluminum (lb/day)***	***Acidity (lb/day)***
Existing Loads at TIOG4	88.0	302.1	217.1	7010.3
Total Load Reduction (FALL2, FALL1, DFB099)	15.6	283.5	211.3	3166.9
Remaining Load	72.4	18.6	5.8	3843.4
Allowable Loads at TIOG4	88.0	93.9	64.5	630.6
Percent Reduction	0	0	0	84
Load Reduction	0	0	0	3212.8

The TMDL for Tioga River at point TIOG4 requires that a load allocation be made for all areas between TIOG4 and TIOG5 for acidity.

Morris Run Above MORR3

The headwaters of Morris Run are the area upstream of the water supply reservoir located on Morris Run. Point MORR3 is located upstream of the reservoir. This section of the watershed was strip mined extensively; the strip mines have been reclaimed. It was documented in the early 1970s that Morris Run above the reservoir lost significant amounts of its flow into underground mine workings. However, reclamation done in the 1980s reclaimed the strip mine where the infiltration was occurring and restored the stream channel. Many entrances into the deep mine workings were located along the eastern edge of Morris Run when deep mining was active in the watershed. According to some studies, water infiltrating from the Morris Run watershed enters into the interconnected mine passages and is carried as groundwater out of the Morris Run Watershed. It is presumed that this water becomes mine drainage that is contributed to the Coal Creek watershed through the DCC005 discharge. In spite of these impacts, the water quality in Morris Run above MORR3 is meeting standards for metals. As in many other areas of the Tioga River watershed, the headwaters of Morris Run contain many wetland areas that produce tannic acid. It is this natural lowering of pH by tannic acids and not mine drainage that causes the pH to be below the standard range. However, because it is not attributable to AMD, it will not be addressed in this TMDL document. Because AMD is not impairing the Morris Run Watershed above MORR3, it is recommended that segments in this segment be changed in the 305(b) report to having naturally occurring low pH. Further, it is recommended that this segment not be listed on the next Section 303(d) list.

Lake Mine Discharge (DMR004)

The Lake Mine Discharge drains the Lake Mine deep mine complex in the Morris Run and the edge of the Fall Brook Watershed. It originates behind the pallet factory in the village of Morris Run and is the largest volume discharge in the Morris Run Watershed. Point DMR004 represents the Lake Mine Discharge at its source.

The TMDL for the Lake Mine Discharge consists of a load allocation to the discharge computed using water quality data collected at point DMR004. Addressing the mining impacts at this point addresses the impairments. An instream flow measurement was available for point DMR004 (1.53mgd).

Sample data at point DMR004 show pH ranging from 3.1 to 3.2; pH will be addressed as part of this TMDL because of the mining impacts. The objective is to reduce acid loading to the stream that will in turn raise the pH to the desired range. The result of this analysis is an acid loading reduction that equates to meeting water quality standards for pH (see Table 2). The method and rationale for addressing pH is contained in Attachment C.

An allowable long-term average instream concentration was determined at point DMR004 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 DMR004 for the discharge are presented in Table E9.

Table E9. Reductions for the Lake Mine Discharge

Station DMR004	***Measured Sample Data***		***Allowable***		***Reduction Identified***
	Conc. (mg/l)	***Load (lb/day)***	***LTA Conc. (mg/l)***	***Load (lb/day)***	***Percent***
Fe	8.20	104.6	0.90	11.5	89
Mn	22.53	287.5	0.68	8.7	97
Al	17.32	221.0	0.17	2.2	97
Acidity	236.37	3016.1	0	0	100
Alkalinity	0	0			

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

The TMDL for the Lake Mine Discharge requires that a load allocation be made for the discharge for total iron, total manganese, total aluminum and total acidity.

East Mine Discharge

The East Mine Discharge drains the East Mine deep mine complex underlying portions of the Morris Run and the Fall Brook Watersheds. It originates behind St. Joseph's Catholic Church from a reclaimed area in the village of Morris Run. Point DMR001 represents the East Mine Discharge at its source.

The TMDL for the East Mine Discharge consists of a load allocation to the discharge computed using water quality data collected at point DMR001. Addressing the mining impacts at this point addresses the impairments. An instream flow measurement was available for point DMR001 (0.653mgd).

Sample data at point DMR001 show pH ranging from 2.8 to 3; pH will be addressed as part of this TMDL because of the mining impacts. The objective is to reduce acid loading to the stream that will in turn raise the pH to the desired range. The result of this analysis is an acid loading reduction that equates to meeting water quality standards for pH (see Table 2). The method and rationale for addressing pH is contained in Attachment C.

An allowable long-term average instream concentration was determined at point DMR001 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 DMR001 for the discharge are presented in Table E10.

Table E10. Reductions for the East Mine Discharge

Station DMR001	***Measured Sample Data***		***Allowable***		***Reduction Identified***
	Conc. (mg/l)	***Load (lb/day)***	***LTA Conc. (mg/l)***	***Load (lb/day)***	***Percent***
Fe	9.05	49.3	1.27	6.9	86
Mn	28.70	156.3	0.58	3.2	98
Al	38.48	209.6	0.38	2.1	99
Acidity	400.83	2182.9	0	0	100
Alkalinity	0	0			

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

The TMDL for the East Mine Discharge at point DMR001 requires that a load allocation be made for the discharge for total iron, total manganese, total aluminum and acidity.

Tioga Mine Discharge

The Tioga Mine Discharge drains the Tioga Mine deep mine complex underlying portions of the Morris Run and the Fall Brook Watersheds. It originates from the bottom of a refuse pile below a series of collapse deep mine openings at the end of Tioga Street in the village of Morris Run. Point DMR003 represents the Tioga Mine Discharge at its source.

The TMDL for the Tioga Mine Discharge consists of a load allocation to the discharge computed using water quality data collected at point DMR003. Addressing the mining impacts at this point addresses the impairments. An instream flow measurement was available for point DMR003 (0.297mgd).

Sample data at point DMR003 show pH ranging from 3.1 to 3.2; pH will be addressed as part of this TMDL because of the mining impacts. The objective is to reduce acid loading to the stream that will in turn raise the pH to the desired range. The result of this analysis is an acid loading reduction that equates to meeting water quality standards for pH (see Table 2). The method and rationale for addressing pH is contained in Attachment C.

An allowable long-term average instream concentration was determined at point DMR003 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 DMR003 for the discharge are presented in Table E11.

Table E11. Reductions for the Tioga Mine Discharge

Station DMR003	***Measured Sample Data***		***Allowable***		***Reduction Identified***
	Conc. (mg/l)	***Load (lb/day)***	***LTA Conc. (mg/l)***	***Load (lb/day)***	***Percent***
Fe	3.78	9.4	1.25	3.1	67
Mn	26.27	65.1	0.53	1.3	98
Al	18.45	45.7	0.18	0.4	97
Acidity	228.40	565.7	0	0	100
Alkalinity	0	0			

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

The TMDL for the Tioga Mine Discharge requires that a load allocation be made for the discharge for total iron, total manganese, total aluminum and acidity.

Morris Run Between MORR3 and MORR2

Morris Run between MORR3 and MORR2 represents that section of Morris Run watershed between the Morris Run Reservoir and the SR2024 bridge. This segment receives drainage from three major deep mine discharges: the Lake Mine Discharge (DMR004), the East Mine Discharge (DMR001) and the Tioga Mine Discharge (DMR003). It also receives drainage from some other minor discharges in this segment. Many of the tributaries shown in this area on the US Geological Survey Blossburg 7.5 minute topographic map do not exist. Many of these tributaries drained unreclaimed water bodies on mine lands that have since been reclaimed and eliminated. During periods of low flow, Morris Run above the confluence with an unnamed tributary affected by DMR004 is often dry. Morris Run downstream of the confluence with the Lake Mine Discharge is made up entirely of mine discharge water under these conditions. Point MORR2 represents Morris Run at the SR2024 bridge.

The TMDL for this section of Morris Run consists of a load allocation to all of the watershed area between points MORR3 and MORR2 computed using water quality data collected at point MORR2. Addressing the mining impacts between these points addresses the impairments. An instream flow measurement was available for point MORR2 (3.70mgd).

Sample data at point MORR2 show pH ranging from 3.2 to 3.4; pH will be addressed as part of this TMDL because of the mining impacts. The objective is to reduce acid loading to the stream that will in turn raise the pH to the desired range. The result of this analysis is an acid loading reduction that equates to meeting water quality standards for pH (see Table 2). The method and rationale for addressing pH is contained in Attachment C.

An allowable long-term average instream concentration was determined at point MORR2 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 MORR2 for this stream segment are presented in Table E12.

Table E12. Long Term Average (LTA) for Morris Run Between MORR3 and MORR2

Station MORR2	***Measured Sample Data***		***Allowable***	
	Conc. (mg/l)	***Load (lb/day)***	***LTA Conc. (mg/l)***	***Load (lb/day)***
Fe	5.24	161.7	0.89	27.5
Mn	17.45	538.5	0.52	16.0
Al	15.85	489.1	0.16	4.9
Acidity	173.17	5343.7	0	0
Alkalinity	0	0		

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

The loading reductions for points DMR004, DMR003 and DMR001 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 MORR2. This value was compared to the allowable load at point MORR2. Reductions at point MORR2 are necessary for any parameter that exceeds the allowable load at this point. A summary of all loads that affect point MORR2 are shown in Table E13. Necessary reductions at point MORR2 are shown in Table E14.

Table E13. Summary of Loads Affecting Point MORR2				
	Iron (lb/day)	***Manganese (lb/day)***	***Aluminum (lb/day)***	***Acidity (lb/day)***
DMR004				
Load Reduction	93.1	278.8	218.8	3016.1
DMR003				
Load Reduction	6.3	63.8	45.3	565.7
DMR001				
Load Reduction	42.4	153.1	207.5	2182.9

Table E14. Reductions Necessary at Point MORR2				
	Iron (lb/day)	***Manganese (lb/day)***	***Aluminum (lb/day)***	***Acidity (lb/day)***
Existing Loads at MORR2	161.7	538.5	489.1	5343.7
Total Load Reduction (DMR004, DMR003, DMR001)	141.8	495.7	471.6	5764.7
Remaining Load	19.9	42.8	17.5	0
Allowable Loads at MORR2	27.5	16.0	4.9	0
Percent Reduction	0	63	72	0
Load Reduction	0	26.8	12.6	0

The TMDL for Morris Run at point MORR2 requires that a load allocation be made for all areas between MORR3 and MORR2 for total manganese and total aluminum.

Morris Run Between MORR2 and MORR1

Morris Run between MORR2 and MORR1 represents Morris Run from below the influence of the three major discharges to the mouth of the stream. This section of Morris Run receives drainage from a few additional small deep mine discharges. Point MORR1 represents Morris Run at the mouth.

The TMDL for this section of Morris Run consists of a load allocation to all of the watershed area between points MORR2 and MORR1 computed using water quality data collected at point MORR1. Addressing the mining impacts between these points addresses the impairments. An instream flow measurement was available for point MORR1 (4.71mgd).

Sample data at point MORR1 show pH ranging from 3.2 to 3.4; pH will be addressed as part of this TMDL because of the mining impacts. The objective is to reduce acid loading to the stream that will in turn raise the pH to the desired range. The result of this analysis is an acid loading reduction that equates to meeting water quality standards for pH (see Table 2). The method and rationale for addressing pH is contained in Attachment C.

An allowable long-term average instream concentration was determined at point MORR1 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 MORR1 for this stream segment are presented in Table E15.

Table E15. Long Term Average (LTA) for Morris Run Between MORR2 and MORR1				
Station MORR1	***Measured Sample Data***		***Allowable***	
	Conc. (mg/l)	***Load (lb/day)***	***LTA Conc. (mg/l)***	***Load (lb/day)***
Fe	4.19	164.6	0.92	36.1
Mn	16.95	665.8	0.51	20.0
Al	15.55	610.8	0.16	6.3
Acidity	165.57	6503.8	0	0
Alkalinity	0	0		

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

The loading reductions for points MORR2, DMR004, DMR003 and DMR001 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 MORR1. This value was compared to the allowable load at point MORR1. Reductions at point MORR1 are necessary for any parameter that exceeds the allowable load at this point. A summary of all loads that affect point MORR1 are shown in Table E16. Necessary reductions at point MORR1 are shown in Table E17.

Table E16. Summary of Loads Affecting Point MORR1				
	Iron (lb/day)	***Manganese (lb/day)***	***Aluminum (lb/day)***	***Acidity (lb/day)***
MORR2				
Load Reduction	0	26.8	12.6	0
DMR004, DMR003, DMR001				
Load Reduction	141.8	495.7	471.6	5764.7

Table E17. Reductions Necessary at Point MORR1				
	Iron (lb/day)	***Manganese (lb/day)***	***Aluminum (lb/day)***	***Acidity (lb/day)***
Existing Loads at MORR1	164.6	665.8	610.8	6503.8
Total Load Reduction (MORR2, DMR004, DMR003, DMR001)	141.8	522.5	484.2	5764.7
Remaining Load	22.8	143.3	126.6	739.1
Allowable Loads at MORR1	36.1	20.0	6.3	0
Percent Reduction	0	86	95	100
Load Reduction	0	123.3	120.3	739.1

The TMDL for Morris Run at point MORR1 requires that a load allocation be made for all areas between MORR2 and MORR1 for total manganese, total aluminum and acidity.

Coal Creek Above COAL2

Coal Creek above COAL2 represents the watershed area upstream of the Mohawk Lane crossing on Coal Creek. Much of the Coal Creek watershed has been extensively deep and surface mined. DCC005 drains into Coal Creek approximately ½ mile downstream. Between points COAL2 and DCC005, Coal Creek loses most of its flow into the underlying mine pool through fissures in the streambed. Coal Creek in this section is often dry. Point COAL2 represents Coal Creek upstream of the influence of the Coal Creek discharge at DCC005.

The TMDL for Coal Creek above COAL2 consists of a load allocation to all of the watershed area above the point computed using water quality data collected at point COAL2. Addressing the mining impacts at this point addresses the impairments. An instream flow measurement was available for point COAL2 (0.181mgd).

Sample data at point COAL2 show pH ranging from 5.41 to 6.2; pH will be addressed as part of this TMDL because the water quality is net acidic due to mining impacts. The objective is to reduce acid loading to the stream that will in turn raise the pH to the desired range. The result of this analysis is an acid loading reduction that equates to meeting water quality standards for pH (see Table 2). The method and rationale for addressing pH is contained in Attachment C.

An allowable long-term average instream concentration was determined at point COAL2 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 COAL2 for this stream segment are presented in Table E18.

Table E18. Reductions for Coal Creek Above COAL2					
Station COAL2	*Measured Sample Data*		*Allowable*		*Reduction Identified*
	Conc. (mg/l)	*Load (lb/day)*	*LTA Conc. (mg/l)*	*Load (lb/day)*	*Percent*
Fe	0.35	0.5	0.35	0.5	0
Mn	0.42	0.6	0.42	0.6	0
Al	0.50	0.8	0.50	0.8	0
Acidity	19.24	29.0	2.18	3.3	89
Alkalinity	9.56	14.4			

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

The TMDL for Coal Creek above COAL2 requires that a load allocation be made for all of the watershed area upstream for acidity.

Coal Creek Discharge (DCC005)

The Coal Creek discharge, monitored at point DCC005, is the largest single contributor of AMD pollution to the Tioga River Watershed. It drains from an opening at the end of a railroad spur into a deep, steeply-sided ravine. In periods of low flow, Coal Creek is entirely dry upstream of this discharge due to capture of the stream flow by the underlying mine pool. According to historical reports, the underground watershed made up of mine passages for this discharge is almost twice that of the above ground topographical watershed and extends significantly into the neighboring Morris Run Watershed. Point DCC005 represents the Coal Creek Discharge at the source.

The TMDL for the Coal Creek Discharge consists of a load allocation to the discharge computed using water quality data collected at point DCC005. Addressing the mining impacts at this point addresses the impairments. An instream flow measurement was available for point DCC005 (2.83mgd).

Sample data at point DCC005 show pH ranging from 2.7 to 2.9; pH will be addressed as part of this TMDL because of the mining impacts. The objective is to reduce acid loading to the stream that will in turn raise the pH to the desired range. The result of this analysis is an acid loading reduction that equates to meeting water quality standards for pH (see Table 2). The method and rationale for addressing pH is contained in Attachment C.

An allowable long-term average instream concentration was determined at point DCC005 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 DCC005 for the discharge are presented in Table E19.

Table E19. Reductions for the Coal Creek Discharge					
Station DCC005	***Measured Sample Data***		***Allowable***		***Reduction Identified***
	Conc. (mg/l)	***Load (lb/day)***	***LTA Conc. (mg/l)***	***Load (lb/day)***	***Percent***
Fe	40.30	951.2	0.81	19.1	98
Mn	9.40	221.9	0.47	11.1	95
Al	31.40	741.1	0.31	7.3	99
Acidity	439.17	10365.4	0	0	100
Alkalinity	0	0			

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

The TMDL for point DCC005 requires that a load allocation be applied to the Coal Creek discharge for total iron, total manganese, total aluminum and acidity

Coal Creek Between COAL2 and COAL1

Coal Creek between COAL2 and COAL1 receives drainage from the DCC005 discharge and a few minor discharges. This discharge is the largest volume discharge in the Tioga River watershed and has highly degraded water quality. At least one other small discharge drains into Coal Creek before its confluence with the Tioga River. Point COAL1 represents the mouth of Coal Creek.

The TMDL for this section of Coal Creek consists of a load allocation to all of the watershed area between points COAL2 and COAL1 computed using water quality data collected at point COAL1. Addressing the mining impacts between these points addresses the impairments. An instream flow measurement was available for point COAL1 (3.02mgd).

Sample data at point COAL1 show pH ranging from 2.7 to 3; pH will be addressed as part of this TMDL because of the mining impacts. The objective is to reduce acid loading to the stream that will in turn raise the pH to the desired range. The result of this analysis is an acid loading reduction that equates to meeting water quality standards for pH (see Table 2). The method and rationale for addressing pH is contained in Attachment C.

An allowable long-term average instream concentration was determined at point COAL1 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 COAL1 for this stream segment are presented in Table E20.

Table E20. Long Term Average (LTA) for Coal Creek Between COAL2 and COAL1				
Station COAL1	***Measured Sample Data***		***Allowable***	
	Conc. (mg/l)	***Load (lb/day)***	***LTA Conc. (mg/l)***	***Load (lb/day)***
Fe	34.32	864.4	0.69	17.4
Mn	7.61	191.7	0.54	13.6
Al	27.38	689.6	0.27	6.8
Acidity	392.30	9880.8	0	0
Alkalinity	0	0		

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

The loading reductions for point DCC005 and COAL2 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 COAL1. This value was compared to the allowable load at point COAL1. Reductions at point COAL1 are necessary for any parameter that exceeds the allowable load at this point. A summary of all loads that affect point COAL1 are shown in Table E21. Necessary reductions at point COAL1 are shown in Table E22.

Table E21. Summary of Loads Affecting Point COAL1				
	Iron (lb/day)	***Manganese (lb/day)***	***Aluminum (lb/day)***	***Acidity (lb/day)***
DCC005				
Load Reduction	932.1	210.8	733.8	10365.4
COAL2				
Load Reduction	0	0	0	25.7

Table E22. Reductions Necessary at Point COAL1				
	Iron (lb/day)	***Manganese (lb/day)***	***Aluminum (lb/day)***	***Acidity (lb/day)***
Existing Loads at COAL1	864.4	191.7	689.6	9880.8
Total Load Reduction (DCC005, COAL2)	932.1	210.8	733.8	10391.1
Remaining Load	0	0	0	0
Allowable Loads at COAL1	17.4	13.6	6.8	0
Percent Reduction	0	0	0	0
Load Reduction	0	0	0	0

The TMDL for Coal Creek at point COAL1 does not require that a load allocation be made between COAL2 and COAL1.

Tioga River Between TIOG4 and TIOG3

The Tioga River between TIOG4 and TIOG3 receives drainage from the Morris Run and Coal Creek Watersheds. This segment of the river travels through the town of Blossburg, a highly residential area. The river is straightened and is usually a bright orange color from the mine drainage in the Morris Run and Coal Creek Watersheds. Point TIOG3 represents the Tioga River upstream of the confluence with Johnson Creek.

The TMDL for this section of the Tioga River consists of a load allocation to all of the watershed area between TIOG4 and TIOG3. Addressing the mining impacts between these points addresses the impairment for the segment. An instream flow measurement was available for point TIOG3 (53.89mgd).

Sample data at point TIOG3 show pH ranging from 3.2 to 4.5; pH will be addressed as part of this TMDL because of the mining impacts. The objective is to reduce acid loading to the stream that will in turn raise the pH to the desired range. The result of this analysis is an acid loading reduction that equates to meeting water quality standards for pH (see Table 2). 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 TIOG3. 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 TIOG3 for this stream segment are presented in Table E23.

Table E23. Long Term Average (LTA) for Tioga River Between TIOG4 and TIOG3

Station TIOG3	***Measured Sample Data***		***Allowable***	
	Conc. (mg/l)	***Load (lb/day)***	***LTA Conc. (mg/l)***	***Load (lb/day)***
Fe	2.96	1330.4	0.39	175.3
Mn	3.96	1779.8	0.32	143.8
Al	5.75	2584.3	0.06	27.0
Acidity	69.97	31447.5	0.35	157.3
Alkalinity	1.27	570.8		

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

The loading reductions for all upstream points 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 TIOG3. This value was compared to the allowable load at point TIOG3. Reductions at point TIOG3 are necessary for any parameter that exceeds the allowable load at this point. A summary of all loads that affect point TIOG3 are shown in Table E24. Necessary reductions at point TIOG3 are shown in Table E25.

Table E24. Summary of Loads Affecting Point TIOG3				
	Iron (lb/day)	***Manganese (lb/day)***	***Aluminum (lb/day)***	***Acidity (lb/day)***
FALL2, FALL1, DFB099, MORR2, DMR004, DMR003, DMR001, COAL2, DCC005				
Load Reduction	1089.5	1016.8	1429.3	19322.7
TIOG4				
Load Reduction	0	0	0	3212.8
MORR1				
Load Reduction	0	123.3	120.3	739.1
COAL1				
Load Reduction	0	0	0	0

Table E25. Reductions Necessary at Point TIOG3				
	Iron (lb/day)	***Manganese (lb/day)***	***Aluminum (lb/day)***	***Acidity (lb/day)***
Existing Loads at TIOG3	1330.4	1779.8	2584.3	31447.5
Total Load Reduction (FALL2, FALL1, DFB099, TIOG4, MORR2, DMR004, DMR003, DMR001, MORR1, COAL2, COAL1, DCC005)	1089.5	1140.1	1549.6	23274.6
Remaining Load	240.9	639.7	1034.7	8172.9
Allowable Loads at TIOG3	175.3	143.8	27.0	157.3
Percent Reduction	28	78	98	99
Load Reduction	65.6	495.9	1007.7	8015.6

The TMDL for point TIOG3 requires that a load allocation be applied to all areas of the Tioga River between TIOG4 and TIOG3 for total iron, total manganese, total aluminum and acidity.

Johnson Creek Above JOHN3

Johnson Creek upstream of JOHN3 is the headwaters of the Johnson Creek Watershed. The drainage boundary between Johnson Creek and neighboring Babb Creek is a drainage pipe connecting two swampy areas in the headwaters of the two watersheds. At least two mine discharges drain into Johnson Creek in this section. One drains from the north and drains the Arnot #2 Mine; one drains from the south and drains the Arnot #1 Mine. Both mine complexes straddle the watershed divide between the Johnson Creek and Babb Creek Watersheds and both complexes have additional discharges into the Babb Creek Watershed. The southern discharge is used by the Arnot Sportsmans Club to feed a co-operative trout nursery and has also been used a public water supply for the village of Arnot. Point JOHN3 represents Johnson Creek upstream of the confluence with the UN7 unnamed tributary.

The TMDL for the unnamed tributary to Johnson Creek consists of a load allocation to the watershed area upstream computed using water quality data collected at point JOHN3. Addressing the mining impacts at this point addresses the impairments. An instream flow measurement was available for point JOHN3 (2.06mgd).

Sample data at point JOHN3 show pH ranging from 6 to 6.5; pH will not be addressed as part of this TMDL because the segment is net alkaline.

An allowable long-term average instream concentration was determined at point JOHN3 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 JOHN3 for the discharge are presented in Table E26.

Table E26. Reductions for Johnson Creek Above JOHN3

Station JOHN3	***Measured Sample Data***		***Allowable***		***Reduction Identified***
	Conc. (mg/l)	***Load (lb/day)***	***LTA Conc. (mg/l)***	***Load (lb/day)***	***Percent***
Fe	0.74	12.7	0.30	5.2	59
Mn	0.47	8.1	0.39	6.7	18
Al	0.51	8.8	0.51	8.8	0
Acidity	13.37	229.7	13.37	229.7	0
Alkalinity	16.33	280.6			

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

The TMDL for point JOHN3 requires that a load allocation be applied to the watershed area above JOHN3 for total iron and total manganese.

Unnamed Tributary to Johnson Creek Above UNT7

The unnamed tributary to Johnson Creek monitored at the point UNT7 receives drainage from the #5 Discharge that drains from the Arnot #3 deep mine complex. This discharge is a large volume discharge but with much milder chemical characteristics compared to discharges in the Morris Run, Coal Creek, Bear Creek and Fall Brook Watersheds. Point UNT7 represents the mouth of the unnamed tributary.

The TMDL for the unnamed tributary to Johnson Creek consists of a load allocation to the watershed area upstream computed using water quality data collected at point UNT7. Addressing the mining impacts at this point addresses the impairments. An instream flow measurement was available for point UNT7 (2.66mgd).

Sample data at point UNT7 show pH ranging from 5.7 to 6.4; pH will be addressed as part of this TMDL because the water quality data are net acidic due to mining impacts. The objective is to reduce acid loading to the stream that will in turn raise the pH to the desired range. The result of this analysis is an acid loading reduction that equates to meeting water quality standards for pH (see Table 2). The method and rationale for addressing pH is contained in Attachment C.

An allowable long-term average instream concentration was determined at point UNT7 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 UNT7 for this stream segment are presented in Table E27.

Table E27. Reductions for the Unnamed Tributary to Johnson Creek Above UNT7

Station UNT7	*Measured Sample Data*		*Allowable*		*Reduction Identified*
	Conc. (mg/l)	*Load (lb/day)*	*LTA Conc. (mg/l)*	*Load (lb/day)*	*Percent*
Fe	0.60	13.3	0.60	13.3	0
Mn	0.52	11.5	0.52	11.5	0
Al	0.54	12.0	0.51	11.3	7
Acidity	24.57	545.1	3.93	87.2	84
Alkalinity	16.30	361.6			

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

The TMDL for point UNT7 requires that a load allocation be applied to all areas of the unnamed tributary to Johnson Creek upstream of point UNT7 for total aluminum and acidity.

Johnson Creek Between JOHN3 and JOHN2

Johnson Creek between JOHN3 and JOHN2 receives drainage from the UNT7 unnamed tributary and a series of discharges from a large abandoned refuse pile in state forest land just outside the village of Arnot. Point JOHN2 represents Johnson Creek upstream of the influence of the UNT5 unnamed tributary.

The TMDL for this section of Johnson Creek consists of a load allocation to all of the watershed area between JOHN3 and JOHN2. Addressing the mining impacts between these points addresses the impairment for the segment. An instream flow measurement was available for point JOHN2 (6.72mgd).

Sample data at point JOHN2 show pH ranging from 6.1 to 6.4; pH will be addressed as part of this TMDL because the water quality data are net acidic due to mining impacts. The objective is to reduce acid loading to the stream that will in turn raise the pH to the desired range. The result of this analysis is an acid loading reduction that equates to meeting water quality standards for pH (see Table 2). 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 JOHN2. 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 JOHN2 for this stream segment are presented in Table E28.

Table E28. Long Term Average (LTA) for Johnson Creek Between JOHN3 and JOHN2

Station JOHN2	***Measured Sample Data***		***Allowable***	
	Conc. (mg/l)	***Load (lb/day)***	***LTA Conc. (mg/l)***	***Load (lb/day)***
Fe	0.36	20.2	0.36	20.2
Mn	0.38	21.3	0.38	21.3
Al	0.50	28.0	0.50	28.0
Acidity	20.40	1143.3	3.06	171.5
Alkalinity	13.83	775.1		

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

The loading reductions for points JOHN3 and UNT7 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 JOHN2. This value was compared to the allowable load at point JOHN2. Reductions at point JOHN2 are necessary for any parameter that exceeds the allowable load at this point. A summary of all loads that affect point JOHN2 are shown in Table E29. Necessary reductions at point JOHN2 are shown in Table E30.

Table E29. Summary of Loads Affecting Point JOHN2				
	Iron (lb/day)	***Manganese (lb/day)***	***Aluminum (lb/day)***	***Acidity (lb/day)***
JOHN3				
Load Reduction	7.5	1.4	0	0
UNT7				
Load Reduction	0	0	0.7	457.9

Table E30. Reductions Necessary at Point JOHN2				
	Iron (lb/day)	***Manganese (lb/day)***	***Aluminum (lb/day)***	***Acidity (lb/day)***
Existing Loads at JOHN2	20.2	21.3	28.0	1143.3
Total Load Reduction (JOHN3, UNT7)	7.5	1.4	0.7	457.9
Remaining Load	12.7	19.9	27.3	685.4
Allowable Loads at JOHN2	20.2	21.3	28.0	171.5
Percent Reduction	0	0	0	75
Load Reduction	0	0	0	513.9

The TMDL for point JOHN2 requires that a load allocation be applied to all areas of Johnson Creek between JOHN3 and JOHN2 for acidity.

Unnamed Tributary to Johnson Creek Above UNT5

The unnamed tributary to Johnson Creek with monitoring point UNT5 drains the South Mountain. South Mountain was extensively mined. Approximately half of the mountain has had surface reclamation completed; however, the other half is not reclaimed. This includes large areas of acid producing overburden material with no vegetation and an open strip pit with a dangerous highwall. In addition, along the edges of the stripped area are diffuse seeps of mine drainage. This drainage aggregates as it flows downhill and forms the South Mountain tributary to Johnson Creek. A small amount of drainage also flows down the opposite side of South Mountain and impacts the Tioga River between TIOG4 and TIOG3. Point UNT5 represents the South Mountain tributary at the mouth.

The TMDL for the South Mountain tributary consists of a load allocation to all of the watershed area above UNT5. Addressing the mining impacts above this point addresses the impairment for the segment. An instream flow measurement was available for point UNT5 (0.504mgd).

Sample data at point UNT5 show pH ranging from 3.5 to 4.1; pH will be addressed as part of this TMDL because of the mining impacts. The objective is to reduce acid loading to the stream that will in turn raise the pH to the desired range. The result of this analysis is an acid loading reduction that equates to meeting water quality standards for pH (see Table 2). 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 UNT5. 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 UNT5 for this stream segment are presented in Table E31.

Table E31. Reductions for the South Mountain Tributary to Johnson Creek

Station UNT5	***Measured Sample Data***		***Allowable***		***Reduction Identified***
	Conc. (mg/l)	***Load (lb/day)***	***LTA Conc. (mg/l)***	***Load (lb/day)***	***Percent***
Fe	0.74	3.1	0.61	2.6	17
Mn	9.05	38.0	0.45	1.9	95
Al	10.22	43.0	0.10	0.4	97
Acidity	107.76	453.0	0.32	1.3	99.7
Alkalinity	0.92	3.9			

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

The TMDL for point UNT5 requires that a load allocation be applied to all areas of the unnamed tributary to Johnson Creek above UNT5 for total iron, total manganese, total aluminum and acidity.

Johnson Creek Between JOHN2 and JOHN1

Johnson Creek between JOHN2 and JOHN1 receives drainage from the UNT5 unnamed tributary and at least one other minor discharge from the Flower Run deep mine. Point JOHN1 represents Johnson Creek at the mouth, upstream of its confluence with the Tioga River.

The TMDL for this section of Johnson Creek consists of a load allocation to all of the watershed area between JOHN2 and JOHN1. Addressing the mining impacts between these points addresses the impairment for the segment. An instream flow measurement was available for point JOHN1 (13.06mgd).

Sample data at point JOHN1 show pH ranging from 6.2 to 6.5; pH will be addressed as part of this TMDL because the water quality data are net acidic due to mining impacts. The objective is to reduce acid loading to the stream that will in turn raise the pH to the desired range. The result of this analysis is an acid loading reduction that equates to meeting water quality standards for pH (see Table 2). 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 JOHN1. 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 JOHN1 for this stream segment are presented in Table E32.

Table E32. Long Term Average (LTA) for Johnson Creek Between JOHN2 and JOHN1

Station JOHN1	***Measured Sample Data***		***Allowable***	
	Conc. (mg/l)	***Load (lb/day)***	***LTA Conc. (mg/l)***	***Load (lb/day)***
Fe	0.31	33.8	0.31	33.8
Mn	0.45	49.0	0.34	37.0
Al	0.53	57.7	0.53	57.7
Acidity	19.17	2088.0	3.07	334.4
Alkalinity	16.63	1811.3		

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

The loading reductions for points JOHN3, UNT7, UNT5 and JOHN2 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 JOHN1. This value was compared to the allowable load at point JOHN1. Reductions at point JOHN1 are necessary for any parameter that exceeds the allowable load at this point. A summary of all loads that affect point JOHN1 are shown in Table E33. Necessary reductions at point JOHN1 are shown in Table E34.

Table E33. Summary of Loads Affecting Point JOHN1

	Iron (lb/day)	***Manganese (lb/day)***	***Aluminum (lb/day)***	***Acidity (lb/day)***
(JOHN3, UNT7)				
Load Reduction	7.5	1.4	0.7	457.9
UNT5				
Load Reduction	0.5	36.1	42.6	451.7
JOHN2				
Load Reduction	0	0	0	513.9

Table E34. Reductions Necessary at Point JOHN1				
	Iron (lb/day)	***Manganese (lb/day)***	***Aluminum (lb/day)***	***Acidity (lb/day)***
Existing Loads at JOHN1	33.8	49.0	57.7	2088.0
Total Load Reduction (JOHN3, UNT7, UNT5, JOHN2)	8.0	37.5	43.3	1423.5
Remaining Load	25.8	11.5	14.4	664.5
Allowable Loads at JOHN1	33.8	37.0	57.7	334.4
Percent Reduction	0	0	0	50
Load Reduction	0	0	0	330.1

The TMDL for point JOHN1 requires that a load allocation be applied to all areas of Johnson Creek between JOHN2 and JOHN1 for acidity.

Bear Creek Above BEAR1

The Bear Creek Watershed is impacted by abandoned deep mine discharges in its mid-reaches. At least five discharges impact the watershed. The largest of these is an artesian discharge that emerges in the stream bottom. Multiple collapsed drift entries, some with a discharge, line the stream channel. Upstream of this point, Bear Creek is dry due to fracturing of the rocks below the stream channel. In the headwaters of the stream, above the fractured zone, water flows in the channel again. In this reach (above the fractured zone), Bear Creek receives AMD from the surface overflow of a water-filled pit on a large, abandoned surface mine on the hilltop between the Bear Creek and East Creek Watersheds. Reclamation of this surface mine would likely have significant impact on the water quality of Bear Creek. Point BEAR1 represents Bear Creek at the mouth.

The TMDL for Bear Creek consists of a load allocation to all of the watershed area above point BEAR1. Addressing the mining impacts above this point addresses the impairment for the segment. An instream flow measurement was available for point BEAR1 (0.414mgd).

Sample data at point BEAR1 show pH ranging from 3 to 3.2; pH will be addressed as part of this TMDL because of the mining impacts. The objective is to reduce acid loading to the stream that will in turn raise the pH to the desired range. The result of this analysis is an acid loading reduction that equates to meeting water quality standards for pH (see Table 2). 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 BEAR1. 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 BEAR1 for this stream segment are presented in Table E35.

Table E35. Reductions for Bear Creek Above BEAR1					
Station BEAR1	***Measured Sample Data***		***Allowable***		***Reduction Identified***
	Conc. (mg/l)	***Load (lb/day)***	***LTA Conc. (mg/l)***	***Load (lb/day)***	***Percent***
Fe	6.54	22.6	0.92	3.2	86
Mn	6.62	22.9	0.33	1.1	95
Al	15.63	54.0	0.16	0.6	99
Acidity	195.30	674.3	0	0	100
Alkalinity	0	0			

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

The TMDL for point BEAR1 requires that a load allocation be applied to all areas of Bear Creek above BEAR1 for total iron, total manganese, total aluminum and acidity.

Tioga River Between TIOG3 and TIOG2

The Tioga River between TIOG3 and TIOG2 receives drainage from the Bear Creek and Johnson Creek Watersheds. In this reach, the river flows out of the Blossburg area and into the agricultural section of the watershed. In this section, the Tioga River begins to receive inputs of alkaline water with few metals, beginning the process of AMD neutralization that continues downstream and in the Tioga/Hammond Complex. TIOG2 represents the Tioga River downstream of the confluence with Bear Creek.

The TMDL for this section of Tioga River consists of a load allocation to all of the watershed area between TIOG3 and TIOG2. Addressing the mining impacts between these points addresses the impairment for the segment. An instream flow measurement was available for point TIOG2 (70.37mgd).

Sample data at point TIOG2 show pH ranging from 3.6 to 4.6; pH will be addressed as part of this TMDL because of the mining impacts. The objective is to reduce acid loading to the stream that will in turn raise the pH to the desired range. The result of this analysis is an acid loading reduction that equates to meeting water quality standards for pH (see Table 2). The method and rationale for addressing pH is contained in Attachment C.

An allowable long-term average instream concentration was determined at point TIOG2 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 TIOG2 for this stream segment are presented in Table E36.

Table E36. Long Term Average (LTA) for Tioga River Between TIOG3 and TIOG2				
Station TIOG2	***Measured Sample Data***		***Allowable***	
	Conc. (mg/l)	***Load (lb/day)***	***LTA Conc. (mg/l)***	***Load (lb/day)***
Fe	0.74	434.3	0.74	434.3
Mn	2.56	1502.4	0.31	181.9
Al	3.75	2200.8	0.04	23.5
Acidity	64.70	37971.5	0.65	381.5
Alkalinity	2.33	1367.4		

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

The loading reductions for all upstream points 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 TIOG2. This value was compared to the allowable load at point TIOG2. Reductions at point TIOG2 are necessary for any parameter that exceeds the allowable load at this point. A summary of all loads that affect point TIOG2 are shown in Table E37. Necessary reductions at point TIOG2 are shown in Table E38.

Table E37. Summary of Loads Affecting Point TIOG2				
	Iron (lb/day)	***Manganese (lb/day)***	***Aluminum (lb/day)***	***Acidity (lb/day)***
FALL2, FALL1, DFB099, TIOG4, MORR2, MORR1, DMR004, DMR003, DMR001, COAL2, DCC005, COAL1, JOHN3, JOHN2, UNT5, UNT7				
Load Reduction	1097.5	1177.6	1592.9	24698.1
JOHN1				
Load Reduction	0	0	0	330.1
BEAR1				
Load Reduction	19.4	21.8	53.4	674.3
TIOG3				
Load Reduction	65.6	495.9	1007.7	8015.6

Table E38. Reductions Necessary at Point TIOG2				
	Iron (lb/day)	***Manganese (lb/day)***	***Aluminum (lb/day)***	***Acidity (lb/day)***
Existing Loads at TIOG2	434.3	1502.4	2200.8	37971.5
Total Load Reduction (FALL2, FALL1, DFB099, TIOG4, MORR2, MORR1, DMR004, DMR003, DMR001, DCC005, COAL2, COAL1, TIOG3, BEAR1, JOHN3, JOHN2, UNT7, UNT5)	1182.5	1695.3	2654.0	33718.1
Remaining Load	0	0	0	4253.4
Allowable Loads at TIOG2	434.3	181.9	23.5	381.5
Percent Reduction	0	0	0	92
Load Reduction	0	0	0	3871.9

The TMDL for Tioga River at point TIOG2 requires that a load allocation be made between TIOG3 and TIOG2 for acidity.

Tioga River Between TIOG2 and TIOG1

The Tioga River between TIOG2 and TIOG1 is a long segment that stretches from below Blossburg to below Mansfield where the Tioga Dam begins to back up and sampling using wadeable techniques is no longer feasible. In this segment, the Tioga River receives no additional inputs of AMD. However, many tributaries, some large, do drain into the Tioga in this reach. Most of these tributaries drain areas that are made largely of agricultural lands. Point TIOG1 represents the Tioga River below Mansfield where the Tioga Dam impoundment begins, effectively the end of the flowing segment upstream of the dam complex.

The TMDL for this section of Tioga River consists of a load allocation to the Tioga River between TIOG2 and TIOG1. Addressing the mining impacts above this point addresses the impairment for the segment. As instream flow measurement was available for point TIOG1 (93.18mgd).

Sample data at point TIOG1 show pH ranging from 4 to 5.8; pH will be addressed as part of this TMDL because of the mining impacts. The objective is to reduce acid loading to the stream that will in turn raise the pH to the desired range. The result of this analysis is an acid loading reduction that equates to meeting water quality standards for pH (see Table 2). 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 TIOG1. 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 TIOG1 for this stream segment are presented in Table E39.

Table E39. Long Term Average (LTA) for Tioga River Between TIOG2 and TIOG1				
Station TIOG1	***Measured Sample Data***		***Allowable***	
	Conc. (mg/l)	***Load (lb/day)***	***LTA Conc. (mg/l)***	***Load (lb/day)***
Fe	0.58	450.7	0.52	404.1
Mn	2.02	1569.8	0.26	202.1
Al	2.87	2230.3	0.03	23.3
Acidity	47.00	36524.7	1.41	1095.7
Alkalinity	7.20	5595.3		

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

The loading reductions for all upstream points 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 TIOG1. This value was compared to the allowable load at point TIOG1. Reductions at point TIOG1 are necessary for any parameter that exceeds the allowable load at this point. A summary of all loads that affect point TIOG1 are shown in Table E40. Necessary reductions at point TIOG1 are shown in Table E41.

Table E40. Summary of Loads Affecting Point TIOG1				
	Iron (lb/day)	***Manganese (lb/day)***	***Aluminum (lb/day)***	***Acidity (lb/day)***
FALL2, FALL1, DFB099, TIOG4, MORR2, MORR1, DMR004, DMR003, DMR001, DCC005, COAL2, COAL1, TIOG3, BEAR1, JOHN3, JOHN2, JOHN1, UNT7, UNT5				
Load Reduction	1182.5	1695.3	2654.0	33718.1
TIOG2				
Load Reduction	0	0	0	3871.9

Table E41. Reductions Necessary at Point TIOG1				
	Iron (lb/day)	***Manganese (lb/day)***	***Aluminum (lb/day)***	***Acidity (lb/day)***
Existing Loads at TIOG1	450.7	1569.8	2230.3	36524.7
Total Load Reduction (FALL2, FALL1, DFB099, TIOG4, MORR2, MORR1, DMR004, DMR003, DMR001, DCC005, COAL2, COAL1, TIOG3, BEAR1, JOHN3, JOHN2, JOHN1, UNT7, UNT5, TIOG2)	1182.5	1695.3	2654.0	37590.0
Remaining Load	0	0	0	0
Allowable Loads at TIOG1	404.1	202.1	23.3	1095.7
Percent Reduction	0	0	0	0
Load Reduction	0	0	0	0

The TMDL for Tioga River at point TIOG1 does not require that a load allocation be made between TIOG2 and TIOG1.

Margin of Safety

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

- Effluent variability plays a major role in determining the average value that will meet water-quality criteria over the long term. The value that provides this variability in our analysis is the standard deviation of the dataset. The simulation results are based on this variability and the existing stream conditions (an uncontrolled system). The general assumption can be made that a controlled system (one that is controlling and stabilizing the pollution load) would be less variable than an uncontrolled system. This implicitly builds in a MOS.
- A MOS is also the fact that the calculations were performed with a daily iron average, instead of the 30-day average.

Seasonal Variation

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

Critical Conditions

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

Attachment F

Water Quality Data Used
In TMDL Calculations

TMDL Point	Date	Flow cfs	pH	Acidity mg/l	Alkalinity mg/l	TFe mg/l	TMn mg/l	TAl mg/l	TSO4 mg/l
TIOG1.0	4/23/2001	403	5.8	6.6	7	0.809	0.822	0.938	38
TIOG1.0	6/4/2001	78	4.9	11.8	10.8	0.3	1.68	1.92	80.9
TIOG1.0	10/9/2001	68	4.6	66.2	8	0.39	2.2	2.96	95.9
TIOG1.0	3/5/2002	124	5.5	27.2	8.6	1.06	1.05	1.66	58.7
TIOG1.0	5/28/2002	177	4.7	51.8	7	0.591	1.37	1.82	60.4
TIOG1.0	8/20/2002	15	4	118.4	1.8	0.3	4.97	7.94	20
	Average	*144.17*	*4.92*	*47.00*	*7.20*	*0.58*	*2.02*	*2.87*	*58.98*
	StDev	*138.09*	*0.65*	*41.84*	*2.99*	*0.31*	*1.53*	*2.57*	*27.59*
TIOG2.0	4/30/2001	349.51	4	26	1.4	*	*	*	70.3
TIOG2.0	6/11/2001	47.367	3.8	49	0	0.52	2.81	3.88	100.1
TIOG2.0	10/18/2001	59.028	4.6	98.2	5.8	0.761	1.37	1.55	32
TIOG2.0	3/19/2002	75.302	4.3	58.8	4.8	0.87	1.47	1.92	23.8
TIOG2.0	6/13/2002	107.487	4	46.8	2	0.941	1.92	2.64	50.2
TIOG2.0	8/19/2002	14.589	3.6	109.4	0	0.605	5.23	8.76	245.1
	Average	*108.88*	*4.05*	*64.70*	*2.33*	*0.74*	*2.56*	*3.75*	*86.92*
	StDev	*121.81*	*0.36*	*32.31*	*2.45*	*0.18*	*1.60*	*2.94*	*82.24*
TIOG3.0	4/30/2001	282.1	3.8	36	0	4.07	4.48	6.39	74
TIOG3.0	6/11/2001	34.232	3.6	64.6	0	2.44	3.57	5.61	136.5
TIOG3.0	10/10/2001	43.013	4.5	59.6	7.6	0.436	2.94	2.56	68.2
TIOG3.0	3/13/2002	54.421	3.8	79.6	0	1.96	1.98	2.59	66.8
TIOG3.0	6/11/2002	77.681	3.9	34.8	0	1.89	2.35	3.03	75.7
TIOG3.0	8/19/2002	8.851	3.2	145.2	0	6.96	8.46	14.3	405.2
	Average	*83.38*	*3.80*	*69.97*	*1.27*	*2.96*	*3.96*	*5.75*	*137.73*
	StDev	*99.96*	*0.42*	*40.69*	*3.10*	*2.28*	*2.38*	*4.50*	*133.65*
TIOG4.0	4/30/2001	172.68	4.9	5.4	7.6	0.3	0.973	0.79	37
TIOG4.0	6/18/2001	24.776	6	3.2	9.4	0.3	0.473	0.5	20
TIOG4.0	10/10/2001	29.421	5.2	40	8.2	0.3	1.08	0.724	42.4
TIOG4.0	3/18/2002	39.387	5.6	27.6	8.2	0.3	0.649	0.5	37.1
TIOG4.0	5/30/2002	56.222	4.8	35.4	7.8	0.3	0.792	0.559	51.7
TIOG4.0	8/14/2002	3.947	4.8	31.8	7	0.3	2.19	1.35	88
	Average	*54.41*	*5.22*	*23.90*	*8.03*	*0.30*	*1.03*	*0.74*	*46.03*
	StDev	*60.44*	*0.49*	*15.74*	*0.80*	*0.00*	*0.61*	*0.32*	*23.00*
TIOG5.0	4/30/2001	102.58	6.4	0.2	11.4	0.3	0.05	0.5	20
TIOG5.0	6/12/2001	17.589	6.2	0	12.8	0.3	0.05	0.5	20
TIOG5.0	10/10/2001	19.734	6.3	2.4	15.6	0.3	0.05	0.5	20
TIOG5.0	3/18/2002	27.962	6.6	0	11.2	0.3	0.05	0.5	20
TIOG5.0	5/29/2002	39.914	6.2	15	10	0.3	0.05	0.5	20
TIOG5.0	8/14/2002	1.783	6.4	0	15	0.3	0.05	0.5	20
	Average	*34.93*	*6.35*	*2.93*	*12.67*	*0.30*	*0.05*	*0.50*	*20.00*

TMDL Point	Date	Flow cfs	pH	Acidity mg/l	Alkalinity mg/l	TFe mg/l	TMn mg/l	TAl mg/l	TSO4 mg/l
	StDev	*35.44*	*0.15*	*5.99*	*2.23*	*0.00*	*0.00*	*0.00*	*0.00*
TIOG6.0	4/24/2001	93.61	6.2	0	9.2	0.3	0.068	0.5	20
TIOG6.0	6/12/2001	14.043	6.4	0	15.2	0.3	0.05	0.5	20
TIOG6.0	10/2/2001	17.471	6.7	0	11.4	0.3	0.066	0.5	20
TIOG6.0	3/18/2002	22.324	6.5	0	11.2	0.3	0.074	0.5	20
TIOG6.0	5/29/2002	31.866	6.2	24.4	9.6	0.3	0.074	0.5	24.4
TIOG6.0	8/14/2002	0.943	6.7	0	22	0.3	0.05	0.5	20
	Average	*30.04*	*6.45*	*4.07*	*13.10*	*0.30*	*0.06*	*0.50*	*20.73*
	StDev	*32.76*	*0.23*	*9.96*	*4.85*	*0.00*	*0.01*	*0.00*	*1.80*
FELL1.0	4/23/2001	20.769	4.6	4.8	5.8	0.3	0.21	0.5	20
FELL1.0	6/4/2001	6.141	4.9	4.2	7.4	0.3	0.137	0.5	20
FELL1.0	10/2/2001	7.349	4.7	28.2	6.2	0.3	0.246	0.5	32.6
FELL1.0	3/14/2002	5.215	4.7	16.2	6.8	0.3	0.149	0.5	20
FELL1.0	5/28/2002	9.65	4.9	19.4	6.4	0.3	0.155	0.5	20
FELL1.0	8/13/2002	0.104	4.9	8.4	7.6	0.3	0.267	0.5	20
	Average	*8.20*	*4.78*	*13.53*	*6.70*	*0.30*	*0.19*	*0.50*	*22.10*
	StDev	*6.92*	*0.13*	*9.45*	*0.70*	*0.00*	*0.05*	*0.00*	*5.14*
FALL1.0	4/30/2001	19.047	4.2	32	4	0.465	4.12	3.3	80
FALL1.0	6/18/2001	4.428	4	48.2	2.2	0.3	7.61	4.76	164.4
FALL1.0	10/10/2001	6.388	4.1	63.2	3.2	0.575	6.13	4.33	112.5
FALL1.0	3/18/2002	9.884	4.1	69.2	3.2	0.451	3.52	2.48	63
FALL1.0	5/30/2002	13.966	4.1	70.6	4	0.427	4.44	3.1	116.2
FALL1.0	8/14/2002	0.899	3.9	108.2	0	0.3	11.1	8.2	235.2
	Average	*9.10*	*4.07*	*65.23*	*2.77*	*0.42*	*6.15*	*4.36*	*128.55*
	StDev	*6.63*	*0.10*	*25.65*	*1.51*	*0.11*	*2.85*	*2.06*	*62.81*
FALL2.0	4/24/2001	15.391	4.5	10.6	6	0.375	0.997	0.742	26
FALL2.0	6/18/2001	2	4	24	2.4	1.13	2.74	1.27	44.6
FALL2.0	10/2/2001	5.184	4.3	41.6	4.4	0.3	0.05	0.5	20
FALL2.0	3/6/2002	8.005	4.4	40.6	5.2	0.527	1.14	0.954	20
FALL2.0	5/28/2002	11.341	4.5	50.6	7.6	0.348	0.972	0.667	20.6
FALL2.0	8/13/2002	0.674	3.9	35	0	1.49	5.59	1.82	60.2
	Average	*7.10*	*4.27*	*33.73*	*4.27*	*0.70*	*1.91*	*0.99*	*31.90*
	StDev	*5.63*	*0.26*	*14.32*	*2.71*	*0.50*	*2.00*	*0.48*	*16.78*
FALL3.0	4/23/2001	4.087	4.7	7	6	0.3	0.596	0.79	20
FALL3.0	6/4/2001	1.407	4.7	7.4	7.8	0.3	0.829	1.04	22.9
FALL3.0	10/1/2001	1.376	4.7	33.8	7.2	0.3	0.783	0.965	109
FALL3.0	3/6/2002	3.212	4.8	15.6	6.8	0.3	0.478	0.755	29.7
FALL3.0	5/28/2002	3.012	4.7	21.2	6.8	0.3	0.518	0.612	20
FALL3.0	8/13/2002	0.286	4.5	41.4	7.4	0.3	2	2	24.3
	Average	*2.23*	*4.68*	*21.07*	*7.00*	*0.30*	*0.87*	*1.03*	*37.65*

TMDL Point	Date	Flow cfs	pH	Acidity mg/l	Alkalinity mg/l	TFe mg/l	TMn mg/l	TAl mg/l	TSO4 mg/l
	StDev	*1.43*	*0.10*	*14.07*	*0.62*	*0.00*	*0.57*	*0.50*	*35.14*
JOHN1.0	4/25/2001	39.071	6.2	0	9	0.3	0.44	0.5	34.6
JOHN1.0	6/11/2001	5.396	6.5	0	22	0.3	0.192	0.5	75.4
JOHN1.0	10/11/2001	8.423	6.2	37.4	16.6	0.3	0.823	0.566	20.9
JOHN1.0	3/13/2002	19.676	6.3	41.2	12.8	0.3	0.512	0.5	49.6
JOHN1.0	6/11/2002	44.94	6.2	36.4	11.4	0.352	0.57	0.61	65.8
JOHN1.0	8/19/2002	3.732	6.5	0	28	0.3	0.153	0.5	47.7
	Average	*20.21*	*6.32*	*19.17*	*16.63*	*0.31*	*0.45*	*0.53*	*49.00*
	StDev	*17.87*	*0.15*	*21.06*	*7.19*	*0.02*	*0.25*	*0.05*	*19.89*
JOHN2.0	4/25/2001	18.313	6.2	1	7.8	0.3	0.457	0.5	53.9
JOHN2.0	6/11/2001	3.061	6.4	0	16	0.3	0.291	0.5	76.2
JOHN2.0	10/9/2001	6.491	6.2	24.8	13.4	0.3	0.367	0.5	69.4
JOHN2.0	3/13/2002	9.611	6.1	41.4	14	0.319	0.371	0.5	52.7
JOHN2.0	6/11/2002	21.36	6.3	40.8	12	0.632	0.453	0.5	49.3
JOHN2.0	8/19/2002	3.571	6.3	14.4	19.8	0.3	0.324	0.5	70.7
	Average	*10.40*	*6.25*	*20.40*	*13.83*	*0.36*	*0.38*	*0.50*	*62.03*
	StDev	*7.73*	*0.10*	*18.47*	*4.01*	*0.13*	*0.07*	*0.00*	*11.36*
JOHN3.0	4/25/2001	6.086	6	1.6	7.4	0.3	0.566	0.5	72.4
JOHN3.0	6/11/2001	0.248	6.3	5	20	0.351	0.224	0.5	50.8
JOHN3.0	10/9/2001	2.932	6.1	20	13.2	0.3	0.501	0.5	62.1
JOHN3.0	3/13/2002	2.633	6.5	0	16.2	0.507	0.325	0.5	85.8
JOHN3.0	6/11/2002	6.36	6.3	32	15.2	0.76	0.357	0.5	45.4
JOHN3.0	8/15/2002	0.84	6.4	21.6	26	2.22	0.85	0.559	81.8
	Average	*3.18*	*6.27*	*13.37*	*16.33*	*0.74*	*0.47*	*0.51*	*66.38*
	StDev	*2.57*	*0.19*	*13.01*	*6.29*	*0.75*	*0.22*	*0.02*	*16.45*
COAL1.0	4/25/2001	8.337	2.7	278	0	27.2	4.97	18.6	394
COAL1.0	6/5/2001	2.828	3	416	0	37.2	9.16	31.6	638.6
COAL1.0	10/4/2001	3.48	2.8	457	0	35.6	8.13	33.1	357.2
COAL1.0	3/13/2002	4.7	2.8	381.8	0	30.7	6.63	22.8	266.2
COAL1.0	5/30/2002	5.948	2.9	313.8	0	29.8	5.86	18.7	276.3
COAL1.0	8/14/2002	2.704	2.8	507.2	0	45.4	10.9	39.5	770.8
	Average	*4.67*	*2.83*	*392.30*	*0.00*	*34.32*	*7.61*	*27.38*	*450.52*
	StDev	*2.18*	*0.10*	*86.36*	*0.00*	*6.59*	*2.21*	*8.61*	*206.97*
COAL2.0	4/25/2001	0.923	5.6	3	6.2	0.3	0.532	0.5	20
COAL2.0	6/5/2001	0.017	5.4	0	11.4	0.3	0.389	0.5	41.5
COAL2.0	10/4/2001	0.09	6.2	30.2	10.8	0.3	0.421	0.5	35.6
COAL2.0	3/13/2002	0.254	5.7	25.6	8	0.3	0.399	0.5	31.1
COAL2.0	5/30/2002	0.126	6	37.4	11.4	0.544	0.376	0.5	20
COAL2.0	8/14/2002	Dry							
	Average	*0.28*	*5.78*	*19.24*	*9.56*	*0.35*	*0.42*	*0.50*	*29.64*

TMDL Point	Date	Flow cfs	pH	Acidity mg/l	Alkalinity mg/l	TFe mg/l	TMn mg/l	TAl mg/l	TSO4 mg/l
	StDev	*0.37*	*0.32*	*16.77*	*2.35*	*0.11*	*0.06*	*0.00*	*9.54*
BEAR1.0	4/25/2001	1.483	3.1	120	0	5.33	3.55	8.87	220
BEAR1.0	6/5/2001	0.107	3.2	226	0	8.31	8.59	19.1	428.5
BEAR1.0	10/4/2001	0.312	3	227.8	0	7.73	7.64	18.9	320.4
BEAR1.0	3/13/2002	0.534	3	206.8	0	6.35	5.05	11.8	214.3
BEAR1.0	5/29/2002	1.303	3	125.4	0	4.49	3.5	8.63	205.1
BEAR1.0	8/19/2002	0.129	3	265.8	0	7.03	11.4	26.5	476.9
	Average	*0.64*	*3.05*	*195.30*	*0.00*	*6.54*	*6.62*	*15.63*	*310.87*
	StDev	*0.60*	*0.08*	*59.43*	*0.00*	*1.45*	*3.14*	*7.07*	*118.54*
MORR1.0	4/24/2001	19.06	3.4	96	0	2.6	10	10	*
MORR1.0	6/5/2001	4.104	3.4	196	0	4.7	20.3	17.3	523
MORR1.0	10/4/2001	4.458	3.2	204	0	5.04	19.2	18.9	520
MORR1.0	3/14/2002	4.727	3.3	146.6	0	4.04	14.4	12	306
MORR1.0	5/29/2002	8.878	3.2	155.2	0	4	15.3	15.2	470.9
MORR1.0	8/14/2002	2.474	3.2	195.6	0	4.75	22.5	19.9	731.7
	Average	*7.28*	*3.28*	*165.57*	*0.00*	*4.19*	*16.95*	*15.55*	*510.32*
	StDev	*6.15*	*0.10*	*41.50*	*0.00*	*0.88*	*4.57*	*3.92*	*152.12*
MORR2.0	4/24/2001	14.22	3.4	98	0	3.86	10.1	9.99	314
MORR2.0	6/5/2001	2.829	3.4	196	0	6.79	21.9	18.6	663.2
MORR2.0	10/4/2001	3.434	3.2	216.6	0	5.83	19.8	19.1	568
MORR2.0	3/14/2002	3.657	3.3	160.4	0	4.55	15.1	12.6	*
MORR2.0	5/29/2002	8.098	3.2	164.8	0	4.24	15.3	15.1	372.9
MORR2.0	8/14/2002	2.083	3.2	203.2	0	6.14	22.5	19.7	707.1
	Average	*5.72*	*3.28*	*173.17*	*0.00*	*5.24*	*17.45*	*15.85*	*525.04*
	StDev	*4.67*	*0.10*	*42.88*	*0.00*	*1.18*	*4.80*	*3.96*	*174.47*
MORR3.0	4/24/2001	5.034	4.8	3.4	6.8	0.3	0.229	0.5	22
MORR3.0	6/5/2001	1.102	4.8	3	8.8	0.3	0.284	0.5	20
MORR3.0	10/2/2001	1.627	4.7	16.6	6.2	0.3	0.261	0.5	20
MORR3.0	3/14/2002	1.376	4.8	13.2	7.2	0.3	0.161	0.5	20
MORR3.0	5/29/2002	1.717	4.6	18	6	0.3	0.235	0.5	20
MORR3.0	8/14/2002	Dry							
	Average	*2.17*	*4.74*	*10.84*	*7.00*	*0.30*	*0.23*	*0.50*	*20.40*
	StDev	*1.62*	*0.09*	*7.19*	*1.11*	*0.00*	*0.05*	*0.00*	*0.89*
DCC005	5/9/2001	5.35	2.8	374	0	37.5	6.93	24	506
DCC005	6/18/2001	3.615	2.8	446.6	0	39.7	9.5	34	564.9
DCC005	11/7/2001	2.866	2.7	494.8	0	42.8	9.66	37.1	571.8
DCC005	3/19/2002	4.508	2.8	414.6	0	37.6	12	29.7	*
DCC005	5/30/2002	7.145	2.9	327	0	30.8	5.92	18.8	293.1
DCC005	8/20/2002	2.804	2.8	578	0	53.4	12.4	44.8	128.4
	Average	*4.38*	*2.80*	*439.17*	*0.00*	*40.30*	*9.40*	*31.40*	*412.84*

TMDL Point	Date	Flow cfs	pH	Acidity mg/l	Alkalinity mg/l	TFe mg/l	TMn mg/l	TAl mg/l	TSO4 mg/l
	StDev	*1.67*	*0.06*	*89.28*	*0.00*	*7.53*	*2.61*	*9.33*	*195.14*
DMR003	5/9/2001	0.594	3.2	206	0	4.05	24.4	17.7	*
DMR003	6/18/2001	0.233	3.2	206	0	3.56	27.6	18.5	771.4
DMR003	11/7/2001	0.203	3.1	277.4	0	3.95	30.4	21.7	810.2
DMR003	3/19/2002	0.411	3.2	269.6	0	3.88	25.6	17.3	626.8
DMR003	5/29/2002	0.87	3.1	184.2	0	3.95	21.5	16.1	668.5
DMR003	8/21/2002	*	3.1	227.2	0	3.3	28.1	19.4	617.4
	Average	*0.46*	*3.15*	*228.40*	*0.00*	*3.78*	*26.27*	*18.45*	*698.86*
	StDev	*0.28*	*0.05*	*37.57*	*0.00*	*0.29*	*3.13*	*1.94*	*87.19*
DMR001	5/9/2001	1	3	362	0	9.4	26.4	35	960
DMR001	6/18/2001	0.254	3	387	0	8.93	31.4	41.1	*
DMR001	11/7/2001	0.39	2.8	443.2	0	9.59	32.3	42.4	880.3
DMR001	3/19/2002	1.5	2.9	441.4	0	8.34	27.7	35.3	630.9
DMR001	5/29/2002	1.91	2.9	351.6	0	8.69	22.5	31.3	480.6
DMR001	8/21/2002	*	2.9	419.8	0	9.33	31.9	45.8	335.7
	Average	*1.01*	*2.92*	*400.83*	*0.00*	*9.05*	*28.70*	*38.48*	*657.50*
	StDev	*0.71*	*0.08*	*39.81*	*0.00*	*0.48*	*3.88*	*5.47*	*263.01*
DMR004	5/9/2001	3.95	3.2	224	0	7.79	21.9	19.3	724
DMR004	6/18/2001	1.512	3.2	210.8	0	8.76	23.4	16.5	475.3
DMR004	11/7/2001	1.407	3.1	266.2	0	10.1	25	18.8	635.6
DMR004	3/19/2002	2.199	3.2	248.6	0	7.34	20.4	14.5	396.5
DMR004	5/29/2002	4.114	3.2	203.2	0	5.52	19.8	17.9	309.6
DMR004	8/20/2002	1.013	3.2	265.4	0	9.66	24.7	16.9	508.7
	Average	*2.37*	*3.18*	*236.37*	*0.00*	*8.20*	*22.53*	*17.32*	*508.28*
	StDev	*1.35*	*0.04*	*27.53*	*0.00*	*1.68*	*2.19*	*1.75*	*152.19*
DFB099	6/18/2001	0.469	3.4	168.2	0	1.66	22.7	15.8	462.2
DFB099	11/7/2001	0.67	3.3	196.8	0	1.42	20.3	14.7	479.6
DFB099	3/18/2002	1.496	3.4	177.8	0	1.4	18.8	13.5	351.6
DFB099	5/29/2002	2.991	3.4	137.8	0	1.25	17	13.2	441.6
DFB099	8/21/2002	0.544	3.3	222.4	0	2.17	29.5	22.7	299.2
	Average	*1.23*	*3.36*	*180.60*	*0.00*	*1.58*	*21.66*	*15.98*	*406.84*
	StDev	*1.06*	*0.05*	*31.64*	*0.00*	*0.36*	*4.86*	*3.90*	*77.79*
UNT5.0	4/25/2001	1.315	3.7	58	0	0.612	6.92	6.99	156
UNT5.0	6/11/2001	0.083	4.1	74.4	4.6	0.3	7.83	8.41	196.3
UNT5.0	10/10/2001	0.439	3.5	168	0	0.956	14	16.7	325.9
UNT5.0	3/13/2002	0.776	3.7	137.2	0	0.682	7.57	8	133.8
UNT5.0	6/11/2002	1.276	3.5	101.2	0	1.14	8.94	11	154.1
UNT5.0	8/19/2002	Dry							
	Average	*0.78*	*3.70*	*107.76*	*0.92*	*0.74*	*9.05*	*10.22*	*193.22*
	StDev	*0.53*	*0.24*	*45.08*	*2.06*	*0.32*	*2.86*	*3.91*	*77.56*

TMDL Point	Date	Flow cfs	pH	Acidity mg/l	Alkalinity mg/l	TFe mg/l	TMn mg/l	TAl mg/l	TSO4 mg/l
UNT7.0	4/25/2001	7.282	6.3	0	11	0.435	0.499	0.72	76.2
UNT7.0	6/11/2001	2.015	6.4	0	19.2	0.784	0.474	0.5	99.7
UNT7.0	10/9/2001	1.976	6.2	32.2	16.6	0.477	0.491	0.5	76.4
UNT7.0	3/13/2002	3.413	6.4	45.6	15.2	0.574	0.512	0.522	89.8
UNT7.0	6/13/2002	8.325	5.7	41.6	15.8	0.648	0.532	0.522	78.8
UNT7.0	8/15/2002	1.627	6.2	28	20	0.683	0.625	0.5	108.8
	Average	*4.11*	*6.20*	*24.57*	*16.30*	*0.60*	*0.52*	*0.54*	*88.28*
	StDev	*2.95*	*0.26*	*20.05*	*3.22*	*0.13*	*0.05*	*0.09*	*13.64*

Attachment G

Comment and Response

No comments were received on this TMDL document during the public comment period.