Tangascootack Creek Watershed TMDL

For Acid Mine Drainage Affected Segments

Prepared by Pennsylvania Department of Environmental Protection

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TMDL's

Tangascootack Watershed
Clinton County, PA

Introduction

This Total Maximum Daily Load (TMDL) calculation has been prepared for segments in the Tangascootack Watershed (Attachments A and B). It was done to address the impairments noted on the 1996 Pennsylvania 303(d) list, required under the Clean Water Act, and covers two segments on this list (shown in 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 associated with acid mine drainage (iron, manganese, aluminum), and pH.

Table 1. 303(d) Sub-List

State Water Plan (SWP) Subbasin: 09-B Kettle Creek Basin

Year	Miles	Segment ID	DEP Stream Code	Stream Name	Designated Use	Data Source	Source	EPA 305(b) Cause Code
1996	8.4	7121	23332	Tangascootack Creek	CWF	305(b) Report	Resource Extraction	Metals
1998	8.48	7121	23332	Tangascootack Creek	CWF	SWMP	AMD	Metals
2000	7.97	990614-1000-TAS	23332	Tangascootack Creek	CWF	UP	AMD	PH
2000	0.61	990611-1125-TAS	23380	Tangascootack Creek Unt	CWF	UP	AMD	Metals & pH
2000	2.04	990611-1125-TAS	23391	Tangascootack Creek Unt	CWF	UP	AMD	Metals & pH

Cold Water Fishes = CWF
Surface Water Monitoring Program = SWMP
Unassessed Project = UP
Abandoned Mine Drainage = AMD

Directions to the Tangascootack Watershed

The Tangascootack Creek Watershed is located in north central Pennsylvania, more specifically; Beech Creek, Bald Eagle and Grugan Townships of Clinton County, Pennsylvania. The creek confluences with the West Branch of the Susquehanna River approximately 6.8 miles *(10.9 km)* north of Lock Haven, Pennsylvania just off Pennsylvania State Route 120. (Attachment A.)

The watershed parallels the Allegheny Front and lies just within the Appalachian Plateau geophysical province. The watershed is displayed on United States Geological Survey maps covering the Beech Creek, Farrandsville, Howard, and Howard NW 7.5-Minute Quadrangles.

Segments addressed in this TMDL

There is one active mining operation in the watershed. This surface mine (Confer Brothers Coal Company) is deemed "active" solely because the company is treating the only point source discharge (MP #12) by means of a passive treatment system constructed in the headwaters area of Bear Swamp. Surface mining of coal on this site is completed and the mine site has been reclaimed. With the exception of this one point source discharge, all of the discharges in the watershed are from abandoned mines and will be treated as non-point sources. The distinction between non-point and point sources in this case is determined on the basis of whether or not there is a responsible party for the discharge. Where there is no responsible party the discharge is considered to be a non-point source. Each segment on the 303(d) list will be addressed as a separate TMDL. These TMDLs will be expressed as long-term, average loadings. Due to the nature and complexity of mining effects on the watershed, expressing the TMDL as a long-term average gives a better representation of the data used for the calculations.

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

Watershed History

The aerial extent of the Tangascootack Creek watershed is 36.5 mi^2 *(9,453 Hectares)* with its entire drainage to the West Branch of the Susquehanna River. The creek is comprised of a north and south fork.

The North Fork of Tangascootack Creek drains a surface area of approximately 19 mi^2 (*4,920 Hectares*) and is not the subject of this AMD TMDL. While the South Fork of Tangascootack Creek drains a surface area of 17.5 mi^2 (*4,531 Hectares*). The Tangascootack Creek Watershed can be characterized as having relatively narrow V-shaped valleys with steep heavily wooded side slopes at its mouth and leading to flat to gently rolling uplands in the headwaters area. Analysis of the stream drainage pattern indicates a trellis drainage style originating from the main stream channel of the forks with dendritic patterns developing in the upper reaches of some tributaries and of each fork. Stream patterns generally parallel the primary joint system within the watershed. The watershed is almost entirely forested with the exception of surface mined areas. The jointing patterns combined with the dominance of sandstone outcroppings at the surface tends to minimize surface runoff and provides for ideal conditions for recharge to groundwater aquifers.

The chemical quality of the North Fork of Tangascootack Creek indicates a very lightly buffered stream system with low metals and sulfate. While some surface and deep mining activities once were active within this sub-watershed, their respective low volume acid mine drainage discharges to North Fork have not significantly impacted stream quality. The stream contains a thriving trout population and macro-invertebrate ecosystem. To prevent future impacts from surface mining on this watershed's coal reserves, an Unsuitable for Mining Petition (#18839901) was adopted thus prohibiting all future surface coal mining activities within the watershed.

The chemical quality of the South Fork of Tangascootack Creek indicates a stream impacted by extensive surface and deep mining activity with depressed pH, elevated acidity, metals, and sulfate. While the lower sections of the South Fork contain struggling aquatic eco-systems that include a marginal fish population, the middle to upper sections of the South Fork are mostly devoid of aquatic life. Some aquatic ecosystems prevail in the extreme headwaters area of South Fork in the Bear Swamp area that lies up-stream from acid mine drainage impacts. The true goal of any watershed rehabilitation effort will be to mitigate the acid mine drainage problems existing within the South Fork sub-watershed, especially those in the Muddy Run and Bear Swamp sub-watersheds of Tangascootack Creek.

The land-use within the impaired segments of the Tangascootack Watershed is almost entirely forestland. In watershed areas disturbed by surface mining, the land use has changed from forestland to abandoned mine lands. These mine lands are typically grasslands or reforested. Less than one percent of the watershed can be classified as seasonal residential area consisting of sporting camps and summer retreats.

TMDL Endpoints

One of the major components of a TMDL is the establishment of an instream numeric endpoint, which is used to evaluate the attainment of acceptable water quality. An instream numeric endpoint, therefore, represents the water quality goal that is to be achieved by implementing the load reductions specified in the TMDL. The endpoint allows for a 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, most of the TMDLs' component makeup will be Load Allocations (LA) that are specified above a point in the stream segment. All allocations will be specified as long-term average concentrations. These long-term average concentrations are expected to meet water-quality criteria 99% of the time. PA Title 25 Chapter 93.5(b) specifies that a minimum 99% level of protection is required. All metals criteria evaluated in these TMDLs are specified as total recoverable. The data used for this analysis report iron as total recoverable. The following table shows the applicable water-quality criteria for the selected parameters.

Table 2. Applicable Water Quality Criteria

Parameter	Criterion value (mg/l)	Total Recoverable/ Dissolved
Aluminum*	0.1 of the 96 hour LC 50 0.75	Total recoverable
Iron	1.50 0.3	Total recoverable dissolved
Manganese	1.00	Total recoverable
PH**	6 - 9	NA

- *- This TMDL was developed using the value of 0.75 mg/l as the in-stream criterion for aluminum. This is the EPA national acute fish and aquatic life criterion for aluminum.

Pennsylvania's current aluminum criterion is 0.1 mg/l of the 96-hour LC-50 and is contained in PA Title 25 Chapter 93. The EPA national criterion was used because the Department has recommended adopting the EPA criterion and is awaiting final promulgation of it.

- ** - 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). This condition is met when the net alkalinity is maintained above zero.

Computational Methodology

A TMDL equation consists of a Wasteload Allocation (WLA), Load Allocation (LA) and a Margin of Safety (MOS). The WLA is the portion of the load assigned to Point Sources. The LA is the portion of the load assigned to Non-point Sources (NPS). The MOS is applied to account for uncertainties in the TMDL. The MOS may be expressed implicitly (documenting conservative processes in the computations) or explicitly (setting aside a portion of the allowable load).

Table 3. Tangascootack Creek Correlations

Sample Point ID	Flow vs				Number of Samples
	Aluminum	Iron	Manganese	Acidity	
MR-1	0.001095	0.146295	0.425075	0.159167	26
BS-1	0.032546	0.123135	0.130406	0.073496	(Al = 23), 35
UNTR-1	0.006117	0.484454	0.212876	0.092008	12
UNTR-2	0.39771	0.065254	0.182913	0.029047	26
SFT-1	0.074629	0.000809	0.148553	0.183984	19

Correlations for flow and each parameter (Table 3.) were calculated for Muddy Run (MR-1), Bear Swamp (BS-1), unnamed tributary 1 (UNTR-1), unnamed tributary 2 (UNTR-2) and South Fork Tangascootack 1 (SFT-1) sampling points. The available data for South Fork Tangascootack 2 (SFT-2) did not have enough paired flow/parameter data to calculate correlations. There are no significant correlations between source flows and pollutant concentrations. Analyses of the data could not determine a critical flow at any sample point.

For purposes of this TMDL, point sources are identified as permitted discharge points and nonpoint sources are other discharges from abandoned mine lands which includes tunnel discharges, seeps and surface runoff. Abandoned and reclaimed mine lands are treated in the allocations as nonpoint sources because there are no NPDES permits associated with these areas. As such, the discharges associated with these lands were assigned load allocations (as opposed to wasteload allocations).

For situations where all of the impact is due to non-point sources, the equations shown below are applied using data for a point in the stream. The load allocation (LA) 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 non-point sources, the same type of evaluation is used. The point-source is mass balanced with the receiving stream, and sources will be reduced as necessary to meet the water quality criteria below the discharge.

TMDLs and LAs for each parameter were determined using Monte Carlo simulation. For each source and pollutant, it was assumed that the observed data are log-normally distributed. The lognormal distribution has long been assumed when dealing with environmental data.

Each pollutant source was evaluated separately using @Risk[1]. Five thousand iterations were performed to determine the required percent reduction so that water-quality criteria will be met in-stream at least 99 percent of the time. For each iteration, the required percent reduction is:

$PR = \text{maximum}\{ 0, (1 – Cc/Cd) \}$ 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 5000 iterations, so that the allowable long-term average (LTA) concentration is:

$LTA = Mean * (1 – PR_{99})$ where (2)

LTA = allowable LTA source concentration in mg/l (the mean of five thousand iterations, from the statistics portion of the @Risk program.)

An example calculation, including detailed tabular summaries of the Monte Carlo results is presented for the Lorberry Creek TMDL in Attachment D.

Muddy Run Watershed

The Muddy Run watershed (Attachment B) has an area of approximately 1.13 $mi.^2$ and includes 2.0 miles of stream. The Muddy Run watershed comprises one of the extreme headwater areas of the main South Fork Tangascootack watershed. The upper headwaters quality of Muddy Run (MR-7) is subtlety affected by AMD with one or two occasional excursions above the criteria for metals and excursions in acidity cause the stream to be net acidic affecting the pH. Muddy Run is affected by acid mine drainage (AMD) in the middle and lower sections of its length as reported by water monitoring point MR-1. The source’s of AMD (MR-2, MR-4, MR-5, and

[1] @ Risk - Risk Analysis and Simulation Add-in for "Micorsoft Excel", Palisade Corporation, Newfield , NY, 1990-1997

MR-6) can be assigned to non-point source discharges related to the surface and deep mining on the Clarion and Lower Kittanning coal formations.

Deep mining operations removed coal and clay in the late 1800s and early 1900s. Surface mining operations of the 1950s and 1960s used the "strip mine" method to remove low cover coal reserves within the Muddy Run watershed. In the 1980s, Antrim Mining Company mined the Clarion and Lower Kittanning coal seams on the "Scootack Northwest" Operation (SMP #18820101). The remining of pre-law surface and deep mines by Antrim Mining did not further degrade Muddy Run, but did not eliminate the pre-Antrim sources of AMD.

Non-point sources of AMD, MR-4, MR-5, and MR-6 are toe of spoil discharges that flow year – round from the base of the "Scootack Northwest" Operation south to Muddy Run. Discharge MR-2 consists of three related seepage areas that emerge at the base of a 1960s era, pre-law surface mine. MR-2 is an intermittent AMD discharge that flows north to Muddy Run. MR-2 normally flows from February to late July of any given year.

The cumulative effect of these AMD discharges on Muddy Run (MR-1) is evident with an in-stream water quality impact. Muddy Run has of a low pH (4-5), is net acidic, and has elevated metal and sulfate concentrations.

TMDL Calculations

The TMDL for Muddy Run consists of a load allocation to all of the area above sampling point MR-1 (Attachment B). This is the first stream monitoring point downstream of all mining impacts. Addressing the mining impacts above this point addresses the impairment for the entire stream segment to its confluence with the South Fork of Tangascootack Creek below Bear Swamp.

There is currently no entry for this segment on the Pa 303(d) list for impairment due to pH. However sample data at point MR-1 shows pH ranging between 3.9 and 5.9. For this reason pH will be addressed as part of this TMDL. Upstream samples taken at sampling point MR-7 do indicate mining impacts; pH at MR-7 ranges between 4.6 and 5.6. The objective is to reduce acid loading to the stream that will in turn raise the pH to the desired range. Sampling point MR-1 has the lowest pH so the alkalinity at MR-1 will be used in the evaluation. The result of this analysis is an acid loading reduction that equates to meeting standards for pH (see Table 2). The method and rationale for addressing pH is contained in Attachment C.

The load allocation for this stream segment was computed using water-quality sample data collected at point MR-1. The average flow, measured at sampling point MR-1 (0.27 MGD), is used for these computations.

An allowable long-term average in-stream concentration was determined at point MR-1 for aluminum, iron, manganese and acidity. The analysis is designed to produce an average value that, when met, will be protective of the water-quality criterion for that parameter 99% of the time. An analysis was performed using Monte Carlo simulation to determine the necessary long-term average concentration needed to attain water-quality criteria 99% of the time. The simulation was run assuming the data set was lognormally distributed. Using the mean and standard deviation of the data set, 5000 iterations of sampling were completed, and compared against the water-quality criterion for that parameter. For each sampling event a percent reduction was calculated, if necessary, to meet water-quality criteria. A second simulation that multiplied the percent reduction times the sampled value was run to insure that criteria were met 99% of the time. The mean value from this data set represents the long-term average concentration that needs to be met to achieve water-quality standards. Table 4 shows the load allocations for this stream segment.

		Table 4. Muddy Run				
		Measured Sample Data		Allowable		Reduction Identified
Station	Parameter	Conc (mg/l)	Load (lbs/day)	LTA conc (mg/l)	Load (lbs/day)	%
MR-1						
	Al	1.45	3.3	0.19	0.4	87%
	Fe	1.68	3.8	0.37	0.8	78%
	Mn	16.15	36.9	0.49	1.1	97%
	Acidity	35.41	80.9	2.83	6.5	92%
	Alkalinity	7.88	18.0			

The allowable loading values shown in Table 4 represent load allocations made at point MR-1.

Margin of Safety

For this study the margin of safety is applied implicitly. A MOS is built in because the allowable concentrations and loadings were simulated using Monte Carlo techniques and employing the @Risk software. Another margin of safety used for this TMDL analysis results from:

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

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. The average of the actual seasonal volume measurements at MR-1 were used to derive loading values for the TMDL.

Bear Swamp Watershed

The Bear Swamp watershed (Attachment B) has an area of approximately 3.82 $mi.^2$ and includes 4.3 miles of stream. The Bear Swamp watershed comprises the other extreme headwater area of the main South Fork Tangascootack watershed. The upper headwaters quality of Bear Swamp (BS-4) is unaffected by mining. Bear Swamp is affected by acid mine drainage (AMD) in the lower section of its length as reported by water monitoring point BS-1. The source of AMD (BS-2 and BS-5) can be contributed to non-point source discharges related to the surface and deep mining of coal and clay on the Clarion formation.

Deep mining operations removed clay in the late 1800s and early 1900s. In the 1950s and 1960s, surface mining under the "strip mine" method removed low cover coal reserves within the Bear Swamp watershed. One strip mine cut into the underlying clay deep mine resulting in an intermittent AMD discharge at BS-2. BS-2 degrades Bear Swamp from its point of confluence (Elev. 1120'MSL) with Bear Swamp. Above the confluence of BS-2 and Bear Swamp, there is a thriving trout population and macroinvertibrate ecosystem. The BS-2 discharge has been targeted for treatment by a vertical flow wetlands system. DEP, USDA-NRCS and the Clinton County Conservation District have received funding through a Federal 319 Grant to construct the passive treatment system. The system is slated for construction in Spring 2001.

In the 1980s, Confer Brothers Coal Company mined the Clarion coal seams on the "Sproul #1" Operation (SMP #18793005). The remining of "strip" and deep mines by Confer Brothers resulted in a low volume, mild AMD point source discharge referenced as Monitoring Point #12 (MP #12). MP #12 did not routinely meet conventional effluent limits for pH, acidity and manganese concentrations. The volume from MP #12 does not account for more than 2% of the volume of water flowing in Bear Swamp as measured at BS-1. MP #12 is not a significant contributor of stream degradation to Bear Swamp. In November 1999, Confer Brothers Coal Company entered into an agreement with PA-DEP whereby Confer Brothers installed an anoxic limestone drain (ALD) capable of treating MP #12 to the mining permit effluent limits. MP #12 has meet effluent limits since installation of the ALD.

A diffuse AMD seepage area exists along the north lower section of the Bear Swamp stream bank. This seepage area (BS-5) is a non-point source of AMD to Bear Swamp up-stream from BS-1. BS-5 first originated from "strip" and deep mines on the Brookville formation. The "strip" and deep mines were re-mined and reclaimed by the Confer Brothers Coal, "Scootack West " Operation (MDP #3166BSM24) in the early 1980s. Confer Brother's remining of the "strip" and deep mines did not further degrade Bear Swamp, nor did remining eliminate the BS-5 AMD discharge.

The cumulative effect of these AMD discharges on Bear Swamp (BS-1) is evident with an in-stream water quality impact. Bear Swamp has of a low pH (4-5), is net acidic, and has elevated metal and sulfate concentrations.

TMDL Calculations

The TMDL for Bear Swamp consists of a load allocation to all of the area above the point BS-1 shown in Attachment B. This is the first stream monitoring point downstream of all mining impacts. Addressing the mining impacts above this point addresses the impairment for the entire stream segment to its confluence with Muddy Run.

There is currently no entry for this segment on the Pa 303(d) list for impairment due to pH. Up-stream sample data is available at BS-4 establish an upstream pH of 6.0 to 6.5. Sample data at point BS-1 shows pH ranging between 4.0 and 6.9; therefore pH will be addressed as part of this TMDL because of the mining impacts. The objective is to reduce acid loading to the stream which will in turn raise the pH. Sampling point BS-1 has the lowest pH so the alkalinity at BS-1 will be used in the evaluation. The result of this analysis is an acid loading reduction that equates to meeting standards for pH (see Table 2). The method and rationale for addressing pH is contained in Attachment C.

The load allocation for this stream segment was computed using water-quality sample data collected at the point BS-1. The average flow, measured at sampling point BS-1 (1.24 MGD), is used for these computations.

An allowable long-term average in-stream concentration was determined at point BS-1 for aluminum, iron, manganese and acidity. The analysis is designed to produce an average value that, when met, will be protective of the water-quality criterion for that parameter 99% of the time. An analysis was performed using Monte Carlo simulation to determine the necessary long-term average concentration needed to attain water-quality criteria 99% of the time. The simulation was run assuming the data set was lognormally distributed. Using the mean and standard deviation of the data set, 5000 iterations of sampling were completed, and compared against the water-quality criterion for that parameter. For each sampling event a percent reduction was calculated, if necessary, to meet water-quality criteria. A second simulation that multiplied the percent reduction times the sampled value was run to insure that criteria were met 99% of the time. The mean value from this data set represents the long-term average concentration that needs to be met to achieve water-quality standards. Table 5 shows the load allocations for this stream segment.

		Table 5. Bear Swamp				
		Measured Sample Data		Allowable		Reduction Identified
Station	Parameter	Conc (mg/l)	Load (lbs/day)	LTA conc (mg/l)	Load (lbs/day)	%
BS-1						
	Al	0.21	2.2	0.21	2.2	0.6%
	Fe	2.02	21.0	0.28	2.9	86%
	Mn	3.51	36.3	0.21	2.2	94%
	Acidity	10.55	109.3	2.43	25.2	77%
	Alkalinity	10.06	104.2			

The allowable loading values shown in Table 5 represent load allocations made at point BS-1.

Margin of Safety

For this study the margin of safety is applied implicitly. A MOS is built in because the allowable concentrations and loadings were simulated using Monte Carlo techniques and employing the @Risk software. Another margin of safety used for this TMDL analysis results from:

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

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. Over the sampling period, in-stream flow measurements were obtained using a flow meter and an in-stream gauging station at BS-1.

Unnamed Tributary #1 to South Fork Tangascootack Watershed

Unnamed Tributary #1 to the South Fork Tangascootack watershed (Attachment B) has an area of approximately 0.27 $mi.^2$ and includes 0.65 miles of stream. The Unnamed Tributary #1 watershed lies adjacent to the Muddy Run watershed and comprises an area north of the main stem of South Fork Tangascootack Creek. The entire length of Unnamed Tributary #1 (UNTR-1) is affected by mining. The tributary originates as an acid mine drainage toe of spoil discharge and the entire tributary is affected by acid mine drainage (AMD) as reported by water monitoring point UNTR-1. The source of AMD can be contributed to non-point source discharges related to the surface mining of coal on the Clarion and Lower Kittanning coal formations.

In the 1950s and 1960s, mining operations used the “strip mine” method to remove low cover coal reserves within this watershed causing AMD degradation to the tributary. In the 1980s and 1990s, Antrim Mining Company mined the Clarion and Lower Kittanning coal seams on the “Scootack Northwest” Operation (SMP #18820101) and “East Hill” Operation (SMP #18900101). The remining of the “strip” mines by Antrim Mining did not further degrade this unnamed tributary, but did not eliminate the pre-Antrim sources of AMD.

A portion of the unnamed tributary #1 was diverted for treatment by a vertical flow wetlands system. DEP, USDA-NRCS and the Clinton County Conservation District received funding through a Federal 104(b)(3) Grant to construct the “Scootack Northwest” passive treatment system. The system designated “TF-2” was constructed in the Summer of 1999 and routinely treats approximately 50 gallons of AMD per minute from the unnamed tributary.

The TF-2 passive treatment system is located just east of the middle of unnamed tributary #1. TF-2 treats non-point source AMD from the unnamed tributary #1 then discharges effluent waters back to unnamed tributary #1 downstream from monitoring point UNTR-1. The vertical flow treatment system neutralizes influent AMD water that has a net acidity of approximately 30 mg/l and discharges effluent waters that have a net alkalinity of 100 mg/l. Note: TF-2 does not treat point source AMD discharges.

The cumulative effect of these AMD discharges on the unnamed tributary (UNTR-1) is evident with an in-stream water quality impact. Unnamed tributary #1 has of a low pH (4-5), is net acidic, and has elevated metal and sulfate concentrations.

<u>TMDL calculations</u>

The TMDL for Unnamed Tributary #1 consists of a load allocation to all of the area above the point UNTR-1 shown in Attachment B. This is the first stream monitoring point downstream of all mining impacts. Addressing the mining impacts above this point addresses the impairment for the entire stream segment to its confluence with the South Fork Tangascootack Creek.

There is currently no entry for this segment on the Pa 303(d) list for impairment due to pH. No sample data is available above point UNTR-1 to establish an upstream pH value. Sample data at point UNTR-1 shows pH ranging between 3.5 and 4.6; therefore pH will be addressed as part of this TMDL because the cause of impairment for the Unnamed Tributary is pH and metals. The objective is to reduce acid loading to the stream which will in turn raise the pH. The result of this analysis is an acid loading reduction that equates to meeting standards for pH (see Table 2). The method and rationale for addressing pH is contained in Attachment C.

The load allocation for this stream segment was computed using water-quality sample data collected at point UNTR-1. The average flow, measured at sampling point UNTR-1 (0.04 MGD), is used for these computations.

An allowable long-term average in-stream concentration was determined at point UNTR-1 for aluminum, iron, manganese and acidity. The analysis is designed to produce an average value that, when met, will be protective of the water-quality criterion for that parameter 99% of the time. An analysis was performed using Monte Carlo simulation to determine the necessary long-term average concentration needed to attain water-quality criteria 99% of the time. The simulation was run assuming the data set was lognormally distributed. Using the mean and standard deviation of the data set, 5000 Iterations of sampling were completed, and compared against the water-quality criterion for that parameter. For each sampling event a percent reduction was calculated, if necessary, to meet water-quality criteria. A second simulation that multiplied the percent reduction times the sampled value was run to insure that criteria were met 99% of the time. The mean value from this data set represents the long-term average concentration that needs to be met to achieve water-quality standards. Table 6 shows the load allocations for this stream segment

Table 6. Unnamed tributary #1 to South Fork Tangascootack Creek

		Measured Sample Data		Allowable		Reduction Identified
Station	Parameter	Conc (mg/l)	Load (lbs/day)	LTA conc (mg/l)	Load (lbs/day)	%
UNTR-1						
	Al	0.37	0.1	0.37	0.1	0%
	Fe	2.41	0.8	0.51	0.2	79%
	Mn	18.06	5.9	0.36	0.1	98%
	Acidity	43.05	14.1	0.86	0.3	98%
	Alkalinity	1.88	0.6			

The allowable loading values shown in Table 6 represent load allocations made at point UNTR-1.

<u>Margin</u> <u>of</u> <u>Safety</u>

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

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

Seasonal Variation

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

Critical Conditions

The reductions specified in this TMDL apply at all flow conditions. A critical flow condition could not be identified from the data used for this analysis. The average flow for this point was used to derive loading values for the TMDL.

Unnamed Tributary #2 to South Fork Tangascootack Watershed

Unnamed Tributary #2 to the South Fork Tangascootack watershed (Attachment B) has an area of approximately 0.30 $mi.^2$ and includes 0.57 miles of stream. The Unnamed Tributary #2 watershed comprises an area north of the main stem of South Fork Tangascootack Creek. The entire length of Unnamed Tributary #2 (UNTR-2) is affected by mining. The tributary originates as an acid mine drainage toe of spoil discharge and the entire tributary is affected by acid mine drainage (AMD) as reported by water monitoring point UNTR-2. The source of AMD can be contributed to non-point source discharges related to the surface and deep mining of coal and clay associated with the Clarion and Lower Kittanning coal formations.

Deep mining operations in the early 1900s mined the Lower Kittanning coal seam. “Strip” mines removed low cover coal reserves and partially reopened the deep mines within this watershed in the 1950s and 1960s causing AMD degradation to the tributary. In the 1970s and early 1980s, K & J Coal Company, Inc. mined the Clarion and Lower Kittanning coal seams on the “Tangascootack” Operation (MDP #4676SM5). The remining of the “strip” mines by K & J Coal did not further degrade this unnamed tributary, or eliminate the pre-K & J sources of AMD.

The cumulative effect of these AMD discharges on the unnamed tributary (UNTR-2) is evident with an in-stream water quality impact. Unnamed tributary #2 has of a low pH (4-5), is net acidic, and has elevated metal and sulfate concentrations.

TMDL Calculations

The TMDL for Unnamed tributary #2 consists of a load allocation to all of the area above the point UNTR-2 shown in Attachment B. This is the first stream monitoring point downstream of all mining impacts. Addressing the mining impacts above this point addresses the impairment for the entire stream segment to its confluence with the South Fork of Tangascootack Creek.

There is currently no entry for this segment on the Pa 303(d) list for impairment due to pH. No sample data is available above point UNTR-2 to establish an upstream pH value. Sample data at point UNTR-2 shows pH ranging between 3.9 and 6.0; pH will be addressed as part of this TMDL because the cause of impairment for the Unnamed Tributary #2 is pH and metals. The objective is to reduce acid loading to the stream, which will in turn raise the pH. Sampling point UNTR-1 be used in the evaluation. The result of this analysis is an acid loading reduction that equates to meeting standards for pH (see Table 2). The method and rationale for addressing pH is contained in Attachment C.

The load allocation for this stream segment was computed using water-quality sample data collected at point UNTR-2. The average flow, measured at sampling point UNTR-2 (0.13 MGD), is used for these computations.

An allowable long-term average in-stream concentration was determined at point UNTR-2 for aluminum, iron, manganese and acidity. The analysis is designed to produce an average value that, when met, will be protective of the water-quality criterion for that parameter 99% of the time. An analysis was performed using Monte Carlo simulation to determine the necessary long-term average concentration needed to attain water-quality criteria 99% of the time. The simulation was run assuming the data set was lognormally distributed. Using the mean and standard deviation of the data set, 5000 iterations of sampling were completed, and compared against the water-quality criterion for that parameter. For each sampling event a percent reduction was calculated, if necessary, to meet water-quality criteria. A second simulation that multiplied the percent reduction times the sampled value was run to insure that criteria were met 99% of the time. The mean value from this data set represents the long-term average concentration that needs to be met to achieve water-quality standards. Table 7 shows the load allocations for this stream segment.

Table 7. Unnamed tributary #2 to South Fork Tangascootack Creek

		Measured Sample Data		Allowable		Reduction Identified
Station	Parameter	Conc (mg/l)	Load (lbs/day)	LTA conc (mg/l)	Load (lbs/day)	%
UNTR-2						
	Al	1.06	1.2	0.20	0.2	81%
	Fe	2.61	2.9	0.23	0.3	91%
	Mn	9.01	9.9	0.45	0.5	95%
	Acidity	21.13	23.1	4.01	4.4	81%
	Alkalinity	7.97	8.7			

The allowable loading values shown in Table 7 represent load allocations made at point UNTR-2.

Margin of Safety

For this study the margin of safety is applied implicitly. AMOS is built in because 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:

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

Seasonal Variation

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

Critical Conditions

The reductions specified in this TMDL apply at all flow conditions. A critical flow condition could not be identified from the data used for this analysis. The average flow for this point was used to derive loading values for the TMDL.

South Fork Tangascootack Creek (Sampling Points SFT-1 and SFT-2)

TMDL Calculations (SFT-1)

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

The existing and allowable loading values for this stream segment were computed using water-quality sample data collected at sampling point SFT-1. The average flow, measured at sampling point SFT-1 (2.55 MGD), is used for these computations.

This segment is not listed on the Pa 303(d) list for impairment due to pH and metals. Sample data at point SFT-1 shows pH ranging between 3.8 and 6.0. There are no upstream SFT-1 samples. The objective is to reduce acid loading to the stream which will in turn raise the pH to the desired range. The alkalinity at sampling point SFT-1 will be used in the evaluation. The result of this analysis is an acid loading reduction that equates to meeting standards for pH (see Table 2). The method and rationale for addressing pH is contained in Attachment C.

An allowable long-term average in-stream concentration was determined at point SFT-1 for aluminum, iron, manganese and alkalinity. The analysis is designed to produce an average value that, when met, will be protective of the water-quality criterion for that parameter 99% of the time. An analysis was performed using Monte Carlo simulation to determine the necessary long-term average concentration needed to attain water-quality criteria 99% of the time. The simulation was run assuming the data set was lognormally distributed. Using the mean and standard deviation of the data set, five thousand iterations of sampling were completed, and compared against the water-quality criterion for that parameter. For each sampling event a percent reduction was calculated, if necessary, to meet water-quality criteria. A second simulation that multiplied the percent reduction times the sampled value was run to insure that criteria were met 99% of the time. The mean value from this data set represents the long-term average concentration that needs to be met to achieve water-quality standards. Table 8. shows the load allocations for this stream segment.

Table 8. South Fork Tangascootack Creek (SFT-1)

SFT-1	Measured Sample Data		Allowable	
Parameter	Conc (mg/l)	Load (lbs/day)	LTAConc (mg/l)	Load (lbs/day)
Al	1.12	23.8	0.30	6.4
Fe	0.87	18.5	0.37	7.8
Mn	15.19	322.9	0.15	3.2
Acidity	27.44	583.4	1.92	40.8
Alkalinity	6.03	128.2		

Table 8 represents the allowable loading values at point SFT-1.

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

The loading reductions for points MR-1, BS-1, and UNTR-1 were summed to show the total load that was removed from upstream sources. This value, for each parameter was then subtracted from the existing load at point SFT-1. This value was then compared to the allowable load at point SFT-1. Reductions at point SFT-1 are necessary for any parameter that exceeded the allowable load at this point. Table 10. shows a summary of all loads that affect point SFT-1. Table 11. illustrates the necessary reductions at point SFT-1. The results of this analysis show that reductions for aluminum, manganese and acidity are necessary at this point.

Table 9. Summary of All Loads that Affect SFT-1				
	Al (#/day)	**Fe (#/day)**	**Mn (#/day)**	**Acidity (#/day)**
Muddy Run (MR-1)				
load reduction=	2.9	3.0	35.8	74.4
Bear Swamp (BS-1)				
load reduction=	0.0	18.0	34.2	84.2
UNTR-1				
load reduction=	0.0	0.6	5.8	13.9

Table 10. Necessary Reductions at Sample Point SFT-1

	Al (#/day)	**Fe (#/day)**	**Mn (#/day)**	**Acidity (#/day)**
Existing Loads at SFT-1	23.8	18.5	322.9	583.4
Total Load Reduction (Sum of MR-1, BS-1 & UNTR-1)	2.9	21.6	75.8	172.5
Remaining Load (Existing Loads at SFT-1 – TLR Sum)	21.0	NA	247.1	410.9
Allowable Loads at SFT-1	6.4	7.8	3.2	40.8
Percent Reduction	69%	NA	99%	90%
Additional Removal Required at SFT-1	14.5	0.0	243.9	370.1

The load allocation for this stream segment was computed using water-quality sample data collected at point SFT-1 and the allowable loads from MR-1, BS-1 and UNTR-1. The average flow, measured at sample point SFT-1, is used for these computations. The TMDL for SFT-1 consists of load allocations for aluminum, manganese and acidity to all of the area between point SFT-1 and the confluence with UNTR-1, Muddy Run and Bear Swamp shown in attachment B. The Percent Reduction in Table 10, above, is calculated (refer to Table 10):

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

No additional loading reductions were necessary for iron.

Margin of Safety

For this study the margin of safety is applied implicitly. A MOS is built in because the allowable concentrations and loadings were simulated using Monte Carlo techniques and employing the @Risk software. Another margin of safety used for this TMDL analysis results from.

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

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. The average flow, measured at sample point SFT-1, is used for these computations.

TMDL Calculations (SFT-2)

The existing and the allowable loading for point SFT-2 for all parameters was determined. This was based on the sample data for this point and did not account for any load reductions already specified from upstream sources. The load reductions from points MR-1, BS-1, UNTR-1, UNTR-2 and the additional removal required at SFT-1 were summed and represent the upstream load reductions. The upstream load reduction was subtracted from the existing load at point SFT-2, and was compared to the allowable load at SFT-2 for each parameter, to determine if any further reductions were needed at this point.

The existing and allowable loading values for this stream segment were computed using water-quality sample data collected at sampling point SFT-2. The average flow, measured at sampling point SFT-2 (4.82 MGD), is used for these computations.

This segment is not listed on the Pa 303(d) list for impairment due to pH. Sample data at point SFT-2 shows pH ranging between 4.0 and 6.3. There are no upstream sampling points unaffected by AMD. The objective is to reduce acid loading to the stream which will in turn raise the pH to the desired range. The alkalinity at sampling point SFT-2 will be used in the evaluation. The result of this analysis is an acid loading reduction that equates to meeting standards for pH (see Table 2). The method and rationale for addressing pH is contained in Attachment C.

An allowable long-term average in-stream concentration was determined at point SFT-2 for aluminum, iron, manganese and alkalinity. The analysis is designed to produce an average value that, when met, will be protective of the water-quality criterion for that parameter 99% of the time. An analysis was performed using Monte Carlo simulation to determine the necessary long-term average concentration needed to attain water-quality criteria 99% of the time. The simulation was run assuming the data set was lognormally distributed. Using the mean and standard deviation of the data set, five thousand iterations of sampling were completed, and compared against the water-quality criterion for that parameter. For each sampling event a percent reduction was calculated, if necessary, to meet water-quality criteria. A second simulation that multiplied the percent reduction times the sampled value was run to insure that criteria were met 99% of the time. The mean value from this data set represents the long-term average concentration that needs to be met to achieve water-quality standards. Table 11. shows the load allocations for this stream segment.

Table 11. South Fork Tangascootack Run (SFT-2)

SFT-2	Measured Sample Data		Allowable	
Parameter	Conc (mg/l)	Load (lbs/day)	LTAConc (mg/l)	Load (lbs/day)
Al	0.40	16.2	0.24	9.6
Fe	0.08	3.2	0.08	3.2
Mn	3.32	133.3	0.47	18.7
Acidity	7.80	313.3	1.24	49.8
Alkalinity	8.73	350.8		

Table 11 represents the allowable loading values at point SFT-2.

The area surrounding and upstream of UNTR-2 is adversely affected by abandoned mine drainage. The area of the South Fork Tangascootack Creek watershed downstream of UNTR-2 is less adversely affected by AMD and one or more allocations may be necessary at SFT-2. In an effort to determine if there is a need for any allocations at sampling point SFT-2 the following procedure was used.

The loading reductions for points MR-1, BS-1, UNTR-1, UNTR-2 and the additional removal required at SFT-1 were summed to show the total load that was removed from upstream sources. This value, for each parameter, was then subtracted from the existing load at point SFT-2. This value was then compared to the allowable load at point SFT-2. Reductions at point SFT-2 are necessary for any parameter that exceeded the allowable load at this point. Table 12. shows a summary of all loads that affect point SFT-2. Table 12. illustrates the necessary reductions at point SFT-2. The results of this analysis show that no reductions are necessary at SFT-2.

Table 12. Summary of All Loads that Affect SFT-2				
	Al (#/day)	**Fe (#/day)**	**Mn (#/day)**	**Net Alkalinity (#/day)**
Sum of MR-1, BS-1 & UNTR-1	2.9	21.6	75.8	172.5
Additional Removal Required at SFT-1	14.5	0.0	243.9	370.1
UNTR-2 load reduction=	0.9	2.6	9.4	18.7

Table 13. Necessary Reductions at Sample Point SFT-2

	Al (#/day)	**Fe (#/day)**	**Mn (#/day)**	**Net Alkalinity (#/day)**
Existing Loads at SFT-2	16.2	3.2	133.3	313.3
Total Load Reduction (Sum of MR-1, BS-1, UNTR-1, SFT-1 & UNTR-2)	18.3	24.2	329.1	561.3
Remaining Load (Existing Loads at SFT-2 – TLR Sum)	NA	NA	NA	NA
Allowable Loads at SFT-2	9.6	3.2	18.7	49.8
Percent Reduction	NA	NA	NA	NA

The load allocation for this stream segment was computed using water-quality sample data collected at point SFT-2 and the allowable loads from MR-1, BS-1, UNTR-1, UNTR-2 and additional removal required at SFT-1. The average flow, measured at sample point SFT-2, is used for these computations. The Percent Reduction in Table 13, above, is calculated (refer to Table 13):

$$\left[1-\left(\frac{\text{Allowable Loads at SFT - 2}}{\text{Remaining Load (Existing Loads at SFT - 2 - TLR Sum}}\right)\right]\times 100\,\%$$

The TMDL for SFT-2 consists of load allocations for none of the parameters for all of the area between sampling points SFT-2 and SFT-1.

Margin of Safety

For this study the margin of safety is applied implicitly. A MOS is built in because the allowable concentrations and loadings were simulated using Monte Carlo techniques and employing the @Risk software. Another margin of safety used for this TMDL analysis results from.

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

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. The average flow, measured at sample point SFT-2, is used for these computations.

Summary of Allocations

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 14 presents the estimated reductions identified for all points in the watershed.

Station		Table 14. Summary Table – South Fork Tangascootack Run Watershed				
		Measured Sample Data		Allowable		Reduction Identified
	Parameter	Conc (mg/l)	load (lbs/day)	LTA Conc (mg/l)	load (lbs/day)	%
MR-1	**In-stream monitoring point located on Muddy Run**					
	Al	1.45	3.3	0.19	0.4	87%
	Fe	1.68	3.8	0.37	0.8	78%
	Mn	16.15	36.9	0.49	1.1	97%
	Acidity	35.41	80.9	2.83	6.5	92%
	Alkalinity	7.88	18.0			
BS-1	**In-stream monitoring point located on Bear Swamp Run**					
	Al	0.21	2.2	0.21	2.2	0.6%
	Fe	2.02	21.0	0.28	2.9	86%
	Mn	3.51	36.3	0.21	2.2	94%
	Acidity	10.55	109.3	2.43	25.2	77%
	Alkalinity	10.06	104.2			
UNTR1	**In-stream sampling point located on UNTR-1**					
	Al	0.37	0.1	0.37	0.1	0%
	Fe	2.41	0.8	0.51	0.2	79%
	Mn	18.06	5.9	0.36	0.1	98%
		43.05	14.1	0.86	0.3	98%
	Alkalinity	1.88	0.6			
SFT-1	**In-stream sampling point located on South Fork Tangascootack Run**					
	Al	1.12	23.8	NA	6.4	69%
	Fe	0.87	18.5	NA	7.8	0%
	Mn	15.19	322.9	NA	3.2	99%
	Acidity	27.44	583.4	NA	58.3	86%
	Alkalinity	6.03	128.2			
UNTR-2	**In-stream sampling point located on UNTR-2**					
	Al	1.06	1.2	0.20	0.2	81%
	Fe	2.61	2.9	0.23	0.3	91%
	Mn	9.01	9.9	0.45	0.5	95%
	Acidity	21.13	23.1	4.01	4.4	81%
	Alkalinity	7.97	8.7			

Station		Table 14. Summary Table – South Fork Tangascootack Run Watershed				
		Measured Sample Data		Allowable		Reduction Identified
	Parameter	Conc (mg/l)	load (lbs/day)	LTA Conc (mg/l)	load (lbs/day)	%
SFT-2	**In-stream sampling point located on South Fork Tangascootack Run**					
	Al	0.40	16.2	NA	9.6	NA
	Fe	0.08	3.2	NA	3.2	NA
	Mn	3.32	133.3	NA	18.7	NA
	Acidity	7.80	313.3	NA	49.8	NA
	Alkalinity	8.73	350.8			

All allocations are load allocations to non-point sources. The margin of safety for all points is applied implicitly through the methods used in the computations.

Recommendations

The South Fork Tangascootack Creek watershed has been under study by the Pennsylvania Department of Environmental Protection (PADEP) for a watershed restoration plan. Hawk Run District Mining Operations (HRDMO) routinely collects water samples at a number of key monitoring stations within the watershed. The hydrologic study has focused on the acid mine drainage problem that plagues the watershed in the headwaters area of Bear Swamp, Muddy Run, Unnamed Tributary #1 and Unnamed Tributary #2.

Initial hydrologic studies have indicated that the South Fork headwaters is favorable to achieving partial stream restoration through installation of a series of passive treatment systems deployed on key AMD discharges. The PADEP has begun to prioritize the polluted discharges by treatment feasibility, accessibility and pollution loading impact. Based upon the current water quality abatement technology, PADEP has applied passive treatment techniques in designing remediation systems that would reduce the overall pollution load in the headwaters area.

The PADEP in cooperation with the United States Department of Agriculture – Natural Resource Conservation Service and the Clinton County Conservation Service has sought and obtained funding for the construction of two passive treatment systems within the watershed. The “Scootack Northwest” vertical flow wetland was installed in 1999 on Unnamed tributary #1. The “Solomon” vertical flow wetland system designed to passively treat AMD from BS-2 is slated for construction in the spring of 2001.

Currently, PADEP-HRDMO is studying AMD discharges in the Muddy Run (MR-1) and Unnamed Tributary #2 (UNTR-2) watersheds with the goal of securing funds to construct additional passive treatment systems. Applications for funding will be prepared for submittal to Pennsylvania’s “Growing Greener” program in 2001. The suitability of passive treatment technology will be determined on a discharge-by-discharge basis. The suitability factors include: water chemistry, topography, as well as construction and long-term costs. A system monitoring and maintenance schedule would also be implemented to check long-term treatment success.

The PADEP will explore various methods of remediation to enhance the water quality of the South Fork. The PADEP has considered the potential to re-mine past mining areas with the goal of reducing pollution from these areas. Past surface remining operations have played an important role in the land reclamation of the South Fork watershed. Antrim Mining Inc. has conducted remining operations within the watershed. Antrim's "Scootack Northwest" Operation used one or more best management practices (BMP's) to reclaim abandoned mine land. Best Management Practices include mining out abandoned deep mines, regrading and replanting poorly vegetated mine land, and the addition of imported alkaline materials to spread upon mine spoil to neutralize acidic discharges. The remining effort in the South Fork watershed has been successful in that mine land has been reclaimed from "strip" mining scars.

Our office would determine if there is a potential to re-mine areas of remaining coal reserves utilizing abatement technologies to improve post-mining groundwater quality in those areas generating AMD quality groundwater. We would present the remining potential areas to interested mine operators where remining would enhance the hydrology of the Tangascootack watershed.

Establishment of a watershed group is an essential part of reaching the goal of restoration. Over the next year, PADEP will solicit involvement from a number of non-profit organizations with the goal of establishing a watershed restoration coalition composed of members from industry, government, sportsmen, landowners, and academic institutions. Public interest and involvement has not been realized to the level of establishment of a watershed group. Public awareness through meetings and informational seminars has only recently started and there are several parties that have shown interest. As PADEP begins the deployment of passive treatment systems in the watershed, the public will notice the restoration effort. PADEP feels confident that the public will get involved with the restoration effort once the overall goal of restoration can be demonstrated to be achievable within attainable funding limits.

The PADEP and the future watershed group will seek out other sources of funding for projects within the watershed. Once the funding requirements for passive treatment deployment are established, the watershed group will seek sponsorship for the various treatment systems. Non-profit organizations, sportsman groups, corporations, or academic institutions could provide sponsorship.

PADEP recommends that the EPA continue the watershed restoration efforts through the funding of passive treatment systems in the headwaters area. The completed projects will be used for public demonstration and will provide desirable results with stream improvement.

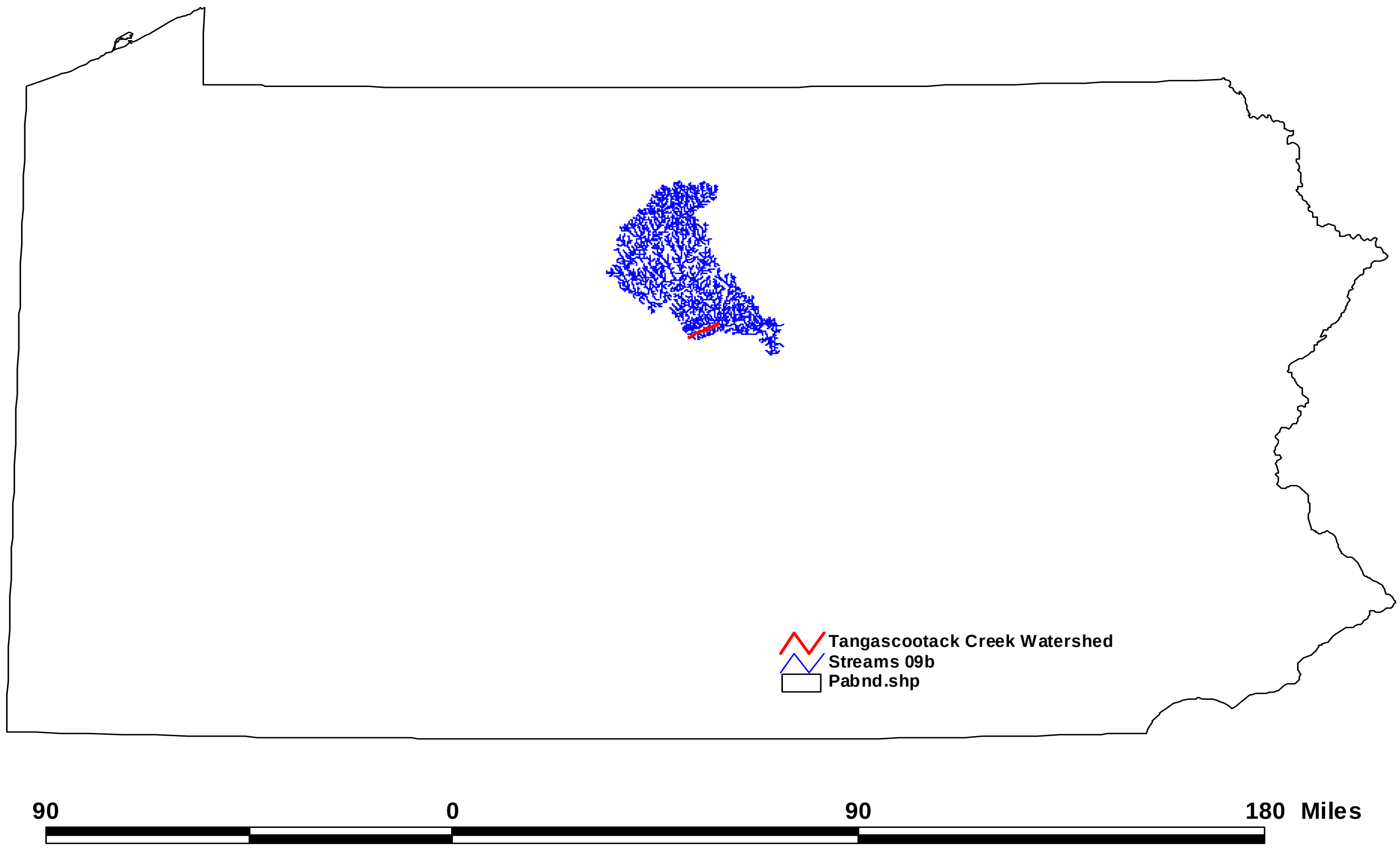
Public Participation

Notice of the draft TMDLs were published in the *PA Bulletin* and Lock Haven Express, Lock Haven, PA with a 60 day comment period ending February 13, 2001 provided. A public meeting with watershed residents was held Monday, January 8, 2001 at 1:00 pm at the Clinton County Conservation District Office. to discuss the TMDLs. Notice of final TMDL approval will be posted on the Department website.

Attachment A

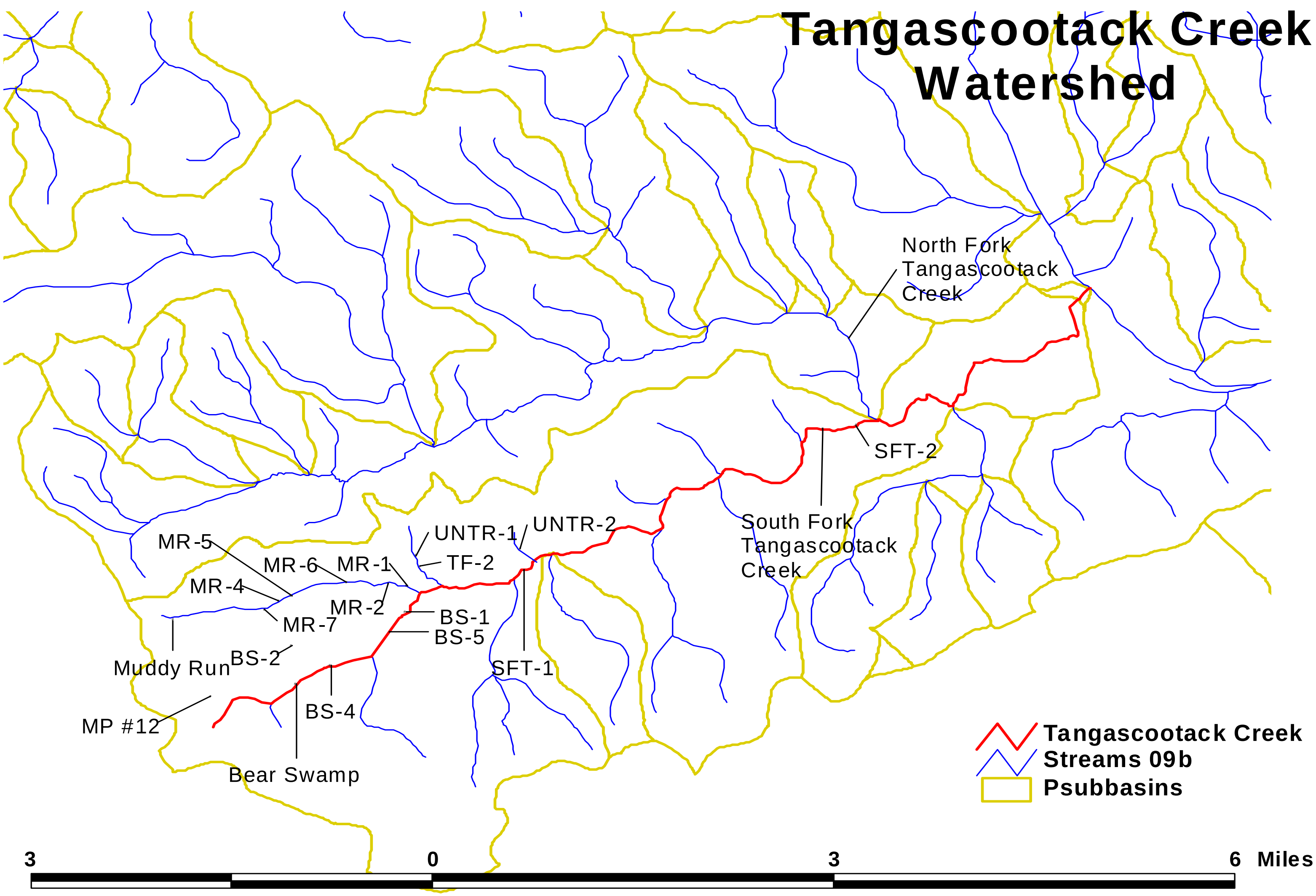
Location of Tangascootack Creek

Tangascootack Creek Location



Attachment B

Tangascootack Watershed



Tangascootack Creek Watershed
North Fork Tangascootack Creek
South Fork Tangascootack Creek
SFT-2
UNTR-1
UNTR-2
TF-2
MR-5
MR-6
MR-1
MR-4
MR-2
MR-7
BS-1
BS-5
BS-2
Muddy Run
SFT-1
BS-4
MP #12
Bear Swamp
Tangascootack Creek
Streams 09b
Psubbasins
3
0
3
6 Miles

Attachment C

The pH Method

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[2] by the PA Department of Environmental Protection demonstrates, that by plotting net alkalinity vs. pH for 794 mine sample points, where net alkalinity is positive (greater or equal to zero), the pH range is most commonly 6 to 8, which is within the EPA's acceptable range of 6 to 9, and meets Pennsylvania water quality criteria in Chapter 93. The included graph (page 3) presents the nonlinear relationship between net alkalinity and pH. The nonlinear positive relation between net alkalinity and pH indicates that pH generally will decline as net alkalinity declines and vice versa; however, the extent of pH change will vary depending on the buffering capacity of solution. Solutions having near-neutral pH ($6 < pH < 8$) or acidic pH ($2 < pH < 4$) tend to be buffered to remain in their respective pH ranges.[3] Relatively large additions of acid or base will be required to change their pH compared to poorly buffered solutions characterized by intermediate pH ($4 < pH < 6$) where the correlation between net alkalinity and pH is practically zero.

The parameter of pH, a measurement of hydrogen ion acidity presented as a negative logarithm of effective hydrogen ion concentration, is not conducive to standard statistics. Additionally pH does not measure latent acidity that can be produced from hydrolysis of metals. For these reasons PA 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 partially dependent upon metals. For this reason, it is extremely difficult to predict the exact pH values which would result from treatment of acid 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 able to measure the reduction of acidity. When acidity in a stream is neutralized or is restored to natural levels, pH will be acceptable (>6.0). 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 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 PA'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

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[2] 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.
[3] Stumm, Werner, and Morgan, J.J., 1996, Aquatic Chemistry--Chemical Equilbria and Rates in Natural Waters (3rd ed.), New York, Wiley-Interscience, 1022p.

the average net alkalinity established from the stream's upper, pristine reaches. In other words, if the pH in an unaffected portion of a stream is found to be naturally occurring below 6, 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% 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.

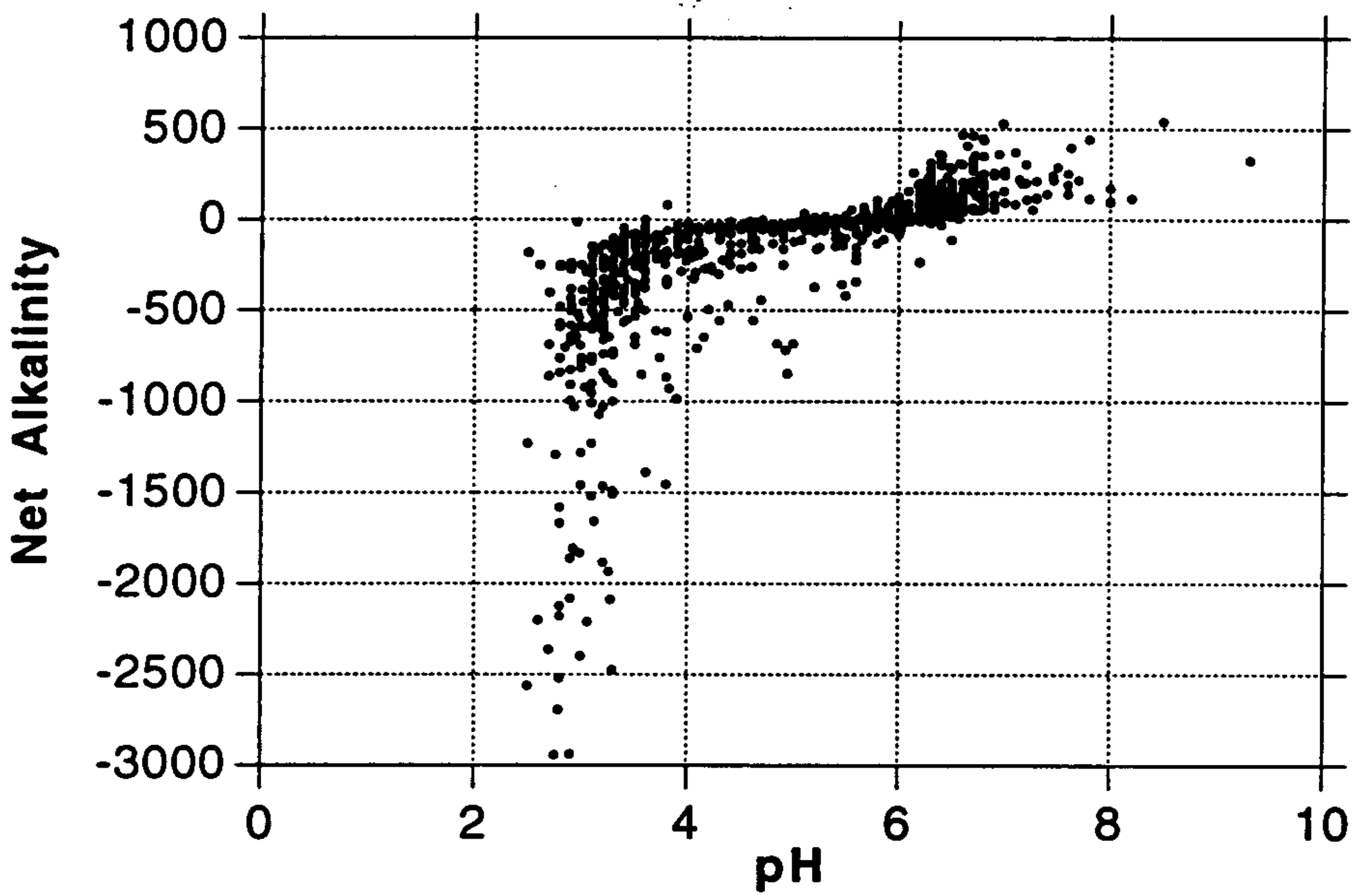

Figure 1.2, Graph C, net alkalinity vs. pH, page 1-5, of Coal Mine Drainage Prediction and Pollution Prevention in PA

Attachment D

Example Calculation: Lorberry Creek

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% 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, and 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 the 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 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 L-1 discharge. However, there is additional flow from overland runoff and one unnamed tributary not impacted by mining. We believe it is reasonable to assume the additional flow provides assimilation capacity below the L-1 discharge and no further analysis is needed downstream.

The calculations are detailed in the following section and Table 9 shows the allocations made on Lorberry Creek

1. A series of 4 equations were 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			
	Field Description	**Equation**	**Explanation**
1	Swat-04 initial Concentration Value (equation 1A)	= Risklognorm(mean,StDev)	This simulates the exisitng concentration of the sampled data.
2	Swat-04 % Reduction (from the 99^{th} percentile of PR)	= (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 - %reduction)	This applies the given percent reduction to the initial concentration.
4	Swat-04 Reduction Target (PR)	= maximum(0, 1- Cd/Cc)	This computes the necessary reduction, if needed, each time a value is sampled. The final reduction target is the 99^{th} percentile value of this computed field.

2. The reduction target (PR) was computed taking the 99th percentile value of 5000 iterations of the equation in row 4 of Table 9. 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 Reduciton % =	**72.2%**	**90.5%**	**77.0%**
Target #1 (Perc%)=	99%	99%	99%

3. This PR value was then used as the % reduction in the equation in row 3. It was tested by checking that the water quality criterion for each metal was achieved at least 99% of the time. This is how the estimated percent reduction necessary for each metal was verified. The following table shows, in boldface type, the percent of the time criteria for each metal was achieved during 5000 iterations of the equation in row 3 of Table 9.

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. The following two tables 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 Reduciton % =	**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. The following table 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 Conc From L-1	C_{L1}
Concentration below L-1 discharge	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

Q_{swat04} = RiskCumul(min,max,bin range,cumulative percent of occurrence)

The RiskCumul function takes 4 arguments: minimum value, maximum value, the bin range from the histogram, cumulative percent of occurrence)

The flow at Swat-11 was randomized using the equation developed by the regression analysis with point Swat-04.

$Q_{swat11} = Q_{swat}04 \times 0.142 + 0.088$

The mass balance equation is as follows:

$$Cstumps = ((Q_{swat04} * C_{swat04}) + (Q_{swat11} * C_{swat11}))/(Q_{swat04}+Q_{swat11})$$

This equation was simulated through 5000 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 the following table.

Table 7. Verification of Meeting WQ 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%**

4. The mass balance was then expanded to determine if any reductions would be necesssary at the L-1 (Shadle discharge).

   The L-1 discharge originated in 1997 and there are very little data 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. We currently do not have data for effluent from the settling pond.

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

Table 8 Shadle 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 was not any means to establish a correlation with point Swat-04.

   The same set of four equations used for point Swat-04 were set up for point L-1. The following equation was used for evaluation of point L-1.

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

This equation was simulated through 5000 iterations and the 99th percentile value of the data set was compared to the water quality criteria to determine if standards had been met. It was estimated that an 81 % reduction in aluminum concentration is needed for point L-1.

The following table shows the simulation results of the equation above

Table 9. Verification of Meeting WQ 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%**

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

		Table 10. Lorberry Creek				
		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	0%
	Mn	0.09	0.27	0.09	0.27	0%
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 is made to the Rowe Tunnel abandoned discharge for the three metals listed, and that a wasteload allocation is made to the L-1 discharge for aluminum. There is no TMDL for metals required for Stumps Run 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. The 99% level of protection is designed to protect for the extreme event so we felt it 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. Our 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

Data Used To Calculate the TMDL

Data Table 1. Muddy Run (MR-1)									
Date	**Flow**	**Field**	**Lab.**	**Conduct.**	**Alk.**	**Alum.**	**Iron**	**Mang.**	**Acidity**
Sampled	**(gpm)**	**pH**	**pH**	**umhos/cm**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
07/01/98	88	4.5	3.9	1071	0	3.12	1.33	21.9	66
08/06/98	16	4.0	4.1	1138	5	1.47	1.64	24.3	60
09/16/98	46	4.0	4.3	1157	6	0.76	2.30	22.6	40
09/17/98	17	4.0	4.5	1109	8	0.60	2.95	22.4	52
10/19/98	65	4.0	4.7	1070	10	0.92	1.98	21.5	34
11/19/98	46	4.5	4.9	1082	10	1.04	2.27	21.6	24
12/22/98	129	5.5	5.7	818	14	0.76	1.96	13.5	16
01/28/99	437	5.0	4.9	477	8	0.94	0.89	7.2	15
03/02/99	366	5.0	5.2	385	9	0.65	0.62	5.1	9
03/18/99	1340	5.5	4.9	312	8	1.19	0.92	3.9	14
04/07/99	437	5.0	4.6	649	8	2.14	0.57	9.6	24
05/13/99	238	5.0	4.2	1029	5	4.08	0.63	18.2	70
06/03/99	84	4.5	4.1	1159	3	4.24	1.15	22.2	58
06/10/99	84	4.5	4.0	1192	3	3.04	0.84	26.2	56
07/08/99	16	4.5	4.2	1034	5	1.22	1.44	20.3	54
08/04/99	16	4.5	4.4	1217	7	0.44	4.41	22.7	26
08/31/99	16	6.5	5.9	1245	19	0.24	6.62	26.5	26
10/06/99	130	4.0	5.2	791	9	0.95	1.59	15.0	20
10/19/99	48	5.0	5.2	823	10	0.67	2.00	15.8	44
11/12/99	84	5.0	5.0	773	9	0.80	1.69	14.4	62
12/09/99	129	5.3	4.9	533	10	1.12	1.92	8.9	19
01/05/00	129	5.0	4.9	447	9	0.96	1.13	6.2	17
02/23/00	300	5.0	4.8	NA	8	0.90	0.67	5.0	14
05/31/00	238	4.5	4.3	863	7	3.20	0.59	15.1	40
06/21/00	300	3.4	4.4	664	7	1.46	0.45	12.3	36
07/25/00	148	4.6	4.5	898	8	0.68	1.07	17.7	24
AVG=	190.28	4.70	4.68	NA	7.88	1.45	1.68	16.15	35.41
STDEV=	NA	NA	NA	NA	NA	1.13	1.34	7.07	18.88

Data Table 2. Bear Swamp (BS-1)									
Date	**Flow**	**Field**	**Lab.**	**Conduct.**	**Alk.**	**Acidity**	**Alum.**	**Iron**	**Mang.**
Sampled	**(gpm)**	**pH**	**pH**	**umhos/cm**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
03/31/95	590	5.30	4.70	230	6	9		1.13	1.53
06/30/95	340	5.20	5.23	370	8	9		1.78	2.58
09/29/95	89	5.10	3.89	550	0	23		9.94	9.46
03/29/96	1125	4.60	4.87	160	6	7		0.40	1.12
06/14/96	270	5.00	4.06	340	3	19		1.62	2.57
09/06/96	51	6.90	6.29	200	23	4		0.71	0.69
11/20/96	358	6.20	5.71	220	8	3		0.03	0.84
03/11/97	646	6.40	5.98	70	11	3		0.08	0.13
06/10/97	359	6.80	6.17	75	13	2		0.14	0.12
08/12/97	15	6.30	6.30	135	19	2		0.40	0.34
10/14/97	24	6.70	6.10	160	17	4		0.14	0.13
03/10/98	842	6.00	5.65	81	8	4		0.07	0.27
07/01/98	376	5.00	4.80	373	9	14	0.10	2.12	3.94
08/06/98	180		6.20	627	24	22	0.10	6.09	15.90
09/17/98	56	4.0	5.9	659	22	20	0.1	6.64	12.6
11/19/98	130	6.0	5.7	642	13	14	0.23	6.92	7.67
12/22/98		5.5	5.5	506	12	15	0.617	3.78	6.03
02/03/99	2050	6	5.5	198	9	8	0.424	2.05	1.81
03/18/99	5260	5	5	169	8	7	0.298	0.478	1.16
04/12/99		5.5	5.1	111	8	5	0.277	0.431	0.701
05/20/99	1275	5.5	5.3	220	10	6	0.01	0.976	1.6
06/03/99	640	5.5	4.9	284	8	7	0.1	1.09	2.29
06/10/99	298	5	4.5	396	7	9	0.1	1.32	2.99
07/08/99	250	5	5	482	9	17	0.109	2.27	4.33
07/14/99	195	5.5	5.1	465	9	11	0.1	2.4	5.06
08/04/99	175	5	4.6	589	8	11	0.1	2.72	7.6
08/31/99	175	5	4.5	658	8	12	0.251	2.91	8.64
10/06/99	250	4	4.4	564	6	16	0.484	2.63	5.14
11/12/99	300	4	4.9	572	8	50	0.301	3.92	6.43
12/09/99	250	4	5.4	329	11	13	0.322	2.81	3.38
1/5/00	1600	5.5	5	234	8	9	0.361	1.15	1.99
2/23/00	2275	5	5.3		8	6	0.25	0.737	1.39
3/16/00	2094	5	5.4	159	9	4	0.1	0.604	1.16
5/4/00	2950	5	5.4	205	9	7	0.2	0.568	1.29
5/31/00	2275	5.7	5.7	181	10	4	0.1	0.752	1.48

Data Table 2. Bear Swamp (BS-1)									
Date Sampled	**Flow (gpm)**	**Field pH**	**Lab. pH**	**Conduct. umhos/cm**	**Alk. mg/L**	**Acidity mg/L**	**Alum. mg/L**	**Iron mg/L**	**Mang. mg/L**
6/21/00	1900	4.5	5.4	198	10	7	0.1	1.1	1.86
7/25/00	537	4	5	373	9	8	0.1	1.92	3.49
avg=	862.86	5.3	5.3		10.06	10.55	0.21	2.02	3.51
stdev=						8.75	0.15	2.22	3.65

Data Table 4. Unnamed Triburary 2 (UNTR-2)

Date Sampled	Flow (gpm)	Field pH	Lab. pH	Conduct. umhos/cm	Alk. mg/L	Acidity mg/L	Iron mg/L	Mang. mg/L	Alum. mg/L
03/07/91	598	4.30	4.60	510	9	18	1.08	5.98	2.80
06/18/91	60	4.20	4.25	805	7	22	0.95	11.98	0.98
12/10/91	70	4.45	4.45	750	8	28	3.80	12.88	0.70
02/11/92	70	4.45	4.50	845	7	16	1.75	12.52	1.58
05/26/92	60	4.75	4.80	645	10	17	1.95	10.62	0.76
08/25/92	50	4.30	4.35	775	10	28	1.69	12.62	1.60
11/10/92	70	4.80	4.80	715	4	21	4.23	11.00	1.24
03/31/93	284	3.95	4.10	575	2	24	0.62	5.31	2.88
06/23/93	50	3.95	3.95	670	1	20	0.50	14.00	2.38
09/22/93	34	3.95	4.00	980	2	21	0.89	15.00	2.02
12/07/93	123	4.20	4.25	505	4	19	1.38	6.01	2.26
11/03/98	*45*	*4.50*	*4.70*	*564*	*9*	*18*	*1.49*	*10.20*	*0.50*
11/03/98	*25*	*6.00*	*6.00*	*588*	*30*	*17*	*12.80*	*9.99*	*0.31*
11/03/98	*4*	*5.00*	*4.60*	*681*	*8*	*38*	*7.42*	*13.50*	*1.04*
11/03/98	*10*	*5.50*	*6.00*	*598*	*26*	*26*	*14.40*	*11.50*	*0.10*
03/23/99	140	4.50	4.60	377	7	14	0.86	4.59	1.06
06/10/99	65	4.50	4.30	497	5	10	0.29	6.64	0.38
07/08/99	42	4.50	4.20	523	4	26	0.20	7.49	0.47
08/31/99	23	4.00	4.30	555	5	10	0.28	8.80	0.43
10/06/99	42	5.00	4.80	520	8	19	2.20	7.94	0.37
11/12/99	23	4.50	4.60	551	6	54	1.38	8.63	0.37
12/09/99	42	5	4.9	525	9	16	2.59	8.99	0.386
01/05/00	65	5	4.7		8	17	1.88	6.64	0.592
02/23/00	150	5	4.6		7	17	1.28	5.32	0.936
03/27/00	119	5	4.6	447	7	13	1.35	5.39	0.794
06/21/00	105	3.5	4.4	469	8	22	0.553	0.614	0.733
avg=	91.16	4.57	4.59		7.96	21.13	2.61	9.00	1.06
stdev=						8.99	3.58	3.51	0.80

Data Table 5 South Fork Tangascootack Creek (SFT-1)									
Date Sampled	**Flow (gpm)**	**Field pH**	**Lab. pH**	**Conduct. umhos/cm**	**Alk. mg/L**	**Alum. mg/L**	**Iron mg/L**	**Mang. mg/L**	**Acidity mg/L**
08/06/98	426	4.5	4.3	1029	7	0.43	0.50	19.70	42
09/17/98	338	4.0	4.0	1175	3	0.72	0.71	22.10	54
11/19/98	380	4.0	4.1	102	3	1.38	1.69	73.50	26
12/22/98	NA	4.5	4.2	866	4	2.43	3.44	15.40	44
01/28/99	NA	5.5	4.8	351	8	0.72	0.95	4.94	11
03/18/99	9230	5.0	4.8	282	8	0.63	0.67	3.14	13
05/13/99	2850	4.5	4.4	525	6	1.13	0.62	6.72	28
06/03/99	1000	4.5	4.1	747	3	1.83	0.52	12.30	24
06/10/99	406	4.5	4.1	777	3	1.27	0.31	9.89	22
07/08/99	225	4.5	4.1	768	3	0.74	0.30	10.70	36
07/14/99	225	4.5	4.0	811	2	0.82	0.36	52.40	26
08/04/99	175	6.0	6.1	977	15	0.64	1.37	15.30	11
08/31/99	200	4.5	4.1	1018	4	1.40	0.53	18.80	24
10/06/99	1000	4.5	4.3	825	6	1.62	0.94	15.50	40
11/12/99	375	4.5	4.1	881	3	1.64	0.57	0.14	78
12/09/99	1600	5.0	4.6	576	9	1.35	1.70	8.58	22
01/05/00	3450	5.0	4.7	NA	8	1.04	0.84	5.27	16
02/23/00	6500	5.5	4.7	NA	7	0.94	0.83	3.45	12
03/16/00	2457	5.5	4.9	311	8	0.65	0.58	3.42	9
06/21/00	2215	3.8	4.7	420	9	0.73	0.48	5.25	15
07/25/00	587	4.0	4.3	791	6	1.44	0.35	12.40	22
avg=	1770.47	4.68	4.45	NA	6.03	1.12	0.87	15.19	27.44
stdev=	NA	NA	NA	NA	NA	0.50	0.72	17.31	16.83

Data Table 6. South Fork Tangascootack Creek (SFT-2)									
Date	**Flow**	**Field**	**Lab.**	**Conduct.**	**Alk.**	**Alum.**	**Iron**	**Mang.**	**Acidity**
Sampled	(gpm)	pH	pH	umhos/cm	mg/L	mg/L	mg/L	mg/L	mg/L
06/10/99	1718	6.0	5.3	444	8	0.30	0.03	3.45	2
07/14/99	810	6.0	5.4	475	9	0.10	0.12	3.15	4
08/31/99	700	6.3	6.0	603	11	0.10	0.03	3.74	0
10/08/99	1129	6.0	5.3	572	9	0.44	0.05	5.36	6
11/12/99	NA	6.0	5.3	539	8	0.33	0.03	4.59	40
02/23/00	8000	6.0	5.1	NA	7	0.78	0.15	1.93	6
03/16/00	7060	6.0	5.4	225	8	0.69	0.10	1.63	3
06/21/00	5985	4.9	5.5	266	10	0.64	0.14	2.38	7
07/25/00	1355	4.0	5.5	446	9	0.27	0.06	3.64	1
avg=	3344.63	5.68	5.42	NA	8.73	0.40	0.08	3.32	7.80
stdev=	NA	NA	NA	NA	NA	0.25	0.05	1.21	12.31

Table 7 Muddy Run (MR-7)									
Date	**Flow**	**Field**	**Lab.**	**Conduct.**	**Alk.**	**Alum.**	**Iron**	**Mang.**	**Acidity**
Sampled	**(gpm)**	**pH**	**pH**	**umhos/cm**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
04/07/99		4.50	4.60	114	7	1.02	0.12	0.97	10
07/08/99	12	6.00	5.60	74	10	0.39	1.73	1.13	8
10/19/99	23	5.00	4.60	112	7	0.33	0.26	0.76	12
11/12/99	23	4.50	4.70	106	6	0.21	0.21	4.86	36
12/09/99	42	5.50	4.80	89	9	0.48	0.15	0.60	8
01/05/00	136	5.00	4.70	96	8	0.54	0.11	0.69	5
02/23/00	295	5.50	4.80	NA	7	0.25	0.15	0.56	6
05/31/00	91	5.00	4.90	86	8	0.62	0.20	0.63	5
avg=	88.80	5.13	4.84	NA	7.75	0.48	0.37	1.27	11.23

Table 8. Bear Swamp (BS-4)									
Date	**Flow**	**Field**	**Lab.**	**Conduct.**	**Alk.**	**Alum.**	**Iron**	**Mang.**	**Acidity**
Sampled	**(gpm)**	**pH**	**pH**	**umhos/cm**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
08/06/98	NA	6.50	6.30	122	20	0.10	0.92	0.27	0
07/08/99	NA	6.50	6.30	187	16	0.21	0.63	0.40	0
05/20/99	NA	6.00	6.20	320	36	0.10	0.11	0.47	0
07/15/99	15	6.00	6.10	79	20	0.10	0.01	0.01	0
avg=	15.0	6.3	6.2	NA	22.9	0.1	0.4	0.3	0.0

Attachment F

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

The following are excerpts from the Pennsylvania Department of Environmental Protection 303(d) narratives that justify changes in listings between the 1996, 1998, and draft 2000 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,
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 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.

Attachment G

Comment and Response

U.S. Fish and Wildlife Service

Comment

Any remediation measures to address identified water quality problems may benefit certain threatened and endangered species in certain watersheds by improving water quality. However, in some instances, these measures have the potential to adversely affect federally listed species; therefore, further consultation will be necessary to identify and address these cases as described above.

Response

Detailed remediation and implementation plans are not required as part of the TMDL submittal and have not been completed at this time. All current regulations will be followed and threatened and endangered species will be protected in developing a remediation plan for the watershed.