LOCKARD RUN WATERSHED TMDL

For Acid Mine Drainage Affected Segments

Prepared by the Pennsylvania Department of Environmental Protection

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Table of Contents

List of Tables

List of Attachments

TMDL
LOCKARD RUN WATERSHED
VENANGO COUNTY, PENNSYLVANIA

Introduction

This Total Maximum Daily Load (TMDL) calculation has been prepared for Lockard Run. It was done to address the impairments noted on the 1996 Pennsylvania 303(d) list, required under the Clean Water Act. The impairment is caused by a decreased pH, negative net alkalinity, and excessive metals. Manganese and aluminum both exceed their respective instream criteria limits of 1.0 and 0.75 mg/l. The impairment is the result of acid drainage from abandoned coal mines. The TMDL addresses pH and the three primary metals associated with acid mine drainage (iron, manganese, and aluminum) and pH.

Table 1. 303(d) Sub-List

State Water Plan (SWP) Subbasin: 16-G Little Scrubgrass Creek

Year	Miles	Segment ID	DEP Stream Code	Stream Name	Designated Use	Data Source	Source	EPA 305(b) Cause Code
1996	2.3	5456	51197	Lockard Run	CWF	305(b) Report	RE	Metals
1998	2.37	5456	51197	Lockard Run	CWF	SWMP	AMD	Metals
2000	No further assessment data collected			Lockard Run	CWF	SWMP	AMD	Metals

CWF = Cold Water Fishes
RE = Resource Extraction
SWMP = State Water Monitoring Program
AMD = Abandoned Mine Drainage

Directions to the Lockard Run Watershed

Lockard Run is located in Scrubgrass Township, Venango County, and can be found on the 7½ Minute Eau Claire quadrangle. From Exit 4, I-80, take Route 308 north to Clintonville. At the intersection of 308 and 208, turn right on 208. Take 208 east for approximately 4.2 miles to Lisbon. At Lisbon turn left onto SR 3007. Travel north on SR 3007 for approximately one mile. (See Attachment B)

Segments addressed in this TMDL

There are no active mining operations in the watershed. All of the discharges in the watershed are from abandoned mines and will be treated as non-point sources. The distinction between non-point and point sources in this case is determined on the basis of whether or not there is a responsible party for the discharge. Where there is no responsible party the discharge is considered to be a non-point source. Each segment on the 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.

Watershed History

There are no active mining operations within the watershed. None of the companies that mined in this watershed are actively pumping and/or treating water. All of the discharges in this watershed are from abandoned mining operations and will be treated as non-point sources. Known companies which have mined within this watershed include Benninger, Permit No. 3775SM10; Romanko, Permit No. 3775SM19; Chutz, Permit No. 3775SM32; and Sunbeam Coal, Permit No. 61860102. All past permitted mining sites have total bond release.

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).

Regressions for flow and each parameter (Table 3.) were calculated for Lockard Run, sample point LR31. There are no significant correlations between source flows and pollutant concentrations. Analyses of the data could not determine a critical flow. This analysis was performed by using the regression function found in Microsoft Excel.

Table 3. Lockard Run Regressions

Station	Flow vs			
	Fe	Mn	Al	Acidity
LR31	1.85E-05	0.12	0.004	0.50

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 (although none were specifically identified), 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.

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

Hydrology

Lockard Run is a tributary to Little Scrubgrass Creek, which flows into the Allegheny River and is classified as cold water fishery (CWF).

Although there are several sample locations on Lockard Run, only two need to be mentioned. Sample point 31 is at the culvert crossing on SR 3007 and GG6 is approximately 1,300 feet downstream of sample point 31. Sample point 31 shows impairment with respect to metals and pH. A comparison of the sample data between the two points shows significant improvement at GG6 to the extent that the stream at this location would not be considered impaired based on chemistry. The sample data shows that the pollutional discharges enter Lockard Run above the SR 3007 crossing. Therefore, sample point 31 has been chosen as the evaluation point.

Lockard Run Watershed

Lockard Run:

The locations of the discharges impairing Lockard Run are unknown. What is known is that the source of impairment enters the stream above SR 3007 (LR31). The TMDL for Lockard Run consists of a load allocation to all of the area above the point LR31 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 Little Scrubgrass Creek.

There is currently no entry for this segment on the Pa 303(d) list for impairment due to pH. However sample data at point LR31 shows pH ranging between 4.6 and 6.0. For this reason pH will be addressed as part of this TMDL. Upstream sampling at sample point VO102 do not indicate mining impacts however, pH at VO102 ranges between 6.7 and 7.1. The objective is to reduce acid loading to the stream which will in turn raise the pH to the desired range. Sampling point LR31 has the lowest pH so the alkalinity at LR31 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 LR31. The average flow measurement (0.22 MGD) for point LR31 was used.

An allowable long-term average in-stream concentration was determined at point LR31 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. Lockard Run Allocations

	Measured Sample Data		Allowable Concentration		Reduction
Parameter	**Concentration (ug/l)**	**Load (lbs/day)**	**Concentration (ug/l)**	**Load (lbs/day)**	**%**
Fe	0.22	0.4	0.22	0.4	0%
Mn	1.67	3.0	0.27	0.5	84%
Al	0.76	1.4	0.21	0.4	72%
Acidity	27.80	50.4	3.89	7.1	86%
Alkalinity	7.50	13.6			

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 for this point was used to derive loading values for the TMDL.

Recommendations

To date, there have been no remediation projects within the Lockard Run watershed. There are no local environmental or watershed groups active in this stream segment. Therefore, no remediation projects are planned at this time. If additional mining is pursued within Lockard Run watershed, the mining company will be required to meet the percent reduction, noted in Table 4, for discharges from the mine site.

As remediation efforts are instituted, each project will have before and after monitoring done to determine the efficiency of the remediation strategy.

Water quality improvement may be achieved by employing various remediation techniques that may include a combination of any of the following. Reclamation and revegatation of unreclaimed pits would create positive drainage by eliminating impoundments that may promote mine drainage formation. Capping disturbed areas with fly ash can further reduce surface water infiltration. Promoting surface run-off would lead to a decrease in loading from the discharges.

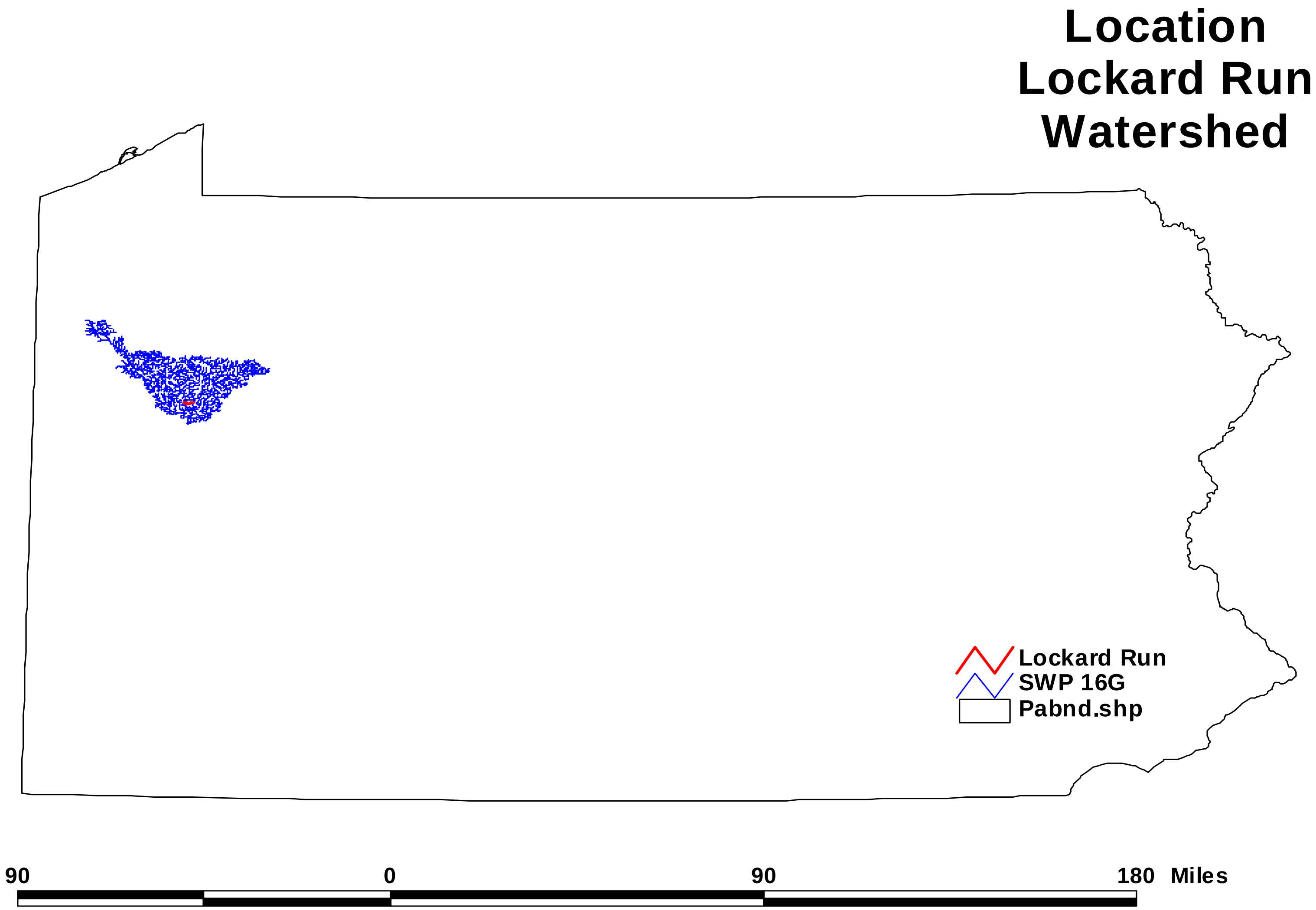
If, during any mining or reclamation activities, deep mine workings are discovered any deep mine discharges may be treated via Successive Alkalinity Producing (SAP) vertical flow treatment systems in conjunction with the construction of wetland treatment systems. Anoxic limestone drains (ALD) may also be a viable treatment option.

Public Participation

Notice of the draft TMDLs was published in the *PA Bulletin* and the Derrick, Oil City, PA with a comment period ending February 13, 2001 provided. A public meeting with watershed residents was held January 10, 2001 at the Holiday Inn in Clarion, PA to discuss the TMDL. Notice of final TMDL approval will be posted on the Department website.

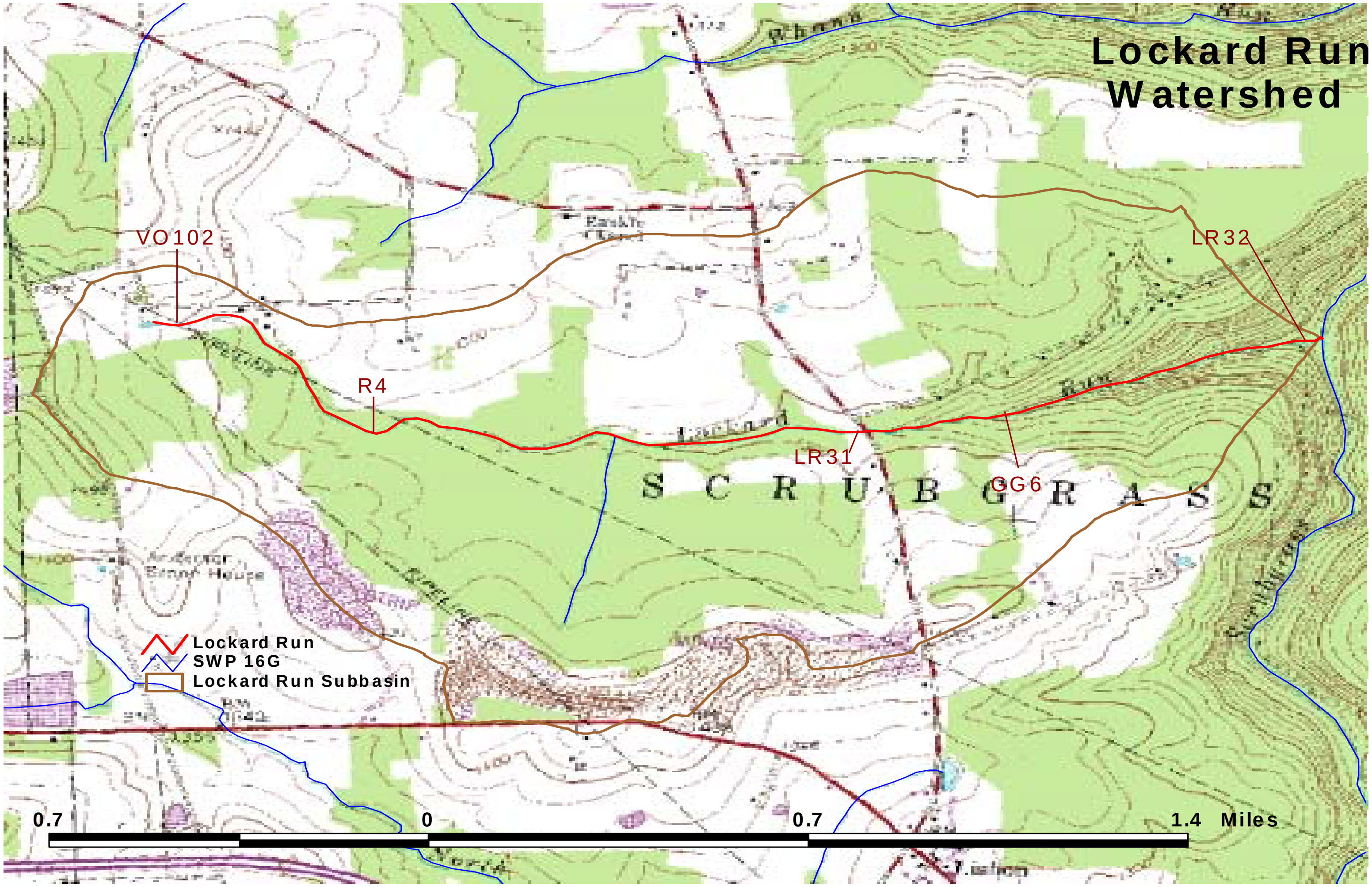
Attachment A

Location of Lockard Run


Location
Lockard Run
Watershed
Lockard Run
SWP 16G
Pabnd.shp
90
0
90
180
Miles

Attachment B

Lockard Run Watershed


Lockard Run
Watershed
VO102
R4
LR31
GG6
LR32
Lockard Run
SWP 16G
Lockard Run Subbasin
0.7
0
0.7
1.4 Miles
S C R U B G R A S S

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 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

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m[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.

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.

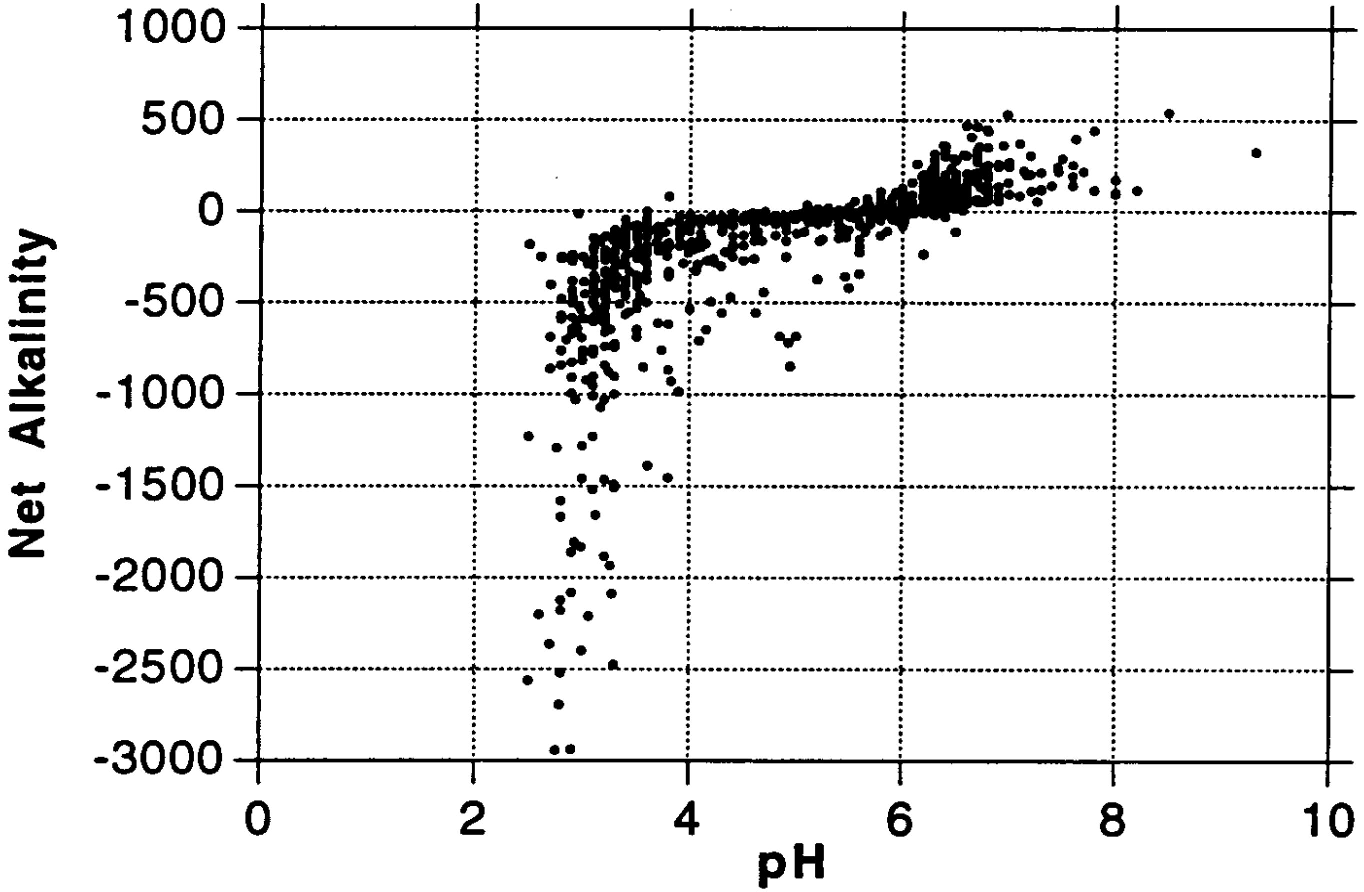

Figure 1.2, Graph C, net alkalinity vs. pH, page 1-5, of Coal Mine Drainage Prediction and Pollution Prevention in PA

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 99th 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 99th 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. Lockard Run Sample Point LR31

COLL NO.	DATE	FLOW (gpm)	pH	ALK (mg/l)	HOT A (mg/l)	Fe (mg/l)	Mn (mg/l)	Al (mg/l)
4217-067	5/1/86	275.00	5.00	7.00	20.00	0.15	2.19	0.72
4217-216	8/5/86	195.00	5.70	9.00	34.00	0.15	0.11	0.25
4217-360	11/5/86	135.00	5.70	8.00	32.00	0.15	1.24	0.25
4217-549	1/23/87	80.00	4.70	7.00	28.00	0.15	1.13	1.14
4217-685	4/17/87	225.00	4.60	7.00	28.00	0.15	1.91	1.79
4217-854	7/24/87	167.00	6.00	9.00	20.00	0.86	0.38	0.25
4217-130	1/6/88	180.00	4.80	8.00	28.00	0.15	1.72	1.20
4217-031	10/23/87	230.00	5.00	7.00	12.00	0.15	2.08	0.25
4217-254	4/6/88	147.00	4.70	7.00	32.00	0.15	1.38	0.90
	7/8/88	0.00						
4217-599	10/20/88	27.00	4.70	6.00	44.00	0.15	4.57	0.89
Average		151.00	5.09	7.50	27.80	0.22	1.67	0.76
StdDev					8.87	0.22	1.23	0.52

Data Table 2. Lockard Run Sample Point VO102

DATE	FLOW (mg/l)	pH	ALK (mg/l)	HOT A (mg/l)	Fe (mg/l)	Mn (mg/l)	Al (mg/l)
10/12/75		7.1	20	0	0.05		
1/27/76		6.7	6	0	0.66		

Data Table 3. Lockard Run Sample Point LR32

DATE	FLOW (mg/l)	pH	ALK (mg/l)	HOT A (mg/l)	IRON (mg/l)	Mn (mg/l)	Al (mg/l)
9/8/99		6.6	34	0	<0.3	<0.05	<0.5

Data Table 4. Lockard Run Samnple Point GG6

DATE	FLOW (mg/l)	pH	ALK (mg/l)	HOT A (mg/l)	IRON (mg/l)	Mn (mg/l)	Al (mg/l)	SO4 (mg/l)
9/11981	415	6.41	3.2	0	0.19	0.05		49
12/31/81		5.8	4.8	7	0.2	0.36	0.48	28

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

EPA comments received January 22, 2001. Lockard Run.

Comment 1:

In Table 1. 303(d) Sub-list, 2.0 miles are listed as impaired in 1996 yet the actual 1996, section 303(d) list cites 2.3 miles as impaired. Please correct the table or explain the difference.

Response:

Correction made.

Comment 2:

The “Watershed History” section identifies several previous mining permits within the watershed. Provide the current status of the permits, e.t., revoked, Phase I release, completely released, etc., approximate location, whether or not they are associated with identified monitoring points, etc. Also the “Recommendations” section refers to deep mine discharges. Please note the locations of any known deep mines on the map and indicate whether or not there is any monitoring data.

Response:

All sites have total bond release. There are no known mining sites associated with the monitoring points. A field review was not performed therefore, there are no known deep mines within the watershed.

Comment 3:

Table 4. Lockard Run Allocations, is missing units in the column headings. Please include.

Response:

Units added.

Comment 4:

As no wasteload allocations for future growth were included in this TMDL, confirm that if additional mining is pursued within the watershed, the mining company will be required to meet water quality standards noted in Table 2 for any discharges from the mine site. Alternately, DEP may choose to revise the TMDL to allocate to the new discharge.

Response:

Yes, see Chapter 87.102 at **www.pacode.com**. Also see the first paragraph of the Recommendations section.

Comment 5:

Deletion of the opening phrase in the second paragraph “If in the future it is determined that remediation efforts are necessary…” Remediation efforts are necessary. This is an impaired stream that is being assigned a Total Maximum Daily Load that will ultimately need to be implemented.

Response:

The sentence in question has been revised.