FINAL

SHAFER RUN WATERSHED TMDL

Somerset County

For Acid Mine Drainage Affected Segments

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Pennsylvania Department of Environmental Protection

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Introduction

This report presents the Total Maximum Daily Loads (TMDLs) developed for segments in the Shafer Run Watershed (Attachments A). These were done to address the impairments noted on the 1996 Pennsylvania Section 303(d) list of impaired waters, required under the Clean Water Act, and covers one segment on this list. All impairments resulted from acid drainage from abandoned coalmines. 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: 19-F Casselman River								
Year	**Miles**	**Segment ID**	**DEP Stream Code**	**Stream Name**	**Designated Use**	**Data Source**	**Source**	**EPA 305(b) Cause Code**
1996	2.0	4858	39055	Shafer Run	CWF	305(b) Report	RE	Metals
1998	1.06	4858	39055	Shafer Run	CWF	SWMP	AMD	Metals
2002	1.1	4858	39055	Shafer Run	CWF	SWMP	AMD	Metals

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

See Attachment D, *Excerpts Justifying Changes Between the 1996, 1998, and 2002 Section 303(d) Lists.* The use designations for the stream segments in this TMDL can be found in PA Title 25 Chapter 93.

Directions to the Shafer Run Watershed

The Shafer Run Watershed is located in Western Pennsylvania, occupying a south central portion of Somerset County in Summit Township. The watershed area is found on United States Geological Survey Markelton, Murdock, Rockwood and Meyersdale 7.5-Minute Quadrangles. The area within the watershed consists of 1.54 square miles. Land uses within the watershed include abandoned mine lands, forestlands, rural residential properties, pastureland and cropland.

[1] Pennsylvania's 1996, 1998, and 2002 Section 303(d) lists were approved by the Environmental Protection Agency (EPA). The 1996 Section 303(d) list provides the basis for measuring progress under the 1997 lawsuit settlement of *American Littoral Society and Public Interest Group of Pennsylvania v. EPA.*

The Borough of Rockwood is the closest populated community approximately 3 miles north of the watershed. The area is mostly rural with residences along S.R. 2016, which crosses the headwaters of Shafer Run.

Hydrology and Geology

Shafer Run and its unnamed tributaries exists until it confluence with the Casselman River. The stream drains from south to north. Shafer Run flows from an elevation of 2,540 feet above sea level near its headwaters to an elevation 1,860 feet above sea level at its confluence with the Casselman River.

The Shafer Run Watershed lies within the Appalachian Plateaus Province due west of the Allegheny Front. The local structure strikes approximately 77 degrees east and dips northwest approximately 3 degrees. The Negro Mountain Anticlinal Axis is southwest approximately 1.5 miles. The watershed is comprised of Pennsylvania aged rocks, which are into the Pottsville Group. The majority of the coal in the watershed is found on the eastern side of the Shafer Run Watershed. The coal is deposited in two seams: the Mercer and Quakertown coals.

Segments addressed in this TMDL

There is one active surface mining operation in the Shafer Run Watershed, Future Industries, Inc., SMP No. 56900112 (NPDES PA058976), Nittany Mine. The permitted discharges from the site are assigned waste load allocations. All of the remaining discharges in the watershed are from abandoned mines and will be treated as non-point sources. Each segment on the Section 303(d) list is addressed as a separate TMDL. These TMDLs are expressed as long-term, average loadings. Due to the nature and complexity of mining effects on the watershed, expressing the TMDL as a long-term average gives a better representation of the data used for the calculations. See Attachment C for TMDL calculations.

Clean Water Act Requirements

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

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

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

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

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

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

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

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

In the cases that have been settled to date, the consent agreements require EPA to backstop TMDL development, track TMDL development, review state monitoring programs, and fund studies on issues of concern (e.g., AMD, implementation of nonpoint source Best Management Practices (BMPs), etc.).

These TMDLs were developed in partial fulfillment of the 1997 lawsuit settlement of *American Littoral Society and Public Interest Group of Pennsylvania v. EPA.*

Section 303(d) Listing Process

Prior to developing TMDLs for specific waterbodies, there must be sufficient data available to assess which streams are impaired and should be on the Section 303(d) list. With guidance from the EPA, the states have developed methods for assessing the waters within their respective jurisdictions.

The primary method adopted by the Pennsylvania Department of Environmental Protection (DEP) for evaluating waters changed between the publication of the 1996 and 1998 Section 303(d) lists. Prior to 1998, data used to list streams were in a variety of formats, collected under differing protocols. Information also was gathered through the Section 305(b)[2] reporting process. DEP is now using the Statewide Surface Waters Assessment Protocol (SSWAP), a modification of the EPA's 1989 Rapid Bioassessment Protocol II (RBP-II), as the primary mechanism to assess Pennsylvania's waters. The SSWAP provides a more consistent approach to assessing Pennsylvania's streams.

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

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

After the survey is completed, the biologist determines the status of the stream segment. The decision is based on habitat scores and a series of narrative biological statements used to evaluate the benthic macroinvertebrate community. If the stream is determined to be impaired, the source and cause of the impairment is documented. An impaired stream must be listed on the state's Section 303(d) list with the source and cause. A TMDL must be developed for the stream segment and each pollutant. In order for the process to be more effective, adjoining stream segments with the same source and cause listing are addressed collectively, and on a watershed basis.

Basic Steps for Determining a TMDL

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

1. Collection and summarization of pre-existing data (watershed characterization, inventory contaminant sources, determination of pollutant loads, etc.);
2. Calculating the TMDL for the waterbody using EPA approved methods and computer models;
3. Allocating pollutant loads to various sources;
4. Determining critical and seasonal conditions;
5. Public review and comment and comment period on draft TMDL;
6. Submittal of final TMDL; and
7. EPA approval of the TMDL.

Watershed History

Coal was discovered in the late 1800's to early 1900's in the Shafer Run Watershed. In the early years coal mining was sparse. No deep mining has occurred in the Shafer Run Watershed. Surface mining activities occurred in the late 1950's to early 1960's by H. Clay Stickel Coal Company, General Refractories, and Sanner Brothers Coal Company on both the Quakertown and Mercer coal seams.

Most recent mining was conducted by Delta Mining, SMP No. 56803014 on the Mercer coal seam on a 142.9-acre permit. This operation was issued on February 13, 1984 and was abandoned and bonds forfeited on February 2, 1993.

The Future Industries, Inc., SMP No. 56920101 was issued on December 17, 1992 on the Quakertown coal seam on a 49-acre permit. The operation was mined, backfilled, and revegetated by September 2000.

Future Industries, Inc., SMP No. 56900112 issued on June 27, 1991 on the Mercer and Quakertown coal seams on 650-acre permit, is conducting the only active mining in the Shafer Run Watershed. The site is located from near the headwaters of Shafer Run to its mouth and largely on the western side.

AMD Methodology

A two-step approach is used for the TMDL analysis of AMD impaired stream segments. The first step uses a statistical method for determining the allowable instream concentration at the point of interest necessary to meet water quality standards. This is done at each point of interest (sample point) in the watershed. The second step is a mass balance of the loads as they pass through the watershed. Loads at these points will be computed based on average annual flow.

The statistical analysis described below can be applied to situations where all of the pollutant loading is from non-point sources as well as those where there are both point and non-point sources. The following defines what are considered point sources and non-point sources for the purposes of our evaluation; point sources are defined as permitted discharges or a discharge that has a responsible party, non-point sources are then any pollution sources that are not point sources. 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 made at that point will be for all of the watershed area that is above that point. For situations where there are point-source impacts alone, or in combination with non-point sources, the evaluation will use the point-source data and perform a mass balance with the receiving water to determine the impact of the point source.

Allowable loads are determined for each point of interest using Monte Carlo simulation. Monte Carlo simulation is an analytical method meant to imitate real-life systems, especially when other analyses are too mathematically complex or too difficult to reproduce. Monte Carlo simulation calculates multiple scenarios of a model by repeatedly sampling values from the probability distribution of the uncertain variables and using those values to populate a larger data set. Allocations were applied uniformly for the watershed area specified for each allocation point. For each source and pollutant, it was assumed that the observed data were log-normally distributed. Each pollutant source was evaluated separately using @Risk[3] by performing 5,000 iterations to determine the required percent reduction so that the water quality criteria, as defined in the *Pennsylvania Code. Title 25 Environmental Protection, Department of Environmental Protection, Chapter 93, Water Quality Standards,* will be met instream at least 99 percent of the time. For each iteration, the required percent reduction is:

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

PR = maximum {0, (1-Cc/Cd)} where (1)

PR = required percent reduction for the current iteration

Cc = criterion in mg/l

Cd = randomly generated pollutant source concentration in mg/l based on the observed data

Cd = RiskLognorm(Mean, Standard Deviation) where (1a)

Mean = average observed concentration

Standard Deviation = standard deviation of observed data

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

LTA = Mean * (1 – PR99) where (2)

LTA = allowable LTA source concentration in mg/l

Once the allowable concentration and load for each pollutant is determined, mass-balance accounting is performed starting at the top of the watershed and working down in sequence. This mass-balance or load tracking is explained below.

Load tracking through the watershed utilizes the change in measured loads from sample location to sample location, as well as the allowable load that was determined at each point using the @Risk program.

There are two basic rules that are applied in load tracking; rule one is that if the sum of the measured loads that directly affect the downstream sample point is less than the measured load at the downstream sample point it is indicative that there is an increase in load between the points being evaluated, and this amount (the difference between the sum of the upstream and downstream loads) shall be added to the allowable load(s) coming from the upstream points to give a total load that is coming into the downstream point from all sources. The second rule is that if the sum of the measured loads from the upstream points is greater than the measured load at the downstream point this is indicative that there is a loss of instream load between the evaluation points, and the ratio of the decrease shall be applied to the load that is being tracked (allowable load(s)) from the upstream point.

Tracking loads through the watershed gives the best picture of how the pollutants are affecting the watershed based on the information that is available. The analysis is done to insure that water quality standards will be met at all points in the stream. The TMDL must be designed to meet standards at all points in the stream, and in completing the analysis, reductions that must be made to upstream points are considered to be accomplished when evaluating points that are lower in the watershed. Another key point is that the loads are being computed based on average annual flow and should not be taken out of the context for which they are intended, which is to depict how the pollutants affect the watershed and where the sources and sinks are located spatially in the watershed.

For pH TMDLs, acidity is compared to alkalinity as described in Attachment B. 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 in units of milligrams per liter (mg/**l**) $CaCO_3$. Statistical procedures are 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 streams affected by low pH from AMD may not a true reflection of acidity. This method assures that Pennsylvania's standard for pH is met when the acid concentration reduction is met.

Information for the TMDL analysis performed using the methodology described above is contained in the "TMDLs by Segment" section of this report.

Method to Quantify Treatment Pond Pollutant Load

The following is an explanation of the quantification of the potential pollution load reporting to the stream from permitted pit water treatment ponds that discharge water at established effluent limits.

Surface coal mines remove soil and overburden materials to expose the underground coal seams for removal. After removal of the coal the overburden is replaced as mine spoil and the soil is replaced for revegetation. In a typical surface mining operation the overburden materials is removed and placed in the previous cut where the coal has been removed. In this fashion, an active mining operation has a pit that progresses through the mining site during the life of the mine. The pit may have water reporting to it, as it is a low spot in the local area. Pit water can be the result of limited shallow groundwater seepage, direct precipitation into the pit, and surface runoff from partially regarded areas that have been backfilled but not yet revegetated. Pit water is pumped to nearby treatment ponds where it is treated to the required treatment pond effluent limits. The standard effluent limits are as follows, although stricter effluent limits may be applied to a mining permit's effluent limits to insure that the discharge of treated water does not cause in-stream limits to be exceeded.

Standard Treatment Pond Effluent Limits:
Alkalinity > Acidity
6.0 <= pH <= 9.0
Fe <= 3.0 mg/l
Mn <= 2.0 mg/l
Al <= 2.0 mg/l

Discharge from treatment ponds on a mine site is intermittent and often varies as a result of precipitation events. Measured flow rates are almost never available. If accurate flow data are available, it is used along with the Best Available Technology (BAT) limits to quantify the WLA for one or more of the following: aluminum, iron, and manganese. The following formula is used:

$$\text{Flow (MGD) X BAT limit (mg/l) X 8.34 = lbs/day}$$

The following is an approach that can be used to determine a waste load allocation for an active mining operation when treatment pond flow rates are not available. The methodology involves quantifying the hydrology of the portion of a surface mine site that contributes flow to the pit and then calculating waste load allocation using NPDES treatment pond effluent limits.

The total water volume reporting to ponds for treatment can come from two primary sources: direct precipitation to the pit and runoff from the unregraded area following the pit's progression through the site. Groundwater seepage reporting to the pit is considered negligible compared to the flow rates resulting from precipitation.

In an active mining scenario, a mine operator pumps pit water to the ponds for chemical treatment. Pit water is often acidic with dissolved metals in nature. At the treatment ponds, alkaline chemicals are added to increase the pH and encourage dissolved metals to precipitate and settle. Pennsylvania averages 41.4 inches of precipitation per year (Mid-Atlantic River Forecast Center, National Weather Service, State College, PA, 1961-1990, http://www.dep.state.pa.us/dep/subject/hotopics/drought/PrecipNorm.htm). A maximum pit dimension without special permit approval is 1500 feet long by 300 feet wide. Assuming that 5 percent of the precipitation evaporates and the remaining 95 percent flows to the low spot in the active pit to be pumped to the treatment ponds, results in the following equation and average flow rates for the pit area.

41.4 in. precip./yr x 0.95 x 1 ft./12/in. x 1500'x300'/pit x 7.48 gal/ft^3 x 1yr/365days x 1day/24hr. x 1hr./60 min. =

= 21.0 gal/min average discharge from direct precipitation into the open mining pit area.

Pit water can also result from runoff from the unregraded and revegetated area following the pit. In the case of roughly backfilled and highly porous spoil, there is very little surface runoff. It is estimated that 80 percent of precipitation on the roughly regraded mine spoil infiltrates, 5 percent evaporates, and 15 percent may run off to the pit for pumping and potential treatment (Jay Hawkins, Office of Surface Mining, Department of the Interior, Personal Communications 2003). Regrading and revegetation of the mine spoil is conducted as the mining progresses. DEP encourages concurrent backfilling and revegetation through its compliance efforts and it is in the interest of the mining operator to minimize the company's reclamation bond liability by keeping the site reclaimed and revegetated. Experience has shown that reclamation and revegetation is accomplished two to three pit widths behind the active mining pit area. DEP uses three pit widths as an area representing potential flow to the pit when reviewing the NPDES permit application and calculating effluent limits based on best available treatment technology and insuring that in-stream limits are met. The same approach is used in the following equation, which represents the average flow reporting to the pit from the unregraded and unrevegetated spoil area.

41.4 in. precip./yr x 3 pit areas x 1 ft./12/in. x 1500’x300’/pit x 7.48 gal/ft^3 x 1yr/365days x 1day/24hr. x 1hr./60 min. x 15 in. runoff/100 in. precipitation =

= 9.9 gal./min. average discharge from spoil runoff into the pit area.

The total average flow to the pit is represented by the sum of the direct pit precipitation and the water flowing to the pit from the spoil area as follows:

Total Average Flow = Direct Pit Precipitation + Spoil Runoff

Total Average Flow = 21.0 gal./min + 9.9 gal./min. = 30.9 gal./min.

The resulting average waste load from a permitted treatment pond area is as follows.

Allowable Iron Waste Load Allocation:
30.9 gal./min. x 3 mg/l x 0.01202 = 1.1 lbs./day

Allowable Manganese Waste Load Allocation:
30.9 gal./min. x 2 mg/l x 0.01202 = 0.7 lbs./day

Allowable Aluminum Waste Load Allocation:
30.9 gal./min. x 2 mg/l x 0.01202 = 0.7 lbs./day

(Note: 0.01202 is a conversion factor to convert from a flow rate in gal/min. and a concentration in mg/l to a load in units of lbs./day.)

There is little or no documentation available to quantify the actual amount of water that is typically pumped from active pits to treatment ponds. Experience and observations suggest that the above approach is very conservative and overestimates the quantity of water, creating a large margin of safety in the methodology. County specific precipitation rates can be used in place of the long-term state average rate, although the margin of safety is greater than differences from individual counties. It is common for many mining sites to have very “dry” pits that rarely accumulate water that would require pumping and treatment.

Also, it is the goal of DEP’s permit review process to not issue mining permits that would cause negative impacts to the environment. As a step to insure that a mine site does not produce acid mine drainage, it is common to require the addition of alkaline materials (waste lime, baghouse lime, limestone, etc.) to the backfill spoil materials to neutralize any acid-forming materials that may be present. This practice of ‘alkaline addition’ or the incorporation of naturally occurring alkaline spoil materials (limestone, alkaline shale or other rocks) may produce alkaline pit water with very low metals concentrations that does not require treatment. A comprehensive study in 1999 evaluated mining permits issued since 1987 and found that only 2.2 percent resulted in a post-mining pollution discharge (Evaluation of Mining Permits Resulting in Acid Mine Drainage

1987-1996: A Post Mortem Study, March 1999). As a result of efforts to insure that acid mine drainage is prevented, most mining operations have alkaline pit water that often meets effluent limits and requires little or no treatment.

While most mining operations are permitted and allowed to have a standard, 1500’ x 300’ pit, most are well below that size and have a corresponding decreased flow and load. Where pit dimensions are greater than the standard size or multiple pits are present, the calculations to define the potential pollution load can be adjusted accordingly. Hence, the above calculated Waste Load Allocation is very generous and likely high compared to actual conditions that are generally encountered. A large margin of safety is included in the WLA calculations.

This is an explanation of the quantification of the potential pollution load reporting to the stream from permitted pit water treatment ponds that discharge water at established effluent limits. This allows for including active mining activities and their associated Waste Load in the TMDL calculations to more accurately represent the watershed pollution sources and the reductions necessary to achieve in-stream limits. When a mining operation is concluded its WLA is available for a different operation. Where there are indications that future mining in a watershed are greater than the current level of mining activity, an additional WLA amount may be included to allow for future mining.

TMDL Endpoints

One of the major components of a TMDL is the establishment of an instream numeric endpoint, which is used to evaluate the attainment of applicable water quality. An instream numeric endpoint, therefore, represents the water quality goal that is to be achieved by implementing the load reductions specified in the TMDL. The endpoint allows for 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 most of the pollution sources in the watershed are nonpoint sources, the TMDLs' component makeup will be Load Allocations (LAs). All allocations will be specified as long-term average daily concentrations. These long-term average concentrations are expected to meet water-quality criteria 99% of the time as required in PA Title 25 Chapter 96.3(c). 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 (Al)	0.75	Total Recoverable
Iron (Fe)	1.50	30 day average; Total Recoverable
Manganese (Mn)	1.00	Total Recoverable
pH *	6.0-9.0	N/A

*The pH values shown will be used when applicable. In the case of freestone streams with little or no buffering capacity, the TMDL endpoint for pH will be the natural background water quality.

TMDL Elements (WLA, LA, MOS)

$$TMDL = WLA + LA + MOS$$

A TMDL equation consists of a waste load allocation (WLA), load allocation (LA), and a margin of safety (MOS). The waste load allocation is the portion of the load assigned to point sources. The load allocation is the portion of the load assigned to non-point sources. The margin of safety is applied to account for uncertainties in the computational process. The margin of safety may be expressed implicitly (documenting conservative processes in the computations) or explicitly (setting aside a portion of the allowable load). The TMDL allocations in this report are based on available data. Other allocation schemes could also meet the TMDL.

Correlation

Analyses of data for select metals for sample points 2, 1A and SP1 indicated that there was no single critical flow condition for pollutant sources, and further, that there was no significant correlation between source flows and pollutant concentrations (Table 3). The other sample points or parameters did not have enough paired flow/parameter data to calculate correlations (fewer than 10 paired observations) or all or nearly all parameter data was less than detection.

Table 3. Correlations between Metals and Flow for Selected Points

Station	*Flow vs.*			*Number of Samples*
	Iron	*Manganese*	*Aluminum*	
2	---	-0.52	-0.51	10
SP1	-0.58	-0.70	-0.52	11
1A	---	-0.75	---	11

Allocation Summary

These TMDLs will focus remediation efforts on the identified numerical reduction targets for each watershed. The reduction schemes in Table 4 for each segment are based on the assumption that all upstream allocations are achieved and take into account all upstream reductions. Attachment C contains the TMDLs by segment analysis for each allocation point in a detailed discussion. As changes occur in the watershed, the TMDLs may be re-evaluated to reflect current conditions. An implicit MOS based on conservative assumptions in the analysis is included in the TMDL calculations.

The allowable LTA concentration in each segment is calculated using Monte Carlo Simulation as described previously. The allowable load is then determined by multiplying the allowable concentration by the flow and a conversion factor at each sample point. The allowable load is the TMDL.

Each permitted discharge in a segment is assigned a waste load allocation and the total waste load allocation for each segment is included in this table. The difference between the TMDL and the WLA at each point is the load allocation (LA) at the point. The LA at each point includes all loads entering the segment, including those from upstream allocation points. The percent reduction is calculated to show the amount of load that needs to be reduced within a segment in order for water quality standards to be met at the point.

In some instances, instream processes, such as settling, are taking place within a stream segment. These processes are evidenced by a decrease in measured loading between consecutive sample points. It is appropriate to account for these losses when tracking upstream loading through a segment. The calculated upstream load lost within a segment is proportional to the difference in the measured loading between the sampling points.

In the instance that the allowable load is equal to the existing load (e.g. manganese point 1A, Table 4), the simulation determined that water quality standards are being met instream 99% of the time and no TMDL is necessary for the parameter at that point. Although no TMDL is necessary, the loading at the point is considered at the next downstream point.

Table 4. TMDL Component Summary for the Shafer Run Watershed

Station	Parameter	Existing Load (lbs/day)	TMDL Allowable Load (lbs/day)	WLA (lbs/day)	LA (lbs/day)	Load Reduction (lbs/day)	Percent Reduction %
1A	*Headwaters of Shafer Run*						
	Fe	0.7	0.2	0.0	0.2	0.4	65
	Mn	0.4	0.4	NA	NA	0.0	0
	Al	0.6	0.3	0.0	0.3	0.3	54
	Acidity	24.8	2.0	0.0	2.0	22.8	92
SP1	*Shafer Run at SR 2016 crossing*						
	Fe	7.5	1.0	0.0	1.0	6.0	86
	Mn	14.4	1.0	0.0	1.0	13.3	93
	Al	12.8	0.9	0.0	0.9	11.6	93
	Acidity	182.8	0.9	0.0	0.9	159.2	99
2	*Shafer Run upstream of Unnamed Tributary 39056*						
	Fe	1.7	1.7	1.0	NA	0.0	0
	Mn	14.1	1.4	0.7	0.7	0.2	25
	Al	14.2	1.4	0.5	0.9	1.4	62
	Acidity	242.1	9.7	0.0	9.7	50.5	84
SP21	*Mouth of Shafer Run*						
	Fe	2.3	2.3	2.0	NA	0.0	0
	Mn	5.8	3.6	1.4	2.2	0.0	0
	Al	7.8	3.3	1.0	2.3	0.0	0
	Acidity	155.3	24.9	0.0	24.9	0.0	0

NA meets WQS. No TMDL necessary.

Following is a generic example of how the allocations, presented in Table 4 are calculated. As demonstrated in the example, all upstream contributing loads are accounted for at each point. Attachment C contains the TMDLs by segment analysis for each allocation point in a detailed discussion. These analyses follow the example. Attachment A contains a map of the sampling point locations for reference.

4	Load (lbs/day)
Existing Load	40.0
Allowable Load	10.0
Load Reduction	30.0
% Reduction	75

10.0

720.0 = 760.0 - 40.0

730.0 = 10.0 + 720.0

3	Load (lbs/day)
Existing Load	760.0
Difference in Existing Loads	720.0
Load tracked from upstream	10.0
Total Load tracked between points	730.0
Allowable Load	15.0
Load Reduction	715.0
% Reduction required	98

15.0

3.5

2	Load (lbs/day)
Existing Load	12.0
Allowable Load	3.5
Load Reduction	8.5
% Reduction	71

18.5 = 15.0 + 3.5

16.0 = 18.5 * 0.87

1	Load (lbs/day)
Existing Load	675.0
Difference in Existing Loads	-97.0
Load tracked from upstream	18.5
% Load lost	13
% Load tracked	87
Total Load tracked between points	16.0
Allowable Load	27.0
Load Reduction	0.0
% Reduction required	0

Waste load allocations are assigned to the permitted discharges from the Future Industries, Inc. SMP 56900112, NPDES PA058976, Nittany Mine. The WLAs are calculated using the method as described in *The Method to Quantify Treatment Pond Pollutant Load* section of the report.

On the Nittany Mine there are seven permitted treatment pond discharges, three of which discharge to Shafer Run, TF-1, TF-4 and TF-8. The permitted dimensions for the two Nittany Mine pits are 1850’ x 170’ and 1200’ x 70’, for a total pit area of 398,500 square feet. Included in the permit are limits for iron, aluminum and manganese. The WLA for TF-8 is being evaluated at sample point 2 and for TF-1 and TF-4 at sample point SP21.

No required reductions of permit limits are required at this time. All necessary reductions are assigned to non-point sources. Table 5 below contains the WLAs for the Shafer Run Watershed permitted discharges.

Table 5. Waste Load Allocations of Permitted Discharges

Mine	Station	Parameter	Allowable Average Monthly Conc. (mg/L)	Average Flow (MGD)	WLA (lbs/day)
Future Industries, Inc.	**TF-1**	Fe	3.0	0.04	1.0
Nittany Mine		Mn	2.0	0.04	0.7
SMP 56900112		Al	1.6	0.04	0.5
NPDES PA058976					
	TF-4	Fe	3.0	0.04	1.0
		Mn	2.0	0.04	0.7
		Al	1.6	0.04	0.5
	TF-8	Fe	3.0	0.04	1.0
		Mn	2.0	0.04	0.7
		Al	1.6	0.04	0.5

Recommendations

Currently there are no projects that have been identified to assess or abate past mining discharges. The active operation has reclaimed abandoned mine lands and is currently treating its pit water in to permit effluent limitations. Water quality at the downstream monitoring point will rely on the outcome of current mining, backfilling and alkaline addition of the existing permit, Future Industries, Inc., SMP No. 56900112.

Two primary programs provide maintenance and improvement of water quality in the watershed. DEP’s efforts to reclaim abandoned mine lands, coupled with its duties and responsibilities for issuing NPDES permits, will be the focal points in water quality improvement.

Additional opportunities for water quality improvement are both ongoing and anticipated. Historically, a great deal of research into mine drainage has been conducted by DEP’s Bureau of

Abandoned Mine Reclamation, which administers and oversees the Abandoned Mine Reclamation Program in Pennsylvania; the United States Office of Surface Mining; the National Mine Land Reclamation Center; the National Environmental Training Laboratory; and many other agencies and individuals. Funding from EPA's CWA Section 319(a) Grant program and Pennsylvania's Growing Greener program has been used extensively to remedy mine drainage impacts. These many activities are expected to continue and result in water quality improvement.

The DEP Bureau of Mining and Reclamation administers an environmental regulatory program for all mining activities, mine subsidence regulation, mine subsidence insurance, and coal refuse disposal; conducts a program to ensure safe underground bituminous mining and protect certain structures form subsidence; administers a mining license and permit program; administers a regulatory program for the use, storage, and handling of explosives; provides for training, examination, and certification of applicants for blaster's licenses; administers a loan program for bonding anthracite underground mines and for mine subsidence; and administers the EPA Watershed Assessment Grant Program, the Small Operator's Assistance Program (SOAP), and the Remining Operators Assistance Program (ROAP).

Mine reclamation and well plugging refers to the process of cleaning up environmental pollutants and safety hazards associated with a site and returning the land to a productive condition, similar to DEP's Brownfields program. Since the 1960's, Pennsylvania has been a national leader in establishing laws and regulations to ensure reclamation and plugging occur after active operation is completed.

Pennsylvania is striving for complete reclamation of its abandoned mines and plugging of its orphaned wells. Realizing this task is no small order, DEP has developed concepts to make abandoned mine reclamation easier. These concepts, collectively called Reclaim PA, include legislative, policy land management initiatives designed to enhance mine operator, volunteer land DEP reclamation efforts. Reclaim PA has the following four objectives.

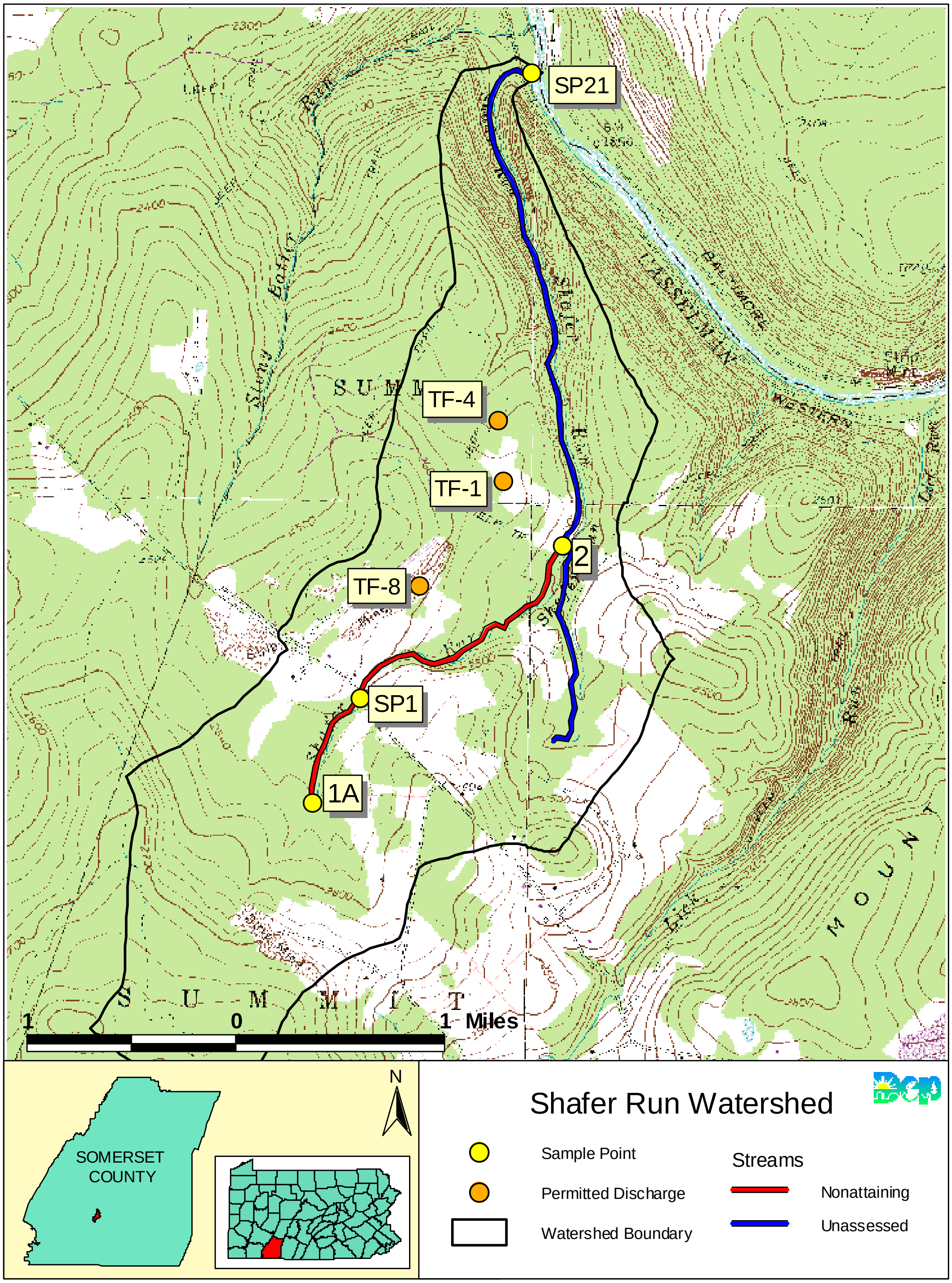
- To encourage private and public participation in abandoned mine reclamation efforts
- To improve reclamation efficiency through better communication between reclamation partners
- To increase reclamation by reducing remining risks
- To maximize reclamation funding by expanding existing sources and exploring new sources.

Reclaim PA is DEP's initiative designed to maximize reclamation of the state's quarter million acres of abandoned mineral extraction lands. Abandoned mineral extraction lands in Pennsylvania constituted a significant public liability – more than 250,000 acres of abandoned surface mines, 2,400 miles of streams polluted with mine drainage, over 7,000 orphaned and abandoned oil and gas wells, widespread subsidence problems, numerous hazardous mine openings, mine fires, abandoned structures and affected water supplies – representing as much as one third of the total problem nationally.

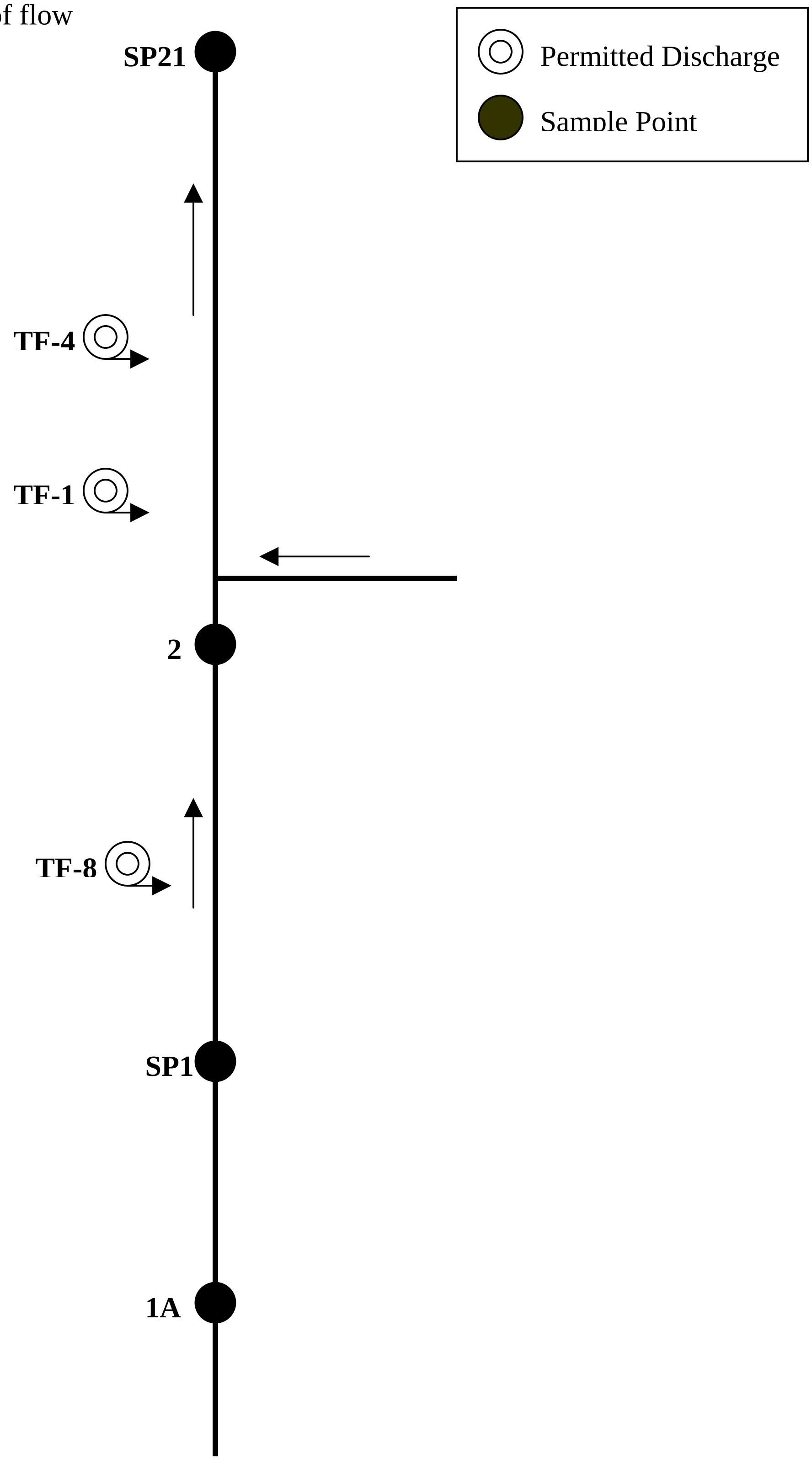
Public Participation

Public notice of the draft TMDL was published in the *Pennsylvania Bulletin* and the *Daily American* on 11/13/2006 to foster public comment on the allowable loads calculated. The public comment period on this TMDL was open from 11/4/2006 to 1/4/2007. A public meeting was held on 11/21/2006 at the Cambria District Mining Office, to discuss the proposed TMDL.

Attachment A
Shafer Run Watershed Maps


SP21
TF-4
TF-1
2
TF-8
SP1
1A
1 0 1 Miles
N
SOMERSET COUNTY
Shafer Run Watershed
Sample Point
Permitted Discharge
Watershed Boundary
Streams
Nonattaining
Unassessed

Shafer Run Sampling Station Diagram
Arrows represent direction of flow
Diagram not to scale



Attachment B

Method for Addressing Section 303(d) Listings for pH

Method for Addressing Section 303(d) Listings for pH

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

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

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

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

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

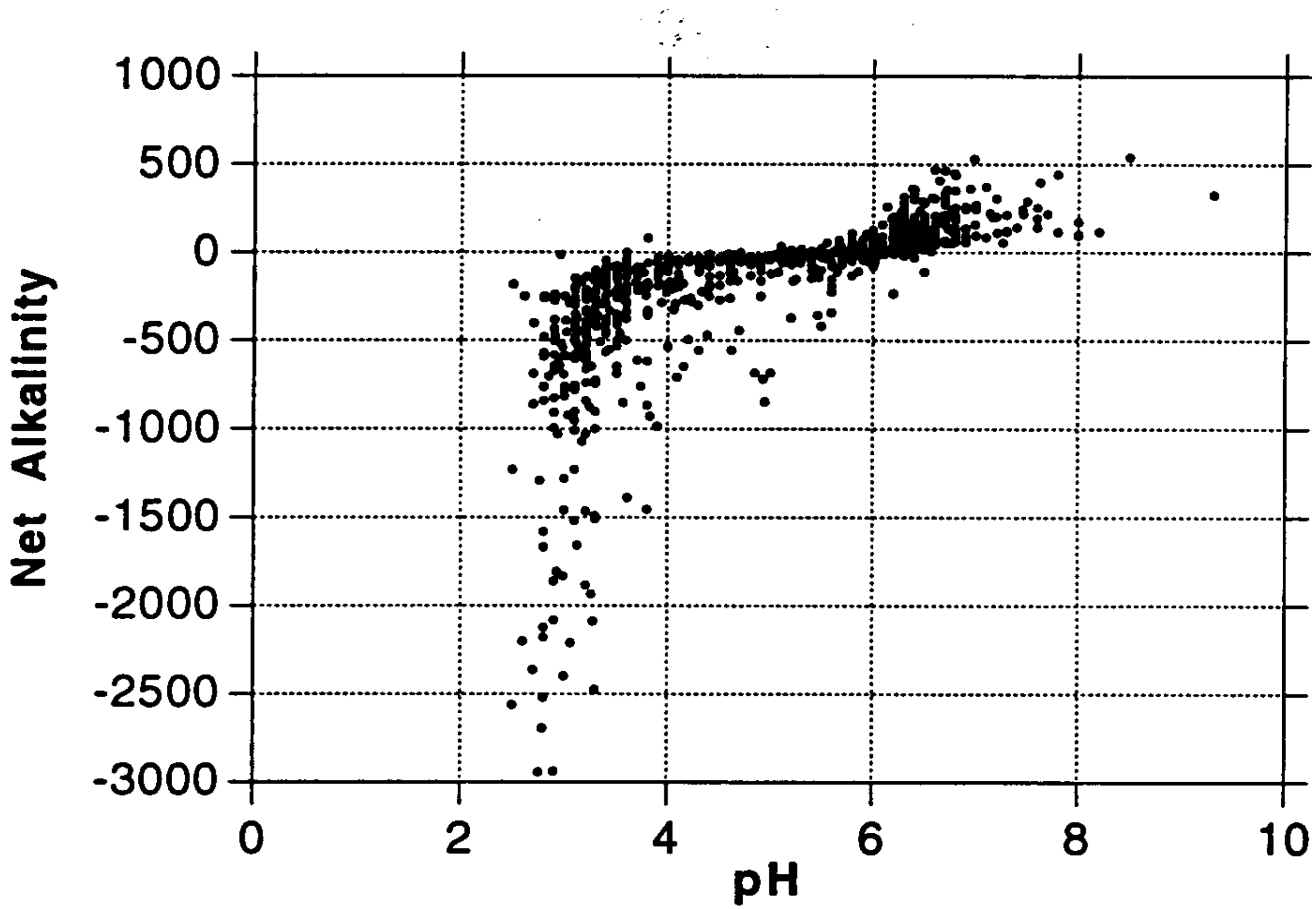


Figure 1. Net Alkalinity vs. pH. Taken from Figure 1.2 Graph C, pages 1-5, of Coal Mine Drainage Prediction and Pollution Prevention in Pennsylvania

Attachment C
TMDLs By Segment

Shafer Run

The TMDL for the Shafer Run consists of waste load allocations of three permitted discharges and load allocations of four sampling sites along the stream.

Shafer Run is listed as impaired on the PA Section 303(d) list by high metals from AMD as being the cause of the degradation to the stream. The stream is not listed for pH impairments; however, data shows that the water quality standard is not met at all points; therefore, pH is addressed as part of the TMDL for Shafer Run. The method and rationale for addressing pH is contained in Attachment B.

An allowable long-term average in-stream concentration was determined at each point for iron, manganese, aluminum, 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.

Waste Load Allocations– Permitted Discharges

The Future Industries Inc. SMP 56900112, Nittany Mine has seven permitted treatment ponds; of these, three discharge to Shafer Run, TF-1, TF-4 and TF-8. The waste load allocations for the discharges are calculated with average monthly permit limits and average flow, which is estimated with permitted pit areas and average rainfall. There are two permitted pits in the permit with a total combined pit area of 398,500 square feet. Included in the permit are limits for iron, manganese and aluminum. The WLAs for TF-1 and TF-4 are evaluated at point SP2 and TF-8 at point 2.

The following table contains the waste load allocations for each discharge.

Table C1. Waste Load Allocations for Permitted Discharges

Mine	Discharge Id	Parameter	Monthly Avg. Allowable Conc. (mg/L)	Average Flow (MGD)	Allowable Load (lbs/day)
Future Industries, Inc.	TF-1	Fe	3.0	0.04	1.0
SMP 56900112		Mn	2.0	0.04	0.7
NPDES PA058976		Al	1.6	0.04	0.5
Nittany Mine					

Table C1. Waste Load Allocations for Permitted Discharges					
Mine	**Discharge Id**	**Parameter**	**Monthly Avg. Allowable Conc. (mg/L)**	**Average Flow (MGD)**	**Allowable Load (lbs/day)**
Future Industries, Inc.	TF-4	Fe	3.0	0.04	1.0
SMP 56900112		Mn	2.0	0.04	0.7
NPDES PA058976		Al	1.6	0.04	0.5
Nittany Mine					
	TF-8	Fe	3.0	0.04	1.0
		Mn	2.0	0.04	0.7
		Al	1.6	0.04	0.5

TMDL Calculations - Sample Point 1A, Headwaters of Shafer Run

The TMDL for sample point 1A consists of a load allocation to all of the area above the point (Attachment A). The load allocation for this segment was computed using water-quality sample data collected at point 1A. The average flow of 0.10 MGD, measured at the point, is used for these computations.

There is currently an entry for this segment on the1996 PA Section 303(d) list for metals impairments from AMD. Sample data at point 1A shows pH ranging between 4.7 and 5.2; pH is addressed as part of this TMDL.

Water quality analysis determined that allowable manganese load is equal to the existing manganese load. Because the WQS is met, a TMDL for manganese is not necessary. Although a TMDL for manganese is not necessary, the measured load is considered at the next downstream point, SP1.

Table C2. TMDL Calculations at Point 1A				
Flow = 0.10 MGD	Measured Sample Data		Allowable	
Parameter	Conc. (mg/l)	Load (lbs/day)	LTA Conc. (mg/l)	Load (lbs/day)
Fe	0.79	0.7	0.28	0.2
Mn	0.43	0.4	0.43	0.4
Al	0.76	0.6	0.35	0.3
Acidity	29.93	24.8	2.39	2.0
Alkalinity	7.35	6.1		

Table C3. Calculation of Load Reduction Necessary at Point 1A				
	Fe (lbs/day)	Mn (lbs/day)	Al (lbs/day)	Acidity (lbs/day)
Existing Load	0.7	0.4	0.6	24.8
Allowable Load	0.2	0.4	0.3	2.0
Load Reduction	0.4	0.0	0.3	22.8
% Reduction required	65	0	54	92

TMDL Calculations - Sample Point SP1, Shafer Run at SR 2016 crossing

The TMDL for sample point SP1 consists of a load allocation to all of the area between points SP1 and 1A (Attachment A). The load allocation for this segment was computed using water-quality sample data collected at point SP1. The average flow of 0.33 MGD, measured at the point, is used for these computations.

This segment was included on the 1996 PA Section 303(d) list for metals impairments from AMD. Sample data at point SP1 shows pH ranging between 3.4 and 4.2; pH is addressed as part of this TMDL.

Table C4. TMDL Calculations at Point SP1				
Flow = 0.33 MGD	Measured Sample Data		Allowable	
Parameter	Conc. (mg/l)	Load (lbs/day)	LTA Conc. (mg/l)	Load (lbs/day)
Fe	2.74	7.5	0.36	1.0
Mn	5.23	14.4	0.37	1.0
Al	4.67	12.8	0.33	0.9
Acidity	66.65	182.8	0.33	0.9
Alkalinity	1.07	2.9		

The calculated upstream load reductions for all the loads that enter point SP1 must be accounted for in the calculated reductions at the sample point shown in Table C5. A comparison of measured loads between points SP1 and 1A shows that there is an increase in loading for all parameters. The total segment load for each parameter is the sum of the upstream load and the additional load entering the segment.

Table C5. Calculation of Load Reduction Necessary at Point SP1				
	Fe (lbs/day)	Mn (lbs/day)	Al (lbs/day)	Acidity (lbs/day)
Existing Load	7.5	14.4	12.8	182.8
Difference in Existing Load between 1A & SP1	6.8	14.0	12.2	158.1
Load tracked from 1A	0.2	0.4	0.3	2.0
Total Load tracked between points 1A & SP1	7.1	14.4	12.5	160.0
Allowable Load at SP1	1.0	1.0	0.9	0.9
Load Reduction at SP1	6.1	13.3	11.6	159.1
% Reduction required at SP1	86	93	93	99

TMDL Calculations - Sample Point 2, Shafer Run upstream of Unnamed Tributary 39056

The TMDL for sample point 2 consists of a waste load allocation to the Nittany Mine TF-8 treatment pond discharge and a load allocation to all of the area between points 2 and SP1 (Attachment A). The load allocation for this segment was computed using water-quality sample data collected at point 2. The average flow of 0.53 MGD, measured at the point, is used for these computations.

This segment was included on the 1996 PA Section 303(d) list for metals impairments from AMD. Sample data at point 2 shows pH ranging between 4.0 and 6.6; pH is addressed as part of this TMDL.

Water quality analysis determined that the allowable iron load is equal to the existing iron load. Because the WQS is met, a TMDL for iron is not necessary. Although a TMDL for iron is not necessary, the measured load is considered at the next downstream point, SP21. In addition, an iron WLA allocation is assigned to the permitted discharge. The actual allowable iron load at the point is the criterion times the flow, which is equal to 6.6 lbs/day; therefore the WLA of 1.0 lbs/day is acceptable.

Table C6. TMDL Calculations at Point 2

Flow = 0.53 MGD	Measured Sample Data		Allowable	
Parameter	Conc. (mg/l)	Load (lbs/day)	LTA Conc. (mg/l)	Load (lbs/day)
Fe	0.39	1.7	0.39	1.7
Mn	3.21	14.1	0.32	1.4
Al	3.23	14.2	0.32	1.4
Acidity	54.89	242.1	2.20	9.7
Alkalinity	6.49	28.6		

The calculated upstream load reductions for all the loads that enter point 2 must be accounted for in the calculated reductions at the sample point shown in Table C7. A comparison of measured loads between points SP1 and 2 shows that there is a decrease in iron and manganese loadings and an increase in aluminum and acidity loadings. For loss of loading, the percent of load lost within the segment is calculated and applied to the upstream loads to determine the amount of load that is tracked through the segment. For increase in loading, the total segment acidity and aluminum load is the sum of the upstream loads and the additional load entering the segment.

Table C7. Calculation of Load Reduction Necessary at Point 2

	Fe (lbs/day)	Mn (lbs/day)	Al (lbs/day)	Acidity (lbs/day)
Existing Load	1.7	14.1	14.2	242.1
Difference in Existing Load between SP1 & 2	-5.8	-0.3	1.4	59.2
Load tracked from SP1	1.0	1.0	0.9	0.9
Percent Load lost	77	2	-	-
Percent Load tracked	23	98	-	-
Total Load tracked between points SP1 & 2	0.2	1.0	2.3	60.1
Allowable Load at 2	1.7	1.4	1.4	9.7
Allowable Load assigned to WLA (TF-8)	1.0	0.7	0.5	0.0
Allowable Load assigned to LA	0.7	0.7	0.9	9.7
Load Reduction at 2	0.0	0.2	1.4	50.5
% Reduction required at 2	0	25	62	84

TMDL Calculation - Sampling Point SP21, Mouth of Shafer Run

The TMDL for sample point SP21 consists of a waste load allocation to the two Nittany Mine permitted discharges, TF-1 and TF-4 and a load allocation to all of the area between points SP21 and 2 (Attachment A). The load allocation for segment was computed using water-quality sample data collected at point SP21. In-stream flow measurements were not available for sample point SP21. Flow for this point was estimated using the unit-area hydrology from a known point (sample point 2) on Shafer Run.

The watershed area above sample point SP21 is 1.54 square miles. The known flow point on Shafer Run had an average flow of 0.53 and a watershed area of 0.89 square miles. This gives a flow yield of 0.60 MGD/sq.mi. Multiplying the flow yield for the known point times the watershed area above point SP21 equals the flow of 0.92 MGD at sample point SP21.

This segment was not included on the PA Section 303(d) list for impairments from AMD. Sample data at point SP21 shows pH ranging between 4.1 and 4.8; pH is addressed as part of this TMDL.

Water quality analysis determined that the allowable iron load is equal to the existing iron load. Because the WQS is met, a TMDL for iron is not necessary. Although a TMDL is not necessary, an iron WLA allocation is assigned to the permitted discharges. The actual allowable iron load at the point is the criterion times the flow, which is equal to 11.5 lbs/day, therefore the WLA of 2.0 lbs/day is acceptable.

Table C8. TMDL Calculations at Point SP21				
Flow = 0.92 MGD	Measured Sample Data		Allowable	
Parameter	Conc. (mg/l)	Load (lbs/day)	LTA Conc. (mg/l)	Load (lbs/day)
Fe	0.30	2.3	0.30	2.3
Mn	0.76	5.8	0.47	3.6
Al	1.02	7.8	0.43	3.3
Acidity	20.31	155.3	3.25	24.9
Alkalinity	6.82	52.1		

The calculated upstream load reductions for all the loads that enter point SP21 must be accounted for in the calculated reductions at the sample point shown in Table C9. A comparison of measured loads between points 2 and SP21 shows that there is a decrease in loading for all parameters except iron. For increase in loading, the total segment load is the sum of the upstream loads and the additional loading entering the segment. For loss of loading, the percent of load lost within the segment is calculated and applied to the upstream loads to determine the amount of load that is tracked through the segment.

Table C9. Calculation of Load Reduction Necessary at Point SP21				
	Fe (lbs/day)	Mn (lbs/day)	Al (lbs/day)	Acidity (lbs/day)
Existing Load	2.3	5.8	7.8	155.3
Difference in Existing Load between 2 & SP21	0.6	-8.3	-6.4	-86.7
Load tracked from 2	1.7	1.4	1.4	9.7
Percent Load lost	-	59	45	36
Percent Load tracked	-	41	55	64
Total Load tracked between points 2 & SP21	2.3	0.6	0.8	6.2
Allowable Load at SP21	2.3	3.6	3.3	24.9
Allowable Load assigned to WLA (TF-1 AND TF-4)	2.0	1.4	1.0	0.0
Allowable Load assigned to LA	0.3	2.2	2.3	24.9
Load Reduction at SP21	0.0	0.0	0.0	0.0
% Reduction required at SP21	0	0	0	0

Margin of Safety

For this study the margin of safety is applied implicitly. A MOS is implicit 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.
- An additional MOS is provided because that the calculations were done with a daily Fe average instead of the 30-day average

Seasonal Variation

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

Critical Conditions

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

Attachment D

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

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

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

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

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

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

Attachment E
Water Quality Data Used In TMDL Calculations

Site	Date	Flow (gpm)	pH	Alk (mg/L)	Acidity (mg/L)	Fe (mg/L)	Mn (mg/L)	Al (mg/L)
1A	5/17/2001	30.00	4.80	8.00	6.00	0.373	0.525	0.744
	6/15/2001	52.00	4.80	8.00	0.80	0.313	0.415	0.534
Latitude:	7/19/2001	34.10	5.00	6.00	25.00	<0.3	0.450	<0.5
39 51' 50"	8/10/2001	9.70	4.70	7.20	26.40	0.345	0.418	<0.5
Longitude:	6/5/2002	100.00	5.00	8.00	25.00	<0.3	0.424	<0.5
79 08' 06"	7/3/2002	10.00	5.00	6.80	37.60	0.347	0.478	<0.5
	8/5/2002	2.00	5.00	7.00	49.00	2.750	0.462	1.210
Headwaters of Shafer Run	5/21/2003	278.30	5.00	6.20	19.20	<0.3	0.274	<0.5
	6/23/2003	219.90	5.10	8.80	27.80	<0.3	0.363	0.521
	7/28/2003	15.10	4.90	8.20	54.40	1.020	0.539	0.781
	8/21/2003	7.50	5.20	6.60	58.00	0.396	0.370	<0.5
	Average	***68.96364***	***4.95455***	***7.34545***	***29.92727***	***0.79200***	***0.42891***	***0.75800***
	St Dev	***94.20204***	***0.14397***	***0.90814***	***18.46928***	***0.89865***	***0.07580***	***0.27900***
SP1	5/17/2001	154.40	3.90	0.00	62.00	0.960	6.070	7.690
	6/15/2001	180.00	4.00	2.60	28.00	0.988	2.610	2.610
Latitude:	7/19/2001	131.80	3.70	0.00	60.00	1.910	4.450	4.100
39 51' 50"	8/10/2001	10.80	3.50	0.00	74.40	4.030	6.610	3.920
Longitude:	6/5/2002	175.00	3.80	0.00	63.60	1.090	4.710	6.290
79 08' 06"	7/3/2002	12.00	3.50	0.00	78.60	4.980	7.000	6.010
	8/5/2002	3.00	3.40	0.00	86.20	7.400	10.600	5.870
Shafer Run at SR 2016 crossing	5/21/2003	1070.00	4.20	3.20	69.90	0.397	1.610	2.440
	6/23/2003	443.00	4.10	6.00	60.20	0.693	2.300	3.010
	7/28/2003	251.00	3.50	0.00	74.60	3.590	5.860	5.250
	8/21/2003	81.90	3.50	0.00	75.60	4.050	5.720	4.190
	Average	***228.44545***	***3.73636***	***1.07273***	***66.64545***	***2.73527***	***5.23091***	***4.67091***
	St Dev	***306.80650***	***0.28026***	***2.00853***	***15.32810***	***2.23975***	***2.54262***	***1.68543***

Site	Date	Flow (gpm)	pH	Alk (mg/L)	Acidity (mg/L)	Fe (mg/L)	Mn (mg/L)	Al (mg/L)
2	5/17/2001	212.90	4.30	5.80	44.00	<0.3	5.130	6.230
	6/15/2001	247.00	4.30	5.60	18.20	<0.3	<0.3	2.250
Latitude:	7/19/2001	165.80	4.00	2.00	76.60	0.356	3.960	3.390
39 52' 16"	8/10/2001	60.00	4.20	6.80	84.20	0.531	6.000	3.680
Longitude:	6/5/2002	318.00	4.50	9.20	67.20	0.301	3.230	4.100
79 07' 27"	7/3/2002	80.00	4.30	5.00	76.80	0.461	4.510	3.890
	8/5/2002	13.30	6.60	11.40	0.00	0.360	0.256	<0.5
Shafer Run upstream of	5/21/2003	1667.00	4.60	6.40	42.40	<0.3	1.030	1.560
Unnamed Tributary 39056	6/23/2003	1055.00	4.70	6.20	50.60	0.324	1.436	1.930
	7/28/2003	181.00	4.30	6.60	74.20	0.396	3.630	3.250
	8/21/2003	39.30	4.70	6.40	69.60	<0.3	2.890	2.010
	Average	***367.20909***	***4.59091***	***6.49091***	***54.89091***	***0.38986***	***3.20720***	***3.22900***
	St Dev	***518.46675***	***0.70065***	***2.35179***	***26.83898***	***0.08092***	***1.84474***	***1.38839***
SP21	1/17/2001	NM	4.7	9	14.6	0.3	1.03	1.16
	4/5/2001	NM	4.7	7.8	11.4	0.3	1.1	1.44
Latitude:	8/6/2001	NM	4.6	6.2	18.6	0.31	1.2	1.23
39 53' 27"	10/10/2001	NM	4.7	6.2	16.2	0.3	0.314	0.903
Longitude:	1/4/2002	NM	4.1	8.4	15.8	0.3	0.642	1.07
79 07' 30"	4/16/2002	NM	4.6	7.4	25.8	0.3	0.741	0.944
	7/1/2002	NM	4.5	6	36.2	0.3	0.775	1.11
Mouth of Shafer Run	10/4/2002	NM	4.8	6.6	13.8	0.3	0.408	0.517
	5/22/2003	NM	4.7	6.4	21.6	0.3	0.712	1.05
	7/2/2003	NM	4.5	6.2	21.6	0.3	0.843	1.17
	10/28/2003	NM	4.8	4.8	27.8	0.3	0.592	0.651
	Average		***4.60909***	***6.81818***	***20.30909***	***0.30091***	***0.75973***	***1.02227***
	St Dev		***0.19725***	***1.21146***	***7.32522***	***0.00302***	***0.27511***	***0.26128***

Attachment F
Comment and Response

No official comments were received for this TMDL.