FINAL

KETTLE CREEK WATERSHED TMDL
Clinton, Potter, and Tioga Counties

Prepared for:

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FINAL TMDL[1]
Kettle Creek Watershed
Clinton, Potter, and Tioga Counties, Pennsylvania

INTRODUCTION

This Total Maximum Daily Load (TMDL) calculation has been prepared for segments in the Kettle Creek Watershed (Attachment A). It was done to address the impairments noted on the 1996, 1998, 2002, and 2004 Pennsylvania Section 303(d) lists required under the Clean Water Act. The TMDL covers one segment on these lists (Table 1). High levels of metals, and in some areas depressed pH, caused these impairments. All impairments are a result of acid drainage from abandoned coal mines. The TMDL addresses the three primary metals (iron, manganese, and aluminum) associated with abandoned mine drainage (AMD) and pH.

Table 1. Kettle Creek Segments Addressed

State Water Plan (SWP) Subbasin: 09-B West Branch Susquehanna River								
Year	**Miles**	**Segment ID**	**DEP Stream Code**	**Stream Name**	**Designated Use**	**Data Source**	**Source**	**EPA 305(b) Cause Code**
1996	3.0	Not Placed on GIS	23661	Kettle Creek	TSF	305(b) Report	RE	Metals
1998	3.0	Not Placed on GIS	23661	Kettle Creek	TSF	Surface Water Monitoring Program	AMD	Metals
2002	1.9	990514-1215-TAS	23661	Kettle Creek	TSF	Surface Water Monitoring Program	AMD	Metals, pH
2004	1.9	990514-1215-TAS	23661	Kettle Creek	TSF	Statewide Surface Water Monitoring Program	AMD	Metals, pH

Attachment B includes a justification of differences between the 1996, 1998, 2002, and 2004 Section 303(d) Lists

TSF = Trout Stocked Fishery
RE = Resource Extraction
AMD = Abandoned Mine Drainage

LOCATION

The Kettle Creek Watershed covers approximately 244 square miles in Potter, Tioga, and Clinton Counties in north central Pennsylvania. The headwaters of Kettle Creek flow through the Susquehannock State Forest in Potter County. The middle portion of the watershed lies in the F. H. Dutlinger Natural Area and the proposed Hammersley Wild Area. Ole Bull State Park is also located in the middle Kettle Creek Watershed. Kettle Creek State Park surrounds the Alvin R. Bush Dam on the mainstem of Kettle Creek approximately 8.5 miles from the confluence of Kettle Creek with the West Branch Susquehanna River. The mainstem of Lower

[1] Pennsylvania's 1996, 1998, 2002, and 2004 Section 303(d) lists were approved by the U.S. Environmental Protection Agency. The 1996 Section 303(d) list provides the basis for measuring progress under the 1996 lawsuit settlement of *American Littoral Society and Public Interest Group of Pennsylvania v. EPA.*

Kettle Creek, from the Alvin R. Bush Dam to the mouth of the stream, is the focus of this TMDL report. All the AMD additions to Kettle Creek are in this section of the stream. The study area can be located on the U. S. Geological Service (USGS) 7.5 minute quadrangles of Keating and Renovo West, Pennsylvania. A large portion of the Lower Kettle Creek Watershed lies in the Sproul State Forest; private parcels account for the remaining land ownership.

In the study area, Kettle Creek flows southeast from the Alvin R. Bush Dam in Kettle Creek State Park to its confluence with the West Branch Susquehanna River in the village of Westport, Clinton County, Pennsylvania. The only major named tributary to Kettle Creek is Twomile Run that enters Kettle Creek from the east. Several small tributaries enter Kettle Creek from the west including Hicks Hollow, Slide Hollow, Short Bend Run, Duck Hollow, and Butler Hollow. The watershed is sparsely populated; hunting cabins are the main dwellings found within the watershed. The village of Westport lies on State Highway 120, to the north of the confluence of Kettle Creek with the West Branch Susquehanna River.

Kettle Creek can be accessed from State Highway 120 at its mouth and from State Route 4001 along its entire length in the study area. Several township roads provide access to other portions of the watershed including T307, T468, Cattaraugus Road, Boyer Road, Crowley Road, and Sugar Camp Road. The upper portions of the Kettle Creek Watershed can be accessed from State Highway 144 and various township and state forest roads.

SEGMENTS ADDRESSED IN THIS TMDL

The Lower Kettle Creek Watershed is affected by pollution from AMD. This pollution has caused high levels of metals and low pH in the mainstem of Kettle Creek, the Twomile Run Watershed, Butler Hollow, Duck Hollow, Short Bend Run, and Slide Hollow. The sources of the AMD are deep mine discharges and seeps from areas disturbed by surface mining. Most of the discharges originate from long abandoned deep mines on the Lower Kittanning coal seams or surface mining of the Upper and Lower Kittanning coal seams that were reclaimed to pre-act standards. All of the discharges are considered to be nonpoint sources of pollution because they are from abandoned Pre-Act mining operations or from coal companies that have settled their bond forfeitures with the Pennsylvania Department of Environmental Protection (PADEP). There are no bond forfeitures in the Kettle Creek Watershed.

A TMDL report for the Twomile Run Watershed was completed in February 2001 and approved by the U. S. Environmental Protection Agency. The loading from the mouth of Twomile Run will be incorporated into the TMDL for the Kettle Creek Watershed. The Twomile Run Watershed will not be discussed in this report; please reference the Twomile Run TMDL document for further details.

There is no active mining in the Kettle Creek Watershed; all active mining ceased in the watershed in 1977. A WLA for a future mining operation was calculated and incorporated into the allocations at KC1 at the request of the PADEP Moshannon District Mining Office. It is possible that there will be mining in the Lower Kettle Creek Watershed in the future based on available coal reserves, mining operator interests, the possibility of reclamation by remining, and other factors. A WLA that is representative of one future surface mining operation has been included to accommodate this possibility.

Any pre-existing discharges listed on permitted sites are treated as nonpoint sources for the purposes of doing the TMDLs, unless otherwise noted. The reduction necessary to meet applicable water quality standards from preexisting conditions (including discharges from areas coextensive with areas permitted under the remining program Subchapter F or G) are expressed in the LA portion of the TMDL. The WLAs express the basis for applicable effluent limitations on point sources. Except for any expressed assumptions, any WLA allocated to a remining permittee does not require the permittee to necessarily implement the reductions from preexisting conditions set forth in the LA. Additional requirements for the permittee to address the preexisting conditions are set forth in the applicable NPDES/mining permit. The individual discharges are not assigned load allocations, however; discharge affects on the stream are taken into account at the closest downstream sampling point and it is noted that the discharge is a contributing pollutant source to the segment.

CLEAN WATER ACT REQUIREMENTS

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

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

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

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

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

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

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

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

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

SECTION 303(D) LISTING PROCESS

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

The primary method adopted by the Pennsylvania Department of Environmental Protection (PADEP) 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. PADEP is now using the Statewide Surface Water Assessment Program (SSWAP), a modification of the USEPA Rapid Bioassessment Protocol II (RPB-II), as the primary mechanism to assess Pennsylvania's waters. The SSWAP provides a more consistent approach to assessing Pennsylvania's streams.

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

After the survey is completed, the biologist determines the status of the stream segment. The decision is based on the performance of the segment using a series of biological metrics. If the stream is determined to be impaired, the source and cause of the impairment is documented. An impaired stream must be listed on the state's Section 303(d) list with the documented source and cause. A TMDL must be developed for the stream segment. A TMDL is for only one pollutant. If a stream segment is impaired by two pollutants, two TMDLs must be developed for that

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

stream segment. In order for the process to be more effective, adjoining stream segments with the same source and cause listing are addressed collectively, and on a watershed basis.

BASIC STEPS FOR DETERMINING A TMDL

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

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

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

WATERSHED BACKGROUND

The headwaters of Kettle Creek begin in Tioga County, Pennsylvania. Kettle Creek flows southwest into Potter County and through the Susquehannock State Forest. The Kettle Creek Watershed contains approximately 244 square miles. The middle portion of the watershed lies in the F. H. Dutlinger Natural Area and the proposed Hammersley Wild Area. Ole Bull State Park is also located in the middle Kettle Creek Watershed. Kettle Creek State Park surrounds the Alvin R. Bush Dam on the mainstem of Kettle Creek approximately 8.5 miles from the mouth of Kettle Creek. The mainstem of Lower Kettle Creek, from the Alvin R. Bush Dam to the mouth of the stream, flows southeast until its confluence with the West Branch Susquehanna River at the village of Westport, Noyes Township, Clinton County, Pennsylvania.

The Lower Kettle Creek Watershed lies within the Appalachian Plateaus Province. The northern section of the study area, from the Alvin R. Bush Dam south to the headwaters of Fivemile Hollow, lies in the Mountainous High Plateau Section. The area from the headwaters of Fivemile Hollow south to the mouth of Kettle Creek lies in Pittsburgh Low Plateau Section. There is a vertical drop in the Lower Kettle Creek study area of 1,495 feet from the headwaters of Summerson Run, a tributary to Kettle Creek, to the mouth of Kettle Creek. Soils throughout the Lower Kettle Creek Watershed are very deep, well drained, and extremely to strongly acidic (USDA, 2004). The surficial geology is a mixture of interbedded sedimentary (22 percent) and sandstone (78 percent).

PA Code, Title 25 Chapter 93 Water Quality Standards designates the Kettle Creek basin from its source to the Kettle Creek Reservoir inlet as Exception Value waters. The Kettle Creek basin from the Kettle Creek Reservoir inlet to the Alvin R. Bush Dam is a High-Quality Trout Stocked Fishery (TSF). The Kettle Creek basin from the Alvin R. Bush Dam to the mouth of Kettle

Creek is a TSF. Tourism plays a large role in the local economy surrounding the Kettle Creek Watershed. Hunting and fishing camps are widespread and receive members from all around Pennsylvania and several other states. Upper Kettle Creek is a world-renowned trout fishery. The DCNR also runs a public ATV trail in the Huling Branch Watershed and Kettle Creek State Park hosts a campground facility which receives many visitors each year. Agriculture and the lumber industry are also present in the watershed.

Coal mining has been a major industry in the watershed since 1874. The Kettle Creek Coal Company founded the town of Bitumen in 1874 and operated six underground mines in the area until 1929. Historical records indicate that there were 16 underground mines in the area surrounding the Lower Kettle Creek Watershed (PADEP BAMR, 2000). The last underground mine closed in the late 1950's. The historical records do not accurately indicate the location or extent of the underground mining. Most of the operations were up-dip mines on the Lower Kittanning coal seam and utilized the room and pillar method of extraction. As a result of the mining practices, many of the drift openings continue to allow free drainage of water polluted with AMD from the abandoned mines. In the 1930's, many of the deep mine entries were sealed through efforts of the Works Project Administration (WPA). Many of the seals were destroyed by later strip mining operations; however, the surviving seals in the western portion of the study area remain functional today (Hedin Environmental, 2000). The Pennsylvanaia Fish and Boat Commission (PFBC) surveyed Kettle Creek in 1933 and indicated that AMD entered the stream near the mouth (Buller, 1932). Twomile Run, a tributary to Kettle Creek was also surveyed in 1932. The PFBC indicated that no pollution entered the stream at this time (Sorenson, 1932).

Surface mining in the Lower Kettle Creek Watershed began in the 1930's and continued until 1977. PADEP records indicate that ten permits in the watershed were issued, from 1960 to 1969, to two companies: D. G. Wertz Coal Company and the Kettle Creek Corporation. The permits were issued to mine the Lower and Middle Kittanning coal seams (PADEP BAMR, 2000). Richmont Coal Company permitted large tracts of land for surface mining in the 1970's; however, not all of the land was mined (PADEP, 2001). PADEP does not have records for the surface mining that occurred before 1960. Both the western and eastern sides of Kettle Creek were extensively surface mined. Upper Kittanning reserves in portions of the watershed were completely exhausted (Hedin Environmental, 2000). Reclamation to pre-act standards was completed on the surface mined sites; no open pits or exposed highwalls exist, but most sites contain unreclaimed spoils that follow the coal crop line or encircle the abandoned deep mine workings. Surface mining in the watershed further exacerbated AMD formation in the watershed by increasing the infiltration of water into the deep mine workings.

PADEP BAMR has identified five problem areas encompassing approximately 908 acres in the western portion of the Lower Kettle Creek Watershed, as of August 10, 2000. At least two other problem areas exist in the Twomile Run sub-watershed. Disturbed land (abandoned coal mines, quarries, etc.) make up approximately 2.7 percent of the study area. Forested land makes up 93.5 percent of the study area. Grasslands, categorized as agriculture, make up 2.4 percent of the land use in the study area. The watershed is thinly populated, with a negligible percent of developed lands. The remaining 1.4 percent of land use in the study area is developed lands and water.

There are currently no active mining permits in the Kettle Creek Watershed (Table 2).

Table 2. Mining Permits in the Kettle Creek Watershed

Permit No.	NPDES No.	Effective Dates	Company Name	Status
none				

The mine drainage treatment facilities for the active permitted areas are assigned a waste load allocation (WLA). Discharge rate and frequency vary as a function of precipitation and runoff. The method to quantify the treatment facility discharges is explained in the *Method to Quantify Treatment Pond Pollution Load* section of this report.

It has been determined that effects from sedimentation ponds are negligible because their potential discharges are based on infrequent and temporary events and the ponds should rarely discharge if reclamation and revegetation is concurrent. In addition, sediment ponds are designed in accordance with PA Code Title 25 Chapter 87.108(h) to, at a minimum, contain runoff from a 10-year, 24-hour precipitation event.

Reclamation activities and watershed studies have been on-going in the Kettle Creek Watershed since the 1970's. Between 1970 and 1972, an Operation Scarlift investigation (SL-115) was conducted by Neilan Engineers on Kettle Creek. The Commonwealth was not satisfied with the final report and never officially accepted its finding or recommendations. The quality of the Operation Scarlift data is suspect; flow measurements were sparse and affected by Tropical Storm Agnes. Acidity and metal concentrations in the report appear to be erroneously high. In cases where direct comparisons are possible, Operation Scarlift acidity concentrations are five to ten times higher than permit data collected for the same points in the same time frame (Hedin Environmental, 2000).

The PFBC has performed several management studies in the Kettle Creek Watershed. In 1981, the stream was surveyed in its entirety to review the PFBC management policies. The report identified Twomile Run and Short Bend Run as contributors of AMD to Kettle Creek in its lower reaches (Hollender and others, 1983). The lower section of Kettle Creek, from the confluence of Owl Hollow to the mouth, was surveryed again in 1997. The water quality at the time of sampling was satisfactory; however, no insects were found below the confluence of Twomile Run (Hollender and others, 1998).

In 1995, PADEP BAMR initiated a sampling program in the Twomile Run Watershed and in 2001, the PADEP TMDL program completed the Twomile Run Watershed TMDL. The Middle Branch Treatment System was built by PADEP BAMR in the Twomile Run Watershed in 2000. The system is expected to restore 1.5 miles of Middle Branch (KCWA website, 2004). Operational improvements to the treatment system are currently being investigated to increase the treatment performance and longevity (Wolfe, 2004).

The Kettle Creek Watershed Association (KCWA) is an incorporated nonprofit organization that has been active in the protection and improvement of upper Kettle Creek and has taken a lead role in the restoration of lower Kettle Creek since 1997. The KCWA, Trout Unlimited, PADEP,

PADEP BAMR, PA Fish and Boat Commission, DCNR Bureau of Forestry, Natural Resources Conservation Service, Clinton County Conservation District, and local conservation groups and sportsmen clubs formed the KCWA AMD Committee in 1998 to pursue AMD restoration of the Lower Kettle Creek Watershed.

In 1998, Kettle Creek became Trout Unlimited's third Home Rivers Initiative. Trout Unlimited hired a full-time watershed coordinator to support the multi-year effort. The Home Rivers Initiative integrates scientific research, community outreach, on-the-ground restoration, and the development of long-term conservation management strategies to protect and improve the Kettle Creek Watershed. The Home Rivers Initiative has successfully risen funding and cooperation for varied projects in the watershed since its outset. Members of the KCWA and Twomile Run Gun Club initiated problem identification and field water chemistry sampling of the Kettle Creek Watershed in 1999 through 2000.

In 2000, PADEP BAMR performed a data collection on the AMD Discharges entering Kettle Creek from the west side of its drainage area. PADEP BAMR identified and sampled seven significant AMD discharges and nine tributary sites that convey AMD to Lower Kettle Creek. The tributaries include Slide Hollow, Short Bend Run, Duck Hollow, Butler Hollow, and an area known as the Beach. Slide Hollow is the first addition of AMD to Kettle Creek. Two major AMD discharges from abandoned deep mines enter this tributary. The pollution plume is very pronounced, though it hugs the west bank of Kettle Creek. The next addition of AMD is from Short Bend Run, which collects at least eight AMD discharges from the abandoned Bitumen mine complex on the west side of Kettle Creek. The Beach is an area of diffuse discharges between Slide Hollow and Duck Hollow, most likely fueled by three deep mine discharges along the western hillside. The Beach causes a distinct plume of iron and aluminum along the western bank of Kettle Creek downstream to the entrance of Duck Hollow. Duck Hollow is the last major contributor of AMD to Kettle Creek upstream of Twomile Run (PADEP BAMR, 2000).

The Lower Kettle Creek and Twomile Run Restoration Plan was completed by Hedin Environmental in 2000. The plan notes that the western side of Kettle Creek is stained orange from Short Bend Hollow downstream, but the center and eastern side of the stream is not visibly or biologically degraded until the confluence of Twomile Run. Twomile Run has a large flow of highly acidic water that significantly degrades Kettle Creek. The substrates in Kettle Creek become discolored by the metal precipitates and most invertebrates and fish are eliminated. The water quality in Kettle Creek shifts from net alkaline to neutral or net acidic (Hedin Environmental, 2000). The restoration activities in the plan are focused on the Twomile Run Watershed. Any reclamation work in Twomile Run would also benefit the water quality in Kettle Creek. Butler Hollow contributes the last AMD additions to Kettle Creek from the Bitumen deep mine complexes in the western ridge.

In February 2001, the KCWA was awarded Pennsylvania Growing Greener funds for the Twomile Run surface reclamation project and Robbins Hollow passive treatment system. The surface reclamation regraded and bio-capped 57 acres of the Robbins Hollow abandoned surface mine, a significant source of AMD to Twomile Run, and established a permanent vegetative cover. The project also placed drains to collect diffuse AMD seeps to further evaluate them for treatment at a later date (KCWA website, 2004). The Growing Greener funds were also earmarked to build a passive treatment system on a discharge in Robbins Hollow; however, further investigation by Hedin Environmental found discharges upstream of this site. The Growing Greener funding was re-directed to treat the four new-found discharges. Four treatment systems were built in 2004 to treat the headwaters of Robbins Hollow (Hedin Environmental website, 2004).

In 2001, the Huling Branch collection system and remediation plan was funded by the Pennsylvania Growing Greener Program. A geophysical study to locate AMD discharges was completed and a collection system was installed in 2003 to monitor the discharges (KCWA website, 2004). Hedin Environmental completed the *Huling Branch Mine Complex: Investigation of Acid Mine Drainage and Recommendations for Remediation* report in March 2004. The report recommends remining of the Huling Branch abandoned Tipple Site and to regrade the area with alkaline addition to reduce the AMD formation (Hedin Environmental, 2004). In August 2004, Hedin Environmental was asked to investigate the AMD problems in the west side of Huling Branch. A final report and reclamation options will be completed by late 2005 (Hedin Environmental website, 2004).

With funding provided by the Pennsylvania Growing Greener Program, Trout Unlimited partnered with the U. S. Department of Energy National Energy Technology Laboratory to conduct an airborne remote sensing and geophysical survey of the Lower Kettle Creek Watershed in 2002. The survey used a combination of thermal infrared imagery and helicopter-mounted electromagnetic surveys to locate abandoned deep mine pools, recharge zones for mine pools, contaminated groundwater discharge points, and areas of acid-generating mine spoils. The survey identified 53 AMD discharges, 27 of which were previously unknown. The survey also identified twelve mine pools, groundwater recharge zones, and acid-generating spoils in a short amount of time (Wolfe, 2004). Trout Unlimited and the KCWA are looking at a variety of reclamation methods, including remining and in-situ treatment of deep mine pools, to improve the water quality in Lower Kettle Creek.

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 nonpoint sources, as well as those where there are both point and nonpoint sources. The following defines what are considered point sources and nonpoint sources for the purposes of our evaluation; point sources are defined as permitted discharges or a discharge that has a responsible party, nonpoint sources are then any pollution sources that are not point sources. For situations where all of the impact is due to nonpoint sources, the equations shown below are applied using data for a point in the stream. The load allocation made at that point will be for all of the watershed area that is above that point. For situations where there are point source impacts alone, or in combination with nonpoint sources, the evaluation will use the point source data and perform a mass balance with the receiving water to determine the impact of the point source.

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:

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.

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

For pH TMDLs, acidity is compared to alkalinity. 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.

ACCOUNTING FOR UPSTREAM REDUCTIONS IN AMD TMDLS

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.

In the instance that the allowable load is equal to the measured load and the simulation determines that water quality standards are being met instream 99% of the time, 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. In addition, when all measured values are below the method detection limit, denoted by ND, no TMDL is necessary. In this case the accounting for upstream loads is not carried through to the next downstream point. Rather, there is a disconnect noted and the allowable load is considered to start over because the water quality standard is satisfied.

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.

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:

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, ttp://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 also can 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. The PADEP 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. PADEP 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 PADEP'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 waste load allocation 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 waste load allocation is available for a different operation. Where there are indications that future mining in a watershed is greater than the current level of mining activity, an additional waste load allocation 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 comparison between observed instream conditions and conditions that are expected to restore designated uses. The endpoint is based on either the narrative or numeric criteria available in water quality standards.

Because of the nature of the pollution sources in the watershed, the TMDLs component makeup will be load allocations that are specified above a point in the stream segment. All allocations will be specified as long-term average daily concentrations. These long-term average daily concentrations are expected to meet water quality criteria 99 percent of the time. Pennsylvania Title 25 Chapter 96.3(c) specifies that the water quality standards must be met 99 percent of the time. The iron TMDLs are expressed as total recoverable as the iron data used for this analysis was reported as total recoverable. Table 3 shows the water quality criteria for the selected parameters.

Table 3. Applicable Water Quality Criteria

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

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

TMDL ELEMENTS (WLA, LA, MOS)

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

TMDL ALLOCATIONS SUMMARY

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

Table 4. Correlation Between Metals and Flow for Selected Points

Point Identification	Flow vs.			Number of Samples
	Iron	Manganese	Aluminum	
KC6	0.1724	0.0282	*	10, 10
KC1	0.0022	0.0122	2×10^{-6}	92, 96, 92

Methodology for dealing with metal and pH impairments is discussed in Attachment C. Information for the TMDL analysis using the methodology described above is contained in the "TMDLs by Segment" section in Attachment D.

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

Table 5. Summary Table–Kettle Creek Watershed

Station	Parameter	Existing Load (lbs/day)	TMDL Allowable Load (lbs/day)	WLA (lbs/day)	LA (lbs/day)	Load Reduction (lbs/day)	Percent Reduction %
KC6	*Kettle Creek at USGS gage*						
	Fe	265.3	265.3	0.0	265.3	0.0	0
	Mn	70.8	70.8	0.0	70.8	0.0	0
	Al	247.6	247.6	0.0	247.6	0.0	0
	Acidity	1,132.1	1,132.1	0.0	1,132.1	0.0	0
TM-1A*	*Two Mile Run at mouth*						
	Fe	234.2	18.7	0.0	18.7	215.5	92
	Mn	296.0	11.8	0.0	11.8	284.2	96
	Al	394.2	11.8	0.0	11.8	382.4	97
	Acidity	4,162.7	0.0	0.0	0.0	4,162.7	100
BH1	*Butler Hollow at mouth*						
	Fe	4.5	2.4	0.0	2.4	2.1	47
	Mn	45.1	1.4	0.0	1.4	43.7	97
	Al	40.2	1.2	0.0	1.2	39.0	97
	Acidity	323.7	0.0	0.0	0.0	323.7	100
KC1	*Kettle Creek at mouth*						
	Fe	278.5	278.5	1.1	277.4	0.0	0
	Mn	130.0	130.0	0.7	129.3	0.0	0
	Al	278.5	241.1	0.7	240.7	0.0	0
	Acidity	3,063.9	1,875.5	0.0	1,875.5	0.0	0

* = The data set and load allocation for TM-1A can be found in the Two Mile Run Watershed TMDL; February 26, 2001.

WLAs are being assigned to a future mining operation for iron, manganese, and aluminum. Acidity is narratively addressed to be exceeded by the alkalinity at all times, because a numeric standard was not included in the permit, no WLA is assigned for this parameter. All waste load allocations were calculated using the methodology explained previously in the *Method to Quantify Treatment Pond Pollutant Load* section of the report. The future waste load allocation is calculated using the pit area method to calculate flow and is assigned to the mouth of Kettle Creek; KC1. Table 6 contains the WLAs for the permitted operation.

Table 6. Waste load Allocation of Permitted Operations

Parameter	Allowable Average Monthly Conc. (mg/l)	Average Flow (MGD)	Allowable Load (lbs/day)
FUTURE			
Fe	3.0	0.0446	1.1
Mn	2.0	0.0446	0.7
Al	2.0	0.0446	0.7

RECOMMENDATIONS

Two primary programs in Pennsylvania that provide reasonable assurance for maintenance and improvements of water quality in the watershed are in effect. The PADEP'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 PADEP BAMR (which administers and oversees the Abandoned Mine Reclamation Program in Pennsylvania), the U. S. Office of Surface Mining, the National Mine Land Reclamation Center, the National Environmental Training Laboratory, and many other agencies and individuals. Funding from USEPA's 319 Grant program and Pennsylvania's Growing Greener program has been used extensively to remedy mine drainage impacts. These activities are expected to continue and result in water quality improvement.

The PADEP BAMR administers an environmental regulatory program for all mining activities, including mine subsidence regulation, mine subsidence insurance, and coal refuse disposal. PADEP BAMR also conducts a program to ensure safe underground bituminous mining and protect certain structures from subsidence; administers a mining license and permit program; administers a regulatory program for the use, storage, and handling of explosives; and provides for training, examination, and certification of applicant's blaster's licenses. In addition, PADEP BAMR administers a loan program for bonding anthracite underground mines and for mine subsidence, administers the USEPA Watershed Assessment Grant Program, the Small Operator's Assistance Program (SOAP), and the Remining Operator's Assistance Program (ROAP).

Reclaim PA is PADEP's initiative designed to maximize reclamation of the state's quarter million acres of abandoned mineral extraction lands. Abandoned mineral extraction lands in Pennsylvania constitute a significant public liability - more than 250,000 acres of abandoned surface mines, 2,400 miles of stream polluted with AMD, 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.

Since the 1960s, Pennsylvania has been a national leader in establishing laws and regulations to ensure mine reclamation and well plugging occur after active operation is completed. 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 PADEP's Brownfields Program. Pennsylvania is striving for complete reclamation of its abandoned mines and plugging of its orphan wells. Realizing this task is no small order, PADEP has developed Reclaim PA, a collection of concepts to make abandoned mine reclamation easier. These concepts include legislative, policy, and land management initiatives designed to enhance mine operator/volunteer/PADEP 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.

In 1995, PADEP BAMR initiated a sampling program in the Twomile Run Watershed and in 2001; the PADEP TMDL program completed its TMDL. The Middle Branch Treatment System was built by PADEP BAMR in the Twomile Run Watershed in 2000. The system is expected to restore 1.5 miles of Middle Branch (KCWA website, 2004). Operational improvements to the treatment system are currently being investigated to increase its treatment performance and longevity (Wolfe, 2004).

The Kettle Creek Watershed Association (KCWA) is an incorporated nonprofit organization that has been active in the protection and improvement of upper Kettle Creek and has taken a lead role in the restoration of lower Kettle Creek since 1997. The KCWA, Trout Unlimited, PADEP, PADEP BAMR, PA Fish and Boat Commission, DCNR Bureau of Forestry, the federal Natural Resources Conservation Service, Clinton County Conservation District, and local conservation groups and sportsmen clubs formed the KCWA AMD Committee in 1998 to pursue AMD restoration of the Lower Kettle Creek Watershed.

In 1998, Kettle Creek became Trout Unlimited's third Home Rivers Initiative. Trout Unlimited hired a full-time watershed coordinator to support the multi-year effort. The Home Rivers Initiative will integrate scientific research, community outreach, on-the-ground restoration, and the development of long-term conservation management strategies to protect and improve the Kettle Creek Watershed. The Home Rivers Initiative has successfully risen funding and cooperation for varied projects in the watershed since its outset. Members of the KCWA and Twomile Run Gun Club initiated problem identification and field water chemistry sampling of the Kettle Creek Watershed in 1999 through 2000.

In 2000, PADEP BAMR performed a data collection on the AMD Discharges entering Kettle Creek from the west side of its drainage area. PADEP BAMR identified and sampled seven significant AMD discharges and nine tributary sites that convey AMD to Lower Kettle Creek. The tributaries include Slide Hollow, Short Bend Run, Duck Hollow, Butler Hollow, and an area known as the Beach. The Lower Kettle Creek and Twomile Run Restoration Plan was completed by Hedin Environmental in 2000. The plan focuses on restoration activities in the Twomile Run Watershed, which will in turn improve the water quality in Lower Kettle Creek.

In February 2001, the KCWA was awarded Pennsylvania Growing Greener funds for the Twomile Run surface reclamation project and Robbins Hollow passive treatment system. The surface reclamation regraded and bio-capped 57 acres of the Robbins Hollow abandoned surface mine, a significant source of AMD to Twomile Run, and established a permanent vegetative cover. The project also placed drains to collect diffuse AMD seeps to further evaluate them for treatment at a later date (KCWA website, 2004). The Growing Greener funds were also earmarked to build a passive treatment system on a discharge in Robbins Hollow; however, further investigation by Hedin Environmental found discharges upstream of this site. The Growing Greener funding was re-directed to treat the four new-found discharges. Four treatment systems were built in 2004 to treat the headwaters of Robbins Hollow (Hedin Environmental website, 2004).

In 2001, the Huling Branch collection system and remediation plan was funded by the Pennsylvania Growing Greener Program. A geophysical study to locate AMD discharges was completed and a collection system was installed in 2003 to monitor the discharges (KCWA website, 2004). Hedin Environmental completed the *Huling Branch Mine Complex: Investigation of Acid Mine Drainage and Recommendations for Remediation* report in March 2004. The report recommends remining of the Huling Branch abandoned Tipple Site and to regrade the area with alkaline addition to reduce the AMD formation (Hedin Environmental, 2004). In August 2004, Hedin Environmental was asked to investigate the AMD problems in the west side of Huling Branch. A final report and reclamation options will be completed by late 2005 (Hedin Environmental website, 2004).

With funding provided by the Pennsylvania Growing Greener Program, Trout Unlimited partnered with the U. S. Department of Energy National Energy Technology Laboratory to conduct an airborne remote sensing and geophysical survey of the Lower Kettle Creek Watershed in 2002. The survey used a combination of thermal infrared imagery and helicopter-mounted electromagnetic surveys to locate abandoned deep mine pools, recharge zones for mine pools, contaminated groundwater discharge points, and areas of acid-generating mine spoils. The survey identified 53 AMD discharges, 27 of which were previously unknown. The survey also identified twelve mine pools, groundwater recharge zones, and acid-generating spoils in a short amount of time (Wolfe, 2004). Trout Unlimited and the KCWA are looking at a variety of reclamation methods, including remining and in-situ treatment of deep mine pools, to improve the water quality in Lower Kettle Creek.

PUBLIC PARTICIPATION

Public notice of the draft TMDL was published in the *Pennsylvania Bulletin* on DATE, and the LOCAL NEWSPAPER on DATE, to foster public comment on the allowable loads calculated. A public meeting was held on March 15, 2005 at 7pm, at the Leidy Township Municipal Building, to discuss the proposed TMDL.

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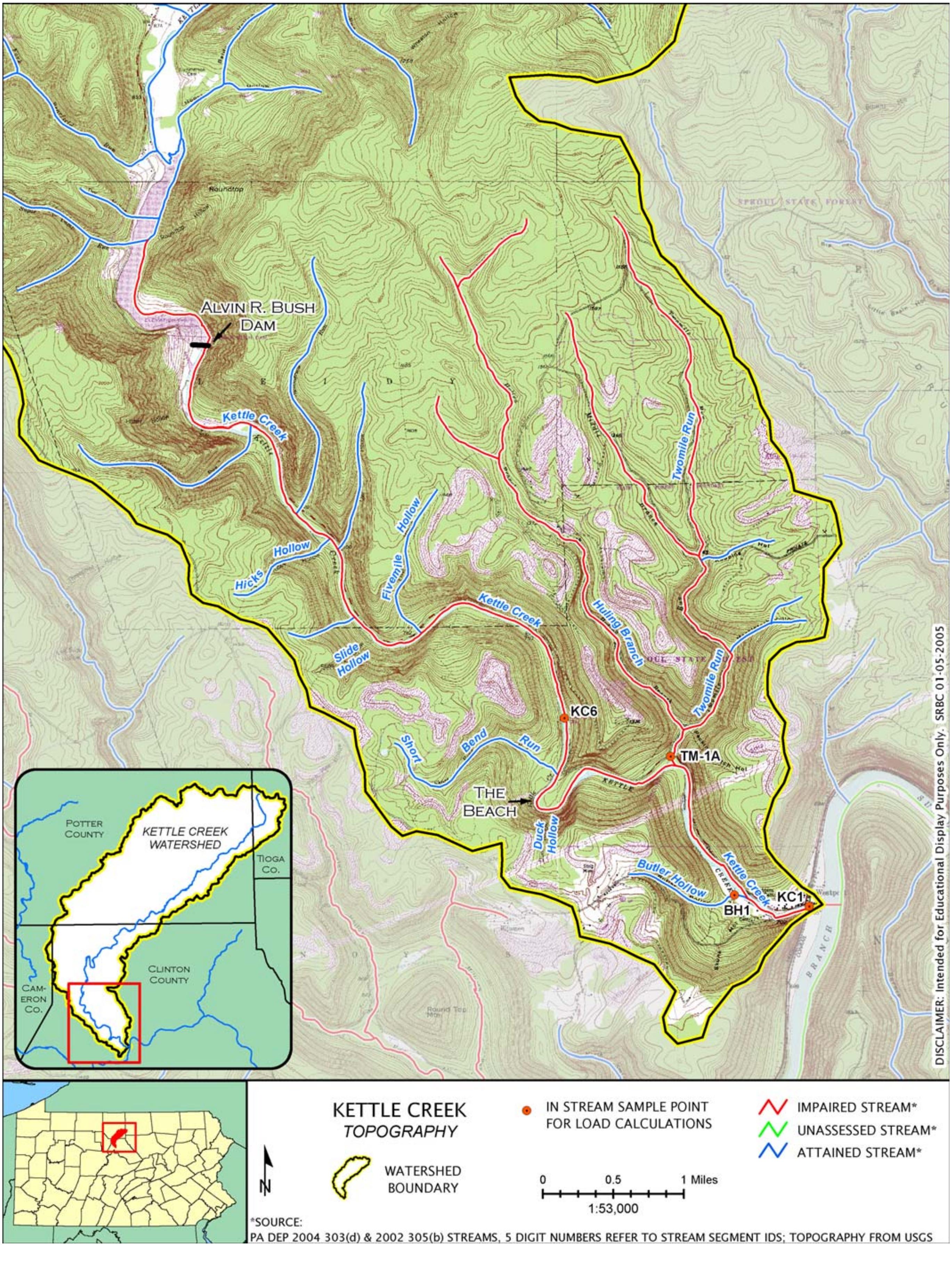
Attachment A

Kettle Creek Watershed Map



ALVIN R. BUSH DAM
Kettle Creek
Hicks Hollow
Fivemile Hollow
Slide Hollow
Huling Branch
Twomile Run
KC6
TM-1A
Short Bend Run
THE BEACH
Duck Hollow
Butler Hollow
BH1
KC1
POTTER COUNTY
KETTLE CREEK WATERSHED
TIOGA CO.
CLINTON COUNTY
CAMERON CO.
KETTLE CREEK
TOPOGRAPHY
WATERSHED BOUNDARY
IN STREAM SAMPLE POINT FOR LOAD CALCULATIONS
IMPAIRED STREAM*
UNASSESSED STREAM*
ATTAINED STREAM*
0 0.5 1 Miles
1:53,000
N
*SOURCE:
PA DEP 2004 303(d) & 2002 305(b) STREAMS, 5 DIGIT NUMBERS REFER TO STREAM SEGMENT IDS; TOPOGRAPHY FROM USGS
DISCLAIMER: Intended for Educational Display Purposes Only. SRBC 01-05-2005

Attachment B

Excerpts Justifying Changes Between the 1996, 1998, Draft 2000, and 2002 Section 303(d) Lists and the 2004 Integrated List

The following are excerpts from the Pennsylvania DEP 303(d) narratives that justify changes in listings between the 1996, 1998, draft 2000, 2002, and 2004 lists. The 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 USEPA 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).

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

In 2004, Pennsylvania developed the Integrated List of All Waters. The water quality status of Pennsylvania's waters is summarized using a five-part categorization of waters according to their water quality standard (WQS) attainment status. The categories represent varying levels of WQS attainment, ranging from Category 1, where all designated water uses are met, to Category 5, where impairment by pollutants requires a TMDL to correct. These category determinations are based on consideration of data and information consistent with the methods outlined by the Statewide Surface Water Assessment Program. Each PADEP five-digit waterbody segment is placed in one of the WQS attainment categories. Different segments of the same stream may appear on more than one list if the attainment status changes as the water flows downstream. The listing categories are as follows:

Category 1: Waters attaining all designated uses.

Category 2: Waters where some, but not all, designated uses are met. Attainment status of the remaining designated uses is unknown because data are insufficient to categorize a water consistent with the state's listing methodology.

Category 3: Waters for which there are insufficient or no data and information to determine, consistent with the state's listing methodology, if designated uses are met.

Category 4: Waters impaired for one or more designated use but not needing a TMDL. States may place these waters in one of the following three subcategories:

- TMDL has been completed.
- Expected to meet all designated uses within a reasonable timeframe.
- Not impaired by a pollutant.

Category 5: Waters impaired for one or more designated uses by any pollutant. Category 5 includes waters shown to be impaired as the result of biological assessments used to evaluate aquatic life use even if the specific pollutant is not known unless the state can demonstrate that nonpollutant stressors cause the impairment or that no pollutant(s) causes or contribute to the impairment. Category 5 constitutes the Section 303(d) list that USEPA will approve or disapprove under the Clean Water Act. Where more than one pollutant is causing the impairment, the water remains in Category 5 until all pollutants are addressed in a completed USEPA-approved TMDL or one of the delisting factors is satisfied.

Attachment C

Method for Addressing 303(d) Listings for pH

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

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

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

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

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

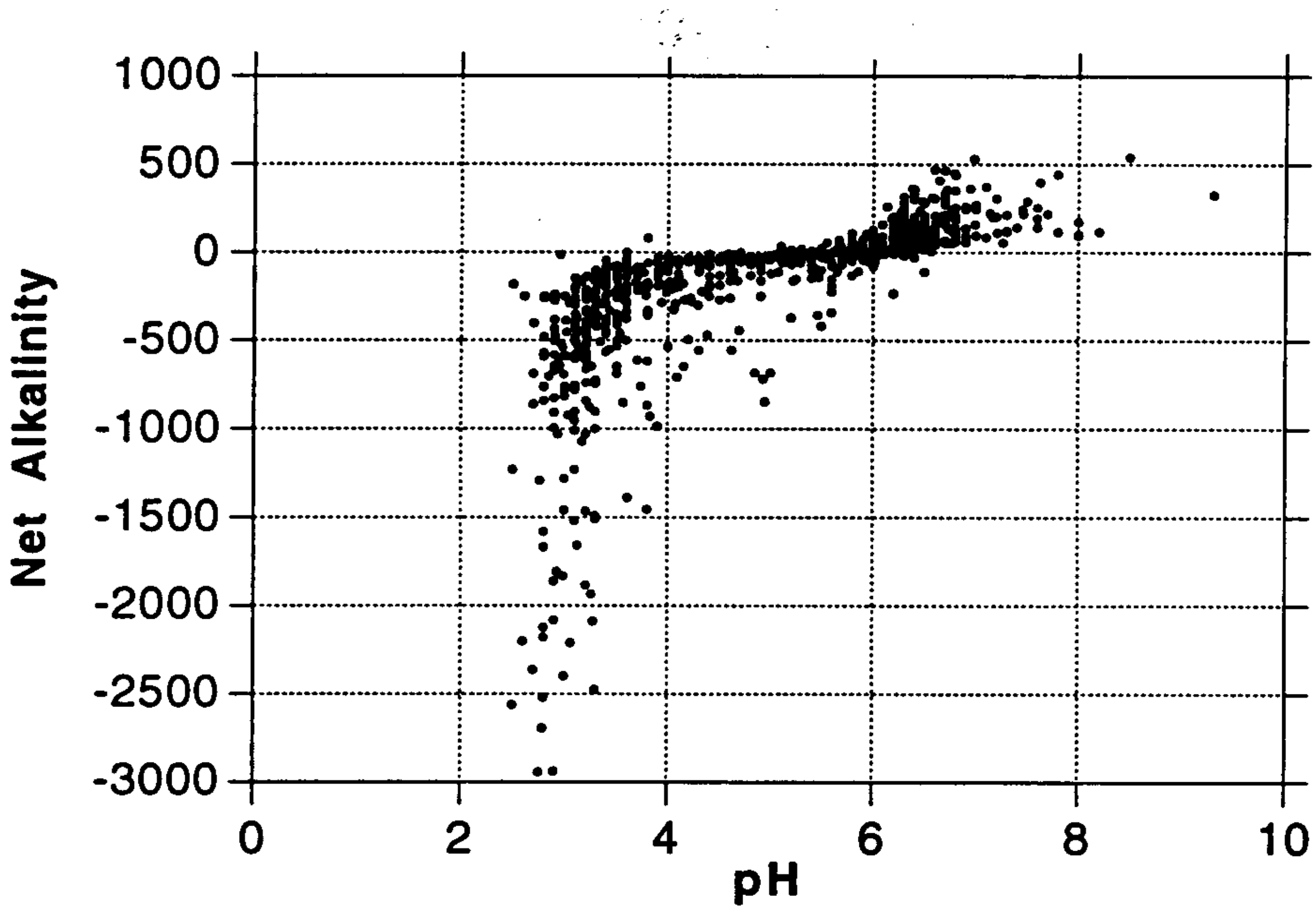


Figure 1. Net Alkalinity vs. pH. Taken from Figure 1.2 Graph C, pages 1-5, of Coal Mine Drainage Prediction and Pollution Prevention in Pennsylvania.

Attachment D
TMDLs By Segment

Kettle Creek

The TMDL for the Kettle Creek Watershed consists of load allocations to two tributaries, Twomile Run and Butler Hollow, and sampling stations at the USGS gage above Twomile Run and at the mouth of Kettle Creek. Waste load allocations (WLAs) are assigned for a future mining operation.

The Twomile Run TMDL document was completed on February 26, 2001 and was approved by the USEPA. Twomile Run is a tributary to Kettle Creek, entering the stream approximately 2.5 miles before the mouth of Kettle Creek. The TMDLs completed for Twomile Run at its mouth are included in this document and are used to account for the upstream reductions at the mouth of Kettle Creek. The data and calculations for Twomile Run are found in the Twomile Run Watershed TMDL document and are not included in this report.

The Kettle Creek Watershed is listed as impaired on the Section 303(d) list by both high metals and low pH from AMD as the cause of the degradation to the stream. For pH, the objective is to reduce acid loading to the stream that will in turn raise the pH to the acceptable range. The result of this analysis is an acid loading reduction that equates to meeting standards for pH (see TMDL Endpoint section in the report, Table 2). The method and rationale for addressing pH is contained in Attachment C.

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

KC6: Kettle Creek at the USGS Gage

Kettle Creek at allocation point KC6 represents the stream after the Alvin R. Bush Dam. AMD from Slide Hollow has entered upstream of this point, but the pollution hugs the western bank and does not mix into the rest of the stream column. The USGS maintains a stream gaging site on Kettle Creek at this location.

The TMDL for this section of Kettle Creek consists of a load allocation to the watershed area above KC6. Addressing the mining impacts above this point addresses the impairment for the stream segment. An average instream flow measurement was available for point KC6 (212.09 mgd). The load allocations made at point KC6 for this stream segment are presented in Table D1.

Table D1. TMDL Calculations at Point KC6				
Flow = 212.09 MGD	***Measured Sample Data***		***Allowable***	
Parameter	***Conc. (mg/l)***	***Load (lbs/day)***	***LTA Conc. (mg/l)***	***Load (lbs/day)***
Fe	0.15	265.3	0.15	265.3
Mn	0.04	70.8	0.04	70.8
Al	0.14	247.6	0.14	247.6
Acidity	0.64	1,132.1	0.64	1,132.1
Alkalinity	11.36	20,093.9		

Table D2. Calculation of Load Reduction Necessary at Point KC6				
	Fe (lbs/day)	***Mn (lbs/day)***	***Al (lbs/day)***	***Acidity (lbs/day)***
Existing load	265.3	70.8	247.6	1,132.1
Existing load from upstream points (none)	0.0	0.0	0.0	0.0
Difference of existing load and upstream existing load	265.3	70.8	247.6	1,132.1
Allowable loads from upstream points	*	*	*	*
Total load at KC6	265.3	70.8	247.6	1,132.1
Allowable load at KC6	265.3	70.8	247.6	1,132.1
Waste load allocation	0.0	0.0	0.0	0.0
Remaining load at KC6	265.3	70.8	247.6	1,132.1
Load Reduction at KC6 (Total load at KC6 - Allowable load at KC6)	0.0	0.0	0.0	0.0
Percent reduction required at KC6	0	0	0	0

The TMDL for point KC6 does not require a load allocation for total iron, total manganese, total aluminum, and acidity.

TM-1A: Twomile Run at its mouth

Twomile Run enters Kettle Creek approximately 2.5 miles from its mouth and is highly polluted by AMD. Kettle Creek cannot maintain a fishery after the confluence of Twomile Run. The TMDLs assigned in Tables D3 and D4 are based on the data and calculations found in the Twomile Run Watershed TMDL completed by PADEP and approved by the USEPA in February 2001.

The TMDL for Twomile Run consists of a load allocation to the watershed area aboveTM-1A. Addressing the mining impacts above this point addresses the impairment for the stream segment. An average instream flow measurement was available for point TM-1A (5.51 mgd). The load allocations made at point TM-1A for this stream segment are presented in Table D3.

Table D3. TMDL Calculations at Point TM-1A				
Flow = 5.51 MGD	***Measured Sample Data***		***Allowable***	
Parameter	***Conc. (mg/l)***	***Load (lbs/day)***	***LTA Conc. (mg/l)***	***Load (lbs/day)***
Fe	5.09	234.2	0.41	18.7
Mn	6.44	296.0	0.26	11.8
Al	8.57	394.2	0.26	11.8
Acidity	90.50	4,162.7	0.00	0.0
Alkalinity	0.00	0.0		

Table D4. Calculation of Load Reduction Necessary at Point TM-1A				
	Fe (lbs/day)	***Mn (lbs/day)***	***Al (lbs/day)***	***Acidity (lbs/day)***
Existing load	234.2	296.0	394.2	4,162.7
Existing load from upstream points (none)	0.0	0.0	0.0	0.0
Difference of existing load and upstream existing load	234.2	296.0	394.2	4,162.7
Allowable loads from upstream points	*	*	*	*
Total load at TM-1A	234.2	296.0	394.2	4,162.7
Allowable load at TM-1A	18.7	11.8	11.8	0.0
Waste load allocation	0.0	0.0	0.0	0.0
Remaining load at TM-1A	18.7	11.8	11.8	0.0
Load Reduction at TM-1A (Total load at TM-1A - Allowable load at TM-1A)	215.5	284.2	382.4	4,162.7
Percent reduction required at TM-1A	92	96	97	100

The TMDL for point TM-1A requires a load allocation for total iron, total manganese, total aluminum, and acidity.

BH1: Butler Hollow at its mouth

Butler Hollow begins on the western hillside of the Kettle Creek watershed near the village of Bitumen. The stream flows southeast through the strip and deep mined sections on the western hillside and joins with Kettle Creek approximately one half mile upstream of the mouth of Kettle Creek. Butler Hollow is highly polluted by AMD discharges from the Bitumen deep mine complex.

The TMDL for Butler Hollow at point BH1 consists of a load allocation to the watershed area above point BH1. Addressing the mining impacts above this point addresses the impairment for the segment. An instream flow measurement was available for point BH1 (0.32 mgd). The load allocations made at point BH1 for this stream segment are presented in Table D5.

Table D5. TMDL Calculations at Point BH1				
Flow = 0.32 MGD	***Measured Sample Data***		***Allowable***	
Parameter	***Conc. (mg/l)***	***Load (lbs/day)***	***LTA Conc. (mg/l)***	***Load (lbs/day)***
Fe	1.68	4.5	0.91	2.4
Mn	16.90	45.1	0.51	1.4
Al	15.05	40.2	0.45	1.2
Acidity	121.28	323.7	0.00	0.0
Alkalinity	0.00	0.0		

Table D6. Calculation of Load Reduction Necessary at Point BH1				
	Fe (lbs/day)	***Mn (lbs/day)***	***Al (lbs/day)***	***Acidity (lbs/day)***
Existing load	4.5	45.1	40.2	323.7
Existing load from upstream points (none)	0.0	0.0	0.0	0.0
Difference of existing load and upstream existing load	4.5	45.1	40.2	323.7
Allowable loads from upstream points	*	*	*	*
Total load at BH1	4.5	45.1	40.2	323.7
Allowable load at BH1	2.4	1.4	1.2	0.0
Waste load allocation	0.0	0.0	0.0	0.0
Remaining load at BH1	2.4	1.4	1.2	0.0
Load Reduction at BH1 (Total load at BH1 - Allowable load at BH1)	2.1	43.7	39.0	323.7
Percent reduction required at BH1	47	97	97	100

The TMDL for point BH1 requires a load allocation for total iron, total manganese, total aluminum, and acidity.

Future Waste Load Allocation

A future waste load allocation is being included in the Kettle Creek TMDL to allow for possible future coal mining permits in the watershed. Any discharge from the operations treatment system will be treated to the Best Available Technology (BAT) limits, assigned in the mining permit, before entering Kettle Creek.

The future waste load allocation is considered to be a point source discharge in the watershed; therefore, the allocation made at this point is a waste load allocation (WLA). The WLAs for iron, manganese, and aluminum were calculated using the methodology explained in the *Method to Quantify Treatment Pond Pollutant Load* section of this report. Table D7 shows the waste load allocations for a future permitted operation.

Table D7. Waste load Allocations For Future Mining Permit			
Parameter	***Monthly Avg. Allowable Conc. (mg/l)***	***Average Flow (MGD)***	***Allowable Load (lbs/day)***
FUTURE			
Fe	3.0	0.0446	1.1
Mn	2.0	0.0446	0.7
Al	2.0	0.0446	0.7

KC1: Kettle Creek at its mouth

Kettle Creek drains into the West Branch Susquehanna River at the village of Westport, Clinton County, Pennsylvania. Point KC1 represents Kettle Creek at its mouth. AMD enters Kettle Creek between KC6 and KC1 from Short Bend Run, the Beach, Duck Hollow, Twomile Run and Butler Hollow.

The TMDL for this section of Kettle Creek consists of a load allocation to all of the watershed area between points KC1 and KC6. Addressing the mining impacts between these points addresses the impairment for the segment. An instream flow measurement was available for point KC1 (222.65 mgd). The load allocations made at point KC1 for this stream segment are presented in Table D8.

Table D8. TMDL Calculations at Point KC1				
Flow = 222.65 MGD	***Measured Sample Data***		***Allowable***	
Parameter	***Conc. (mg/l)***	***Load (lbs/day)***	***LTA Conc. (mg/l)***	***Load (lbs/day)***
Fe	0.15	278.5	0.15	278.5
Mn	0.07	130.0	0.07	130.0
Al	0.15	278.5	0.13	241.4
Acidity	1.65	3,063.9	1.01	1,875.5
Alkalinity	11.17	20,741.6		

The calculated load reductions for all the loads that enter point KC1 must be accounted for in the calculated reductions at sample point KC1, shown in Table D9. A comparison of measured loads between points KC1, KC6, TM-1A and BH1 shows that the loading for the parameters has decreased in the segment.

Table D9. Calculation of Load Reduction Necessary at Point KC1				
	Fe (lbs/day)	***Mn (lbs/day)***	***Al (lbs/day)***	***Acidity (lbs/day)***
Existing load	278.5	130.0	278.5	3,063.9
Existing load from upstream points (KC6, TM-1A, and BH1)	504.0	411.9	682.0	5,618.5
Difference of existing load and upstream existing load	-225.5	-281.9	-403.5	-2,554.6
Allowable loads from upstream points	286.4	84.0	260.6	1,132.1
Percent load loss due to instream process	45	68	59	45
Percent load remaining at KC1	55	32	41	55
Total load at KC1	157.5	26.9	106.8	622.7
Allowable load at KC1	278.5	130.0	241.4	1,875.5
Waste load allocation (FUTURE)	1.1	0.7	0.7	0.0
Remaining load at KC1	277.4	129.3	240.7	1,875.5
Load Reduction at KC1 (Total load at KC1 – (Allowable load at KC1 – FUTURE))	0.0	0.0	0.0	0.0
Percent reduction required at KC1	0	0	0	0

The TMDL for Kettle Creek at KC1 does not require a load reduction for total iron, total manganese, total aluminum, and acidity. All necessary reductions have been made upstream of this point.

Margin of Safety (MOS)

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

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

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

- The method used to calculate a flow for a WLA using the area of the pit and ungraded portions of an active mine is conservative and an implicit MOS.

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 E

Water Quality Data Used
In TMDL Calculations

Data Source	Site	Date	Flow mgd	pH (lab)	TFe mg/L	TMn mg/L	TAl mg/L	Acid mg/L	Alk mg/L	TSO4 mg/L
KC1: Kettle Creek at mouth										
PADEP	WQN434	1/10/1990	229.03	6.6	0.142	0.083	0.135	0	10	19
PADEP	WQN434	2/7/1990	584.52	6.4	0.113	0.033	0.135	4	6	17
PADEP	WQN434	3/14/1990	312.26	6.7	0.133	0.035	0.178	*	8	21
PADEP	WQN434	4/17/1990	354.19	6.4	0.173	0.031	0.149	*	7	21
PADEP	WQN434	5/8/1990	157.42	6.3	0.119	0.043	0.135	0	10	23
PADEP	WQN434	6/6/1990	123.23	6.7	0.166	0.042	0.237	0	11	21
PADEP	WQN434	7/11/1990	58.71	6.8	0.129	0.04	0.135	0	13	21
PADEP	WQN434	8/22/1990	50.32	6.7	0.218	0.089	0.148	0	13	24
PADEP	WQN434	9/11/1990	216.13	7	0.099	0.032	0.103	0	10	16
PADEP	WQN434	10/17/1990	543.23	6.8	0.141	0.064	0.176	0	9	21
PADEP	WQN434	11/7/1990	141.29	6.4	0.123	0.047	0.135	10	10	23
PADEP	WQN434	12/10/1990	310.97	6.2	0.0102	0.04	0.135	0	8	20
PADEP	WQN434	1/8/1991	209.68	6.5	0.164	0.049	0.135	0	7	15
PADEP	WQN434	2/4/1991	114.84	6.2	0.122	0.06	0.168	2	9	20
PADEP	WQN434	3/4/1991	208.39	6.7	1.83	0.066	1.92	0	6	22
PADEP	WQN434	4/2/1991	276.77	6.8	0.195	0.042	0.231	0	8	23
PADEP	WQN434	5/6/1991	160	6.7	0.191	0.0779	0.139	0	9	12.9
PADEP	WQN434	6/3/1991	36.13	6.8	0.07	0.0375	0.111	0	12	13.2
PADEP	WQN434	7/1/1991	*	7.1	0.073	0.0166	0.126	0	12	19.7
PADEP	WQN434	8/5/1991	*	8.4	0.07	0.0213	0.157	0	15	16.7
PADEP	WQN434	9/4/1991	*	7	0.064	0.0382	0.0498	0	20	17.2
PADEP	WQN434	10/2/1991	*	7	0.032	0.0498	0.117	0	14	21.7
PADEP	WQN434	11/4/1991	*	6.7	0.045	0.283	0.137	0	15	27.3
PADEP	WQN434	12/9/1991	88.39	7.1	0.256	0.0577	0.166	0	14	12.4
PADEP	WQN434	1/9/1992	150.32	6.7	0.061	0.0417	0.101	0	9	10.9
PADEP	WQN434	2/3/1992	98.06	6.8	0.177	0.0493	0.109	0	8	11.3
PADEP	WQN434	3/9/1992	491.61	6.3	0.105	0.0383	0.104	0	10	11.1
PADEP	WQN434	4/1/1992	572.9	6.6	0.096	0.0314	0.0838	0	7	10.4
PADEP	WQN434	5/11/1992	146.45	6.7	0.069	0.06489	0.09848	0	11	12
PADEP	WQN434	6/18/1992	46.45	6.2	0.11	0.0369	0.0826	0	14	12.4
PADEP	WQN434	7/21/1992	709.68	6.6	0.115	0.0276	0.106	0	9	10.2
PADEP	WQN434	8/13/1992	160.65	6.8	0.115	0.0276	0.0735	0	11	10.5
PADEP	WQN434	9/2/1992	298.71	6.7	0.122	0.0193	0.0592	0	11	9.9
PADEP	WQN434	10/7/1992	121.29	6	0.0775	0.0233	0.0761	0.4	11	9.9

Data Source	Site	Date	Flow mgd	pH (lab)	TFe mg/L	TMn mg/L	TAl mg/L	Acid mg/L	Alk mg/L	TSO4 mg/L
PADEP	WQN434	11/12/1992	300	7	0.073	0.0591	0.0889	0	10	12.3
PADEP	WQN434	12/2/1992	282.58	6.7	0.071	0.0625	0.0938	0	8	12.5
PADEP	WQN434	1/6/1993	1180.65	6.4	0.199	0.0254	0.173	2.4	9	9.9
PADEP	WQN434	2/11/1993	101.29	6.5	0.115	0.0809	0.1335	0	9	14
PADEP	WQN434	3/3/1993	72.9	6.5	0.224	0.0893	0.264	0	9	14.4
PADEP	WQN434	4/2/1993	767.74	6.5	0.124	0.0637	0.154	0	7	11.9
PADEP	WQN434	5/13/1993	196.77	8.3	0.12	0.0491	0.137	0	8	12
PADEP	WQN434	6/16/1993	25.81	6.5	0.104	0.0512	0.141	0	15	15.3
PADEP	WQN434	7/6/1993	38.71	6.8	0.212	0.0488	0.171	0	15	12.8
PADEP	WQN434	8/5/1993	19.35	6.4	0.349	0.0368	0.144	0	18	15.9
PADEP	WQN434	9/14/1993	36.77	6.8	0.314	0.0217	0.0816	0	15	12.1
PADEP	WQN434	10/13/1993	61.29	6.7	0.135	0.0238	0.0711	0	11.2	9.5
PADEP	WQN434	11/9/1993	336.77	6.4	0.08	0.025	0.055	0	8.8	10.1
PADEP	WQN434	12/8/1993	516.77	6.3	0.121	0.0548	0.101	8.6	7.4	11.6
PADEP	WQN434	1/13/1994	70.97	6.2	0.144	0.0956	0.122	5.4	8.8	13.2
PADEP	WQN434	2/10/1994	90.32	6.1	0.097	0.203	0.263	0	7.4	16.1
PADEP	WQN434	3/23/1994	1135.48	6.1	0.517	0.047	0.222	4.4	7.4	10.2
PADEP	WQN434	4/19/1994	508.39	6.4	0.275	0.0598	0.109	2.6	7.4	11.1
PADEP	WQN434	5/18/1994	139.35	6.3	0.173	0.0678	0.12	11.2	9.6	11.4
PADEP	WQN434	6/9/1994	69.68	6.5	0.106	0.0622	0.107	0	12.2	12.4
PADEP	WQN434	7/13/1994	93.55	6.2	0.152	0.0311	0.0921	0	13.4	9.8
PADEP	WQN434	8/4/1994	131.61	6.4	0.133	0.0963	0.119	0	11.4	13.8
PADEP	WQN434	9/19/1994	67.74	6.7	0.046	0.0416	0.115	0	12.8	12.1
PADEP	WQN434	10/18/1994	28.39	6.5	0.111	0.0455	0.114	0	14.4	14.4
PADEP	WQN434	11/8/1994	49.03	6.8	0.097	0.0636	0.0894	0	15.4	12.6
PADEP	WQN434	12/8/1994	877.42	6.6	0.127	0.0533	0.12	0	7.8	10.9
PADEP	WQN434	1/11/1995	77.42	6.4	0.095	0.0692	0.105	0	10.4	13.5
PADEP	WQN434	2/8/1995	103.23	6.4	0.111	0.0676	0.118	0	8.6	13.4
PADEP	WQN434	3/9/1995	569.68	6.4	0.153	0.051	0.109	2.8	8.4	9.8
PADEP	WQN434	4/12/1995	703.23	7.2	0.08	0.042	0.073	3.6	7.2	11.3
PADEP	WQN434	5/11/1995	116.13	6.4	0.232	0.0902	0.1435	40	10.4	12.6
PADEP	WQN434	6/8/1995	105.16	6.7	0.148	0.0601	0.0974	0	11.6	12.2
PADEP	WQN434	7/11/1995	49.68	6.8	0.126	0.0337	0.1014	0	14	12.2
PADEP	WQN434	8/8/1995	31.61	7.2	0.136	0.0258	0.1034	0	17.8	11.2
PADEP	WQN434	9/13/1995	12.26	6.9	0.047	0.0195	0.0684	0	16.6	21
PADEP	WQN434	10/17/1995	38.71	6.4	0.161	0.0583	0.104	4	16.4	12.3
PADEP	WQN434	11/6/1995	263.87	6.5	0.088	0.0351	0.0608	0	10.4	9.9

Data Source	Site	Date	Flow mgd	pH (lab)	TFe mg/L	TMn mg/L	TAl mg/L	Acid mg/L	Alk mg/L	TSO4 mg/L
PADEP	WQN434	12/20/1995	75.48	6.5	0.107	0.0591	0.111	0	9.2	12.2
PADEP	WQN434	1/18/1996	165.81	6.4	0.162	0.157	0.225	5.8	10	17.6
PADEP	WQN434	2/15/1996	123.23	6.3	0.133	0.0549	0.151	8.4	9	12
PADEP	WQN434	3/14/1996	234.19	6.4	0.079	0.0539	0.1124	29.6	7.6	11.8
PADEP	WQN434	4/9/1996	275.48	6.4	0.091	0.0457	0.0811	2.2	9	11.6
PADEP	WQN434	5/15/1996	587.1	6.3	0.09	0.0492	0.0999	0	7.6	11.1
PADEP	WQN434	6/11/1996	60	6.4	0.148	0.0691	0.11	0	12.4	11.8
PADEP	WQN434	7/8/1996	56.13	6.9	0.258	0.0286	0.0739	0	15.2	10.6
PADEP	WQN434	8/6/1996	28.39	8.3	0.115	0.0178	0.163	0	15.2	11.7
PADEP	WQN434	9/5/1996	28.39	6.7	0.145	0.0215	0.114	0	17.8	13.2
PADEP	WQN434	10/1/1996	416.13	6.2	0.108	0.0524	0.0886	3.4	11.2	10.1
PADEP	WQN434	11/6/1996	129.68	6.4	0.073	0.041	0.0962	0	10.8	10.4
PADEP	WQN434	12/10/1996	234.84	6.4	0.107	0.0328	0.0985	6.2	8.4	10.2
PADEP	WQN434	1/15/1997	122.58	6.3	0.096	0.0573	0.123	5	9.6	11.9
PADEP	WQN434	2/4/1997	83.87	6.4	0.089	0.0541	0.108	2	10.2	12.4
PADEP	WQN434	3/12/1997	368.39	6.3	0.075	0.0438	0.112	2.4	7.6	10.9
PADEP	WQN434	4/2/1997	463.23	6.4	0.078	0.0369	0.0994	3.2	7.6	10.5
PADEP	WQN434	5/6/1997	221.94	6.4	0.206	0.0643	0.109	0.6	10.8	10.5
PADEP	WQN434	6/12/1997	105.81	6.4	0.109	0.0405	0.0828	7.2	11	10.6
PADEP	WQN434	7/9/1997	29.03	6.7	0	0.0268	0.109	0	14.6	12.8
PADEP	WQN434	8/6/1997	34.84	6.9	0.178	0.0304	0.124	0	18.4	10.6
PADEP	WQN434	9/11/1997	27.1	6.3	0.243	0.0244	0.0953	4.2	22	10.5
PADEP	WQN434	10/7/1997	*	6.4	0.065	0.0249	0.0958	0	15.8	10.4
PADEP	WQN434	11/4/1997	*	6.6	0.286	0.0574	0.11	0	14.6	9.7
PADEP	WQN434	12/3/1997	*	6.5	0.08	0.0603	0.0865	0	9.4	10.6
PADEP	WQN434	1/14/1998	*	6.2	0.11	0.051	0.0974	0	7.8	11.5
PADEP	WQN434	2/10/1998	*	6.4	0.129	0.053	0.111	1.6	10.2	12.8
PADEP	WQN434	3/17/1998	*	6.5	0.081	0.0315	0.0765	0	7.6	10.7
PADEP	WQN434	4/8/1998	*	6.4	0.555	0.0363	0.0587	0	9.6	10.3
PADEP	WQN434	5/13/1998	*	6.3	0.168	0.0513	0.101	0	8	10.5
PADEP	WQN434	6/3/1998	*	6.4	0.054	0.0422	0.0685	0	12	11
PADEP	WQN434	7/16/1998	*	6.7	0.339	0.0488	0.1	0	13.2	10.8
PADEP	WQN434	8/15/1998	*	6.8	0.171	0.0191	0.0772	0	14.6	11.2
PADEP	WQN434	9/12/1998	*	6.8	0.136	0.0235	0.108	0	18.4	10.4
PADEP	WQN434	10/21/1998	*	6.7	0.049	0.048	0.107	0	15.2	22
PADEP	WQN434	10/10/1998	*	6.4	0.039	0.15	0.0989	0	14.6	22.7
SRBC	KTTL 0.2	9/9/2002	*	6.3	0.139	0.562	0.506	*	3.6	79.1

Data Source	Site	Date	Flow mgd	pH (lab)	TFe mg/L	TMn mg/L	TAl mg/L	Acid mg/L	Alk mg/L	TSO4 mg/L
SRBC	KTTL 0.2	7/7/1994	*	6.4	0.202	0.117	0.326	8.40	10	< 20
KCWA	KC1	5/31/2000	243.17	6.40	0.13	0.12	0.20	0.00	14.00	< 20
SRBC	KETL000	2/28/2001	134.84	6.4	< 0.3	0.206	< 0.5	0.00	13.8	20
SRBC	KETL000	4/19/2001	416.13	6.3	< 0.3	0.1	< 0.5	0.00	12	21.5
SRBC	KETL000	5/23/2001	145.16	5.5	0.368	0.539	0.624	0.00	7.8	39.7
SRBC	KETL000	6/21/2001	48.39	6.7	< 0.3	0.152	< 0.5	0.00	16	22.9
SRBC	KETL000	8/9/2001	8.39	6.5	< 0.3	0.186	< 0.5	0.00	14.6	45.8
SRBC	KETL000	9/6/2001	61.94	7.2	*	*	*	0.00	7.2	54.4
KCWA	KC1	10/21/2002	*	7.00	0.21	0.27	0.25	0.00	13.60	31.50
KCWA	KC1	*	242.16	6.40	0.13	0.12	0.20	0.00	14.00	< 20
KCWA	KC1	6/24/2002	183.02	7.02	0.13	0.11	0.26	0.00	9.20	*
		Average	**222.65**	**6.59**	**0.15**	**0.07**	**0.15**	**1.65**	**11.17**	**15.50**
		St Dev	**234.66**	**0.39**	**0.18**	**0.08**	**0.18**	**5.04**	**3.42**	**9.19**

BH1: Butler Hollow at mouth										
KCWA	BH1	5/31/2000	0.25	3.30	1.54	14.20	12.50	130.00	0.00	228.00
KCWA	BH1	7/17/2000	*	3.30	1.65	18.00	15.80	40.00	0.00	823.00
KCWA	BH1	8/1/2000	*	3.20	1.34	21.10	16.30	190.00	0.00	807.00
KCWA	BH1	6/24/2002	0.38	3.27	2.20	14.30	15.60	125.10	0.00	*
		Average	**0.32**	**3.27**	**1.68**	**16.90**	**15.05**	**121.28**	**0.00**	**619.33**
		St Dev	**0.09**	**0.05**	**0.37**	**3.31**	**1.73**	**61.70**	**0.00**	**339.00**

KC6: Kettle Creek at USGS gage										
KCWA	KC6	6/5/2000	143.23	6.10	0.04	0.06	0.20	0.00	11.00	30.00
KCWA	KC6	6/24/2002	134.97	6.70	0.11	0.05	0.15	0.00	10.00	*
USGS	1545000	4/24/2002	190.97	6.60	0.16	0.04	0.10	0.00	10.00	10.80
USGS	1545000	6/17/2002	806.45	6.90	0.17	0.04	0.10	0.00	10.00	8.70
USGS	1545000	8/13/2002	5.29	6.70	0.03	0.01	0.20	0.00	17.00	19.60
USGS	1545000	11/20/2002	324.52	6.90	0.18	0.03	0.10	0.00	11.00	9.20
USGS	1545000	1/16/2003	154.84	6.60	0.16	0.05	0.10	0.00	8.00	10.80
USGS	1545000	3/24/2003	*	6.40	0.27	0.06	0.20	7.00	8.00	8.60
USGS	1545000	5/15/2003	188.39	6.50	0.18	0.05	*	0.00	11.00	10.10
USGS	1545000	7/16/2003	39.35	7.40	0.15	0.02	0.10	0.00	16.00	11.90
USGS	1545000	9/18/2003	132.9	6.80	0.17	0.04	*	0.00	13.00	8.80
		Average	**212.09**	**6.69**	**0.15**	**0.04**	**0.14**	**0.64**	**11.36**	**12.85**
		St Dev	**226.02**	**0.33**	**0.07**	**0.02**	**0.05**	**2.11**	**2.91**	**6.84**

Data Source	Site	Date	Flow mgd	pH (lab)	TFe mg/L	TMn mg/L	TAl mg/L	Acid mg/L	Alk mg/L	TSO4 mg/L
KC2: Kettle Creek between Twomile Run and Butler Hollow										
KCWA	KC2	10/21/2002	*	7.00	0.23	0.28	0.30	0.00	13.80	28.40
KC3: Kettle Creek between Duck Hollow and Twomile Run										
KCWA	KC3	10/21/2002	*	7.10	0.17	0.12	< 0.2	0.00	15.80	20.10
SRBC	KTTL 2.1	9/30/2002	59.35	6.9	0.17	0.07	0.191	*	17.6	13.90
KC4: Kettle Creek below Duck Hollow										
KCWA	KC4	7/18/2000	*	6.40	0.17	0.08	< 0.2	0.00	13.00	< 20
DH1: Duck Hollow at mouth										
KCWA	DH1	7/18/2000	*	3.10	32.40	14.90	9.35	168.00	0.00	598.00
KC5: Kettle Creek between the Beach and Duck Hollow										
KCWA	KC5	7/18/2000	*	6.60	0.10	0.02	< 0.2	0.00	15.00	27.00
SB1: Short Bend Run at mouth										
KCWA	SB1	7/18/2000	*	3.20	1.22	13.70	11.40	126.00	0.00	426.00
KCWA	SB1	6/25/2002	0.32	3.23	1.30	8.40	9.10	119.00	0.00	*
SLH1: Slide Hollow at mouth										
KCWA	SLH1	7/17/2000	*	2.60	63.80	15.20	38.40	598.00	0.00	733.00
KCWA	SLH1	6/26/2002	0.06	2.60	48.60	10.60	33.70	400.00	0.00	*
KC7: Kettle Creek at Slide Hollow confluence										
KCWA	KC7	6/5/2000	*	6.50	0.04	0.02	0.20	0.00	12.00	20.00
HH1: Hicks Hollow at mouth										
KCWA	HH1	6/26/2002	0.21	6.36	0.04	0.01	0.10	0	< 5	*

KCWA = Kettle Creek Watershed Association
SRBC = Susquehanna River Basin Commission
USGS = United States Geological Service
* = Data Not Available

Attachment F
Comment and Response

Michael J. Klimkos, Program Coordinator, Dirt and Gravel Road Maintenance Program; State Conservation Commission

Comment:

Page 2 – Para 2 - Delete reference to settlement and call Westport a village or town. Settlement is archaic. Also might want to note percentages of public versus private land. I believe it is something like 68% public.

Para 3 - Access to the watershed on Crowley Road and Sugar Camp Road also.

Reponse: The word village was substituted for settlement in the document. Crowley Road and Sugar Camp Road were added to the access list. The exact percentage of public versus private lands in the watershed cannot be verified easily; therefore, the information was not added.

Comment:

Para 4 – Poorly reclaimed might better be changed to old law or pre-law reclamation standards.

- There are no bond forfeitures in the Kettle Creek watershed.

Para 6 – The active mining ceased about 1977. Reclamation of a couple of sites continued on into the 80s.

Page 6 – Para 2 - Coal mining was certainly an important industry in the lower Kettle Creek valley but I would not say it was the primary industry. Lumber, tourism and agriculture need to be considered.

- Even though he one of my heroes I would eliminate the reference to FDR and just say the WPA. Most of the seals are in fact in tact and were not destroyed by surface mining, at least on the west side. They are aging and in some disrepair but they are still there and are draining the underground mine pools.

Para 3 – The sites were reclaimed to old law standards. This is important. No open pits or exposed highwalls exist as is suggested.

Page 7 – Para 2 - There are no sediment ponds in place on the west side. One pond off Cattaraugus Road may have been a sediment pond and has been sampled. It is continuously discharging and is noted as a sample point but it discharges to Crowley Run. There are a couple of other ponds near Slide Hollow and Short Bend Hollow but their effects on the discharges have not been fully examined.

Reponse: Additional text or minor chages to text were made to address the comments on the coal mining sections of the document.

Comment:

Para 3 – Agnes was a Tropical Storm in Pennsylvania and not a Hurricane. The acididty and metal concentrations may have spiked because of the high flows that year. Because no previous or post data was collected it is difficult to speculate. The Scarlift Report was inaccurate.

Reponse: Tropical Storm was substituted for Hurricane in the document.

Comment:

Para 4 – The USGS and DCNR's Bureau of Topographic and Geologic Survey have named the run Short Bond Run. Local information describes the stream as Short Bend Run and the BAMR 2000 report used that nomenclature. Either way, pick one and stick with it. It is an important source of AMD and using both names will only confuse the reader.

Reponse: The stream is referred to as Short Bend Run throughout the document and on the watershed map.

Comment:

Page 18 – Para 2 – The Bureau of Mining and Reclamation (BMR) and the Bureau of District Mining Operations (BDMO) administer the mining regulatory program. The Bureau of Abandoned Mine Reclamation (BAMR) administers only the abandoned mine reclamation program. The Bureau of Deep Mine Safety administers the underground safety program. BMR administers the Mine Subsidence Insurance Program. The entire paragraph is messed up and erroneous. Contact Robert Agnew in the Bureau of Mining and Reclamation for a complete explanation of who does what.

Page 19 – Para 1 – Clarify the difference between PADEP and PADEP BAMR. The Natural Resources Conservation Service is a Federal agency and should be noted as so. Also the private groups should be give recognition.

Reponse: The explanation of PADEP BAMR's programs is meant only as a guide. More in-depth details of the programs administered can be found on the website: http://www.dep.state.pa.us/dep/deputate/minres/bamr/bamr.htm

Explanation of PADEP BAMR is found in the document prior to this paragraph, a repetition of that explanation is unnecessary. The NRCS was changed to the federal Natural Resources Conservation Service. The private groups were given recognition by noting their involvement with the KCWA.

Comment:

Don't bet the ranch that there are no insects below Twomile Run. See summary.
Page 8 – Para 3 - The section, "…but the center and eastern side of the stream is not visibly or biologically degraded until the confluence of Twomile Run…" is erroneous. It is degraded. See summary.

Summary:

Having a long association with Kettle Creek and as the biologist who conducted most of the BAMR sampling and prepared the report, other than the minor technical errors noted above, your report is fairly on point. However, I do not believe that AMD is the only source of impairment to Kettle Creek below Alvin Bush Dam.

Following the preparation of the BAMR report in October 2000 I conducted subsequent investigations in Kettle Creek. I conducted several invertebrate samplings and the results were somewhat surprising. Though the data was never fully collated and I left BAMR before I could fully analyze the data I got a sense from the composition of the benthic communities that excess nutrients and temperature are also sources of impairment.

The reservoir at the Bush Dam and the dam at the Lower Campground provide opportunities for warming the water. Also excessive algae blooms point to a high nutrient load. In my most upstream section above Slide Hollow I found a low diversity and high numbers of tolerant organisms, chironomids mostly as I recall.

Macroinvertebrates were found at every sampling station down to the mouth. Mostly they were pollution tolerant organisms and again diversity was low. This was expected because the water chemistry did not provide the best situation for invertebrates due to both water chemistry and the resulting substrate impairment.

During my invertebrate sample collection fish were also sampled and it should be noted that both during my survey and a PFBC survey fish were collected at all stations.

AMD enters Kettle Creek beginning at Slide Hollow and its effects are readily apparent. At KC6 it should be noted that the stream bottom is covered with manganese precipitate. Iron and aluminum precipitates cover other sections of the stream. In at least one instance the entrance of AMD into Kettle Creek is so subtle that only through the use of a conductivity meter and several transects across Kettle Creek was I able to determine where the AMD entered Kettle Creek as baseflow or a groundwater seep. It is not unreasonable to expect AMD polluted baseflow as well as surface water to be impacting Kettle Creek from Slide Hollow to the mouth of Kettle Creek from both sides of the Kettle Creek..

Based on the information collected but not finally correlated it can also be assumed that temperature and nutrients are having an effect on lower Kettle Creek that is being masked by the AMD. Those effects will become more pronounced as AMD mitigation occurs.

Reponse: The text, "but the center and eatern side of the stream is not visibly or biologically degraded until the confluence of Twomile Run," is cited from the Lower Kettle Creek and Twomile Run Restoration Plan (Hedin Environmental, 2000); the text was not changed in this document. This TMDL document deals only with the impairments caused by AMD, namely lowered pH and elevated concentrations of metals such as iron, aluminum, and manganese. The data used at KC6 (samples from 2000-2003) were run through the TMDL model and no water quality impairments were found.