Revised

Panther Creek Watershed TMDL
Schuylkill and Carbon Counties

For Acid Mine Drainage Affected Segments

Prepared by the Pennsylvania Department of Environmental Protection

June 2014

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Schuylkill County, PA

Introduction

This report presents the Total Maximum Daily Loads (TMDLs) developed for impaired stream segments in the Panther Creek Watershed (Attachment A). These were done to address the impairments noted on the 1996 Pennsylvania Section 303(d) list, and subsequent lists of impaired waters, required under the Clean Water Act, and covers the stream segments shown in Table 1. High levels of metals are the cause for these impairments. All impairments resulted from drainage from abandoned coalmines. The TMDL addresses the three primary metals associated with acid mine drainage (iron, manganese, aluminum) and pH. The Panther Creek TMDL is being revised to reflect significant changes in the watershed since the original Panther Creek TMDL was developed including the new treatment proposal of the Route 309 discharge. The TMDL for the Little Schuylkill River, to which Panther Creek flows, is being revised concurrently.

Table 1. Pennsylvania Integrated Water Quality Monitoring and Assessment Report Streams, Category 5 Waterbodies, Pollutants Requiring a TMDL

Hydrologic Unit Code: 02040203 Schuylkill			
Stream Name **Use Designation (Assessment ID)** **Source**	**Cause**	**Date Listed**	**TMDL Date**
<u>Panther Creek</u> HUC: 02040203 Aquatic Life (719) - 6.48 miles; 4 Segment(s)* Abandoned Mine Drainage Industrial Point Source Surface Mining	Metals Unknown Toxicity Siltation	1996 2002 1998	2009 2015 2014**
<u>Slum Creek</u> HUC: 02040203 Aquatic Life (727) - 1.58 miles; 3 Segment(s)* Industrial Point Source Industrial Point Source	Other Organics Unknown Toxicity	2002 2002	2015 2015

*Segments are defined as individual COM IDs.
** Siltation TMDL for Little Schuykill Watershed. Panther Creek/Slum Creek specific TMDL may be developed in the future.

Report Summary
Watershed Summary

	Stream Miles	Assessment Units	Segments (COMIDs)
Watershed Characteristics	9.11	2	9

Impairment Summary

Source	Cause	Miles	Assessment Units	Segments (COMIDs)
Abandoned Mine Drainage	Metals	6.48	1	4
Industrial Point Source	Other Organics	1.58	1	3
Industrial Point Source	Unknown Toxicity	8.06	2	7
Surface Mining	Siltation	6.48	1	4
		8.06**	2**	7**

**Totals reflect actual miles of impaired stream. Each stream segment may have multiple impairments (different sources or causes contributing to the impairment). So the sum of individual impairment numbers may not add up to the totals shown.

Use Designation Summary

	Miles	Assessment Units	Segments (COMIDs)
Aquatic Life	6.06	2	7

Directions to the Panther Creek Watershed

Panther Creek originates approximately 0.5 miles east of the Borough of Lansford in Carbon County. The stream flows southwesterly until reaching the Little Schuylkill River at Tamaqua. Panther Creek can be accessed from Interstate 81 at the Hometown Exit. Travel east on State Route 54 towards Hometown. In Hometown turn right onto State Route 309 and head south towards Tamaqua. In Tamaqua turn left onto US Route 209 and travel approximately a ¼ of a mile to where the stream crosses under US Route 209. The stream runs along the north side of US Route 209 from Tamaqua until the headwaters east of Lansford. Panther Creek is found on the 7 ½-minute Tamaqua and Nesquehoning quadrangles. It exists in State Water Plan 03 A and HUC 02040203.

Segments addressed in this TMDL

There is an active discharge in the Panther Creek Watershed. The Lehigh Coal and Navigation (LCN) permit has been transferred to BET Associates to operate the current anthracite surface mining operation. The permitted discharge that previously discharged to the Little Schuylkill River will be discharging to Panther Creek and is included in this revised TMDL. Because of its proximity to Route 309 and its limited capacity to contain the flows from large precipitation events, the existing Route 309 Treatment System is a threat to public safety and welfare. In addition, the existing system is undersized, was not properly designed, operated and maintained by LCN, does not efficiently and adequately treat the mine drainage discharge, and cannot be sufficiently expanded because of topographic limitations, adjacent businesses and nearby public utility lines. In order to protect public safety and welfare, to provide for ongoing efficient water treatment, and to avoid periodic episodes of high flows bypassing the treatment system, the Department told LCN beginning in 2008, and more recently, BET Associates which purchased LCN's assets at a sale in bankruptcy court in late May 2010, that a new treatment system or systems had to be constructed at another location or locations. There is no location close to the Little Schuylkill River where a new treatment system can be built. The Department and BET Associates entered in to a Consent Order and Agreement on May 5, 2011 which contains provisions addressing the design, construction and operation of new treatment systems.

All of the discharges in the watershed, except for the permitted discharge, are from abandoned and or reclaimed surface mines and will be treated as non-point sources. The distinction between non-point and point sources in this case is determined on the basis of whether or not there is a responsible party for the discharge. Where there is no responsible party the discharge is considered to be a non-point source. The TMDLs will be expressed as long-term, average loadings. Due to the nature and complexity of mining effects on the watershed, expressing the TMDL as a long-term average gives a better representation of the data used for the calculations. The facility holding a discharge permit has been given a waste load allocation (WLA) within the TMDL calculations.

The designation for this stream segment can be found in PA Title 25 Chapter 93.

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 Part 130) require:

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

* States to establish priority rankings for waters on the lists based on severity of pollution and the designated use of the waterbody; states must also identify those waters for which TMDLs will be developed and a schedule for development;
* States to submit the list of waters to USEPA every two years (April 1 of the even numbered years);

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

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

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

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

Section 303(d) Listing Process

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

The primary method adopted by the Pennsylvania Department of Environmental Protection (Pa. DEP) for evaluating waters changed between the publication of the 1996 and 1998 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) [1] reporting process. Pa. DEP is now using the Unassessed Waters Protocol (UWP), a modification of the USEPA Rapid Bioassessment Protocol II (RPB-II), as the primary mechanism to assess Pennsylvania's waters. The UWP provides a more consistent approach to assessing Pennsylvania's streams.

The assessment method requires selecting representative stream segments based on factors such as surrounding land uses, stream characteristics, surface geology, and point source discharge locations. The biologist selects as many sites as necessary to establish an accurate assessment for a stream segment; the length of the stream segment can vary between sites. All the biological surveys included kick-screen sampling of benthic macro invertebrates, habitat surveys, and measurements of pH, temperature, conductivity, dissolved oxygen, and alkalinity. Benthic macro invertebrates 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 two pollutants impair a stream segment, two TMDLs must be developed for that stream segment. In order for the process to be more effective, adjoining stream segments with the same source and cause listing are addressed collectively, and on a watershed basis.

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

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 water body using USEPA approved methods and/or 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 Panther Creek Watershed TMDL.

Watershed History

The Panther Creek Watershed (attachment A) is approximately 10.9 square miles in a valley setting. Panther Creek originates approximately 0.5 miles east of the Borough of Lansford and flows westward for 6.5 miles to the Little Schuylkill River. The watershed is 1 ¾ miles wide and is bordered by Nesquehoning Mountain on the north and by Pisgah Mountain on the south. The critical protected use in Panther Creek is Cold Water Fishes (CWF). The majority of the watershed had been affected by underground and surface mining activities dating back at least 200 years. BET Associates operates an anthracite mining operation in Tamaqua Borough and Coaldale Borough, Schuylkill County, and Nesquehoning Borough, Lansford Borough, and Summit Hill Borough in Carbon County. This anthracite surface mining operation includes two (2) major open pits, named Job 111 and Springdale, and numerous other affected areas, which are described in more detail below. The entire mine site of 7,596 acres is contained within Surface Mining Permit No. 543333020, which was issued on August 28, 1985, as a primacy re-permitting action. This surface mining permit overlaps basically the entire Panther Creek Watershed.

The current surface mining permit replaced Mine Drainage Permit No.667MOU1, which was originally issued to Greenwood Stripping Corporation, and then transferred to Bethlehem Mines Corporation. Portions of the mine were originally covered by Mine Drainage Permit No. 667MO45, which was issued to Greenwood Stripping Corporation on March 8, 1968.

The mine was originally established in 1793 on an 8000 + acre tract which corresponds to the present BET Associates Mine. The coal was removed by means of quarried in shallow, open pits until the 1840s when underground mining began on the site. Deep mining operations were begun by the Lehigh Coal &Navigation circa 1840 and continued by the same company on the site until 1957. The Tamaqua Colliery, the Greenwood/Coaldale Colliery, and the Lanford Colliery were three of the collieries operated by LCN on the Panther Valley tract. LCN was conducting surface mining at this site during the time that underground mining was taking place, and some relatively deep (i.e. estimated 500 feet deep) pits were developed during the 1940s and 1950s.

Greenwood Stripping Corporation began surface mining the site in 1960. Greenwood operated several pits on the LCN site, including a very large operation located to the west of LC&N's current Job #111.

The extensive historic deep mining below the natural groundwater level on both sides of the valley has caused the formation of a large pool of acid mine water, named the Tamaqua mine pool. In order to keep the operation dry to strip mine coal below the Tamaqua pool mine, Bethlehem Mines Corporation and LCN pumped the mine pool via large pumps placed within two separate abandoned deep mine shafts, named Shaft Nos. 10 and 14, located on permitted area on the north side of the valley between Tamaqua and Coaldale. The maximum lowering of mine pool exceeded a depth of 350 feet. The permitted discharge from the pumping was treated on-site prior to release to Panther Creek. On several occasions, pumping temporarily ceased, due to malfunctions, causing the mine pool to flood to and discharge from an abandoned deep mine opening along S.R. 309 south of Tamaqua before reaching the Little Schuylkill River in Tamaqua. Since February 9, 2001, LCN has ceased pumping operations due to financial problems. The Tamaqua mine pool has been discharging at the S.R. 309 location since May 2001. A temporary treatment facility with an associated retention pond was constructed by LCN to treat the water prior to discharge into the Little Schuylkill River.

As required by a 2011 consent order and agreement, BET Associates submitted a proposal to relocate and treat all or part of the Route 309 Discharge. The proposal involved pumping the mine pools, construction of a new treatment system in an area adjacent to Panther Creek, and re-authorization of discharges from Outfalls 001, 003 and 004 into Panther Creek. BET Associates also submitted an application to modify NPDES Permit No. 0012360 to incorporate this proposal. Resuming pumping in the Panther Creek watershed will lower the mine pools and eliminate or substantially reduce the discharge from the Buck Mountain Drift location, thus preventing any threat to public health and safety. The original Panther Creek TMDL was developed and approved after LCN ceased pumping the mine pools, thus the TMDL did not account for flows from the resumption of pumping. Consequently, DEP is revising this TMDL for Panther Creek along with the Little Schuylkill River TMDL (DEP 2014) which did not account for flows from the resumption of pumping and discharge into Panther Creek/Little Schuylkill River as a result of the proposed treatment system.

There is currently one (1) active coal mining permit in the watershed (see Table 2) which involves remining of underground surface mine works. The operators are reclaiming piles of previously unusable refuse (culm) bank material and reprocessing it to turn it into a fuel source. The BET Associates site also involves surface mining of anthracite coal deposits. It should be noted that discharges from ponds in this area are rare, as much of the surface runoff percolates down into the extensive underground mining works that underlay the valley. For the mining sites that do not hold NPDES permits, no waste load allocation has been assigned due to the lack of a discharge. Only Outfall 005 on the BET Associates permit is actively discharging, therefore a WLA (Waste Load Allocation) has been calculated. In order to mine deeper coal reserves, BET has proposed the installation of two high capacity pumps that will draw down the water elevation in the underground mine works, and at the same time dry up an existing discharge to surface waters from an abandoned mule hole (abandoned underground mine entrance) along Highway 309. The sedimentation ponds have no recorded discharges and have not been assigned waste load allocations. It has been determined that effects from the sedimentation ponds in this area are negligible because much of their discharge percolates down into the underground mine works and the ponds should rarely discharge if reclamation and revegetation is concurrent. In addition, sedimentation ponds are designed in accordance with PA Code Title 25 Chapter 88.98 to, at a minimum, contain runoff from a 10-year 24-hour precipitation event.

Table 2. Mining Permit in the Panther Creek Watershed TMDL

Mining Permit	*NPDES Permit*	*Permittee*	*Operation*	*Status*
54733020R4	PA0012360	BET Associates	LCN Mine	Coal preparation plant on site. Surface mining, refuse reprocessing and coal ash placement are active on this site. NPDES permit for Outfalls 001. 003, 004 and 005

* Please see Table 4 for non-mining NPDES permits in the Panther Creek Watershed

The watershed contains many acres of abandoned mine land, including abandoned pits, spoil piles, and refuse piles, which were affected and abandoned prior to State and Federal laws and regulations requiring reclamation of surface mines.

Although, the natural condition of the surface of the watershed has been tremendously altered by coal mining activity, the developed areas (boroughs) within the watershed also impact the quality of Panther Creek. These areas account for approximately 13% of the total watershed.

Most of the boroughs in the watershed have sewage collection pipes from residences and businesses. Many of the piping systems are old and leaky and nearly all discharge raw sewage directly in the streams. A treatment plant in Coaldale Borough has had numerous reports of discharges of raw sewage into Panther Creek and has reported discharge of raw sewage during heavy storm events.

AMD Methodology

The Panther Creek TMDL was revised applying a modification of the original methodology with the addition of a WLA for the proposed discharge. This method relies on a statistical analysis of available data and determining an average long-term allowable concentration that applies a safety factor based on the variability in the data. This factor was addressed in the TMDL revision to account for the more controllable effluent/stream quality when the pumping and discharge commence. Water quality data collected from 1996-2000, when the pumps were previously in operation, were available but not used in the original TMDL because pumping had ceased. There were approximately 40 samples that included chemistry, but no flow data were available. A 5-year daily flow record for Panther Creek, corresponding to the time period for which the previously mentioned water quality data were available, was created from a flow gage located downstream on the Little Schuylkill using a unit area method. Flows associated with the days when the data were collected were patched into the water quality data set to allow for the concentration/flow relationship to be developed for the watershed under conditions similar to those that will be encountered when the pumping resumes. That relationship was then applied to the entire 5-year daily flow record created for Panther Creek in order to assign a daily pollutant concentration. That dataset was then run through @Risk to determine the new long-term allowable concentrations and loads for Panther Creek in the proposed revision to the TMDL.

Table 6 (page 14) shows the total allowable loads by category. The majority of the allowable loads will be allocated to the relocated discharge (WLAs) for the following reasons. There will be substantial improvements in water quality parameters critical to restoring aquatic life in the stream when the discharge is introduced. Recent sampling events within Panther Creek have shown Al concentrations to be in the 6-9 mg/l range and Fe levels to be in the 8-16 mg/l range. This relocated discharge will be contributing a significant amount of water at near in-stream criteria for these parameters and will represent a major advance toward restoring the aquatic community in Panther Creek.

Independent water quality analyses undertaken in the determination of Water Quality Based Effluent Limitations (WQBELs) corroborate the results derived in the TMDL process.

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 describes below can be applied to situations where all of the pollutant loading is from non-point sources as well as those where there are both point and non-point sources. The following defines what are considered point sources and non-point sources for the purposes of our evaluation; point sources are defined as permitted discharges, non-point 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[1] by performing 5,000

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

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.

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

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

In Low pH TMDLs, acidity is compared to alkalinity as described in Attachment B. Each sample point used in the analysis of pH by this method must have measurements for total alkalinity and total acidity. Net alkalinity is alkalinity minus acidity, both in units of milligrams per liter (mg/l) $CaCO_3$. Statistical procedures are applied, using the average value for total alkalinity at that point as the target to specify a reduction in the acid concentration. By maintaining a net alkaline stream, the pH value will be in the range between six and eight. This method negates the need to specifically compute the pH value, which for streams affected by low pH 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.

Changes in TMDLs That May Require EPA Approval

- Increase in total load capacity.
- Transfer of load between point (WLA) and nonpoint (LA) sources.
- Modification of the margin of safety (MOS).
- Change in water quality standards (WQS).
- Non-attainment of WQS with implementation of the TMDL.
- Allocations in trading programs.

Changes in TMDLs That May Not Require EPA Approval

- Total loading shift less than or equal to 1% of the total load.
- Increase of WLA results in greater LA reductions provided reasonable assurance of implementation is demonstrated (a compliance/implementation plan and schedule).
- Changes among WLAs with no other changes; TMDL public notice concurrent with permit public notice.
- Removal of a pollutant source that will not be reallocated.
- Reallocation between LAs.
- Changes in land use.

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 (LAs) 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 the water quality standards must be met 99% of the time. The iron TMDLs are expressed as total recoverable as the iron data used for this analysis was reported as total recoverable. The following table shows the applicable water-quality criteria for the selected parameters.

Table 3. Applicable Water Quality Criteria

Parameter	*Criterion Value (Mg/l)*	*Total Recoverable/Dissolved*	*Critical Use*
Aluminum (Al)	0.75	Total Recoverable	Aquatic Life
Iron (Fe)	1.50	Total Recoverable	Aquatic Life
Manganese (Mn)*	1.00	Total Recoverable	Potable Water Supply
pH **	6.0-9.0	N/A	Aquatic Life

* Manganese potable water supply use criterion based on potential for objectionable taste and laundry staining
** The pH values shown will be used when applicable. In the case of freestone streams with little or no buffering capacity, the TMDL endpoint for pH will be the natural background water quality. These values are typically as low as 5.4 (Pennsylvania Fish and Boat Commission).

TMDL Elements (WLA, LA, MOS)

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

$$TMDL = WLA + LA + MOS$$

Allocation Summary

This TMDL will focus remediation efforts on the identified numerical reduction targets for each Panther Creek and is shown in Table 6. Attachment C contains the TMDLs by segment analysis for each allocation point in a detailed discussion. As changes occur in the watershed, the TMDLs may be re-evaluated to reflect current conditions. An implicit MOS based on conservative assumptions in the analysis is included in the TMDL calculations.

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

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

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

This modification of the Panther Creek AMD TMDL is the result of the redirecting of the permitted discharge from the Little Schuylkill River at S.R. 309 (discussed previously in the Watershed history section) to Panther Creek. The current discharge poses a safety risk making its relocation necessary and Panther Creek is the only available option. The proposed BET Associates discharge will be located upstream of sample point 003 initially at the old LCN #14 deep mine shaft where operational pumps exist and then at a new facility to be constructed but will discharge at approximately the same location.

The permits shown in Table 4 are within the boundaries of the Panther Creek Watershed, but are not receiving individual wasteload allocations in this TMDL document. In most cases, an aggregate wasteload allocation of 2% of the total allowable load will be set aside to account for any trace amounts of the pollutants of concern at any time from these discharges. These discharges fall into one of three categories: 1) permits with non-numeric effluent limitations; and 2) permits that have numeric effluent limitations for some parameters but do not contain numeric effluent limits for the parameters of concern addressed in this TMDL document. The reasons these discharges have not received individual wasteload allocations include one or more of the following:

- This class of discharge is not a significant contributor of pollutants of concern as addressed in the TMDL,
- The discharge concentration is at or below the level of the instream water quality criterion value for the parameters of concern,
- The discharge does not cause or contribute to a downstream impairment, or
- The discharge has been evaluated via the reasonable potential analysis to discharge the pollutants of concern at current levels.

Table 4. NPDES permits in the Panther Creek Watershed not receiving individual waste load allocations for metals

NPDES Permit	Facility Name	Sample Point in Little Schuylkill TMDL
PA0026476	Coaldale Lansford Summit Hill Sew Auth	LS11
PAG052223	Slusser Brothers, Inc. Panther Valley Middle School	LS11
PAR202240	Hart Metals	LS11

A Waste Load Allocation is being assigned at 003 to BET Associates (SMP54733020, NPDES PA0012360). This WLA is associated with a permit that will contain up to four treatment outfalls (three discharging to Panther Creek and one to the Little Schuylkill) and two stormwater outfalls/sedimentation ponds. To be conservative, the entire WLA was assigned to Panther Creek in the event that the discharges are entirely into Panther Creek at a given time. The BET Associates treatment system will vary pumping rates, so the possibility exists that there will be simultaneous discharges from the Route 309 Discharge/Outfall 005 into the Little Schuylkill River and from Outfalls 001, 003, or 004 into Panther Creek (see Attachment A for outfall location). Table 5 shows the WLA for the combined Panther Creek and Little Schuylkill River discharge points, but only to account for the instances when BET Associates is discharging from outfalls in both watersheds. The intent is not to allocate the same load to outfalls in both watersheds (i.e. the entire allocated wasteload for all BET Associates outfalls combined is shown in Table 5), rather it represents the worst case scenario when the entire discharge is coming from outfall(s) in one watershed. The allowable loads for Al, Fe and Mn were calculated to meet water quality standards at all points instream, including the nearest potable water supply intake (Pottstown Borough Water Authority approximately 65 miles downstream). There will be substantial improvements in the water quality parameters critical to restoring aquatic life when the continuous BET discharge is introduced. The allowable loads and components of the TMDL are shown in Table 6.

Table 5. Combined Waste Load Allocations for BET Associates Outfalls 001, 003, 004 and 005

Parameter	Average Flow (MGD)	Allowable Load (lbs/day)
Al	14.4	90.1
Fe	14.4	180.1
Mn	14.4	168.0

Table 6. Summary Table – Panther Creek Watershed

Station	Para-meter	Existing Conc. (mg/l)	Existing Load (lbs/day)	Allowable Conc. (mg/l)	TMDL Allowable Load (lbs/day)	WLA (lbs/day)	LA (lbs/day)	Percent Reduction %
003	Panther Creek upstream of confluence with Little Schuylkill River*							
	Al	1.73	384.0	0.52	115.0	92.4 = (90.1 + *2.3*)	22.6	70
	Fe	2.11	468.4	1.44	319.0	186.5 = (180.1 + *6.4*)	132.5	32

Station	Para-meter	Existing Conc. (mg/l)	Existing Load (lbs/day)	Allowable Conc. (mg/l)	TMDL Allowable Load (lbs/day)	WLA (lbs/day)	LA (lbs/day)	Percent Reduction %
	Mn	2.00	444.3	0.80	178.0	171.6 = (168.0 + *3.6*)	6.4	60
	Acidity	1.12	249.2	1.12	249.2		249.2	0

* WLA assigned to BET Associates' operation with outfalls on Panther and Little Schuylkill, see explanation above
Note – Italicized numbers = 2% Bulk Reserve WLA

Recommendations and Reasonable Assurance

The allowable loads for Al, Fe and Mn were calculated to meet water quality standards at all points instream, including the nearest potable water supply intake (Pottstown Borough Water Authority approximately 65 miles downstream). Recent sampling events have shown Al concentrations in Panther Creek to be elevated as high as 6-9 mg/l range during storm events and Fe levels of over 16 mg/l during one storm. There will be substantial improvements in water quality parameters critical to restoring aquatic life in the stream when the continuous BET discharge is introduced. This discharge will be contributing a significant amount of water at in-stream criteria for these parameters and will represent a major advance toward restoring the aquatic community in Panther Creek. Therefore, the majority of the total allowable load was allocated to the discharge.

In the May 5, 2011 Consent Order and Agreement, the Department and BET Associates agreed to a provision which requires the company to propose and implement a restoration project in Slum Creek, the major nonpoint source load in the Panther Creek watershed. Slum Creek enters Panther Creek just upstream of the new BET Associates discharge and contributes the most significant nonpoint source loadings in the watershed (see Appendix F). Samples collected over various conditions in Slum Creek showed an average Fe concentration of over 11 mg/l and average Al concentrations over 9 mg/l. Data also show the deleterious impact that the Slum Creek flows have on Panther Creek. The reclamation of the Slum Creek subwatershed would provide reasonable assurance that the nonpoint source reductions required in the TMDL will be met. DEP and BET Associates are also in discussions regarding potential remediation of other sites in the Panther Creek watershed.

Various methods to eliminate or treat pollutant sources and to provide a reasonable assurance that the proposed TMDLs can be met exist in Pennsylvania. These methods include PADEP's primary efforts to improve water quality through reclamation of abandoned mine lands (for abandoned mining) and through the National Pollution Discharge Elimination System (NPDES) permit program (for active mining). Funding sources available that are currently being used for projects designed to achieve TMDL reductions include the Environmental Protection Agency (EPA) 319 grant program and Pennsylvania's Growing Greener Program. Federal funding is through the Department the Interior, Office of Surface Mining (OSM), for reclamation and mine drainage treatment through the Appalachian Clean Streams Initiative and through Watershed Cooperative Agreements.

OSM reports that nationally, of the $8.5 billion of high priority (defined as priority 1&2 features or those that threaten public health and safety) coal related AML problems in the AML inventory, $6.6 billion (78%) have yet to be reclaimed; $3.6 billion of this total is attributable to Pennsylvania watershed costs. Almost 83 percent of the $2.3 billion of coal related environmental problems (priority 3) in the AML inventory are not reclaimed.

The Bureau of Abandoned Mine Reclamation, Pennsylvania's primary bureau in dealing with abandoned mine reclamation (AMR) issues, has established a comprehensive plan for abandoned mine reclamation throughout the Commonwealth to prioritize and guide reclamation efforts for throughout the state to make the best use of valuable funds (www.dep.state.pa.us/dep/deputate/minres/bamr/complan1.htm). In developing and implementing a comprehensive plan for abandoned mine reclamation, the resources (both human and financial) of the participants must be coordinated to insure cost-effective results. The following set of principles is intended to guide this decision making process:

- Partnerships between the DEP, watershed associations, local governments, environmental groups, other state agencies, federal agencies and other groups organized to reclaim abandoned mine lands are essential to achieving reclamation and abating acid mine drainage in an efficient and effective manner.

- Partnerships between AML interests and active mine operators are important and essential in reclaiming abandoned mine lands.

- Preferential consideration for the development of AML reclamation or AMD abatement projects will be given to watersheds or areas for which there is an approved rehabilitation plan. (guidance is given in Appendix B to the Comprehensive Plan).

- Preferential consideration for the use of designated reclamation moneys will be given to projects that have obtained other sources or means to partially fund the project or to projects that need the funds to match other sources of funds.

- Preferential consideration for the use of available moneys from federal and other sources will be given to projects where there are institutional arrangements for any necessary long-term operation and maintenance costs.

- Preferential consideration for the use of available moneys from federal and other sources will be given to projects that have the greatest worth.

- Preferential consideration for the development of AML projects will be given to AML problems that impact people over those that impact property.

- No plan is an absolute; occasional deviations are to be expected.

A detailed decision framework is included in the plan that outlines the basis for judging projects for funding, giving high priority to those projects whose cost/benefit ratios are most favorable and those in which stakeholder and landowner involvement is high and secure.

In addition to the abandoned mine reclamation program, regulatory programs also are assisting in the reclamation and restoration of Pennsylvania's land and water. PADEP has been effective in implementing the NPDES program for mining operations throughout the Commonwealth. This reclamation was done, through the use of remining permits which have the potential for reclaiming abandoned mine lands, at no cost to the Commonwealth or the federal government. Long-term treatment agreements were initialized for facilities/operators who need to assure treatment of post-mining discharges or discharges they degraded which will provide for long-term treatment of discharges. According to OSM, "PADEP is conducting a program where active mining sites are, with very few exceptions, in compliance with the approved regulatory program".

The Commonwealth is exploring all options to address its abandoned mine problem. During 2000-2006, many new approaches to mine reclamation and mine drainage remediation have been explored and projects funded to address problems in innovative ways. These include:

- Project XL - The Pennsylvania Department of Environmental Protection ("PADEP"), has proposed this XL Project to explore a new approach to encourage the remining and reclamation of abandoned coal mine sites. The approach would be based on compliance with in-stream pollutant concentration limits and implementation of best management practices ("BMPs"), instead of National Pollutant Discharge Elimination System ("NPDES") numeric effluent limitations measured at individual discharge points. This XL project would provide for a test of this approach in up to eight watersheds with significant acid mine drainage ("AMD") pollution. The project will collect data to compare in-stream pollutant concentrations versus the loading from individual discharge points and provide for the evaluation of the performance of BMPs and this alternate strategy in PADEP's efforts to address AMD.
- Awards of grants for 1) proposals with economic development or industrial application as their primary goal and which rely on recycled mine water and/or a site that has been made suitable for the location of a facility through the elimination of existing Priority 1 or 2 hazards, and 2) new and innovative mine drainage treatment technologies that will provide waters of higher purity that may be needed by a particular industry at costs below conventional treatment costs as in common use today or reduce the costs of water treatment below those of conventional lime treatment plants. Eight contracts totaling $4.075 M were awarded in 2006 under this program.

Two primary programs that provide reasonable assurance for maintenance and improvement 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's Bureau of Abandoned Mine Reclamation, which administers and oversees the Abandoned Mine Reclamation Program in Pennsylvania, the United States Office of Surface Mining, the National Mine Land Reclamation Center, the National Environmental Training Laboratory, and many other agencies and individuals. Funding from EPA's 319 Grant program, and Pennsylvania's

Growing Greener program have been used extensively to remedy mine drainage impacts. These many activities are expected to continue and result in water quality improvement.

The majority of the Panther Creek Watershed has been affected by the coal mining activities and would benefit greatly from remediation. The PA DEP must insure that BET completes its reclamation responsibilities at all the operations on which they have a legal responsibility for reclamation. In addition, the area would benefit from any PA Bureau of Abandoned Mine Projects or "Growing Greener" projects. The goal of these projects would be to stop AMD from forming and reduce the amount of AMD entering Panther Creek. Remediation may include, among other things, removal of abandoned highwalls, backfilling of abandoned pits, regarding and revegetation, and maintaining the deep mine pumps and treatment of mine pool water.

Abandoned highwall removal in conjunction with backfilling pits is recommended because these practices eliminate surface water accumulations. Such accumulations currently exhibit characteristics of AMD. An ancillary section of highwall removal is elimination of a safety hazard. Regrading and replanting abandoned areas is also recommended in the study area. The former may be in conjunction with highwall removal and backfilling of impoundment areas or it may involve old mined areas in which there are no abandoned highwalls. Regrading is beneficial by re-routing surface water and eliminating low areas in which surface water can impound. Replanting is a necessary follow-up to regrading. It aids in establishing reclaimed spoil and preventing silt and sedimentation from entering receiving streams.

The PA DEP will enforce all applicable coal mining laws and regulations to insure proper reclamation of all active mining areas that have been affected by the Lehigh Coal & Navigation Company. The reclamation of abandoned mine land features is dependent on Bureau of Abandoned Mine Land projects and "Growing Greener" projects

Candidate or federally-listed threatened and endangered species may occur in or near the watershed. While implementation of the TMDL should result in improvements to water quality, they could inadvertently destroy habitat for candidate or federally-listed species. TMDL implementation projects should be screened through the Pennsylvania Natural Diversity Inventory (PNDI) early in their planning process, in accordance with the Department's policy titled Policy for Pennsylvania Natural Diversity Inventory (PNDI) Coordination during Permit Review and Evaluation (Document ID# 400-0200-001).

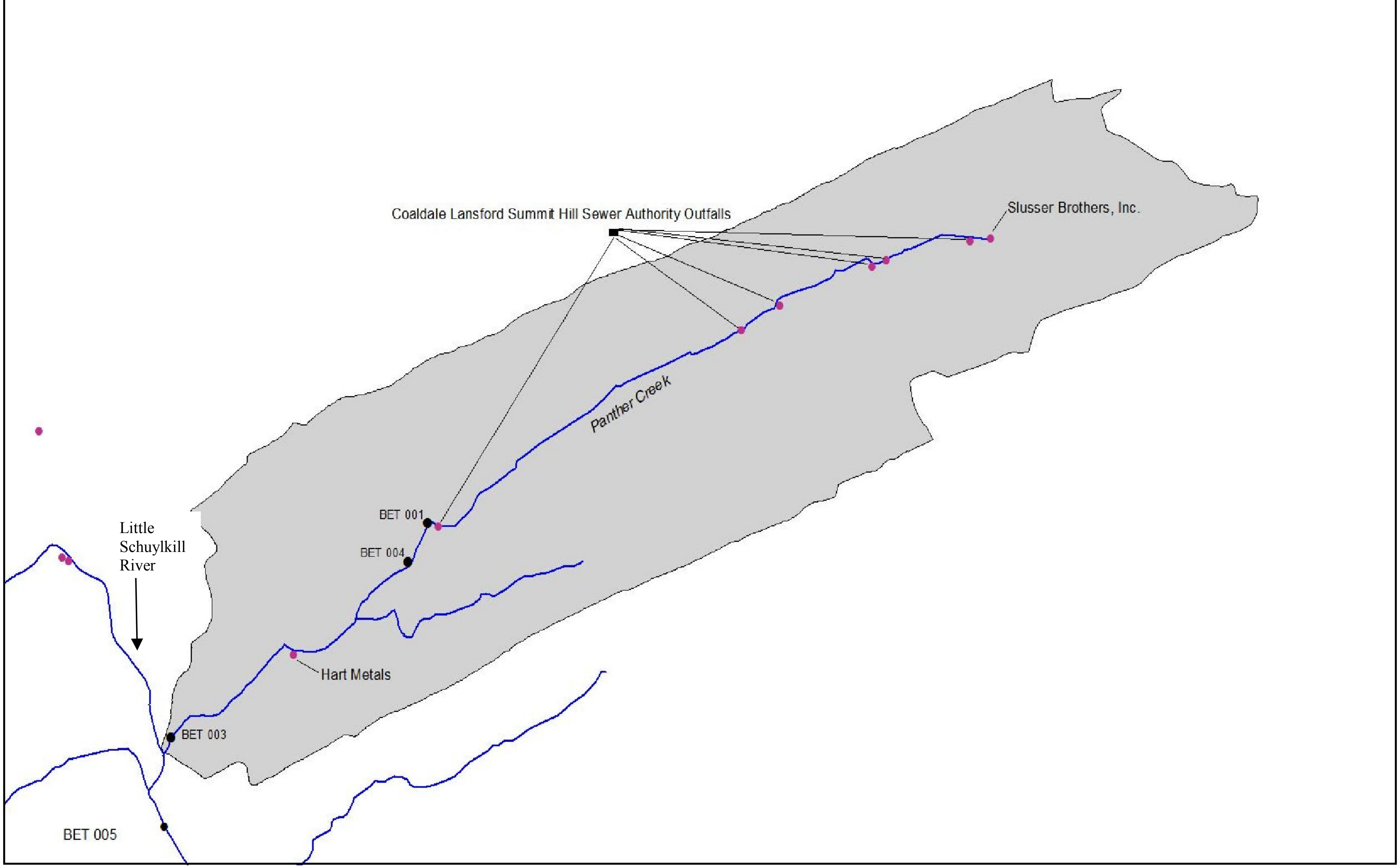
Public Participation

Notice of the draft TMDLs were published in the *PA Bulletin* on June 23, 2012 with a 30-day comment period provided to foster public comment on the allowable loads calculated. Attachment H provides PADEP's response to the comments received.

Attachment A

Panther Creek Watershed Map

NPDES Permits in the Panther Creek Watershed



Attachment B

The pH Method

Method for Addressing Section 303(d) Listings for pH

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

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

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

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

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

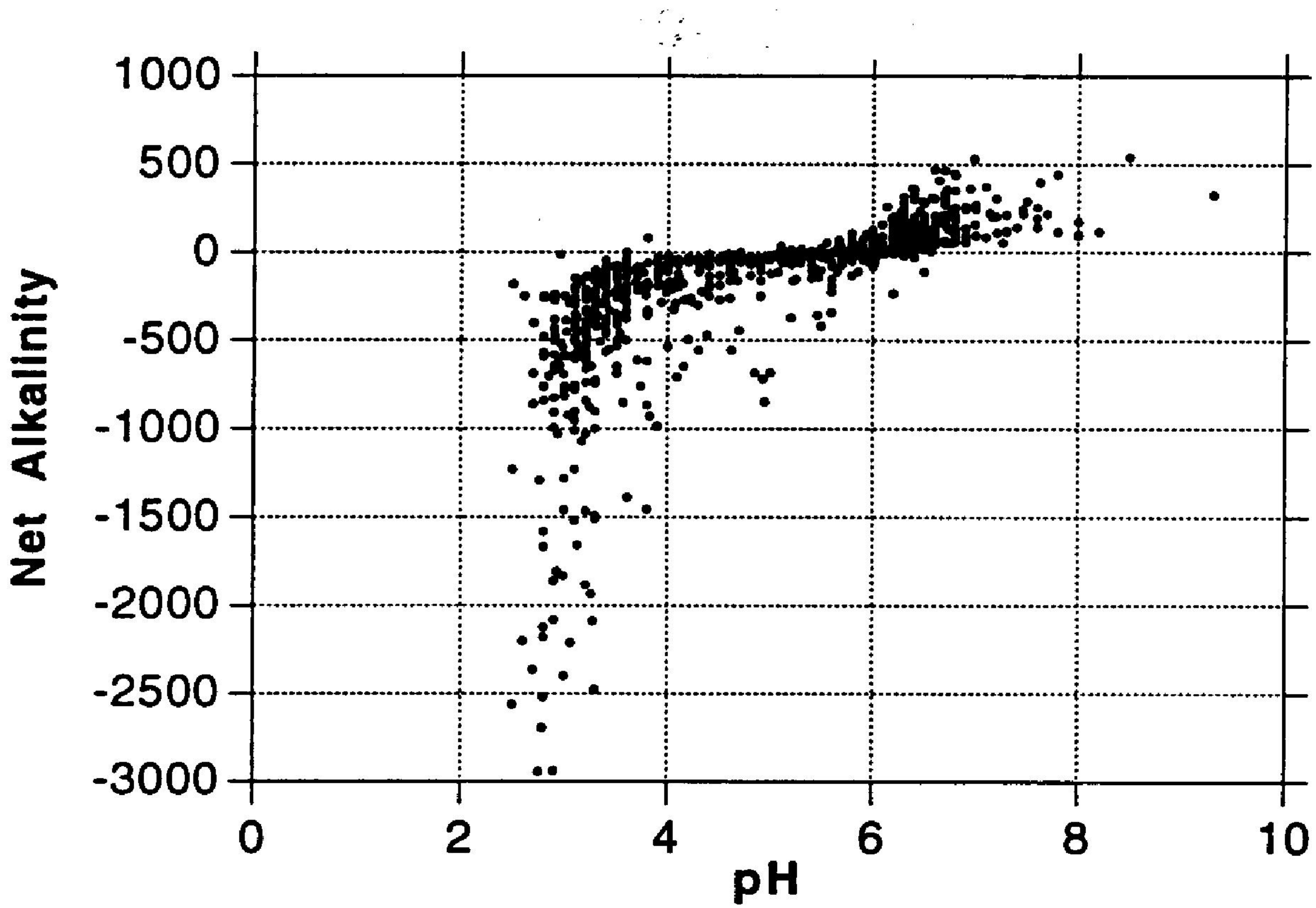


Figure 1. Net Alkalinity vs. pH. Taken from Figure 1.2 Graph C, pages 1-5, of Coal Mine Drainage Prediction and Pollution Prevention in Pennsylvania

Attachment C

TMDLs by Segment

Panther Creek Watershed

Panther Creek, a cold water fishery (CWF), is a tributary to the Little Schuylkill River, which eventually flows into the Schuylkill River. Panther Creek (stream code 02252) is identified as Segment 0432 under State Water Plan 3-A. One sample location, 003 was used for this Panther Creek TMDL.

Panther Creek was put on the 303(d) list for high metals as being the cause of the degradation to the stream. The method and rationale for addressing pH is contained in Attachment B. Following is an explanation of the TMDL for each allocation point.

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

The Panther Creek TMDL was revised applying a modification of the original methodology with the addition of a WLA for the proposed discharge. This method relies on a statistical analysis of available data and determining an average long-term allowable concentration that applies a safety factor based on the variability in the data. This factor was addressed in the TMDL revision to account for the more controllable effluent/stream quality when the pumping and discharge commence. Water quality data collected from 1996-2000, when the pumps were previously in operation, were available but not used in the original TMDL because pumping had ceased. There were approximately 40 samples that included chemistry, but no flow data were available. A 5-year daily flow record for Panther Creek, corresponding to the time period for which the previously mentioned water quality data were available, was created from a flow gage located downstream on the Little Schuylkill using a unit area method. Flows associated with the days when the data were collected were patched into the water quality data set to allow for the concentration/flow relationship to be developed for the watershed under conditions similar to those that will be encountered when the pumping resumes. That relationship was then applied to the entire 5-year daily flow record created for Panther Creek in order to assign a daily pollutant concentration. That dataset was then run through @Risk to determine the new long-term allowable concentrations and loads for Panther Creek in the proposed revision to the TMDL. The relationship between flow and concentration for Fe and Al is not clear. Pennsylvania soils are rich in Fe and Al, so at low flows the stream has high concentrations from mine drainage. Then at high flows, the sediment in the stream leads to high Fe and Al concentrations. The coal silt in Slum Creek is not rich in Mn and does not present the same problem. Therefore, the method of applying a LTA based on the flow/concentration relationship was applied only to Mn.

TMDL Calculation – Sampling Point 003 Panther Creek at the mouth of the stream at the confluence with Little Schuylkill River

The TMDL for sample point 003 consists of a load allocation to all of the area above the point shown in Attachment A. The average flow (26.59 MGD), is used for these computations.

There currently is not an entry for this segment on the Pa 303(d) list for impairment due to pH. Sample data at point 003 shows pH ranging between 5.1 and 7.6. For this reason pH will be addressed as part of this TMDL. The method and rationale for addressing pH is contained in Attachment B.

A TMDL for aluminum, iron, manganese and acidity at Sampling Point 003 has been calculated. Table C1 shows the measured and allowable concentrations and loads at Sampling Point 003. Table C2 shows the percent reductions for aluminum, iron, manganese and acidity required at this point.

Table C1. Load Allocations at Point 003

	Existing Conditions*		Allowable	
Parameter	Conc. (mg/l)	Load (lbs/day)	LTA Conc. (mg/l)	Load (lbs/day)
Al	1.73	384.0	0.52	115.0
Fe	2.11	468.4	1.44	319.0
Mn	2.00	444.3	0.80	178.0
Acidity	1.12	249.2	1.12	249.2
Alkalinity	66.58	14764.6		

* Long-term dataset constructed to represent long-term conditions with new discharge

Table C2. Calculation of Load Reduction at Point 003

	Al	Fe	Mn	Acidity
Existing Load at 003	384.0	468.4	444.3	249.2
Allowable Load at 003	115.0	319.0	178.0	249.2
Load Reduction at 003	269.0	149.4	266.3	0.0
% Reduction required at 003	70	32	60	0

BET Associates (SMP 54733020R2 & R3CB, PA0012360) is proposing to discharge from Outfalls 001, 003 and 004 into Panther Creek, a tributary to the Little Schuylkill River. The Waste Load Allocation associated with BET Associates' permit is determined from projected maximum discharge volume and in-stream criteria for aluminum and iron. The manganese WLA was calculated using projected maximum discharge volume and the average allowable monthly concentration as calculated by PennToxSD. The following table shows the waste load allocation for this discharge.

Table C3. BET Waste Load Allocations - Outfalls 001, 003, 004		
Parameter	Average Flow (MGD)	Allowable Load (lbs/day)
Al	14.4	90.1
Fe	14.4	180.1
Mn**	14.4	168.0

** Manganese in-stream criterion of 1.0 mg/l for protection of water supply use criterion based on potential for objectionable taste and laundry staining

Margin of Safety (MOS)

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

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

- A MOS is added when the calculations were performed with a daily iron average instead of the 30-day average.

Seasonal Variation

Seasonal variation is implicitly accounted for in this TMDL because the data used represent all seasons. The 40 data samples at Point 003 were collected during all months and seasons from 1996-2000, thus taking into account any seasonal influences and variation in the analysis.

Critical Conditions

A critical flow condition could not be identified from the data used for this analysis as concentrations of Fe and Al, and to a lesser degree Mn, were high at both low flows and during storm events and no seasonal component was present.

Attachment D

Excerpts Justifying Changes To The Section 303(d) Lists and Integrated Report/List

The following are excerpts from the Pennsylvania DEP Section 303(d) narratives that justify changes in listings between the 1996, 1998, 2002, 2004 and 2006 303(d) Lists and Integrated Report/List (2006). The Section 303(d) listing process has undergone an evolution in Pennsylvania since the development of the 1996 list.

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

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

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

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

<u>Migration to National Hydrography Data (NHD)</u>

New to the 2006 report is use of the 1/24,000 National Hydrography Data (NHD) streams GIS layer. Up until 2006 the Department relied upon its own internally developed stream layer. Subsequently, the United States Geologic Survey (USGS) developed 1/24,000 NHD streams layer for the Commonwealth based upon national geodatabase standards. In 2005, DEP contracted with USGS to add missing streams and correct any errors in the NHD. A GIS contractor transferred the old DEP stream assessment information to the improved NHD and the old DEP streams layer was archived. Overall, this marked an improvement in the quality of the streams layer and made the stream assessment data compatible with national standards but it necessitated a change in the Integrated Listing format. The NHD is not attributed with the old DEP five digit stream codes so segments can no longer be listed by stream code but rather only by stream name or a fixed combination of NHD fields known as reachcode and ComID. The NHD is aggregated by Hydrologic Unit Code (HUC) watersheds so HUCs rather than the old State Water Plan (SWP) watersheds are now used to group streams together. The map in

Appendix E illustrates the relationship between the old SWP and new HUC watershed delineations. A more basic change was the shift in data management philosophy from one of "dynamic segmentation" to "fixed segments". The dynamic segmentation records were proving too difficult to manage from an historical tracking perspective. The fixed segment methods will remedy that problem. The stream assessment data management has gone through many changes over the years as system requirements and software changed. It is hoped that with the shift to the NHD and OIT's (Office of Information Technology) fulltime staff to manage and maintain SLIMS the systems and formats will now remain stable over many Integrated Listing cycles.

Attachment E

Water Quality Dataset Used In TMDL Calculations

Original Data

DATE	Panther 003 cfs	Panther 003 + Discharge cfs	pH	Alk	Acid	Al	Fe	Mn
5/7/1996	34.79	45.93	6.4	36	2.4	2.38	1.49	2.39
6/4/1996	9.12	20.26	6.4	36	3.2	2.54	1.65	2.48
7/2/1996	28.31	39.45	6.2	34	0	2.31	1.54	2.53
8/5/1996	20.39	31.53	6.9	50	0	2.49	2.14	2.04
9/3/1996	5.04	16.18	6.7	44	0	2.3	1.71	2.1
10/7/1996	6.00	17.14	7.1	50	0	2.19	1.86	2.01
11/4/1996	16.79	27.93	6.4	42	0	2.49	1.86	2.21
12/2/1996	307.08	318.22	5.1	10.6	17	3.86	2.64	1.11
1/2/1997	26.15	37.29	6.3	36	5.8	5.2	4.19	2.7
2/3/1997	18.95	30.09	6.5	42	0	2.93	2.09	1.77
3/3/1997	25.19	36.33	6.9	74	0	1.59	1.66	1.8
4/3/1997	44.62	55.76	6.5	42	0	2.17	1.73	1.8
5/5/1997	13.67	24.81	7	72	0	1.27	1.49	1.68
6/4/1997	28.07	39.21	6.8	76	0	1.28	1.8	1.87
7/2/1997	10.08	21.22	6.9	60	0	8.77	15.1	1.91
8/4/1997	6.00	17.14	6.9	88	0	0.956	1.56	1.86
9/3/1997	4.32	15.46	6.8	90	0	1.08	1.52	1.74
10/1/1997	4.32	15.46	7	120	0	0.983	1.48	2.64
11/3/1997	8.40	19.54	7.5	112	0	0.837	1.23	2.27
12/3/1997	12.00	23.14	7.3	94	0	0.847	1.39	1.97
1/5/1998	13.91	25.05	6.9	88	0	0.84	1.53	1.78
2/2/1998	20.87	32.01	7.4	92	0	1.16	1.9	1.98
3/4/1998	44.86	56.00	7	86	0	1.65	1.93	2.21
4/1/1998	24.95	36.09	6.9	84	0	1.64	1.5	2.09
5/6/1998	23.99	35.13	7	90	0	1.34	1.62	2.5
6/3/1998	9.12	20.26	7	104	0	1.23	2.2	2.91
8/3/1998	3.12	14.26	7.4	120	0	0.976	1.64	2.6
9/2/1998	6.00	17.14	7.1	102	0	3.38	8.06	2.38
10/6/1998	2.30	13.44	7.6	118	0	0.577	1.82	2.16
11/2/1998	4.08	15.22	7.4	110	0	0.5	1.37	1.87
12/2/1998	4.08	15.22	6.8	56	0	0.984	1.2	1.81
4/5/1999	18.95	30.09	6.7	36	0	1.42	2.55	1.59
5/5/1999	7.20	18.34	6.9	68	0	0.984	1.37	1.62
6/2/1999	8.40	19.54	7.5	104	0	1.01	1.48	3.44
7/14/1999	2.40	13.54	6.6	42	0	3.01	3.78	4.84
9/8/1999	8.16	19.30	6.5	36	0	2.31	4.58	4.37
10/4/1999	22.55	33.69	6.6	44	0	1.53	1.96	1.16
11/3/1999	28.79	39.93	6.7	66	0	1.49	1.8	2.46
1/5/2000	15.11	26.25	6.3	24	3.4	3.62	3.83	3.35
2/2/2000	9.12	20.26	6.4	40	0	2.63	4.17	3.09
9/19/2000	5.76	16.90	6.9	96	0	1.13	1.82	2.66

Calculated Data

Date (YYYYMMDD)	Flow (mgd)	Mn (mg/l)	Al (mg/l)	Fe (mg/l)	acid (mg/l)	Date (YYYYMMDD)	Flow (mgd)	Mn (mg/l)	Al (mg/l)	Fe (mg/l)	acid (mg/l)
19960501	71.3032	1.4922	2.6079	2.0128	5.5611	19981201	16.88	2.24	1.44	2.153	0
19960502	61.6901	1.5452	2.4782	2.0245	4.9839	19981202	17.035	2.232	1.448	2.152	0
19960503	53.6275	1.5993	2.3566	2.0361	4.415	19981203	16.88	2.24	1.44	2.153	0
19960504	48.0456	1.6439	2.2637	2.0454	3.9599	19981204	16.725	2.247	1.433	2.155	0
19960505	43.2391	1.6887	2.1765	2.0546	3.5151	19981205	16.725	2.247	1.433	2.155	0
19960506	40.7583	1.7148	2.1283	2.0598	3.2617	19981206	16.88	2.24	1.44	2.153	0
19960507	36.882	1.7606	2.0478	2.0689	2.8257	19981207	16.725	2.247	1.433	2.155	0
19960508	34.8663	1.7874	2.0031	2.0741	2.5758	19981208	16.725	2.247	1.433	2.155	0
19960509	35.9517	1.7727	2.0274	2.0712	2.7125	19981209	16.88	2.24	1.44	2.153	0
19960510	34.5562	1.7917	1.996	2.0749	2.5358	19981210	16.725	2.247	1.433	2.155	0
19960511	40.2931	1.7199	2.119	2.0609	3.2122	19981211	16.725	2.247	1.433	2.155	0
19960512	58.279	1.5668	2.4284	2.0292	4.7542	19981212	16.725	2.247	1.433	2.155	0
19960513	48.5108	1.6399	2.2718	2.0446	4.0001	19981213	16.57	2.255	1.426	2.156	0
19960514	44.6345	1.675	2.2026	2.0518	3.6501	19981214	16.57	2.255	1.426	2.156	0
19960515	41.3785	1.708	2.1406	2.0585	3.3268	19981215	16.57	2.255	1.426	2.156	0
19960516	39.2077	1.7323	2.0969	2.0633	3.0937	19981216	16.57	2.255	1.426	2.156	0
19960517	36.7269	1.7626	2.0444	2.0693	2.8071	19981217	16.725	2.247	1.433	2.155	0
19960518	34.0911	1.7983	1.9853	2.0762	2.4749	19981218	16.725	2.247	1.433	2.155	0
19960519	32.0754	1.8287	1.9373	2.082	2.1981	19981219	16.57	2.255	1.426	2.156	0
19960520	30.2148	1.8595	1.8906	2.0878	1.9219	19981220	16.57	2.255	1.426	2.156	0
19960521	29.1295	1.8789	1.8621	2.0914	1.7502	19981221	16.57	2.255	1.426	2.156	0
19960522	28.3542	1.8934	1.8412	2.0941	1.6224	19981222	16.88	2.24	1.44	2.153	0
19960523	26.4936	1.9313	1.7887	2.101	1.2953	19981223	16.725	2.247	1.433	2.155	0
19960524	25.5633	1.9519	1.7612	2.1047	1.1197	19981224	16.57	2.255	1.426	2.156	0
19960525	24.4779	1.9776	1.7278	2.1092	0.9033	19981225	16.415	2.263	1.418	2.157	0
19960526	23.5476	2.0012	1.6981	2.1134	0.7066	19981226	16.415	2.263	1.418	2.157	0
19960527	24.0128	1.9892	1.7131	2.1113	0.8063	19981227	16.415	2.263	1.418	2.157	0
19960528	23.8577	1.9932	1.7081	2.112	0.7734	19981228	16.57	2.255	1.426	2.156	0
19960529	23.2375	2.0095	1.6879	2.1149	0.6386	19981229	16.57	2.255	1.426	2.156	0
19960530	22.3072	2.0354	1.6565	2.1194	0.4263	19981230	16.57	2.255	1.426	2.156	0
19960531	21.3769	2.0634	1.6238	2.1242	0.2005	19981231	16.26	2.272	1.411	2.158	0
19960601	20.9118	2.0783	1.6068	2.1267	0.082	19990101	16.415	2.263	1.418	2.157	0
19960602	20.4466	2.0937	1.5895	2.1293	0	19990102	16.415	2.263	1.418	2.157	0
19960603	20.2916	2.099	1.5837	2.1302	0	19990103	21.687	2.054	1.635	2.123	0.277
19960604	20.2916	2.099	1.5837	2.1302	0	19990104	22.152	2.04	1.651	2.12	0.39
19960605	21.532	2.0586	1.6293	2.1234	0.2391	19990105	19.206	2.138	1.541	2.137	0
19960606	20.4466	2.0937	1.5895	2.1293	0	19990106	18.741	2.157	1.522	2.14	0
19960607	19.9815	2.1099	1.5718	2.1321	0	19990107	18.431	2.169	1.509	2.142	0
19960608	19.8264	2.1154	1.5658	2.133	0	19990108	18.121	2.182	1.496	2.144	0
19960609	19.8264	2.1154	1.5658	2.133	0	19990109	18.741	2.157	1.522	2.14	0
19960610	37.1921	1.7567	2.0545	2.0681	2.8626	19990110	19.826	2.115	1.566	2.133	0
19960611	36.5719	1.7646	2.0411	2.0697	2.7884	19990111	20.602	2.088	1.595	2.128	0.001
19960612	46.03	1.6619	2.2281	2.0491	3.7801	19990112	20.602	2.088	1.595	2.128	0.001
19960613	39.6729	1.7269	2.1064	2.0623	3.1449	19990113	20.602	2.088	1.595	2.128	0.001
19960614	33.936	1.8006	1.9817	2.0766	2.4543	19990114	20.602	2.088	1.595	2.128	0.001
19960615	30.68	1.8515	1.9025	2.0863	1.9929	19990115	20.447	2.094	1.59	2.129	0
19960616	28.3542	1.8934	1.8412	2.0941	1.6224	19990116	20.292	2.099	1.584	2.13	0

Date (YYYYMMDD)	Flow (mgd)	Mn (mg/l)	Al (mg/l)	Fe (mg/l)	acid (mg/l)	Date (YYYYMMDD)	Flow (mgd)	Mn (mg/l)	Al (mg/l)	Fe (mg/l)	acid (mg/l)
19960617	32.2305	1.8262	1.9411	2.0815	2.2201	19990117	19.671	2.121	1.56	2.134	0
19960618	34.7113	1.7895	1.9996	2.0745	2.5559	19990118	35.021	1.785	2.007	2.074	2.596
19960619	33.0057	1.8143	1.9598	2.0793	2.3285	19990119	45.565	1.666	2.22	2.05	3.737
19960620	31.6103	1.8361	1.9259	2.0834	2.131	19990120	36.572	1.765	2.041	2.07	2.788
19960621	29.2845	1.876	1.8663	2.0908	1.7753	19990121	32.851	1.817	1.956	2.08	2.307
19960622	27.4239	1.9118	1.8154	2.0974	1.4626	19990122	33.161	1.812	1.963	2.079	2.35
19960623	26.1835	1.938	1.7797	2.1022	1.2377	19990123	40.448	1.718	2.122	2.061	3.229
19960624	26.6486	1.9279	1.7932	2.1004	1.3237	19990124	138.13	1.28	3.263	1.962	8.098
19960625	29.4396	1.8732	1.8704	2.0903	1.8001	19990125	108.36	1.353	3.01	1.98	7.182
19960626	25.5633	1.9519	1.7612	2.1047	1.1197	19990126	71.303	1.492	2.608	2.013	5.561
19960627	23.8577	1.9932	1.7081	2.112	0.7734	19990127	56.108	1.581	2.395	2.032	4.6
19960628	22.7724	2.0222	1.6723	2.1171	0.534	19990128	49.596	1.631	2.29	2.043	4.092
19960629	22.3072	2.0354	1.6565	2.1194	0.4263	19990129	44.945	1.672	2.208	2.051	3.679
19960630	44.7896	1.6735	2.2055	2.0515	3.6648	19990130	39.673	1.727	2.106	2.062	3.145
19960701	38.2774	1.7433	2.0776	2.0655	2.9889	19990131	35.642	1.777	2.021	2.072	2.674
19960702	32.6956	1.819	1.9524	2.0802	2.2855	19990201	33.006	1.814	1.96	2.079	2.328
19960703	31.1451	1.8437	1.9143	2.0848	2.0626	19990202	48.511	1.64	2.272	2.045	4
19960704	30.68	1.8515	1.9025	2.0863	1.9929	19990203	46.495	1.658	2.236	2.048	3.822
19960705	28.3542	1.8934	1.8412	2.0941	1.6224	19990204	42.154	1.7	2.156	2.057	3.406
19960706	26.6486	1.9279	1.7932	2.1004	1.3237	19990205	39.673	1.727	2.106	2.062	3.145
19960707	25.4082	1.9554	1.7565	2.1053	1.0896	19990206	37.192	1.757	2.055	2.068	2.863
19960708	25.0981	1.9627	1.7471	2.1066	1.0286	19990207	35.487	1.779	2.017	2.072	2.655
19960709	26.3385	1.9346	1.7842	2.1016	1.2666	19990208	34.711	1.79	2	2.075	2.556
19960710	23.5476	2.0012	1.6981	2.1134	0.7066	19990209	32.23	1.826	1.941	2.082	2.22
19960711	22.3072	2.0354	1.6565	2.1194	0.4263	19990210	30.835	1.849	1.906	2.086	2.016
19960712	21.687	2.0538	1.6348	2.1226	0.2774	19990211	29.75	1.868	1.879	2.089	1.849
19960713	46.03	1.6619	2.2281	2.0491	3.7801	19990212	29.75	1.868	1.879	2.089	1.849
19960714	41.6886	1.7047	2.1466	2.0578	3.3589	19990213	30.525	1.854	1.899	2.087	1.969
19960715	35.0214	1.7852	2.0066	2.0737	2.5957	19990214	28.819	1.885	1.854	2.092	1.7
19960716	32.0754	1.8287	1.9373	2.082	2.1981	19990215	27.734	1.906	1.824	2.096	1.517
19960717	29.7497	1.8676	1.8785	2.0893	1.8493	19990216	27.269	1.915	1.811	2.098	1.435
19960718	27.734	1.9056	1.8241	2.0963	1.5167	19990217	27.269	1.915	1.811	2.098	1.435
19960719	29.1295	1.8789	1.8621	2.0914	1.7502	19990218	28.199	1.896	1.837	2.095	1.596
19960720	27.4239	1.9118	1.8154	2.0974	1.4626	19990219	27.269	1.915	1.811	2.098	1.435
19960721	24.9431	1.9663	1.7423	2.1072	0.9977	19990220	26.339	1.935	1.784	2.102	1.267
19960722	24.3229	1.9814	1.7229	2.1099	0.8712	19990221	25.718	1.948	1.766	2.104	1.15
19960723	24.0128	1.9892	1.7131	2.1113	0.8063	19990222	24.633	1.974	1.733	2.109	0.935
19960724	23.2375	2.0095	1.6879	2.1149	0.6386	19990223	23.858	1.993	1.708	2.112	0.773
19960725	23.7027	1.9972	1.7031	2.1127	0.7402	19990224	23.858	1.993	1.708	2.112	0.773
19960726	34.4012	1.7939	1.9925	2.0753	2.5156	19990225	23.548	2.001	1.698	2.113	0.707
19960727	28.9744	1.8817	1.858	2.0919	1.725	19990226	23.393	2.005	1.693	2.114	0.673
19960728	25.5633	1.9519	1.7612	2.1047	1.1197	19990227	22.927	2.018	1.678	2.116	0.569
19960729	31.9204	1.8311	1.9335	2.0824	2.1758	19990228	25.098	1.963	1.747	2.107	1.029
19960730	32.8507	1.8167	1.9561	2.0797	2.3071	19990301	27.424	1.912	1.815	2.097	1.463
19960731	30.68	1.8515	1.9025	2.0863	1.9929	19990302	25.873	1.945	1.77	2.103	1.179
19960801	29.1295	1.8789	1.8621	2.0914	1.7502	19990303	24.478	1.978	1.728	2.109	0.903
19960802	27.734	1.9056	1.8241	2.0963	1.5167	19990304	35.176	1.783	2.01	2.073	2.615
19960803	28.0441	1.8995	1.8327	2.0952	1.5699	19990305	31.61	1.836	1.926	2.083	2.131
19960804	28.5092	1.8905	1.8454	2.0935	1.6483	19990306	30.99	1.846	1.91	2.085	2.04

Date (YYYYMMDD)	Flow (mgd)	Mn (mg/l)	Al (mg/l)	Fe (mg/l)	acid (mg/l)	Date (YYYYMMDD)	Flow (mgd)	Mn (mg/l)	Al (mg/l)	Fe (mg/l)	acid (mg/l)
19960805	27.5789	1.9087	1.8197	2.0969	1.4897	19990307	30.99	1.846	1.91	2.085	2.04
19960806	25.8734	1.9449	1.7705	2.1034	1.1792	19990308	29.129	1.879	1.862	2.091	1.75
19960807	24.788	1.97	1.7375	2.1079	0.9665	19990309	28.664	1.888	1.85	2.093	1.674
19960808	23.8577	1.9932	1.7081	2.112	0.7734	19990310	28.199	1.896	1.837	2.095	1.596
19960809	24.1678	1.9853	1.718	2.1106	0.8389	19990311	27.269	1.915	1.811	2.098	1.435
19960810	24.3229	1.9814	1.7229	2.1099	0.8712	19990312	26.649	1.928	1.793	2.1	1.324
19960811	22.7724	2.0222	1.6723	2.1171	0.534	19990313	25.408	1.955	1.757	2.105	1.09
19960812	21.8421	2.0492	1.6403	2.1217	0.3152	19990314	25.408	1.955	1.757	2.105	1.09
19960813	25.8734	1.9449	1.7705	2.1034	1.1792	19990315	26.804	1.925	1.798	2.1	1.352
19960814	23.7027	1.9972	1.7031	2.1127	0.7402	19990316	25.408	1.955	1.757	2.105	1.09
19960815	21.9971	2.0445	1.6457	2.1209	0.3526	19990317	25.563	1.952	1.761	2.105	1.12
19960816	22.3072	2.0354	1.6565	2.1194	0.4263	19990318	27.424	1.912	1.815	2.097	1.463
19960817	21.9971	2.0445	1.6457	2.1209	0.3526	19990319	26.959	1.921	1.802	2.099	1.38
19960818	20.9118	2.0783	1.6068	2.1267	0.082	19990320	26.028	1.941	1.775	2.103	1.209
19960819	20.2916	2.099	1.5837	2.1302	0	19990321	27.734	1.906	1.824	2.096	1.517
19960820	19.8264	2.1154	1.5658	2.133	0	19990322	48.976	1.636	2.28	2.044	4.04
19960821	19.6714	2.121	1.5597	2.1339	0	19990323	44.014	1.681	2.191	2.053	3.591
19960822	20.4466	2.0937	1.5895	2.1293	0	19990324	42.464	1.697	2.162	2.056	3.438
19960823	19.6714	2.121	1.5597	2.1339	0	19990325	39.828	1.725	2.11	2.062	3.162
19960824	19.6714	2.121	1.5597	2.1339	0	19990326	36.727	1.763	2.044	2.069	2.807
19960825	19.2062	2.1384	1.5412	2.1368	0	19990327	34.556	1.792	1.996	2.075	2.536
19960826	18.7411	2.1566	1.5222	2.1398	0	19990328	33.316	1.81	1.967	2.078	2.371
19960827	18.586	2.1629	1.5158	2.1409	0	19990329	31.61	1.836	1.926	2.083	2.131
19960828	18.431	2.1693	1.5092	2.1419	0	19990330	30.06	1.862	1.887	2.088	1.898
19960829	18.2759	2.1758	1.5027	2.143	0	19990331	28.819	1.885	1.854	2.092	1.7
19960830	17.9658	2.1891	1.4893	2.1452	0	19990401	28.354	1.893	1.841	2.094	1.622
19960831	17.9658	2.1891	1.4893	2.1452	0	19990402	27.889	1.903	1.828	2.096	1.543
19960901	17.9658	2.1891	1.4893	2.1452	0	19990403	26.804	1.925	1.798	2.1	1.352
19960902	17.8108	2.1959	1.4826	2.1463	0	19990404	27.734	1.906	1.824	2.096	1.517
19960903	17.6557	2.2029	1.4757	2.1474	0	19990405	26.649	1.928	1.793	2.1	1.324
19960904	17.6557	2.2029	1.4757	2.1474	0	19990406	25.408	1.955	1.757	2.105	1.09
19960905	17.8108	2.1959	1.4826	2.1463	0	19990407	24.788	1.97	1.738	2.108	0.966
19960906	17.8108	2.1959	1.4826	2.1463	0	19990408	24.013	1.989	1.713	2.111	0.806
19960907	22.7724	2.0222	1.6723	2.1171	0.534	19990409	25.563	1.952	1.761	2.105	1.12
19960908	20.6017	2.0885	1.5953	2.1285	0.0007	19990410	29.285	1.876	1.866	2.091	1.775
19960909	19.0512	2.1444	1.5349	2.1378	0	19990411	27.114	1.918	1.807	2.099	1.408
19960910	18.2759	2.1758	1.5027	2.143	0	19990412	27.269	1.915	1.811	2.098	1.435
19960911	18.2759	2.1758	1.5027	2.143	0	19990413	26.183	1.938	1.78	2.102	1.238
19960912	18.1209	2.1824	1.496	2.1441	0	19990414	25.563	1.952	1.761	2.105	1.12
19960913	19.2062	2.1384	1.5412	2.1368	0	19990415	25.253	1.959	1.752	2.106	1.059
19960914	19.0512	2.1444	1.5349	2.1378	0	19990416	26.028	1.941	1.775	2.103	1.209
19960915	18.2759	2.1758	1.5027	2.143	0	19990417	26.339	1.935	1.784	2.102	1.267
19960916	17.9658	2.1891	1.4893	2.1452	0	19990418	25.563	1.952	1.761	2.105	1.12
19960917	26.0284	1.9414	1.7751	2.1028	1.2086	19990419	24.943	1.966	1.742	2.107	0.998
19960918	26.8037	1.9247	1.7977	2.0998	1.3519	19990420	24.943	1.966	1.742	2.107	0.998
19960919	23.0825	2.0137	1.6827	2.1156	0.6041	19990421	29.75	1.868	1.879	2.089	1.849
19960920	21.2219	2.0683	1.6182	2.125	0.1614	19990422	34.556	1.792	1.996	2.075	2.536
19960921	20.4466	2.0937	1.5895	2.1293	0	19990423	34.866	1.787	2.003	2.074	2.576
19960922	20.4466	2.0937	1.5895	2.1293	0	19990424	34.711	1.79	2	2.075	2.556

Date (YYYYMMDD)	Flow (mgd)	Mn (mg/l)	Al (mg/l)	Fe (mg/l)	acid (mg/l)	Date (YYYYMMDD)	Flow (mgd)	Mn (mg/l)	Al (mg/l)	Fe (mg/l)	acid (mg/l)
19960923	20.2916	2.099	1.5837	2.1302	0	19990425	32.696	1.819	1.952	2.08	2.286
19960924	19.9815	2.1099	1.5718	2.1321	0	19990426	29.129	1.879	1.862	2.091	1.75
19960925	19.5163	2.1267	1.5536	2.1349	0	19990427	23.082	2.014	1.683	2.116	0.604
19960926	18.8961	2.1505	1.5286	2.1388	0	19990428	20.137	2.104	1.578	2.131	0
19960927	18.7411	2.1566	1.5222	2.1398	0	19990429	19.826	2.115	1.566	2.133	0
19960928	19.8264	2.1154	1.5658	2.133	0	19990430	19.671	2.121	1.56	2.134	0
19960929	23.3926	2.0053	1.693	2.1141	0.6728	19990501	19.516	2.127	1.554	2.135	0
19960930	20.6017	2.0885	1.5953	2.1285	0.0007	19990502	19.671	2.121	1.56	2.134	0
19961001	19.6714	2.121	1.5597	2.1339	0	19990503	19.361	2.133	1.547	2.136	0
19961002	19.3613	2.1325	1.5474	2.1359	0	19990504	19.206	2.138	1.541	2.137	0
19961003	19.2062	2.1384	1.5412	2.1368	0	19990505	19.051	2.144	1.535	2.138	0
19961004	18.7411	2.1566	1.5222	2.1398	0	19990506	19.051	2.144	1.535	2.138	0
19961005	18.586	2.1629	1.5158	2.1409	0	19990507	19.051	2.144	1.535	2.138	0
19961006	18.431	2.1693	1.5092	2.1419	0	19990508	20.292	2.099	1.584	2.13	0
19961007	18.2759	2.1758	1.5027	2.143	0	19990509	20.137	2.104	1.578	2.131	0
19961008	19.5163	2.1267	1.5536	2.1349	0	19990510	19.206	2.138	1.541	2.137	0
19961009	22.4623	2.031	1.6618	2.1186	0.4626	19990511	18.741	2.157	1.522	2.14	0
19961010	21.3769	2.0634	1.6238	2.1242	0.2005	19990512	18.431	2.169	1.509	2.142	0
19961011	20.1365	2.1044	1.5778	2.1311	0	19990513	18.276	2.176	1.503	2.143	0
19961012	19.5163	2.1267	1.5536	2.1349	0	19990514	17.966	2.189	1.489	2.145	0
19961013	19.5163	2.1267	1.5536	2.1349	0	19990515	17.966	2.189	1.489	2.145	0
19961014	19.3613	2.1325	1.5474	2.1359	0	19990516	17.811	2.196	1.483	2.146	0
19961015	19.0512	2.1444	1.5349	2.1378	0	19990517	17.656	2.203	1.476	2.147	0
19961016	18.8961	2.1505	1.5286	2.1388	0	19990518	17.656	2.203	1.476	2.147	0
19961017	18.8961	2.1505	1.5286	2.1388	0	19990519	17.811	2.196	1.483	2.146	0
19961018	19.0512	2.1444	1.5349	2.1378	0	19990520	17.811	2.196	1.483	2.146	0
19961019	152.5498	1.2516	3.3723	1.9548	8.4695	19990521	17.501	2.21	1.469	2.149	0
19961020	159.372	1.2393	3.4212	1.9516	8.6325	19990522	17.346	2.217	1.462	2.15	0
19961021	119.8341	1.3221	3.1128	1.9727	7.5636	19990523	18.431	2.169	1.509	2.142	0
19961022	75.0245	1.4742	2.6545	2.0087	5.7616	19990524	26.494	1.931	1.789	2.101	1.295
19961023	55.4881	1.5858	2.3859	2.0333	4.5546	19990525	27.269	1.915	1.811	2.098	1.435
19961024	50.9916	1.6195	2.3138	2.0404	4.2073	19990526	24.013	1.989	1.713	2.111	0.806
19961025	43.8593	1.6825	2.1882	2.0534	3.5757	19990527	22.772	2.022	1.672	2.117	0.534
19961026	39.8279	1.7252	2.1096	2.0619	3.1619	19990528	21.997	2.045	1.646	2.121	0.353
19961027	37.5022	1.7528	2.0612	2.0674	2.8991	19990529	21.377	2.063	1.624	2.124	0.2
19961028	36.1067	1.7706	2.0309	2.0708	2.7316	19990530	20.912	2.078	1.607	2.127	0.082
19961029	33.0057	1.8143	1.9598	2.0793	2.3285	19990531	20.447	2.094	1.59	2.129	0
19961030	31.4552	1.8386	1.922	2.0839	2.1084	19990601	20.137	2.104	1.578	2.131	0
19961031	29.9047	1.8649	1.8826	2.0888	1.8737	19990602	19.826	2.115	1.566	2.133	0
19961101	29.1295	1.8789	1.8621	2.0914	1.7502	19990603	19.516	2.127	1.554	2.135	0
19961102	27.734	1.9056	1.8241	2.0963	1.5167	19990604	19.051	2.144	1.535	2.138	0
19961103	26.4936	1.9313	1.7887	2.101	1.2953	19990605	18.741	2.157	1.522	2.14	0
19961104	25.2532	1.959	1.7518	2.1059	1.0592	19990606	18.276	2.176	1.503	2.143	0
19961105	24.788	1.97	1.7375	2.1079	0.9665	19990607	18.276	2.176	1.503	2.143	0
19961106	24.1678	1.9853	1.718	2.1106	0.8389	19990608	19.206	2.138	1.541	2.137	0
19961107	24.1678	1.9853	1.718	2.1106	0.8389	19990609	18.276	2.176	1.503	2.143	0
19961108	65.8765	1.5208	2.5364	2.0192	5.2468	19990610	17.966	2.189	1.489	2.145	0
19961109	157.2013	1.2431	3.4058	1.9526	8.5814	19990611	17.811	2.196	1.483	2.146	0
19961110	105.7245	1.3606	2.9847	1.9821	7.0881	19990612	17.656	2.203	1.476	2.147	0

Date (YYYYMMDD)	Flow (mgd)	Mn (mg/l)	Al (mg/l)	Fe (mg/l)	acid (mg/l)	Date (YYYYMMDD)	Flow (mgd)	Mn (mg/l)	Al (mg/l)	Fe (mg/l)	acid (mg/l)
19961111	76.1098	1.4692	2.6678	2.0076	5.818	19990613	17.501	2.21	1.469	2.149	0
19961112	56.4184	1.5793	2.4002	2.0319	4.6224	19990614	18.276	2.176	1.503	2.143	0
19961113	46.9603	1.6534	2.2447	2.0474	3.8642	19990615	18.741	2.157	1.522	2.14	0
19961114	42.3088	1.6982	2.1587	2.0565	3.4222	19990616	17.966	2.189	1.489	2.145	0
19961115	38.7426	1.7377	2.0873	2.0644	3.0417	19990617	18.431	2.169	1.509	2.142	0
19961116	35.9517	1.7727	2.0274	2.0712	2.7125	19990618	21.222	2.068	1.618	2.125	0.161
19961117	34.0911	1.7983	1.9853	2.0762	2.4749	19990619	18.586	2.163	1.516	2.141	0
19961118	32.6956	1.819	1.9524	2.0802	2.2855	19990620	17.811	2.196	1.483	2.146	0
19961119	32.6956	1.819	1.9524	2.0802	2.2855	19990621	17.501	2.21	1.469	2.149	0
19961120	30.5249	1.8541	1.8986	2.0868	1.9694	19990622	17.346	2.217	1.462	2.15	0
19961121	28.8194	1.8846	1.8538	2.0924	1.6996	19990623	17.191	2.225	1.455	2.151	0
19961122	27.5789	1.9087	1.8197	2.0969	1.4897	19990624	17.191	2.225	1.455	2.151	0
19961123	26.3385	1.9346	1.7842	2.1016	1.2666	19990625	17.035	2.232	1.448	2.152	0
19961124	25.5633	1.9519	1.7612	2.1047	1.1197	19990626	16.88	2.24	1.44	2.153	0
19961125	24.788	1.97	1.7375	2.1079	0.9665	19990627	16.88	2.24	1.44	2.153	0
19961126	36.1067	1.7706	2.0309	2.0708	2.7316	19990628	17.191	2.225	1.455	2.151	0
19961127	33.6259	1.8051	1.9744	2.0775	2.4129	19990629	17.191	2.225	1.455	2.151	0
19961128	30.68	1.8515	1.9025	2.0863	1.9929	19990630	17.035	2.232	1.448	2.152	0
19961129	30.2148	1.8595	1.8906	2.0878	1.9219	19990701	16.88	2.24	1.44	2.153	0
19961130	29.7497	1.8676	1.8785	2.0893	1.8493	19990702	16.725	2.247	1.433	2.155	0
19961201	93.9406	1.3984	2.8677	1.9912	6.6355	19990703	16.725	2.247	1.433	2.155	0
19961202	212.8645	1.1617	3.7606	1.9307	9.7027	19990704	16.725	2.247	1.433	2.155	0
19961203	152.3947	1.2519	3.3712	1.9549	8.4657	19990705	16.57	2.255	1.426	2.156	0
19961204	114.7174	1.3353	3.0677	1.976	7.3984	19990706	16.26	2.272	1.411	2.158	0
19961205	79.3659	1.4547	2.7067	2.0043	5.982	19990707	16.105	2.28	1.403	2.16	0
19961206	67.8921	1.5098	2.5635	2.0167	5.3668	19990708	15.95	2.289	1.395	2.161	0
19961207	55.9532	1.5826	2.3931	2.0326	4.5886	19990709	15.95	2.289	1.395	2.161	0
19961208	50.3714	1.6245	2.3035	2.0414	4.1566	19990710	16.57	2.255	1.426	2.156	0
19961209	45.4098	1.6676	2.2168	2.0503	3.7229	19990711	16.26	2.272	1.411	2.158	0
19961210	41.5335	1.7064	2.1436	2.0582	3.3429	19990712	16.105	2.28	1.403	2.16	0
19961211	39.5178	1.7287	2.1033	2.0626	3.1279	19990713	15.95	2.289	1.395	2.161	0
19961212	41.9987	1.7015	2.1527	2.0572	3.3907	19990714	15.95	2.289	1.395	2.161	0
19961213	73.629	1.4808	2.6372	2.0102	5.6877	19990715	15.95	2.289	1.395	2.161	0
19961214	107.8952	1.3543	3.0052	1.9806	7.1655	19990716	15.919	2.291	1.394	2.161	0
19961215	91.4598	1.4071	2.8417	1.9932	6.5324	19990717	16.26	2.272	1.411	2.158	0
19961216	74.2492	1.4779	2.6449	2.0096	5.7207	19990718	16.57	2.255	1.426	2.156	0
19961217	62.9305	1.5378	2.4957	2.0229	5.0638	19990719	16.26	2.272	1.411	2.158	0
19961218	57.1936	1.5741	2.4121	2.0307	4.6779	19990720	16.26	2.272	1.411	2.158	0
19961219	53.9376	1.597	2.3616	2.0356	4.4386	19990721	16.105	2.28	1.403	2.16	0
19961220	49.286	1.6334	2.2851	2.0433	4.0662	19990722	15.95	2.289	1.395	2.161	0
19961221	44.6345	1.675	2.2026	2.0518	3.6501	19990723	15.935	2.29	1.395	2.161	0
19961222	41.6886	1.7047	2.1466	2.0578	3.3589	19990724	15.811	2.297	1.388	2.162	0
19961223	39.8279	1.7252	2.1096	2.0619	3.1619	19990725	15.749	2.3	1.385	2.163	0
19961224	40.9133	1.7131	2.1314	2.0595	3.2781	19990726	15.687	2.304	1.382	2.163	0
19961225	41.2234	1.7097	2.1375	2.0588	3.3106	19990727	15.578	2.31	1.377	2.164	0
19961226	37.037	1.7586	2.0512	2.0685	2.8442	19990728	15.532	2.313	1.374	2.165	0
19961227	35.7966	1.7747	2.024	2.0716	2.6933	19990729	15.516	2.314	1.373	2.165	0
19961228	35.0214	1.7852	2.0066	2.0737	2.5957	19990730	15.516	2.314	1.373	2.165	0
19961229	35.6416	1.7768	2.0205	2.072	2.674	19990731	15.516	2.314	1.373	2.165	0

Date (YYYYMMDD)	Flow (mgd)	Mn (mg/l)	Al (mg/l)	Fe (mg/l)	acid (mg/l)	Date (YYYYMMDD)	Flow (mgd)	Mn (mg/l)	Al (mg/l)	Fe (mg/l)	acid (mg/l)
19961230	35.7966	1.7747	2.024	2.0716	2.6933	19990801	15.423	2.32	1.369	2.166	0
19961231	33.6259	1.8051	1.9744	2.0775	2.4129	19990802	15.376	2.322	1.366	2.166	0
19970101	31.9204	1.8311	1.9335	2.0824	2.1758	19990803	15.392	2.321	1.367	2.166	0
19970102	31.3002	1.8411	1.9181	2.0843	2.0856	19990804	15.376	2.322	1.366	2.166	0
19970103	31.1451	1.8437	1.9143	2.0848	2.0626	19990805	15.361	2.323	1.365	2.166	0
19970104	30.2148	1.8595	1.8906	2.0878	1.9219	19990806	15.314	2.326	1.363	2.167	0
19970105	30.0598	1.8622	1.8866	2.0883	1.8978	19990807	15.33	2.325	1.364	2.167	0
19970106	29.2845	1.876	1.8663	2.0908	1.7753	19990808	15.609	2.308	1.378	2.164	0
19970107	27.5789	1.9087	1.8197	2.0969	1.4897	19990809	15.563	2.311	1.376	2.165	0
19970108	26.0284	1.9414	1.7751	2.1028	1.2086	19990810	15.423	2.32	1.369	2.166	0
19970109	25.8734	1.9449	1.7705	2.1034	1.1792	19990811	15.392	2.321	1.367	2.166	0
19970110	26.4936	1.9313	1.7887	2.101	1.2953	19990812	15.361	2.323	1.365	2.166	0
19970111	25.2532	1.959	1.7518	2.1059	1.0592	19990813	15.733	2.301	1.385	2.163	0
19970112	23.7027	1.9972	1.7031	2.1127	0.7402	19990814	18.586	2.163	1.516	2.141	0
19970113	23.3926	2.0053	1.693	2.1141	0.6728	19990815	16.415	2.263	1.418	2.157	0
19970114	23.3926	2.0053	1.693	2.1141	0.6728	19990816	15.935	2.29	1.395	2.161	0
19970115	22.9274	2.0179	1.6776	2.1163	0.5692	19990817	15.733	2.301	1.385	2.163	0
19970116	25.7183	1.9483	1.7659	2.104	1.1496	19990818	15.609	2.308	1.378	2.164	0
19970117	23.7027	1.9972	1.7031	2.1127	0.7402	19990819	15.516	2.314	1.373	2.165	0
19970118	22.9274	2.0179	1.6776	2.1163	0.5692	19990820	15.64	2.307	1.38	2.164	0
19970119	22.9274	2.0179	1.6776	2.1163	0.5692	19990821	15.857	2.294	1.391	2.162	0
19970120	22.9274	2.0179	1.6776	2.1163	0.5692	19990822	15.718	2.302	1.384	2.163	0
19970121	22.9274	2.0179	1.6776	2.1163	0.5692	19990823	15.547	2.312	1.375	2.165	0
19970122	22.4623	2.031	1.6618	2.1186	0.4626	19990824	15.5	2.315	1.373	2.165	0
19970123	23.2375	2.0095	1.6879	2.1149	0.6386	19990825	15.485	2.316	1.372	2.165	0
19970124	23.3926	2.0053	1.693	2.1141	0.6728	19990826	15.687	2.304	1.382	2.163	0
19970125	33.1608	1.812	1.9635	2.0788	2.3498	19990827	15.594	2.309	1.377	2.164	0
19970126	30.3699	1.8568	1.8946	2.0873	1.9457	19990828	15.547	2.312	1.375	2.165	0
19970127	26.6486	1.9279	1.7932	2.1004	1.3237	19990829	15.423	2.32	1.369	2.166	0
19970128	30.3699	1.8568	1.8946	2.0873	1.9457	19990830	15.299	2.327	1.362	2.167	0
19970129	28.8194	1.8846	1.8538	2.0924	1.6996	19990831	15.423	2.32	1.369	2.166	0
19970130	26.1835	1.938	1.7797	2.1022	1.2377	19990901	15.175	2.335	1.355	2.168	0
19970131	25.5633	1.9519	1.7612	2.1047	1.1197	19990902	15.237	2.331	1.359	2.168	0
19970201	25.5633	1.9519	1.7612	2.1047	1.1197	19990903	15.299	2.327	1.362	2.167	0
19970202	25.0981	1.9627	1.7471	2.1066	1.0286	19990904	15.19	2.334	1.356	2.168	0
19970203	26.6486	1.9279	1.7932	2.1004	1.3237	19990905	15.345	2.324	1.364	2.167	0
19970204	27.1138	1.9182	1.8066	2.0986	1.4077	19990906	16.415	2.263	1.418	2.157	0
19970205	37.6572	1.7509	2.0645	2.067	2.9173	19990907	25.563	1.952	1.761	2.105	1.12
19970206	35.1764	1.7831	2.0101	2.0733	2.6154	19990908	19.671	2.121	1.56	2.134	0
19970207	31.1451	1.8437	1.9143	2.0848	2.0626	19990909	17.346	2.217	1.462	2.15	0
19970208	29.4396	1.8732	1.8704	2.0903	1.8001	19990910	16.725	2.247	1.433	2.155	0
19970209	28.0441	1.8995	1.8327	2.0952	1.5699	19990911	16.26	2.272	1.411	2.158	0
19970210	26.9587	1.9214	1.8022	2.0992	1.3799	19990912	15.95	2.289	1.395	2.161	0
19970211	26.0284	1.9414	1.7751	2.1028	1.2086	19990913	15.826	2.296	1.389	2.162	0
19970212	25.4082	1.9554	1.7565	2.1053	1.0896	19990914	15.749	2.3	1.385	2.163	0
19970213	24.9431	1.9663	1.7423	2.1072	0.9977	19990915	15.935	2.29	1.395	2.161	0
19970214	25.4082	1.9554	1.7565	2.1053	1.0896	19990916	50.681	1.622	2.309	2.041	4.182
19970215	25.5633	1.9519	1.7612	2.1047	1.1197	19990917	70.063	1.498	2.592	2.014	5.492
19970216	24.788	1.97	1.7375	2.1079	0.9665	19990918	37.967	1.747	2.071	2.066	2.953

Date (YYYYMMDD)	Flow (mgd)	Mn (mg/l)	Al (mg/l)	Fe (mg/l)	acid (mg/l)	Date (YYYYMMDD)	Flow (mgd)	Mn (mg/l)	Al (mg/l)	Fe (mg/l)	acid (mg/l)
19970217	23.8577	1.9932	1.7081	2.112	0.7734	19990919	28.974	1.882	1.858	2.092	1.725
19970218	23.5476	2.0012	1.6981	2.1134	0.7066	19990920	25.718	1.948	1.766	2.104	1.15
19970219	26.1835	1.938	1.7797	2.1022	1.2377	19990921	26.804	1.925	1.798	2.1	1.352
19970220	31.3002	1.8411	1.9181	2.0843	2.0856	19990922	28.509	1.89	1.845	2.094	1.648
19970221	31.1451	1.8437	1.9143	2.0848	2.0626	19990923	25.563	1.952	1.761	2.105	1.12
19970222	38.7426	1.7377	2.0873	2.0644	3.0417	19990924	23.703	1.997	1.703	2.113	0.74
19970223	39.2077	1.7323	2.0969	2.0633	3.0937	19990925	22.772	2.022	1.672	2.117	0.534
19970224	37.8123	1.7489	2.0678	2.0666	2.9353	19990926	21.532	2.059	1.629	2.123	0.239
19970225	35.9517	1.7727	2.0274	2.0712	2.7125	19990927	20.912	2.078	1.607	2.127	0.082
19970226	34.2461	1.7961	1.9889	2.0758	2.4953	19990928	20.447	2.094	1.59	2.129	0
19970227	34.0911	1.7983	1.9853	2.0762	2.4749	19990929	20.292	2.099	1.584	2.13	0
19970228	32.5406	1.8214	1.9486	2.0806	2.2639	19990930	41.378	1.708	2.141	2.058	3.327
19970301	30.68	1.8515	1.9025	2.0863	1.9929	19991001	32.075	1.829	1.937	2.082	2.198
19970302	31.4552	1.8386	1.922	2.0839	2.1084	19991002	28.974	1.882	1.858	2.092	1.725
19970303	30.68	1.8515	1.9025	2.0863	1.9929	19991003	27.269	1.915	1.811	2.098	1.435
19970304	30.3699	1.8568	1.8946	2.0873	1.9457	19991004	28.974	1.882	1.858	2.092	1.725
19970305	30.5249	1.8541	1.8986	2.0868	1.9694	19991005	28.974	1.882	1.858	2.092	1.725
19970306	37.8123	1.7489	2.0678	2.0666	2.9353	19991006	26.183	1.938	1.78	2.102	1.238
19970307	35.4865	1.7789	2.0171	2.0725	2.6546	19991007	24.788	1.97	1.738	2.108	0.966
19970308	34.8663	1.7874	2.0031	2.0741	2.5758	19991008	24.013	1.989	1.713	2.111	0.806
19970309	34.0911	1.7983	1.9853	2.0762	2.4749	19991009	23.703	1.997	1.703	2.113	0.74
19970310	34.0911	1.7983	1.9853	2.0762	2.4749	19991010	27.424	1.912	1.815	2.097	1.463
19970311	32.8507	1.8167	1.9561	2.0797	2.3071	19991011	27.734	1.906	1.824	2.096	1.517
19970312	31.1451	1.8437	1.9143	2.0848	2.0626	19991012	25.253	1.959	1.752	2.106	1.059
19970313	29.5946	1.8704	1.8744	2.0898	1.8248	19991013	24.788	1.97	1.738	2.108	0.966
19970314	34.8663	1.7874	2.0031	2.0741	2.5758	19991014	25.253	1.959	1.752	2.106	1.059
19970315	41.3785	1.708	2.1406	2.0585	3.3268	19991015	24.168	1.985	1.718	2.111	0.839
19970316	38.4325	1.7414	2.0808	2.0651	3.0066	19991016	23.548	2.001	1.698	2.113	0.707
19970317	37.3471	1.7547	2.0578	2.0677	2.8809	19991017	23.082	2.014	1.683	2.116	0.604
19970318	36.5719	1.7646	2.0411	2.0697	2.7884	19991018	23.082	2.014	1.683	2.116	0.604
19970319	35.0214	1.7852	2.0066	2.0737	2.5957	19991019	22.152	2.04	1.651	2.12	0.39
19970320	33.6259	1.8051	1.9744	2.0775	2.4129	19991020	22.307	2.035	1.657	2.119	0.426
19970321	32.2305	1.8262	1.9411	2.0815	2.2201	19991021	21.997	2.045	1.646	2.121	0.353
19970322	31.6103	1.8361	1.9259	2.0834	2.131	19991022	21.377	2.063	1.624	2.124	0.2
19970323	29.7497	1.8676	1.8785	2.0893	1.8493	19991023	21.067	2.073	1.613	2.126	0.122
19970324	28.3542	1.8934	1.8412	2.0941	1.6224	19991024	20.447	2.094	1.59	2.129	0
19970325	27.2688	1.915	1.811	2.098	1.4352	19991025	20.137	2.104	1.578	2.131	0
19970326	31.6103	1.8361	1.9259	2.0834	2.131	19991026	19.671	2.121	1.56	2.134	0
19970327	29.5946	1.8704	1.8744	2.0898	1.8248	19991027	19.516	2.127	1.554	2.135	0
19970328	28.0441	1.8995	1.8327	2.0952	1.5699	19991028	19.361	2.133	1.547	2.136	0
19970329	27.5789	1.9087	1.8197	2.0969	1.4897	19991029	19.206	2.138	1.541	2.137	0
19970330	27.1138	1.9182	1.8066	2.0986	1.4077	19991030	18.896	2.15	1.529	2.139	0
19970331	34.0911	1.7983	1.9853	2.0762	2.4749	19991031	18.741	2.157	1.522	2.14	0
19970401	36.2618	1.7686	2.0343	2.0705	2.7507	19991101	18.741	2.157	1.522	2.14	0
19970402	35.3315	1.781	2.0136	2.0729	2.6351	19991102	25.563	1.952	1.761	2.105	1.12
19970403	43.2391	1.6887	2.1765	2.0546	3.5151	19991103	33.006	1.814	1.96	2.079	2.328
19970404	49.4411	1.6321	2.2877	2.043	4.0793	19991104	28.354	1.893	1.841	2.094	1.622
19970405	48.3557	1.6412	2.2691	2.0449	3.9868	19991105	26.339	1.935	1.784	2.102	1.267
19970406	45.0997	1.6705	2.2112	2.0509	3.694	19991106	25.563	1.952	1.761	2.105	1.12

Date (YYYYMMDD)	Flow (mgd)	Mn (mg/l)	Al (mg/l)	Fe (mg/l)	acid (mg/l)	Date (YYYYMMDD)	Flow (mgd)	Mn (mg/l)	Al (mg/l)	Fe (mg/l)	acid (mg/l)
19970407	41.8436	1.7031	2.1497	2.0575	3.3748	19991107	24.788	1.97	1.738	2.108	0.966
19970408	37.9673	1.747	2.071	2.0662	2.9533	19991108	24.013	1.989	1.713	2.111	0.806
19970409	35.6416	1.7768	2.0205	2.072	2.674	19991109	23.548	2.001	1.698	2.113	0.707
19970410	33.3158	1.8097	1.9671	2.0784	2.3709	19991110	23.858	1.993	1.708	2.112	0.773
19970411	31.6103	1.8361	1.9259	2.0834	2.131	19991111	23.393	2.005	1.693	2.114	0.673
19970412	31.3002	1.8411	1.9181	2.0843	2.0856	19991112	22.152	2.04	1.651	2.12	0.39
19970413	34.7113	1.7895	1.9996	2.0745	2.5559	19991113	21.687	2.054	1.635	2.123	0.277
19970414	30.835	1.8489	1.9064	2.0858	2.0163	19991114	21.532	2.059	1.629	2.123	0.239
19970415	28.6643	1.8875	1.8496	2.093	1.6741	19991115	21.067	2.073	1.613	2.126	0.122
19970416	27.4239	1.9118	1.8154	2.0974	1.4626	19991116	20.602	2.088	1.595	2.128	0.001
19970417	31.9204	1.8311	1.9335	2.0824	2.1758	19991117	20.137	2.104	1.578	2.131	0
19970418	35.1764	1.7831	2.0101	2.0733	2.6154	19991118	19.671	2.121	1.56	2.134	0
19970419	34.0911	1.7983	1.9853	2.0762	2.4749	19991119	19.671	2.121	1.56	2.134	0
19970420	33.3158	1.8097	1.9671	2.0784	2.3709	19991120	19.671	2.121	1.56	2.134	0
19970421	32.3855	1.8238	1.9449	2.0811	2.2421	19991121	20.137	2.104	1.578	2.131	0
19970422	31.1451	1.8437	1.9143	2.0848	2.0626	19991122	19.826	2.115	1.566	2.133	0
19970423	31.3002	1.8411	1.9181	2.0843	2.0856	19991123	19.516	2.127	1.554	2.135	0
19970424	28.1991	1.8964	1.837	2.0946	1.5962	19991124	19.826	2.115	1.566	2.133	0
19970425	24.4779	1.9776	1.7278	2.1092	0.9033	19991125	21.222	2.068	1.618	2.125	0.161
19970426	22.6173	2.0266	1.6671	2.1178	0.4985	19991126	25.098	1.963	1.747	2.107	1.029
19970427	22.6173	2.0266	1.6671	2.1178	0.4985	19991127	43.239	1.689	2.176	2.055	3.515
19970428	25.5633	1.9519	1.7612	2.1047	1.1197	19991128	35.176	1.783	2.01	2.073	2.615
19970429	23.8577	1.9932	1.7081	2.112	0.7734	19991129	32.075	1.829	1.937	2.082	2.198
19970430	22.9274	2.0179	1.6776	2.1163	0.5692	19991130	30.37	1.857	1.895	2.087	1.946
19970501	22.7724	2.0222	1.6723	2.1171	0.534	19991201	28.819	1.885	1.854	2.092	1.7
19970502	21.9971	2.0445	1.6457	2.1209	0.3526	19991202	27.579	1.909	1.82	2.097	1.49
19970503	24.0128	1.9892	1.7131	2.1113	0.8063	19991203	26.804	1.925	1.798	2.1	1.352
19970504	24.633	1.9738	1.7327	2.1086	0.935	19991204	26.183	1.938	1.78	2.102	1.238
19970505	23.2375	2.0095	1.6879	2.1149	0.6386	19991205	25.563	1.952	1.761	2.105	1.12
19970506	22.3072	2.0354	1.6565	2.1194	0.4263	19991206	26.649	1.928	1.793	2.1	1.324
19970507	22.1522	2.04	1.6511	2.1202	0.3896	19991207	25.873	1.945	1.77	2.103	1.179
19970508	21.687	2.0538	1.6348	2.1226	0.2774	19991208	24.323	1.981	1.723	2.11	0.871
19970509	23.3926	2.0053	1.693	2.1141	0.6728	19991209	23.393	2.005	1.693	2.114	0.673
19970510	23.0825	2.0137	1.6827	2.1156	0.6041	19991210	23.393	2.005	1.693	2.114	0.673
19970511	21.9971	2.0445	1.6457	2.1209	0.3526	19991211	23.548	2.001	1.698	2.113	0.707
19970512	21.532	2.0586	1.6293	2.1234	0.2391	19991212	22.617	2.027	1.667	2.118	0.498
19970513	21.2219	2.0683	1.6182	2.125	0.1614	19991213	22.307	2.035	1.657	2.119	0.426
19970514	21.2219	2.0683	1.6182	2.125	0.1614	19991214	27.269	1.915	1.811	2.098	1.435
19970515	20.9118	2.0783	1.6068	2.1267	0.082	19991215	34.401	1.794	1.992	2.075	2.516
19970516	20.6017	2.0885	1.5953	2.1285	0.0007	19991216	32.386	1.824	1.945	2.081	2.242
19970517	20.4466	2.0937	1.5895	2.1293	0	19991217	31.145	1.844	1.914	2.085	2.063
19970518	20.2916	2.099	1.5837	2.1302	0	19991218	30.37	1.857	1.895	2.087	1.946
19970519	21.0668	2.0732	1.6125	2.1259	0.1219	19991219	29.44	1.873	1.87	2.09	1.8
19970520	22.7724	2.0222	1.6723	2.1171	0.534	19991220	29.595	1.87	1.874	2.09	1.825
19970521	21.0668	2.0732	1.6125	2.1259	0.1219	19991221	30.525	1.854	1.899	2.087	1.969
19970522	20.2916	2.099	1.5837	2.1302	0	19991222	28.354	1.893	1.841	2.094	1.622
19970523	19.8264	2.1154	1.5658	2.133	0	19991223	27.114	1.918	1.807	2.099	1.408
19970524	19.8264	2.1154	1.5658	2.133	0	19991224	26.339	1.935	1.784	2.102	1.267
19970525	22.9274	2.0179	1.6776	2.1163	0.5692	19991225	25.408	1.955	1.757	2.105	1.09

Date (YYYYMMDD)	Flow (mgd)	Mn (mg/l)	Al (mg/l)	Fe (mg/l)	acid (mg/l)	Date (YYYYMMDD)	Flow (mgd)	Mn (mg/l)	Al (mg/l)	Fe (mg/l)	acid (mg/l)
19970526	25.4082	1.9554	1.7565	2.1053	1.0896	19991226	25.253	1.959	1.752	2.106	1.059
19970527	22.9274	2.0179	1.6776	2.1163	0.5692	19991227	24.943	1.966	1.742	2.107	0.998
19970528	21.8421	2.0492	1.6403	2.1217	0.3152	19991228	24.478	1.978	1.728	2.109	0.903
19970529	21.532	2.0586	1.6293	2.1234	0.2391	19991229	24.013	1.989	1.713	2.111	0.806
19970530	21.2219	2.0683	1.6182	2.125	0.1614	19991230	23.703	1.997	1.703	2.113	0.74
19970531	21.3769	2.0634	1.6238	2.1242	0.2005	19991231	23.238	2.009	1.688	2.115	0.639
19970601	21.2219	2.0683	1.6182	2.125	0.1614	20000101	22.772	2.022	1.672	2.117	0.534
19970602	27.1138	1.9182	1.8066	2.0986	1.4077	20000102	22.462	2.031	1.662	2.119	0.463
19970603	35.9517	1.7727	2.0274	2.0712	2.7125	20000103	22.462	2.031	1.662	2.119	0.463
19970604	32.5406	1.8214	1.9486	2.0806	2.2639	20000104	23.082	2.014	1.683	2.116	0.604
19970605	31.1451	1.8437	1.9143	2.0848	2.0626	20000105	24.168	1.985	1.718	2.111	0.839
19970606	30.2148	1.8595	1.8906	2.0878	1.9219	20000106	22.307	2.035	1.657	2.119	0.426
19970607	28.9744	1.8817	1.858	2.0919	1.725	20000107	21.532	2.059	1.629	2.123	0.239
19970608	27.5789	1.9087	1.8197	2.0969	1.4897	20000108	21.067	2.073	1.613	2.126	0.122
19970609	26.4936	1.9313	1.7887	2.101	1.2953	20000109	20.757	2.083	1.601	2.128	0.042
19970610	25.2532	1.959	1.7518	2.1059	1.0592	20000110	26.183	1.938	1.78	2.102	1.238
19970611	24.3229	1.9814	1.7229	2.1099	0.8712	20000111	31.765	1.834	1.93	2.083	2.153
19970612	23.3926	2.0053	1.693	2.1141	0.6728	20000112	28.044	1.899	1.833	2.095	1.57
19970613	23.3926	2.0053	1.693	2.1141	0.6728	20000113	27.424	1.912	1.815	2.097	1.463
19970614	22.9274	2.0179	1.6776	2.1163	0.5692	20000114	26.028	1.941	1.775	2.103	1.209
19970615	21.9971	2.0445	1.6457	2.1209	0.3526	20000115	25.563	1.952	1.761	2.105	1.12
19970616	21.2219	2.0683	1.6182	2.125	0.1614	20000116	25.253	1.959	1.752	2.106	1.059
19970617	20.7567	2.0833	1.6011	2.1276	0.0416	20000117	23.703	1.997	1.703	2.113	0.74
19970618	21.2219	2.0683	1.6182	2.125	0.1614	20000118	23.082	2.014	1.683	2.116	0.604
19970619	24.4779	1.9776	1.7278	2.1092	0.9033	20000119	22.772	2.022	1.672	2.117	0.534
19970620	21.687	2.0538	1.6348	2.1226	0.2774	20000120	23.393	2.005	1.693	2.114	0.673
19970621	20.6017	2.0885	1.5953	2.1285	0.0007	20000121	22.772	2.022	1.672	2.117	0.534
19970622	20.1365	2.1044	1.5778	2.1311	0	20000122	22.462	2.031	1.662	2.119	0.463
19970623	19.6714	2.121	1.5597	2.1339	0	20000123	22.152	2.04	1.651	2.12	0.39
19970624	19.0512	2.1444	1.5349	2.1378	0	20000124	21.997	2.045	1.646	2.121	0.353
19970625	18.8961	2.1505	1.5286	2.1388	0	20000125	21.842	2.049	1.64	2.122	0.315
19970626	18.7411	2.1566	1.5222	2.1398	0	20000126	22.152	2.04	1.651	2.12	0.39
19970627	18.586	2.1629	1.5158	2.1409	0	20000127	21.842	2.049	1.64	2.122	0.315
19970628	18.2759	2.1758	1.5027	2.143	0	20000128	21.687	2.054	1.635	2.123	0.277
19970629	18.1209	2.1824	1.496	2.1441	0	20000129	21.222	2.068	1.618	2.125	0.161
19970630	17.8108	2.1959	1.4826	2.1463	0	20000130	21.532	2.059	1.629	2.123	0.239
19970701	17.8108	2.1959	1.4826	2.1463	0	20000131	21.067	2.073	1.613	2.126	0.122
19970702	20.9118	2.0783	1.6068	2.1267	0.082	20000201	20.602	2.088	1.595	2.128	0.001
19970703	20.2916	2.099	1.5837	2.1302	0	20000202	20.292	2.099	1.584	2.13	0
19970704	18.7411	2.1566	1.5222	2.1398	0	20000203	20.137	2.104	1.578	2.131	0
19970705	18.1209	2.1824	1.496	2.1441	0	20000204	19.671	2.121	1.56	2.134	0
19970706	17.8108	2.1959	1.4826	2.1463	0	20000205	19.361	2.133	1.547	2.136	0
19970707	17.5007	2.21	1.4688	2.1486	0	20000206	19.206	2.138	1.541	2.137	0
19970708	17.5007	2.21	1.4688	2.1486	0	20000207	19.051	2.144	1.535	2.138	0
19970709	17.6557	2.2029	1.4757	2.1474	0	20000208	19.051	2.144	1.535	2.138	0
19970710	18.431	2.1693	1.5092	2.1419	0	20000209	18.896	2.15	1.529	2.139	0
19970711	17.5007	2.21	1.4688	2.1486	0	20000210	18.741	2.157	1.522	2.14	0
19970712	17.1906	2.2245	1.4548	2.1509	0	20000211	18.741	2.157	1.522	2.14	0
19970713	17.0355	2.232	1.4477	2.1521	0	20000212	18.896	2.15	1.529	2.139	0

Date (YYYYMMDD)	Flow (mgd)	Mn (mg/l)	Al (mg/l)	Fe (mg/l)	acid (mg/l)	Date (YYYYMMDD)	Flow (mgd)	Mn (mg/l)	Al (mg/l)	Fe (mg/l)	acid (mg/l)
19970714	16.8804	2.2396	1.4405	2.1533	0	20000213	19.516	2.127	1.554	2.135	0
19970715	16.8804	2.2396	1.4405	2.1533	0	20000214	24.788	1.97	1.738	2.108	0.966
19970716	16.7254	2.2474	1.4332	2.1546	0	20000215	26.339	1.935	1.784	2.102	1.267
19970717	16.7254	2.2474	1.4332	2.1546	0	20000216	24.168	1.985	1.718	2.111	0.839
19970718	16.7254	2.2474	1.4332	2.1546	0	20000217	23.393	2.005	1.693	2.114	0.673
19970719	16.8804	2.2396	1.4405	2.1533	0	20000218	23.548	2.001	1.698	2.113	0.707
19970720	16.5703	2.2553	1.4258	2.1558	0	20000219	24.013	1.989	1.713	2.111	0.806
19970721	16.5703	2.2553	1.4258	2.1558	0	20000220	23.082	2.014	1.683	2.116	0.604
19970722	17.5007	2.21	1.4688	2.1486	0	20000221	22.462	2.031	1.662	2.119	0.463
19970723	17.5007	2.21	1.4688	2.1486	0	20000222	22.307	2.035	1.657	2.119	0.426
19970724	22.1522	2.04	1.6511	2.1202	0.3896	20000223	22.772	2.022	1.672	2.117	0.534
19970725	19.2062	2.1384	1.5412	2.1368	0	20000224	24.478	1.978	1.728	2.109	0.903
19970726	17.8108	2.1959	1.4826	2.1463	0	20000225	29.44	1.873	1.87	2.09	1.8
19970727	17.3456	2.2172	1.4618	2.1497	0	20000226	38.432	1.741	2.081	2.065	3.007
19970728	17.1906	2.2245	1.4548	2.1509	0	20000227	42.929	1.692	2.171	2.055	3.484
19970729	17.0355	2.232	1.4477	2.1521	0	20000228	82.622	1.441	2.744	2.001	6.139
19970730	16.8804	2.2396	1.4405	2.1533	0	20000229	72.078	1.488	2.618	2.012	5.604
19970731	16.5703	2.2553	1.4258	2.1558	0	20000301	60.915	1.55	2.467	2.026	4.933
19970801	16.4153	2.2634	1.4184	2.1571	0	20000302	52.387	1.609	2.337	2.038	4.319
19970802	16.4153	2.2634	1.4184	2.1571	0	20000303	44.479	1.676	2.2	2.052	3.635
19970803	16.2602	2.2717	1.4108	2.1584	0	20000304	39.208	1.732	2.097	2.063	3.094
19970804	18.2759	2.1758	1.5027	2.143	0	20000305	36.107	1.771	2.031	2.071	2.732
19970805	18.8961	2.1505	1.5286	2.1388	0	20000306	33.316	1.81	1.967	2.078	2.371
19970806	17.5007	2.21	1.4688	2.1486	0	20000307	31.3	1.841	1.918	2.084	2.086
19970807	17.0355	2.232	1.4477	2.1521	0	20000308	30.37	1.857	1.895	2.087	1.946
19970808	16.7254	2.2474	1.4332	2.1546	0	20000309	29.285	1.876	1.866	2.091	1.775
19970809	16.5703	2.2553	1.4258	2.1558	0	20000310	28.509	1.89	1.845	2.094	1.648
19970810	16.2602	2.2717	1.4108	2.1584	0	20000311	30.525	1.854	1.899	2.087	1.969
19970811	16.2602	2.2717	1.4108	2.1584	0	20000312	41.068	1.711	2.134	2.059	3.294
19970812	16.1052	2.2802	1.4032	2.1597	0	20000313	34.711	1.79	2	2.075	2.556
19970813	16.5703	2.2553	1.4258	2.1558	0	20000314	32.23	1.826	1.941	2.082	2.22
19970814	16.7254	2.2474	1.4332	2.1546	0	20000315	31.61	1.836	1.926	2.083	2.131
19970815	16.2602	2.2717	1.4108	2.1584	0	20000316	30.99	1.846	1.91	2.085	2.04
19970816	17.0355	2.232	1.4477	2.1521	0	20000317	41.534	1.706	2.144	2.058	3.343
19970817	20.6017	2.0885	1.5953	2.1285	0.0007	20000318	35.797	1.775	2.024	2.072	2.693
19970818	21.0668	2.0732	1.6125	2.1259	0.1219	20000319	34.091	1.798	1.985	2.076	2.475
19970819	18.431	2.1693	1.5092	2.1419	0	20000320	33.316	1.81	1.967	2.078	2.371
19970820	19.9815	2.1099	1.5718	2.1321	0	20000321	45.565	1.666	2.22	2.05	3.737
19970821	26.9587	1.9214	1.8022	2.0992	1.3799	20000322	108.67	1.352	3.012	1.98	7.193
19970822	21.0668	2.0732	1.6125	2.1259	0.1219	20000323	88.514	1.418	2.81	1.996	6.406
19970823	19.3613	2.1325	1.5474	2.1359	0	20000324	68.977	1.504	2.578	2.015	5.43
19970824	18.431	2.1693	1.5092	2.1419	0	20000325	57.039	1.575	2.41	2.031	4.667
19970825	17.9658	2.1891	1.4893	2.1452	0	20000326	48.821	1.637	2.277	2.044	4.027
19970826	17.6557	2.2029	1.4757	2.1474	0	20000327	43.549	1.686	2.182	2.054	3.546
19970827	17.5007	2.21	1.4688	2.1486	0	20000328	69.753	1.5	2.588	2.015	5.474
19970828	17.9658	2.1891	1.4893	2.1452	0	20000329	57.349	1.573	2.414	2.031	4.689
19970829	17.6557	2.2029	1.4757	2.1474	0	20000330	50.992	1.619	2.314	2.04	4.207
19970830	17.3456	2.2172	1.4618	2.1497	0	20000331	45.72	1.665	2.222	2.05	3.752
19970831	17.0355	2.232	1.4477	2.1521	0	20000401	41.223	1.71	2.137	2.059	3.311

Date (YYYYMMDD)	Flow (mgd)	Mn (mg/l)	Al (mg/l)	Fe (mg/l)	acid (mg/l)	Date (YYYYMMDD)	Flow (mgd)	Mn (mg/l)	Al (mg/l)	Fe (mg/l)	acid (mg/l)
19970901	19.2062	2.1384	1.5412	2.1368	0	20000402	38.277	1.743	2.078	2.065	2.989
19970902	17.6557	2.2029	1.4757	2.1474	0	20000403	35.642	1.777	2.021	2.072	2.674
19970903	17.1906	2.2245	1.4548	2.1509	0	20000404	40.293	1.72	2.119	2.061	3.212
19970904	16.8804	2.2396	1.4405	2.1533	0	20000405	35.642	1.777	2.021	2.072	2.674
19970905	16.7254	2.2474	1.4332	2.1546	0	20000406	32.075	1.829	1.937	2.082	2.198
19970906	16.7254	2.2474	1.4332	2.1546	0	20000407	35.487	1.779	2.017	2.072	2.655
19970907	16.7254	2.2474	1.4332	2.1546	0	20000408	40.293	1.72	2.119	2.061	3.212
19970908	16.5703	2.2553	1.4258	2.1558	0	20000409	52.542	1.607	2.339	2.038	4.331
19970909	16.5703	2.2553	1.4258	2.1558	0	20000410	47.58	1.648	2.256	2.046	3.919
19970910	16.7254	2.2474	1.4332	2.1546	0	20000411	47.425	1.649	2.253	2.047	3.906
19970911	30.5249	1.8541	1.8986	2.0868	1.9694	20000412	46.65	1.656	2.239	2.048	3.836
19970912	24.4779	1.9776	1.7278	2.1092	0.9033	20000413	44.014	1.681	2.191	2.053	3.591
19970913	21.0668	2.0732	1.6125	2.1259	0.1219	20000414	42.154	1.7	2.156	2.057	3.406
19970914	19.8264	2.1154	1.5658	2.133	0	20000415	41.068	1.711	2.134	2.059	3.294
19970915	18.8961	2.1505	1.5286	2.1388	0	20000416	40.448	1.718	2.122	2.061	3.229
19970916	18.431	2.1693	1.5092	2.1419	0	20000417	35.176	1.783	2.01	2.073	2.615
19970917	18.1209	2.1824	1.496	2.1441	0	20000418	31.3	1.841	1.918	2.084	2.086
19970918	17.9658	2.1891	1.4893	2.1452	0	20000419	28.199	1.896	1.837	2.095	1.596
19970919	17.6557	2.2029	1.4757	2.1474	0	20000420	27.114	1.918	1.807	2.099	1.408
19970920	17.5007	2.21	1.4688	2.1486	0	20000421	28.354	1.893	1.841	2.094	1.622
19970921	17.3456	2.2172	1.4618	2.1497	0	20000422	29.44	1.873	1.87	2.09	1.8
19970922	17.1906	2.2245	1.4548	2.1509	0	20000423	29.285	1.876	1.866	2.091	1.775
19970923	17.1906	2.2245	1.4548	2.1509	0	20000424	27.734	1.906	1.824	2.096	1.517
19970924	17.1906	2.2245	1.4548	2.1509	0	20000425	27.114	1.918	1.807	2.099	1.408
19970925	17.0355	2.232	1.4477	2.1521	0	20000426	26.494	1.931	1.789	2.101	1.295
19970926	17.0355	2.232	1.4477	2.1521	0	20000427	26.494	1.931	1.789	2.101	1.295
19970927	16.8804	2.2396	1.4405	2.1533	0	20000428	26.183	1.938	1.78	2.102	1.238
19970928	16.8804	2.2396	1.4405	2.1533	0	20000429	27.424	1.912	1.815	2.097	1.463
19970929	18.2759	2.1758	1.5027	2.143	0	20000430	27.424	1.912	1.815	2.097	1.463
19970930	17.5007	2.21	1.4688	2.1486	0	20000501	26.649	1.928	1.793	2.1	1.324
19971001	17.1906	2.2245	1.4548	2.1509	0	20000502	27.114	1.918	1.807	2.099	1.408
19971002	17.0355	2.232	1.4477	2.1521	0	20000503	25.873	1.945	1.77	2.103	1.179
19971003	16.7254	2.2474	1.4332	2.1546	0	20000504	25.098	1.963	1.747	2.107	1.029
19971004	16.7254	2.2474	1.4332	2.1546	0	20000505	24.788	1.97	1.738	2.108	0.966
19971005	16.7254	2.2474	1.4332	2.1546	0	20000506	24.478	1.978	1.728	2.109	0.903
19971006	16.7254	2.2474	1.4332	2.1546	0	20000507	23.858	1.993	1.708	2.112	0.773
19971007	16.5703	2.2553	1.4258	2.1558	0	20000508	23.238	2.009	1.688	2.115	0.639
19971008	16.4153	2.2634	1.4184	2.1571	0	20000509	22.617	2.027	1.667	2.118	0.498
19971009	16.5703	2.2553	1.4258	2.1558	0	20000510	38.743	1.738	2.087	2.064	3.042
19971010	16.4153	2.2634	1.4184	2.1571	0	20000511	52.387	1.609	2.337	2.038	4.319
19971011	16.2602	2.2717	1.4108	2.1584	0	20000512	39.208	1.732	2.097	2.063	3.094
19971012	16.1052	2.2802	1.4032	2.1597	0	20000513	36.417	1.767	2.038	2.07	2.77
19971013	16.1052	2.2802	1.4032	2.1597	0	20000514	37.037	1.759	2.051	2.069	2.844
19971014	16.2602	2.2717	1.4108	2.1584	0	20000515	32.386	1.824	1.945	2.081	2.242
19971015	16.5703	2.2553	1.4258	2.1558	0	20000516	30.215	1.859	1.891	2.088	1.922
19971016	16.4153	2.2634	1.4184	2.1571	0	20000517	28.974	1.882	1.858	2.092	1.725
19971017	16.2602	2.2717	1.4108	2.1584	0	20000518	28.974	1.882	1.858	2.092	1.725
19971018	16.1052	2.2802	1.4032	2.1597	0	20000519	35.797	1.775	2.024	2.072	2.693
19971019	15.9501	2.2888	1.3955	2.1611	0	20000520	35.487	1.779	2.017	2.072	2.655

Date (YYYYMMDD)	Flow (mgd)	Mn (mg/l)	Al (mg/l)	Fe (mg/l)	acid (mg/l)	Date (YYYYMMDD)	Flow (mgd)	Mn (mg/l)	Al (mg/l)	Fe (mg/l)	acid (mg/l)
19971020	15.9501	2.2888	1.3955	2.1611	0	20000521	33.936	1.801	1.982	2.077	2.454
19971021	15.9191	2.2905	1.3939	2.1614	0	20000522	36.107	1.771	2.031	2.071	2.732
19971022	15.8416	2.2949	1.39	2.1621	0	20000523	41.534	1.706	2.144	2.058	3.343
19971023	15.8106	2.2967	1.3884	2.1623	0	20000524	58.744	1.564	2.435	2.029	4.786
19971024	15.7331	2.3012	1.3845	2.163	0	20000525	62	1.543	2.483	2.024	5.004
19971025	17.3456	2.2172	1.4618	2.1497	0	20000526	53.472	1.6	2.354	2.036	4.403
19971026	17.0355	2.232	1.4477	2.1521	0	20000527	46.65	1.656	2.239	2.048	3.836
19971027	18.2759	2.1758	1.5027	2.143	0	20000528	41.689	1.705	2.147	2.058	3.359
19971028	17.5007	2.21	1.4688	2.1486	0	20000529	37.657	1.751	2.064	2.067	2.917
19971029	16.8804	2.2396	1.4405	2.1533	0	20000530	34.246	1.796	1.989	2.076	2.495
19971030	16.5703	2.2553	1.4258	2.1558	0	20000531	31.765	1.834	1.93	2.083	2.153
19971031	16.4153	2.2634	1.4184	2.1571	0	20000601	30.06	1.862	1.887	2.088	1.898
19971101	17.8108	2.1959	1.4826	2.1463	0	20000602	28.819	1.885	1.854	2.092	1.7
19971102	20.9118	2.0783	1.6068	2.1267	0.082	20000603	27.579	1.909	1.82	2.097	1.49
19971103	19.8264	2.1154	1.5658	2.133	0	20000604	26.183	1.938	1.78	2.102	1.238
19971104	18.586	2.1629	1.5158	2.1409	0	20000605	25.563	1.952	1.761	2.105	1.12
19971105	17.9658	2.1891	1.4893	2.1452	0	20000606	37.657	1.751	2.064	2.067	2.917
19971106	17.6557	2.2029	1.4757	2.1474	0	20000607	31.92	1.831	1.934	2.082	2.176
19971107	17.8108	2.1959	1.4826	2.1463	0	20000608	27.269	1.915	1.811	2.098	1.435
19971108	17.9658	2.1891	1.4893	2.1452	0	20000609	25.253	1.959	1.752	2.106	1.059
19971109	18.8961	2.1505	1.5286	2.1388	0	20000610	24.168	1.985	1.718	2.111	0.839
19971110	18.8961	2.1505	1.5286	2.1388	0	20000611	23.548	2.001	1.698	2.113	0.707
19971111	18.586	2.1629	1.5158	2.1409	0	20000612	27.889	1.903	1.828	2.096	1.543
19971112	18.431	2.1693	1.5092	2.1419	0	20000613	28.819	1.885	1.854	2.092	1.7
19971113	18.1209	2.1824	1.496	2.1441	0	20000614	27.269	1.915	1.811	2.098	1.435
19971114	18.7411	2.1566	1.5222	2.1398	0	20000615	25.563	1.952	1.761	2.105	1.12
19971115	18.8961	2.1505	1.5286	2.1388	0	20000616	25.098	1.963	1.747	2.107	1.029
19971116	18.7411	2.1566	1.5222	2.1398	0	20000617	24.013	1.989	1.713	2.111	0.806
19971117	18.586	2.1629	1.5158	2.1409	0	20000618	24.478	1.978	1.728	2.109	0.903
19971118	18.2759	2.1758	1.5027	2.143	0	20000619	24.013	1.989	1.713	2.111	0.806
19971119	18.1209	2.1824	1.496	2.1441	0	20000620	22.927	2.018	1.678	2.116	0.569
19971120	18.1209	2.1824	1.496	2.1441	0	20000621	24.478	1.978	1.728	2.109	0.903
19971121	18.1209	2.1824	1.496	2.1441	0	20000622	41.844	1.703	2.15	2.058	3.375
19971122	20.4466	2.0937	1.5895	2.1293	0	20000623	30.835	1.849	1.906	2.086	2.016
19971123	20.6017	2.0885	1.5953	2.1285	0.0007	20000624	28.509	1.89	1.845	2.094	1.648
19971124	19.9815	2.1099	1.5718	2.1321	0	20000625	29.595	1.87	1.874	2.09	1.825
19971125	19.5163	2.1267	1.5536	2.1349	0	20000626	35.487	1.779	2.017	2.072	2.655
19971126	19.6714	2.121	1.5597	2.1339	0	20000627	36.727	1.763	2.044	2.069	2.807
19971127	19.9815	2.1099	1.5718	2.1321	0	20000628	34.246	1.796	1.989	2.076	2.495
19971128	19.8264	2.1154	1.5658	2.133	0	20000629	34.711	1.79	2	2.075	2.556
19971129	19.8264	2.1154	1.5658	2.133	0	20000630	35.176	1.783	2.01	2.073	2.615
19971130	20.6017	2.0885	1.5953	2.1285	0.0007	20000701	31.61	1.836	1.926	2.083	2.131
19971201	24.788	1.97	1.7375	2.1079	0.9665	20000702	29.905	1.865	1.883	2.089	1.874
19971202	22.7724	2.0222	1.6723	2.1171	0.534	20000703	28.819	1.885	1.854	2.092	1.7
19971203	22.1522	2.04	1.6511	2.1202	0.3896	20000704	28.509	1.89	1.845	2.094	1.648
19971204	22.1522	2.04	1.6511	2.1202	0.3896	20000705	27.269	1.915	1.811	2.098	1.435
19971205	22.3072	2.0354	1.6565	2.1194	0.4263	20000706	25.718	1.948	1.766	2.104	1.15
19971206	21.8421	2.0492	1.6403	2.1217	0.3152	20000707	24.633	1.974	1.733	2.109	0.935
19971207	21.532	2.0586	1.6293	2.1234	0.2391	20000708	23.548	2.001	1.698	2.113	0.707

Date (YYYYMMDD)	Flow (mgd)	Mn (mg/l)	Al (mg/l)	Fe (mg/l)	acid (mg/l)	Date (YYYYMMDD)	Flow (mgd)	Mn (mg/l)	Al (mg/l)	Fe (mg/l)	acid (mg/l)
19971208	20.9118	2.0783	1.6068	2.1267	0.082	20000709	22.927	2.018	1.678	2.116	0.569
19971209	20.6017	2.0885	1.5953	2.1285	0.0007	20000710	23.082	2.014	1.683	2.116	0.604
19971210	20.7567	2.0833	1.6011	2.1276	0.0416	20000711	22.307	2.035	1.657	2.119	0.426
19971211	20.7567	2.0833	1.6011	2.1276	0.0416	20000712	21.377	2.063	1.624	2.124	0.2
19971212	20.4466	2.0937	1.5895	2.1293	0	20000713	20.757	2.083	1.601	2.128	0.042
19971213	19.9815	2.1099	1.5718	2.1321	0	20000714	20.292	2.099	1.584	2.13	0
19971214	19.6714	2.121	1.5597	2.1339	0	20000715	23.548	2.001	1.698	2.113	0.707
19971215	19.5163	2.1267	1.5536	2.1349	0	20000716	22.617	2.027	1.667	2.118	0.498
19971216	19.2062	2.1384	1.5412	2.1368	0	20000717	21.067	2.073	1.613	2.126	0.122
19971217	19.0512	2.1444	1.5349	2.1378	0	20000718	20.292	2.099	1.584	2.13	0
19971218	18.8961	2.1505	1.5286	2.1388	0	20000719	19.671	2.121	1.56	2.134	0
19971219	18.8961	2.1505	1.5286	2.1388	0	20000720	19.516	2.127	1.554	2.135	0
19971220	18.8961	2.1505	1.5286	2.1388	0	20000721	18.896	2.15	1.529	2.139	0
19971221	18.8961	2.1505	1.5286	2.1388	0	20000722	18.896	2.15	1.529	2.139	0
19971222	18.586	2.1629	1.5158	2.1409	0	20000723	18.586	2.163	1.516	2.141	0
19971223	19.0512	2.1444	1.5349	2.1378	0	20000724	18.586	2.163	1.516	2.141	0
19971224	19.3613	2.1325	1.5474	2.1359	0	20000725	18.276	2.176	1.503	2.143	0
19971225	23.8577	1.9932	1.7081	2.112	0.7734	20000726	18.276	2.176	1.503	2.143	0
19971226	24.633	1.9738	1.7327	2.1086	0.935	20000727	18.431	2.169	1.509	2.142	0
19971227	24.0128	1.9892	1.7131	2.1113	0.8063	20000728	18.121	2.182	1.496	2.144	0
19971228	24.0128	1.9892	1.7131	2.1113	0.8063	20000729	18.121	2.182	1.496	2.144	0
19971229	23.5476	2.0012	1.6981	2.1134	0.7066	20000730	19.361	2.133	1.547	2.136	0
19971230	24.9431	1.9663	1.7423	2.1072	0.9977	20000731	24.788	1.97	1.738	2.108	0.966
19971231	23.7027	1.9972	1.7031	2.1127	0.7402	20000801	38.432	1.741	2.081	2.065	3.007
19980101	22.1522	2.04	1.6511	2.1202	0.3896	20000802	38.898	1.736	2.091	2.064	3.059
19980102	22.1522	2.04	1.6511	2.1202	0.3896	20000803	28.509	1.89	1.845	2.094	1.648
19980103	22.1522	2.04	1.6511	2.1202	0.3896	20000804	27.114	1.918	1.807	2.099	1.408
19980104	23.0825	2.0137	1.6827	2.1156	0.6041	20000805	24.168	1.985	1.718	2.111	0.839
19980105	23.3926	2.0053	1.693	2.1141	0.6728	20000806	22.772	2.022	1.672	2.117	0.534
19980106	23.3926	2.0053	1.693	2.1141	0.6728	20000807	22.772	2.022	1.672	2.117	0.534
19980107	25.0981	1.9627	1.7471	2.1066	1.0286	20000808	21.687	2.054	1.635	2.123	0.277
19980108	70.683	1.4953	2.5999	2.0135	5.5266	20000809	21.222	2.068	1.618	2.125	0.161
19980109	94.8709	1.3952	2.8773	1.9904	6.6734	20000810	20.602	2.088	1.595	2.128	0.001
19980110	72.8537	1.4846	2.6275	2.0111	5.646	20000811	20.292	2.099	1.584	2.13	0
19980111	58.279	1.5668	2.4284	2.0292	4.7542	20000812	20.447	2.094	1.59	2.129	0
19980112	48.6658	1.6386	2.2745	2.0443	4.0134	20000813	20.912	2.078	1.607	2.127	0.082
19980113	42.6189	1.695	2.1646	2.0559	3.4534	20000814	20.137	2.104	1.578	2.131	0
19980114	37.6572	1.7509	2.0645	2.067	2.9173	20000815	19.826	2.115	1.566	2.133	0
19980115	34.8663	1.7874	2.0031	2.0741	2.5758	20000816	19.051	2.144	1.535	2.138	0
19980116	44.3244	1.678	2.1969	2.0524	3.6205	20000817	18.431	2.169	1.509	2.142	0
19980117	38.8976	1.7359	2.0905	2.064	3.0591	20000818	18.431	2.169	1.509	2.142	0
19980118	37.5022	1.7528	2.0612	2.0674	2.8991	20000819	18.276	2.176	1.503	2.143	0
19980119	35.1764	1.7831	2.0101	2.0733	2.6154	20000820	17.966	2.189	1.489	2.145	0
19980120	33.781	1.8028	1.9781	2.0771	2.4337	20000821	17.656	2.203	1.476	2.147	0
19980121	31.9204	1.8311	1.9335	2.0824	2.1758	20000822	17.501	2.21	1.469	2.149	0
19980122	30.5249	1.8541	1.8986	2.0868	1.9694	20000823	17.656	2.203	1.476	2.147	0
19980123	33.3158	1.8097	1.9671	2.0784	2.3709	20000824	17.811	2.196	1.483	2.146	0
19980124	38.5875	1.7396	2.0841	2.0648	3.0242	20000825	17.656	2.203	1.476	2.147	0
19980125	37.1921	1.7567	2.0545	2.0681	2.8626	20000826	17.501	2.21	1.469	2.149	0

Date (YYYYMMDD)	Flow (mgd)	Mn (mg/l)	Al (mg/l)	Fe (mg/l)	acid (mg/l)	Date (YYYYMMDD)	Flow (mgd)	Mn (mg/l)	Al (mg/l)	Fe (mg/l)	acid (mg/l)
19980126	34.5562	1.7917	1.996	2.0749	2.5358	20000827	17.501	2.21	1.469	2.149	0
19980127	33.0057	1.8143	1.9598	2.0793	2.3285	20000828	17.811	2.196	1.483	2.146	0
19980128	32.8507	1.8167	1.9561	2.0797	2.3071	20000829	17.966	2.189	1.489	2.145	0
19980129	31.3002	1.8411	1.9181	2.0843	2.0856	20000830	17.656	2.203	1.476	2.147	0
19980130	30.835	1.8489	1.9064	2.0858	2.0163	20000831	17.346	2.217	1.462	2.15	0
19980131	30.0598	1.8622	1.8866	2.0883	1.8978	20000901	21.067	2.073	1.613	2.126	0.122
19980201	28.6643	1.8875	1.8496	2.093	1.6741	20000902	20.912	2.078	1.607	2.127	0.082
19980202	27.889	1.9025	1.8284	2.0957	1.5434	20000903	19.051	2.144	1.535	2.138	0
19980203	27.2688	1.915	1.811	2.098	1.4352	20000904	18.431	2.169	1.509	2.142	0
19980204	28.0441	1.8995	1.8327	2.0952	1.5699	20000905	17.966	2.189	1.489	2.145	0
19980205	57.8138	1.5699	2.4214	2.0298	4.7217	20000906	17.501	2.21	1.469	2.149	0
19980206	54.5578	1.5925	2.3714	2.0347	4.4855	20000907	17.191	2.225	1.455	2.151	0
19980207	48.3557	1.6412	2.2691	2.0449	3.9868	20000908	17.035	2.232	1.448	2.152	0
19980208	43.2391	1.6887	2.1765	2.0546	3.5151	20000909	17.035	2.232	1.448	2.152	0
19980209	39.2077	1.7323	2.0969	2.0633	3.0937	20000910	17.035	2.232	1.448	2.152	0
19980210	35.9517	1.7727	2.0274	2.0712	2.7125	20000911	17.035	2.232	1.448	2.152	0
19980211	34.0911	1.7983	1.9853	2.0762	2.4749	20000912	17.035	2.232	1.448	2.152	0
19980212	46.4951	1.6576	2.2364	2.0483	3.8224	20000913	19.051	2.144	1.535	2.138	0
19980213	41.0684	1.7114	2.1344	2.0592	3.2944	20000914	17.656	2.203	1.476	2.147	0
19980214	39.5178	1.7287	2.1033	2.0626	3.1279	20000915	18.276	2.176	1.503	2.143	0
19980215	37.8123	1.7489	2.0678	2.0666	2.9353	20000916	17.501	2.21	1.469	2.149	0
19980216	35.4865	1.7789	2.0171	2.0725	2.6546	20000917	17.191	2.225	1.455	2.151	0
19980217	36.1067	1.7706	2.0309	2.0708	2.7316	20000918	17.035	2.232	1.448	2.152	0
19980218	50.0613	1.627	2.2982	2.0419	4.131	20000919	18.121	2.182	1.496	2.144	0
19980219	51.7669	1.6134	2.3266	2.0391	4.2697	20000920	20.292	2.099	1.584	2.13	0
19980220	48.9759	1.636	2.2798	2.0438	4.0399	20000921	18.276	2.176	1.503	2.143	0
19980221	46.03	1.6619	2.2281	2.0491	3.7801	20000922	17.501	2.21	1.469	2.149	0
19980222	42.3088	1.6982	2.1587	2.0565	3.4222	20000923	17.191	2.225	1.455	2.151	0
19980223	41.3785	1.708	2.1406	2.0585	3.3268	20000924	17.191	2.225	1.455	2.151	0
19980224	74.5593	1.4764	2.6488	2.0092	5.7371	20000925	17.191	2.225	1.455	2.151	0
19980225	67.427	1.5123	2.5573	2.0173	5.3395	20000926	17.966	2.189	1.489	2.145	0
19980226	60.4497	1.5529	2.4603	2.0262	4.9021	20000927	17.811	2.196	1.483	2.146	0
19980227	54.8679	1.5902	2.3762	2.0342	4.5086	20000928	17.191	2.225	1.455	2.151	0
19980228	51.9219	1.6122	2.3291	2.0388	4.282	20000929	17.035	2.232	1.448	2.152	0
19980301	52.5421	1.6074	2.3392	2.0378	4.3309	20000930	16.88	2.24	1.44	2.153	0
19980302	47.2704	1.6507	2.2502	2.0468	3.8918	20001001	16.88	2.24	1.44	2.153	0
19980303	46.3401	1.659	2.2336	2.0486	3.8084	20001002	16.88	2.24	1.44	2.153	0
19980304	43.3941	1.6871	2.1794	2.0543	3.5304	20001003	16.88	2.24	1.44	2.153	0
19980305	39.6729	1.7269	2.1064	2.0623	3.1449	20001004	16.88	2.24	1.44	2.153	0
19980306	36.882	1.7606	2.0478	2.0689	2.8257	20001005	17.966	2.189	1.489	2.145	0
19980307	34.5562	1.7917	1.996	2.0749	2.5358	20001006	17.966	2.189	1.489	2.145	0
19980308	34.7113	1.7895	1.9996	2.0745	2.5559	20001007	17.346	2.217	1.462	2.15	0
19980309	60.7598	1.5509	2.4648	2.0258	4.9227	20001008	17.035	2.232	1.448	2.152	0
19980310	80.4512	1.4501	2.7194	2.0032	6.035	20001009	16.88	2.24	1.44	2.153	0
19980311	65.7214	1.5217	2.5343	2.0194	5.2374	20001010	16.88	2.24	1.44	2.153	0
19980312	54.7128	1.5914	2.3738	2.0344	4.4971	20001011	17.191	2.225	1.455	2.151	0
19980313	47.5805	1.6479	2.2556	2.0463	3.9192	20001012	18.276	2.176	1.503	2.143	0
19980314	43.2391	1.6887	2.1765	2.0546	3.5151	20001013	18.586	2.163	1.516	2.141	0
19980315	39.6729	1.7269	2.1064	2.0623	3.1449	20001014	18.586	2.163	1.516	2.141	0

Date (YYYYMMDD)	Flow (mgd)	Mn (mg/l)	Al (mg/l)	Fe (mg/l)	acid (mg/l)	Date (YYYYMMDD)	Flow (mgd)	Mn (mg/l)	Al (mg/l)	Fe (mg/l)	acid (mg/l)
19980316	36.1067	1.7706	2.0309	2.0708	2.7316	20001015	18.586	2.163	1.516	2.141	0
19980317	33.3158	1.8097	1.9671	2.0784	2.3709	20001016	18.431	2.169	1.509	2.142	0
19980318	33.1608	1.812	1.9635	2.0788	2.3498	20001017	18.896	2.15	1.529	2.139	0
19980319	34.7113	1.7895	1.9996	2.0745	2.5559	20001018	21.687	2.054	1.635	2.123	0.277
19980320	32.3855	1.8238	1.9449	2.0811	2.2421	20001019	19.981	2.11	1.572	2.132	0
19980321	47.7355	1.6466	2.2583	2.046	3.9328	20001020	26.183	1.938	1.78	2.102	1.238
19980322	46.8052	1.6548	2.2419	2.0477	3.8503	20001021	24.013	1.989	1.713	2.111	0.806
19980323	44.1694	1.6795	2.194	2.0527	3.6057	20001022	22.152	2.04	1.651	2.12	0.39
19980324	41.5335	1.7064	2.1436	2.0582	3.3429	20001023	21.377	2.063	1.624	2.124	0.2
19980325	38.5875	1.7396	2.0841	2.0648	3.0242	20001024	19.206	2.138	1.541	2.137	0
19980326	36.5719	1.7646	2.0411	2.0697	2.7884	20001025	17.966	2.189	1.489	2.145	0
19980327	34.5562	1.7917	1.996	2.0749	2.5358	20001026	17.656	2.203	1.476	2.147	0
19980328	33.0057	1.8143	1.9598	2.0793	2.3285	20001027	17.346	2.217	1.462	2.15	0
19980329	31.6103	1.8361	1.9259	2.0834	2.131	20001028	17.501	2.21	1.469	2.149	0
19980330	30.3699	1.8568	1.8946	2.0873	1.9457	20001029	17.346	2.217	1.462	2.15	0
19980331	29.4396	1.8732	1.8704	2.0903	1.8001	20001030	17.191	2.225	1.455	2.151	0
19980401	30.5249	1.8541	1.8986	2.0868	1.9694	20001031	17.035	2.232	1.448	2.152	0
19980402	31.6103	1.8361	1.9259	2.0834	2.131	20001101	17.035	2.232	1.448	2.152	0
19980403	28.8194	1.8846	1.8538	2.0924	1.6996	20001102	17.035	2.232	1.448	2.152	0
19980404	27.4239	1.9118	1.8154	2.0974	1.4626	20001103	17.035	2.232	1.448	2.152	0
19980405	26.3385	1.9346	1.7842	2.1016	1.2666	20001104	17.035	2.232	1.448	2.152	0
19980406	29.2845	1.876	1.8663	2.0908	1.7753	20001105	17.035	2.232	1.448	2.152	0
19980407	31.1451	1.8437	1.9143	2.0848	2.0626	20001106	16.88	2.24	1.44	2.153	0
19980408	30.835	1.8489	1.9064	2.0858	2.0163	20001107	16.88	2.24	1.44	2.153	0
19980409	35.3315	1.781	2.0136	2.0729	2.6351	20001108	16.88	2.24	1.44	2.153	0
19980410	49.131	1.6347	2.2825	2.0435	4.0531	20001109	17.035	2.232	1.448	2.152	0
19980411	42.1537	1.6998	2.1557	2.0569	3.4065	20001110	19.051	2.144	1.535	2.138	0
19980412	40.2931	1.7199	2.119	2.0609	3.2122	20001111	19.051	2.144	1.535	2.138	0
19980413	38.7426	1.7377	2.0873	2.0644	3.0417	20001112	18.121	2.182	1.496	2.144	0
19980414	39.8279	1.7252	2.1096	2.0619	3.1619	20001113	17.656	2.203	1.476	2.147	0
19980415	39.8279	1.7252	2.1096	2.0619	3.1619	20001114	17.656	2.203	1.476	2.147	0
19980416	29.2845	1.876	1.8663	2.0908	1.7753	20001115	17.656	2.203	1.476	2.147	0
19980417	27.2688	1.915	1.811	2.098	1.4352	20001116	17.346	2.217	1.462	2.15	0
19980418	26.0284	1.9414	1.7751	2.1028	1.2086	20001117	17.346	2.217	1.462	2.15	0
19980419	33.3158	1.8097	1.9671	2.0784	2.3709	20001118	17.191	2.225	1.455	2.151	0
19980420	46.9603	1.6534	2.2447	2.0474	3.8642	20001119	17.191	2.225	1.455	2.151	0
19980421	47.7355	1.6466	2.2583	2.046	3.9328	20001120	17.191	2.225	1.455	2.151	0
19980422	44.9446	1.672	2.2083	2.0512	3.6794	20001121	17.191	2.225	1.455	2.151	0
19980423	41.0684	1.7114	2.1344	2.0592	3.2944	20001122	17.035	2.232	1.448	2.152	0
19980424	37.9673	1.747	2.071	2.0662	2.9533	20001123	16.88	2.24	1.44	2.153	0
19980425	34.5562	1.7917	1.996	2.0749	2.5358	20001124	16.88	2.24	1.44	2.153	0
19980426	37.1921	1.7567	2.0545	2.0681	2.8626	20001125	17.035	2.232	1.448	2.152	0
19980427	40.7583	1.7148	2.1283	2.0598	3.2617	20001126	18.896	2.15	1.529	2.139	0
19980428	34.4012	1.7939	1.9925	2.0753	2.5156	20001127	19.206	2.138	1.541	2.137	0
19980429	32.6956	1.819	1.9524	2.0802	2.2855	20001128	18.276	2.176	1.503	2.143	0
19980430	31.9204	1.8311	1.9335	2.0824	2.1758	20001129	17.966	2.189	1.489	2.145	0
19980501	31.4552	1.8386	1.922	2.0839	2.1084	20001130	18.121	2.182	1.496	2.144	0
19980502	31.7653	1.8336	1.9297	2.0829	2.1535	20001201	17.966	2.189	1.489	2.145	0
19980503	30.68	1.8515	1.9025	2.0863	1.9929	20001202	17.811	2.196	1.483	2.146	0

Date (YYYYMMDD)	Flow (mgd)	Mn (mg/l)	Al (mg/l)	Fe (mg/l)	acid (mg/l)	Date (YYYYMMDD)	Flow (mgd)	Mn (mg/l)	Al (mg/l)	Fe (mg/l)	acid (mg/l)
19980504	30.5249	1.8541	1.8986	2.0868	1.9694	20001203	17.811	2.196	1.483	2.146	0
19980505	30.9901	1.8463	1.9104	2.0853	2.0396	20001204	17.966	2.189	1.489	2.145	0
19980506	29.9047	1.8649	1.8826	2.0888	1.8737	20001205	18.431	2.169	1.509	2.142	0
19980507	28.0441	1.8995	1.8327	2.0952	1.5699	20001206	20.602	2.088	1.595	2.128	0.001
19980508	31.7653	1.8336	1.9297	2.0829	2.1535	20001207	20.447	2.094	1.59	2.129	0
19980509	34.7113	1.7895	1.9996	2.0745	2.5559	20001208	20.447	2.094	1.59	2.129	0
19980510	44.0143	1.681	2.1911	2.053	3.5907	20001209	20.447	2.094	1.59	2.129	0
19980511	57.3487	1.573	2.4144	2.0305	4.6889	20001210	20.447	2.094	1.59	2.129	0
19980512	75.3346	1.4728	2.6583	2.0084	5.7778	20001211	19.981	2.11	1.572	2.132	0
19980513	66.0315	1.52	2.5385	2.019	5.2562	20001212	17.966	2.189	1.489	2.145	0
19980514	55.178	1.588	2.3811	2.0337	4.5317	20001213	17.966	2.189	1.489	2.145	0
19980515	47.1153	1.652	2.2474	2.0471	3.8781	20001214	18.741	2.157	1.522	2.14	0
19980516	41.6886	1.7047	2.1466	2.0578	3.3589	20001215	18.741	2.157	1.522	2.14	0
19980517	37.6572	1.7509	2.0645	2.067	2.9173	20001216	19.361	2.133	1.547	2.136	0
19980518	34.0911	1.7983	1.9853	2.0762	2.4749	20001217	101.383	1.374	2.943	1.985	6.928
19980519	31.7653	1.8336	1.9297	2.0829	2.1535	20001218	82.467	1.442	2.743	2.001	6.131
19980520	30.2148	1.8595	1.8906	2.0878	1.9219	20001219	61.38	1.547	2.474	2.025	4.964
19980521	28.3542	1.8934	1.8412	2.0941	1.6224	20001220	50.526	1.623	2.306	2.041	4.169
19980522	26.6486	1.9279	1.7932	2.1004	1.3237	20001221	41.999	1.701	2.153	2.057	3.391
19980523	25.5633	1.9519	1.7612	2.1047	1.1197	20001222	37.967	1.747	2.071	2.066	2.953
19980524	24.633	1.9738	1.7327	2.1086	0.935	20001223	33.781	1.803	1.978	2.077	2.434
19980525	24.3229	1.9814	1.7229	2.1099	0.8712	20001224	31.455	1.839	1.922	2.084	2.108
19980526	23.5476	2.0012	1.6981	2.1134	0.7066	20001225	29.595	1.87	1.874	2.09	1.825
19980527	22.7724	2.0222	1.6723	2.1171	0.534	20001226	27.734	1.906	1.824	2.096	1.517
19980528	22.1522	2.04	1.6511	2.1202	0.3896	20001227	27.269	1.915	1.811	2.098	1.435
19980529	22.1522	2.04	1.6511	2.1202	0.3896	20001228	26.494	1.931	1.789	2.101	1.295
19980530	23.8577	1.9932	1.7081	2.112	0.7734	20001229	25.718	1.948	1.766	2.104	1.15
19980531	21.8421	2.0492	1.6403	2.1217	0.3152	20001230	25.098	1.963	1.747	2.107	1.029
19980601	21.8421	2.0492	1.6403	2.1217	0.3152	20001231	24.788	1.97	1.738	2.108	0.966
19980602	20.6017	2.0885	1.5953	2.1285	0.0007	20010101	23.703	1.997	1.703	2.113	0.74
19980603	20.2916	2.099	1.5837	2.1302	0	20010102	23.082	2.014	1.683	2.116	0.604
19980604	19.6714	2.121	1.5597	2.1339	0	20010103	22.772	2.022	1.672	2.117	0.534
19980605	19.3613	2.1325	1.5474	2.1359	0	20010104	22.152	2.04	1.651	2.12	0.39
19980606	19.0512	2.1444	1.5349	2.1378	0	20010105	22.152	2.04	1.651	2.12	0.39
19980607	18.7411	2.1566	1.5222	2.1398	0	20010106	22.152	2.04	1.651	2.12	0.39
19980608	19.3613	2.1325	1.5474	2.1359	0	20010107	21.687	2.054	1.635	2.123	0.277
19980609	18.8961	2.1505	1.5286	2.1388	0	20010108	21.377	2.063	1.624	2.124	0.2
19980610	18.7411	2.1566	1.5222	2.1398	0	20010109	21.222	2.068	1.618	2.125	0.161
19980611	18.7411	2.1566	1.5222	2.1398	0	20010110	20.602	2.088	1.595	2.128	0.001
19980612	24.0128	1.9892	1.7131	2.1113	0.8063	20010111	20.292	2.099	1.584	2.13	0
19980613	29.2845	1.876	1.8663	2.0908	1.7753	20010112	19.981	2.11	1.572	2.132	0
19980614	30.2148	1.8595	1.8906	2.0878	1.9219	20010113	19.826	2.115	1.566	2.133	0
19980615	27.1138	1.9182	1.8066	2.0986	1.4077	20010114	19.516	2.127	1.554	2.135	0
19980616	24.0128	1.9892	1.7131	2.1113	0.8063	20010115	19.516	2.127	1.554	2.135	0
19980617	22.4623	2.031	1.6618	2.1186	0.4626	20010116	19.516	2.127	1.554	2.135	0
19980618	22.3072	2.0354	1.6565	2.1194	0.4263	20010117	19.361	2.133	1.547	2.136	0
19980619	20.9118	2.0783	1.6068	2.1267	0.082	20010118	19.361	2.133	1.547	2.136	0
19980620	20.1365	2.1044	1.5778	2.1311	0	20010119	20.602	2.088	1.595	2.128	0.001
19980621	19.9815	2.1099	1.5718	2.1321	0	20010120	22.307	2.035	1.657	2.119	0.426

Date (YYYYMMDD)	Flow (mgd)	Mn (mg/l)	Al (mg/l)	Fe (mg/l)	acid (mg/l)	Date (YYYYMMDD)	Flow (mgd)	Mn (mg/l)	Al (mg/l)	Fe (mg/l)	acid (mg/l)
19980622	19.6714	2.121	1.5597	2.1339	0	20010121	21.842	2.049	1.64	2.122	0.315
19980623	20.7567	2.0833	1.6011	2.1276	0.0416	20010122	20.447	2.094	1.59	2.129	0
19980624	30.9901	1.8463	1.9104	2.0853	2.0396	20010123	19.981	2.11	1.572	2.132	0
19980625	23.8577	1.9932	1.7081	2.112	0.7734	20010124	19.671	2.121	1.56	2.134	0
19980626	22.6173	2.0266	1.6671	2.1178	0.4985	20010125	19.516	2.127	1.554	2.135	0
19980627	22.3072	2.0354	1.6565	2.1194	0.4263	20010126	19.206	2.138	1.541	2.137	0
19980628	21.3769	2.0634	1.6238	2.1242	0.2005	20010127	19.206	2.138	1.541	2.137	0
19980629	20.9118	2.0783	1.6068	2.1267	0.082	20010128	19.051	2.144	1.535	2.138	0
19980630	21.9971	2.0445	1.6457	2.1209	0.3526	20010129	19.206	2.138	1.541	2.137	0
19980701	23.0825	2.0137	1.6827	2.1156	0.6041	20010130	21.222	2.068	1.618	2.125	0.161
19980702	20.9118	2.0783	1.6068	2.1267	0.082	20010131	23.703	1.997	1.703	2.113	0.74
19980703	19.9815	2.1099	1.5718	2.1321	0	20010201	23.238	2.009	1.688	2.115	0.639
19980704	19.6714	2.121	1.5597	2.1339	0	20010202	23.238	2.009	1.688	2.115	0.639
19980705	19.6714	2.121	1.5597	2.1339	0	20010203	23.082	2.014	1.683	2.116	0.604
19980706	19.2062	2.1384	1.5412	2.1368	0	20010204	22.617	2.027	1.667	2.118	0.498
19980707	18.8961	2.1505	1.5286	2.1388	0	20010205	23.703	1.997	1.703	2.113	0.74
19980708	20.4466	2.0937	1.5895	2.1293	0	20010206	24.013	1.989	1.713	2.111	0.806
19980709	20.4466	2.0937	1.5895	2.1293	0	20010207	23.238	2.009	1.688	2.115	0.639
19980710	19.5163	2.1267	1.5536	2.1349	0	20010208	22.617	2.027	1.667	2.118	0.498
19980711	18.7411	2.1566	1.5222	2.1398	0	20010209	22.462	2.031	1.662	2.119	0.463
19980712	18.431	2.1693	1.5092	2.1419	0	20010210	25.563	1.952	1.761	2.105	1.12
19980713	18.1209	2.1824	1.496	2.1441	0	20010211	26.649	1.928	1.793	2.1	1.324
19980714	17.9658	2.1891	1.4893	2.1452	0	20010212	26.183	1.938	1.78	2.102	1.238
19980715	17.8108	2.1959	1.4826	2.1463	0	20010213	26.183	1.938	1.78	2.102	1.238
19980716	17.9658	2.1891	1.4893	2.1452	0	20010214	26.649	1.928	1.793	2.1	1.324
19980717	17.8108	2.1959	1.4826	2.1463	0	20010215	28.974	1.882	1.858	2.092	1.725
19980718	17.8108	2.1959	1.4826	2.1463	0	20010216	29.129	1.879	1.862	2.091	1.75
19980719	17.6557	2.2029	1.4757	2.1474	0	20010217	30.37	1.857	1.895	2.087	1.946
19980720	17.5007	2.21	1.4688	2.1486	0	20010218	28.819	1.885	1.854	2.092	1.7
19980721	17.5007	2.21	1.4688	2.1486	0	20010219	28.199	1.896	1.837	2.095	1.596
19980722	17.5007	2.21	1.4688	2.1486	0	20010220	28.199	1.896	1.837	2.095	1.596
19980723	17.3456	2.2172	1.4618	2.1497	0	20010221	28.354	1.893	1.841	2.094	1.622
19980724	17.1906	2.2245	1.4548	2.1509	0	20010222	27.424	1.912	1.815	2.097	1.463
19980725	17.0355	2.232	1.4477	2.1521	0	20010223	27.424	1.912	1.815	2.097	1.463
19980726	17.0355	2.232	1.4477	2.1521	0	20010224	26.339	1.935	1.784	2.102	1.267
19980727	16.8804	2.2396	1.4405	2.1533	0	20010225	27.114	1.918	1.807	2.099	1.408
19980728	16.8804	2.2396	1.4405	2.1533	0	20010226	28.509	1.89	1.845	2.094	1.648
19980729	16.8804	2.2396	1.4405	2.1533	0	20010227	27.889	1.903	1.828	2.096	1.543
19980730	16.8804	2.2396	1.4405	2.1533	0	20010228	27.269	1.915	1.811	2.098	1.435
19980731	17.0355	2.232	1.4477	2.1521	0	20010301	26.804	1.925	1.798	2.1	1.352
19980801	16.8804	2.2396	1.4405	2.1533	0	20010302	27.114	1.918	1.807	2.099	1.408
19980802	16.5703	2.2553	1.4258	2.1558	0	20010303	26.959	1.921	1.802	2.099	1.38
19980803	16.4153	2.2634	1.4184	2.1571	0	20010304	27.269	1.915	1.811	2.098	1.435
19980804	16.4153	2.2634	1.4184	2.1571	0	20010305	28.509	1.89	1.845	2.094	1.648
19980805	16.4153	2.2634	1.4184	2.1571	0	20010306	27.269	1.915	1.811	2.098	1.435
19980806	16.2602	2.2717	1.4108	2.1584	0	20010307	26.339	1.935	1.784	2.102	1.267
19980807	16.1052	2.2802	1.4032	2.1597	0	20010308	25.873	1.945	1.77	2.103	1.179
19980808	16.1052	2.2802	1.4032	2.1597	0	20010309	25.718	1.948	1.766	2.104	1.15
19980809	16.1052	2.2802	1.4032	2.1597	0	20010310	25.253	1.959	1.752	2.106	1.059

Date (YYYYMMDD)	Flow (mgd)	Mn (mg/l)	Al (mg/l)	Fe (mg/l)	acid (mg/l)	Date (YYYYMMDD)	Flow (mgd)	Mn (mg/l)	Al (mg/l)	Fe (mg/l)	acid (mg/l)
19980810	17.0355	2.232	1.4477	2.1521	0	20010311	24.943	1.966	1.742	2.107	0.998
19980811	17.3456	2.2172	1.4618	2.1497	0	20010312	24.788	1.97	1.738	2.108	0.966
19980812	16.7254	2.2474	1.4332	2.1546	0	20010313	32.23	1.826	1.941	2.082	2.22
19980813	16.4153	2.2634	1.4184	2.1571	0	20010314	35.176	1.783	2.01	2.073	2.615
19980814	16.8804	2.2396	1.4405	2.1533	0	20010315	35.331	1.781	2.014	2.073	2.635
19980815	16.7254	2.2474	1.4332	2.1546	0	20010316	35.487	1.779	2.017	2.072	2.655
19980816	16.5703	2.2553	1.4258	2.1558	0	20010317	37.657	1.751	2.064	2.067	2.917
19980817	16.8804	2.2396	1.4405	2.1533	0	20010318	38.432	1.741	2.081	2.065	3.007
19980818	17.6557	2.2029	1.4757	2.1474	0	20010319	37.037	1.759	2.051	2.069	2.844
19980819	17.8108	2.1959	1.4826	2.1463	0	20010320	36.572	1.765	2.041	2.07	2.788
19980820	16.8804	2.2396	1.4405	2.1533	0	20010321	39.053	1.734	2.094	2.064	3.076
19980821	16.5703	2.2553	1.4258	2.1558	0	20010322	47.425	1.649	2.253	2.047	3.906
19980822	16.4153	2.2634	1.4184	2.1571	0	20010323	44.324	1.678	2.197	2.052	3.621
19980823	20.4466	2.0937	1.5895	2.1293	0	20010324	43.084	1.69	2.174	2.055	3.5
19980824	17.8108	2.1959	1.4826	2.1463	0	20010325	40.758	1.715	2.128	2.06	3.262
19980825	17.0355	2.232	1.4477	2.1521	0	20010326	38.432	1.741	2.081	2.065	3.007
19980826	17.5007	2.21	1.4688	2.1486	0	20010327	35.797	1.775	2.024	2.072	2.693
19980827	16.8804	2.2396	1.4405	2.1533	0	20010328	33.626	1.805	1.974	2.077	2.413
19980828	16.5703	2.2553	1.4258	2.1558	0	20010329	32.23	1.826	1.941	2.082	2.22
19980829	16.4153	2.2634	1.4184	2.1571	0	20010330	58.589	1.565	2.433	2.029	4.776
19980830	16.2602	2.2717	1.4108	2.1584	0	20010331	53.783	1.598	2.359	2.036	4.427
19980831	15.9346	2.2896	1.3947	2.1612	0	20010401	49.131	1.635	2.282	2.044	4.053
19980901	15.8106	2.2967	1.3884	2.1623	0	20010402	44.79	1.673	2.205	2.052	3.665
19980902	18.2759	2.1758	1.5027	2.143	0	20010403	40.913	1.713	2.131	2.06	3.278
19980903	19.0512	2.1444	1.5349	2.1378	0	20010404	38.122	1.745	2.074	2.066	2.971
19980904	17.3456	2.2172	1.4618	2.1497	0	20010405	35.021	1.785	2.007	2.074	2.596
19980905	16.8804	2.2396	1.4405	2.1533	0	20010406	36.262	1.769	2.034	2.07	2.751
19980906	16.5703	2.2553	1.4258	2.1558	0	20010407	36.107	1.771	2.031	2.071	2.732
19980907	17.0355	2.232	1.4477	2.1521	0	20010408	33.161	1.812	1.963	2.079	2.35
19980908	19.0512	2.1444	1.5349	2.1378	0	20010409	31.92	1.831	1.934	2.082	2.176
19980909	17.6557	2.2029	1.4757	2.1474	0	20010410	32.386	1.824	1.945	2.081	2.242
19980910	17.0355	2.232	1.4477	2.1521	0	20010411	32.075	1.829	1.937	2.082	2.198
19980911	16.7254	2.2474	1.4332	2.1546	0	20010412	32.23	1.826	1.941	2.082	2.22
19980912	16.5703	2.2553	1.4258	2.1558	0	20010413	30.68	1.851	1.903	2.086	1.993
19980913	16.4153	2.2634	1.4184	2.1571	0	20010414	29.75	1.868	1.879	2.089	1.849
19980914	16.4153	2.2634	1.4184	2.1571	0	20010415	29.44	1.873	1.87	2.09	1.8
19980915	16.2602	2.2717	1.4108	2.1584	0	20010416	33.936	1.801	1.982	2.077	2.454
19980916	16.1052	2.2802	1.4032	2.1597	0	20010417	32.386	1.824	1.945	2.081	2.242
19980917	16.5703	2.2553	1.4258	2.1558	0	20010418	32.696	1.819	1.952	2.08	2.286
19980918	16.5703	2.2553	1.4258	2.1558	0	20010419	30.68	1.851	1.903	2.086	1.993
19980919	16.2602	2.2717	1.4108	2.1584	0	20010420	29.905	1.865	1.883	2.089	1.874
19980920	16.1052	2.2802	1.4032	2.1597	0	20010421	29.905	1.865	1.883	2.089	1.874
19980921	16.1052	2.2802	1.4032	2.1597	0	20010422	29.595	1.87	1.874	2.09	1.825
19980922	16.5703	2.2553	1.4258	2.1558	0	20010423	28.974	1.882	1.858	2.092	1.725
19980923	16.5703	2.2553	1.4258	2.1558	0	20010424	28.354	1.893	1.841	2.094	1.622
19980924	16.1052	2.2802	1.4032	2.1597	0	20010425	27.269	1.915	1.811	2.098	1.435
19980925	16.1052	2.2802	1.4032	2.1597	0	20010426	26.339	1.935	1.784	2.102	1.267
19980926	16.4153	2.2634	1.4184	2.1571	0	20010427	25.873	1.945	1.77	2.103	1.179
19980927	16.1052	2.2802	1.4032	2.1597	0	20010428	25.408	1.955	1.757	2.105	1.09

Date (YYYYMMDD)	Flow (mgd)	Mn (mg/l)	Al (mg/l)	Fe (mg/l)	acid (mg/l)	Date (YYYYMMDD)	Flow (mgd)	Mn (mg/l)	Al (mg/l)	Fe (mg/l)	acid (mg/l)
19980928	16.1052	2.2802	1.4032	2.1597	0	20010429	24.478	1.978	1.728	2.109	0.903
19980929	15.8106	2.2967	1.3884	2.1623	0	20010430	24.013	1.989	1.713	2.111	0.806
19980930	15.7331	2.3012	1.3845	2.163	0	20010501	23.548	2.001	1.698	2.113	0.707
19981001	15.7331	2.3012	1.3845	2.163	0	20010502	23.238	2.009	1.688	2.115	0.639
19981002	15.5625	2.3112	1.3758	2.1646	0	20010503	23.082	2.014	1.683	2.116	0.604
19981003	15.609	2.3084	1.3782	2.1642	0	20010504	22.617	2.027	1.667	2.118	0.498
19981004	16.4153	2.2634	1.4184	2.1571	0	20010505	22.307	2.035	1.657	2.119	0.426
19981005	16.1052	2.2802	1.4032	2.1597	0	20010506	21.687	2.054	1.635	2.123	0.277
19981006	15.8881	2.2923	1.3924	2.1617	0	20010507	21.222	2.068	1.618	2.125	0.161
19981007	15.8106	2.2967	1.3884	2.1623	0	20010508	20.912	2.078	1.607	2.127	0.082
19981008	19.8264	2.1154	1.5658	2.133	0	20010509	20.757	2.083	1.601	2.128	0.042
19981009	19.5163	2.1267	1.5536	2.1349	0	20010510	20.602	2.088	1.595	2.128	0.001
19981010	25.0981	1.9627	1.7471	2.1066	1.0286	20010511	20.292	2.099	1.584	2.13	0
19981011	21.0668	2.0732	1.6125	2.1259	0.1219	20010512	19.826	2.115	1.566	2.133	0
19981012	19.2062	2.1384	1.5412	2.1368	0	20010513	19.826	2.115	1.566	2.133	0
19981013	18.431	2.1693	1.5092	2.1419	0	20010514	19.361	2.133	1.547	2.136	0
19981014	20.9118	2.0783	1.6068	2.1267	0.082	20010515	19.206	2.138	1.541	2.137	0
19981015	19.6714	2.121	1.5597	2.1339	0	20010516	19.051	2.144	1.535	2.138	0
19981016	18.586	2.1629	1.5158	2.1409	0	20010517	18.896	2.15	1.529	2.139	0
19981017	18.1209	2.1824	1.496	2.1441	0	20010518	19.051	2.144	1.535	2.138	0
19981018	17.9658	2.1891	1.4893	2.1452	0	20010519	19.051	2.144	1.535	2.138	0
19981019	17.8108	2.1959	1.4826	2.1463	0	20010520	19.051	2.144	1.535	2.138	0
19981020	17.6557	2.2029	1.4757	2.1474	0	20010521	20.137	2.104	1.578	2.131	0
19981021	17.5007	2.21	1.4688	2.1486	0	20010522	25.098	1.963	1.747	2.107	1.029
19981022	17.3456	2.2172	1.4618	2.1497	0	20010523	24.168	1.985	1.718	2.111	0.839
19981023	17.1906	2.2245	1.4548	2.1509	0	20010524	21.377	2.063	1.624	2.124	0.2
19981024	17.1906	2.2245	1.4548	2.1509	0	20010525	20.137	2.104	1.578	2.131	0
19981025	17.1906	2.2245	1.4548	2.1509	0	20010526	21.067	2.073	1.613	2.126	0.122
19981026	17.0355	2.232	1.4477	2.1521	0	20010527	24.013	1.989	1.713	2.111	0.806
19981027	17.1906	2.2245	1.4548	2.1509	0	20010528	25.408	1.955	1.757	2.105	1.09
19981028	17.1906	2.2245	1.4548	2.1509	0	20010529	23.238	2.009	1.688	2.115	0.639
19981029	17.6557	2.2029	1.4757	2.1474	0	20010530	22.152	2.04	1.651	2.12	0.39
19981030	17.3456	2.2172	1.4618	2.1497	0	20010531	21.067	2.073	1.613	2.126	0.122
19981031	17.1906	2.2245	1.4548	2.1509	0	20010601	20.757	2.083	1.601	2.128	0.042
19981101	17.0355	2.232	1.4477	2.1521	0	20010602	24.013	1.989	1.713	2.111	0.806
19981102	17.0355	2.232	1.4477	2.1521	0	20010603	24.633	1.974	1.733	2.109	0.935
19981103	19.8264	2.1154	1.5658	2.133	0	20010604	23.082	2.014	1.683	2.116	0.604
19981104	19.3613	2.1325	1.5474	2.1359	0	20010605	21.842	2.049	1.64	2.122	0.315
19981105	19.5163	2.1267	1.5536	2.1349	0	20010606	21.067	2.073	1.613	2.126	0.122
19981106	18.7411	2.1566	1.5222	2.1398	0	20010607	20.912	2.078	1.607	2.127	0.082
19981107	17.8108	2.1959	1.4826	2.1463	0	20010608	20.292	2.099	1.584	2.13	0
19981108	17.1906	2.2245	1.4548	2.1509	0	20010609	19.826	2.115	1.566	2.133	0
19981109	17.1906	2.2245	1.4548	2.1509	0	20010610	19.516	2.127	1.554	2.135	0
19981110	17.1906	2.2245	1.4548	2.1509	0	20010611	19.361	2.133	1.547	2.136	0
19981111	17.8108	2.1959	1.4826	2.1463	0	20010612	19.361	2.133	1.547	2.136	0
19981112	17.5007	2.21	1.4688	2.1486	0	20010613	19.981	2.11	1.572	2.132	0
19981113	17.3456	2.2172	1.4618	2.1497	0	20010614	19.516	2.127	1.554	2.135	0
19981114	17.0355	2.232	1.4477	2.1521	0	20010615	19.206	2.138	1.541	2.137	0
19981115	17.0355	2.232	1.4477	2.1521	0	20010616	19.361	2.133	1.547	2.136	0

Date (YYYYMMDD)	Flow (mgd)	Mn (mg/l)	Al (mg/l)	Fe (mg/l)	acid (mg/l)	Date (YYYYMMDD)	Flow (mgd)	Mn (mg/l)	Al (mg/l)	Fe (mg/l)	acid (mg/l)
19981116	16.8804	2.2396	1.4405	2.1533	0	20010617	24.478	1.978	1.728	2.109	0.903
19981117	16.8804	2.2396	1.4405	2.1533	0	20010618	20.757	2.083	1.601	2.128	0.042
19981118	16.7254	2.2474	1.4332	2.1546	0	20010619	19.206	2.138	1.541	2.137	0
19981119	16.5703	2.2553	1.4258	2.1558	0	20010620	20.292	2.099	1.584	2.13	0
19981120	16.5703	2.2553	1.4258	2.1558	0	20010621	23.858	1.993	1.708	2.112	0.773
19981121	16.7254	2.2474	1.4332	2.1546	0	20010622	22.617	2.027	1.667	2.118	0.498
19981122	16.4153	2.2634	1.4184	2.1571	0	20010623	23.548	2.001	1.698	2.113	0.707
19981123	16.2602	2.2717	1.4108	2.1584	0	20010624	21.842	2.049	1.64	2.122	0.315
19981124	16.4153	2.2634	1.4184	2.1571	0	20010625	20.292	2.099	1.584	2.13	0
19981125	16.2602	2.2717	1.4108	2.1584	0	20010626	19.516	2.127	1.554	2.135	0
19981126	19.0512	2.1444	1.5349	2.1378	0	20010627	18.896	2.15	1.529	2.139	0
19981127	18.431	2.1693	1.5092	2.1419	0	20010628	18.741	2.157	1.522	2.14	0
19981128	17.6557	2.2029	1.4757	2.1474	0	20010629	18.586	2.163	1.516	2.141	0
19981129	17.1906	2.2245	1.4548	2.1509	0	20010630	18.276	2.176	1.503	2.143	0
19981130	17.035	2.232	1.448	2.152	0	20010701	18.276	2.176	1.503	2.143	0

Attachment F

Panther Creek Upstream/Downstream of Slum Creek

Sample #	Location	Date	pH	Alk	TSS	Fe	Mn	Al	Acid	TDS
4542013	# 14 Shaft	12/1/2010	6.6	98.8	28	22.318	8.239	4.449	-40.0	
4542010	Panther above Slum	9/30/2010	7.0	33.2	90	3.215	0.427	2.962		
4542014	Panther above Slum	12/1/2010	6.9	19.8	284	8.115	0.776	6.262	2.6	
4521813	Panther above Slum	12/8/2010	6.8	31.6	38	1.340	1.103	2.206	-17.2	
4521815	Panther above Slum	12/21/2010	6.9	44.4	24	1.870	1.218	2.559	-23.4	264
4521818	Panther above Slum	12/28/2010	7.0	58.0	30	2.068	1.228	2.240	-36.6	566
4521821	Panther above Slum	1/5/2011	7.0	69.2	24	2.395	1.296	2.290	-48.8	
4521824	Panther above Slum	1/11/2011				3.122	1.410	2.688	-54.8	
4542011	Slum Creek	9/30/2010	4.6	5.2	1274	30.590	0.340	14.401		
4542015	Slum Creek	12/1/2010	4.3	5.0	2618	39.589	0.303	13.298	36.0	
4521812	Slum Creek	12/8/2010	3.5	0.0	34	0.802	2.442	6.420	54.8	
4521814	Slum Creek	12/21/2010	3.5	0.0	86	4.246	2.860	9.703	68.0	372
4521817	Slum Creek	12/21/2010	3.5	0.0	48	0.716	2.744	6.924	70.4	392
4521820	Slum Creek	1/5/2011	3.4	0.0	<5	0.720	2.938	7.287	71.0	
4521823	Slum Creek	1/11/2011				0.683	3.047	7.145	70.6	
4542012	Panther below Slum	9/30/2010	6.3	17.6	116	5.515	6.017	0.743		
4542016	Panther below Slum	12/1/2010	6.7	17.8	408	16.266	0.772	9.202	1.6	
4521811	Panther below Slum	12/8/2010	6.4	20.8	28	1.278	1.691	3.078	-3.4	
4521816	Panther below Slum	12/21/2010	6.6	25.4	26	1.791	2.040	3.878	-3.2	574
4521819	Panther below Slum	12/28/2010	6.5	32.8	32	1.989	2.400	4.273	-9.2	640
4521822	Panther below Slum	1/5/2011	6.3	34.2	16	2.369	2.801	4.632	-10.0	
4521825	Panther below Slum	1/11/2011				2.705	3.003	5.080	-13.8	

Attachment G

2008 Pennsylvania Integrated Water Quality Monitoring and Assessment Report Streams, Category 5, Waterbodies, Pollutants Requiring a TMDL

Pennsylvania Integrated Water Quality Monitoring and Assessment Report Streams, Category 5 Waterbodies, Pollutants Requiring a TMDL

Hydrologic Unit Code: 02040203 Schuylkill			
Stream Name **Use Designation (Assessment ID)** **Source**	**Cause**	**Date Listed**	**TMDL Date**
<u>Panther Creek</u> HUC: 02040203 Aquatic Life (719) - 6.48 miles; 4 Segment(s)* Abandoned Mine Drainage Industrial Point Source Surface Mining	Metals Unknown Toxicity Siltation	1996 2002 1998	2009 2015 2011
<u>Slum Creek</u> HUC: 02040203 Aquatic Life (727) - 1.58 miles; 3 Segment(s)* Industrial Point Source Industrial Point Source	Other Organics Unknown Toxicity	2002 2002	2015 2015

*Segments are defined as individual COM IDs.

Report Summary
Watershed Summary

	Stream Miles	Assessment Units	Segments (COMIDs)
Watershed Characteristics	9.11	2	9

Impairment Summary

Source	Cause	Miles	Assessment Units	Segments (COMIDs)
Abandoned Mine Drainage	Metals	6.48	1	4
Industrial Point Source	Other Organics	1.58	1	3
Industrial Point Source	Unknown Toxicity	8.06	2	7
Surface Mining	Siltation	6.48	1	4
		8.06**	2**	7**

**Totals reflect actual miles of impaired stream. Each stream segment may have multiple impairments (different sources or causes contributing to the impairment). So the sum of individual impairment numbers may not add up to the totals shown.

Use Designation Summary

	Miles	Assessment Units	Segments (COMIDs)
Aquatic Life	6.06	2	7

Attachment H – Comment and Response

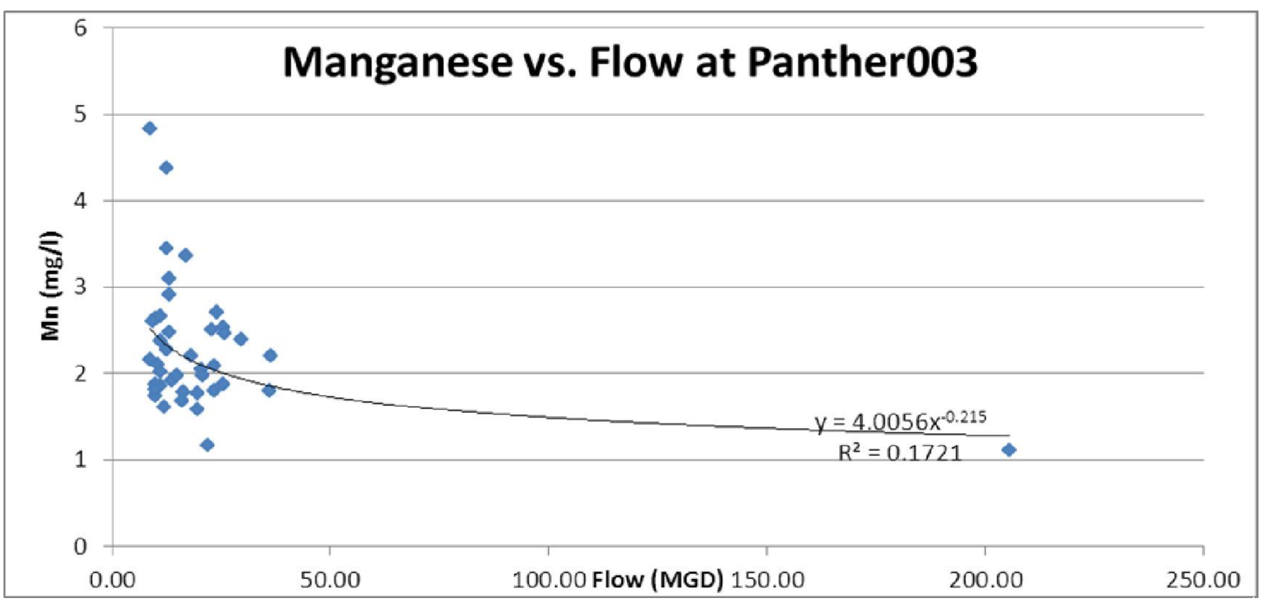
Comment:

The Department's modified "AMD Methodology" is unsound and yields excessive long-term average allowable pollutant concentrations and loads at monitoring point Panther 003.

Response:

The modified methodology for computing the long term allowable concentration was only applied to manganese; therefore, comments regarding the applicability of the methodology to iron and aluminum are not relevant. That being said, it is not surprising that the relationship between flow and iron or aluminum is weak. Pennsylvania soils are comprised primarily of iron and alumina-silicate clays, so the levels of these pollutants are high at low flows from mine drainage and high at high flows because of sediment loads delivered to the stream – thus no discernible relationship to flow. The Department regrets the inclusion of these parameters in the datasets provided with the TMDL if they gave the mistaken impression that the methodology was applied to them. No further modification of the TMDLs for these parameters was necessary as the permits will be written using in-stream criteria as effluent limitations and WLAs are easily accommodated in the original TMDLs.

The relationship between manganese and flow for the original 41 data points is shown below. Whereas the comments suggest a weak linear relationship, the appropriate fit is a power function that clearly demonstrates the relationship of Mn concentration to flow. Looking at the plot below and the data, it is evident that the highest concentrations of manganese were observed at the lowest flows. In fact, the six highest concentrations of Mn are when the flow is less than 17 MGD and range from 2.91 to 4.84 mg/l Mn. When the flows are above 18 MGD[1], there is not a single measurement above 2.7 mg/l Mn and a clear signal of decreasing Mn with increased flow. Further, the lowest observed Mn concentration corresponds to the highest flow. It is difficult not to notice the marked difference in the Mn concentrations, regardless of what the R-squared value indicates, as flows increase. The Department believes that this relationship is strong enough to allow us to proceed with the rest of the analysis.



1. Flows included only 5 MGD of discharge at the time the samples were collected

The building of a dataset with over 1,800 points was not an attempt to artificially lower the standard deviation, it was an attempt to provide a dataset that will resemble what the stream will look like once pumping resumes and the discharge is tightly controlled with respect to effluent quality. As can be seen from the plot, the variability in the original data exists at low flows when the future discharge will make up 70% or more of the streamflow. It would have been more artificial and unrepresentative of future conditions if the steady discharge of 14.4 MGD with consistent quality was not accounted for in the dataset. While the methodology did decrease the standard deviation of the data set, the fact that most of the variability in the initial dataset is at low flows where the BET discharge will dominate justifies the Department's attempt to account for the discharge's volume and the quality and the long-term impacts on the stream. It could be argued that the LTAs have, in the past, been driven artificially low by the lack of samples used to calculate it. Further, the Department's past efforts to collect samples over all flow regimes only exacerbated the phenomenon of the LTAs being driven to levels 3 to 4 times less than the in-stream criteria.

Comment:
The WLA's to the BET Associates LCN Mine are excessive.

Response:

There are no rules, or even guidelines, on the proportion of the total allowable load that must be given to any individual discharge. The Department believes that the proportions/allocations provided in the TMDL, at the levels expected from the treatment system, provide Panther Creek the best chance of supporting aquatic life in the future. The justification for the unbalanced allocation is that it provides the greatest chance of returning aquatic life to Panther Creek by discharging large volumes of water at, or near, in-stream criteria. The cleanup of Slum Creek is used to justify the assumption that LAs can be met without reducing the WLAs, thus satisfying Reasonable Assurance requirements. It's not clear to the Department where the problem exists or why the two should be taken as mutually exclusive.

The Department believes that achieving the draft TMDL loadings will lead to Panther Creek meeting state water quality standards.