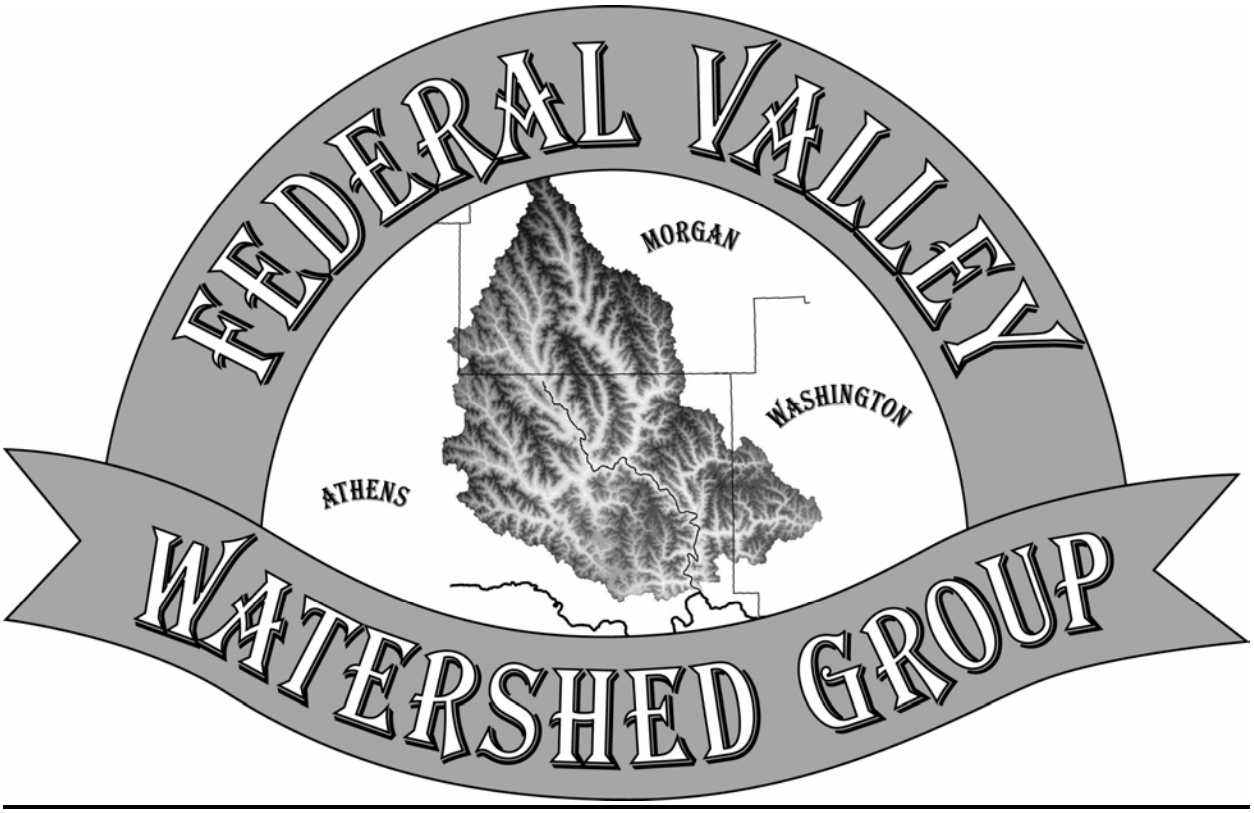
APPENDIX F

AMDAT for the Federal Creek Watershed



The Federal Valley Watershed
Acid Mine Drainage Abatement Plan
April 12, 2006

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SECTION I BACKGROUND

PURPOSE

In 2002, the Federal Valley Watershed Group, in cooperation with the Ohio Department of Natural Resources, Division of Mineral Resources Management, and Midwest Biodiversity Institute conducted an investigation to determine to what extent mine drainage is affecting stream health. Sources of acid mine drainage (AMD) were determined by characterizing chemical constituents in the water, measuring stream flow, and determining the condition of aquatic life. From this information, an Acid Mine Drainage Abatement and Treatment (AMDAT) Plan was written to systematically identify and restore mine impacted segments of Federal Creek and its tributaries to meet their "aquatic life designated use" as established by the Ohio EPA. The goal of the plan is to improve surface water quality that has been adversely affected by coal mining practices that occurred prior to passage of the Surface Mining Control and Reclamation Act (SMCRA) in 1977. The AMDAT Plan identifies all of the major existing sources of acid mine drainage in the Federal Creek Watershed, and prioritizes areas for treatment based on their chemical load and relative effects on the aquatic health of the watershed. Because acid mine drainage is diffuse in the basin, an intensive field investigation was conducted to identify (1) the impacted tributaries, and (2) sources of pollution within six subwatersheds and one section of the mainstem.

Chemical data from this investigation, along with biological data collected during the summer of 2002 by the Federal Valley Watershed Group and during the summer of 2005 by Midwest Biodiversity Institute (MBI) were used to prioritize potential sites for acid mine drainage abatement and treatment in the Federal Valley Watershed. Treatment strategy is discussed in Section II of this plan.

SCOPE OF REPORT

This AMDAT will include the following:

- An identification of the qualified hydrologic unit, including geology and physiography.
- An identification of the sources of acid mine drainage, including methodology.
- The extent to which AMD is affecting the water quality and biological resources within the hydrologic unit
- Water quality designations, and water quality targets for achieving stream health
- An identification of individual projects and the measures proposed to be undertaken to abate and treat the causes or effects of acid mine drainage. An identification of subsidence features within the watershed, if appropriate.
- The cost of undertaking the proposed abatement and treatment measures and an analysis of the cost-effectiveness and environmental benefits.
- An identification of existing and proposed sources of funding for individual projects
- A monitoring plan for assessment of actual environmental benefit realized.

Map 1 Federal Valley and its Subwatersheds

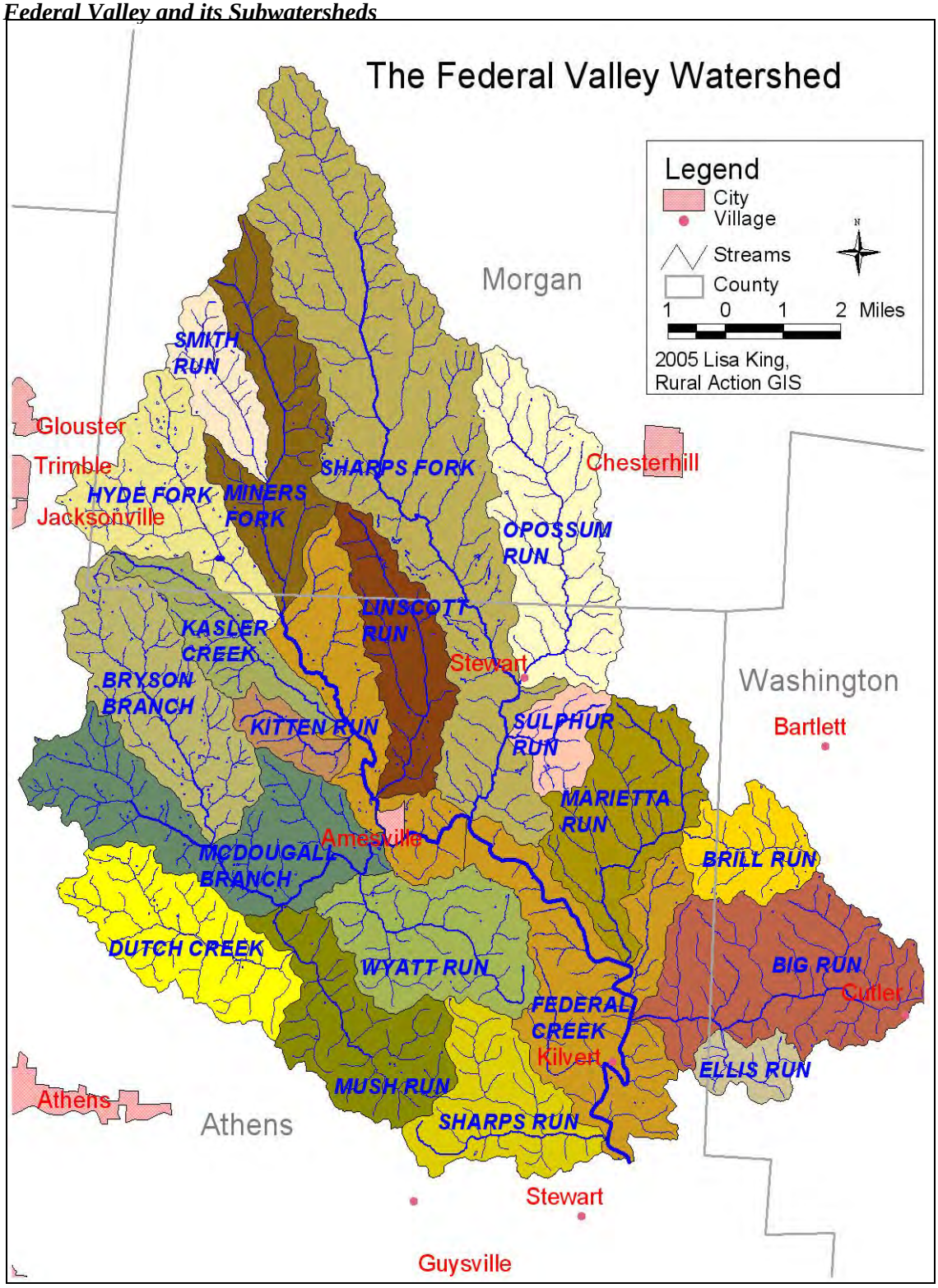
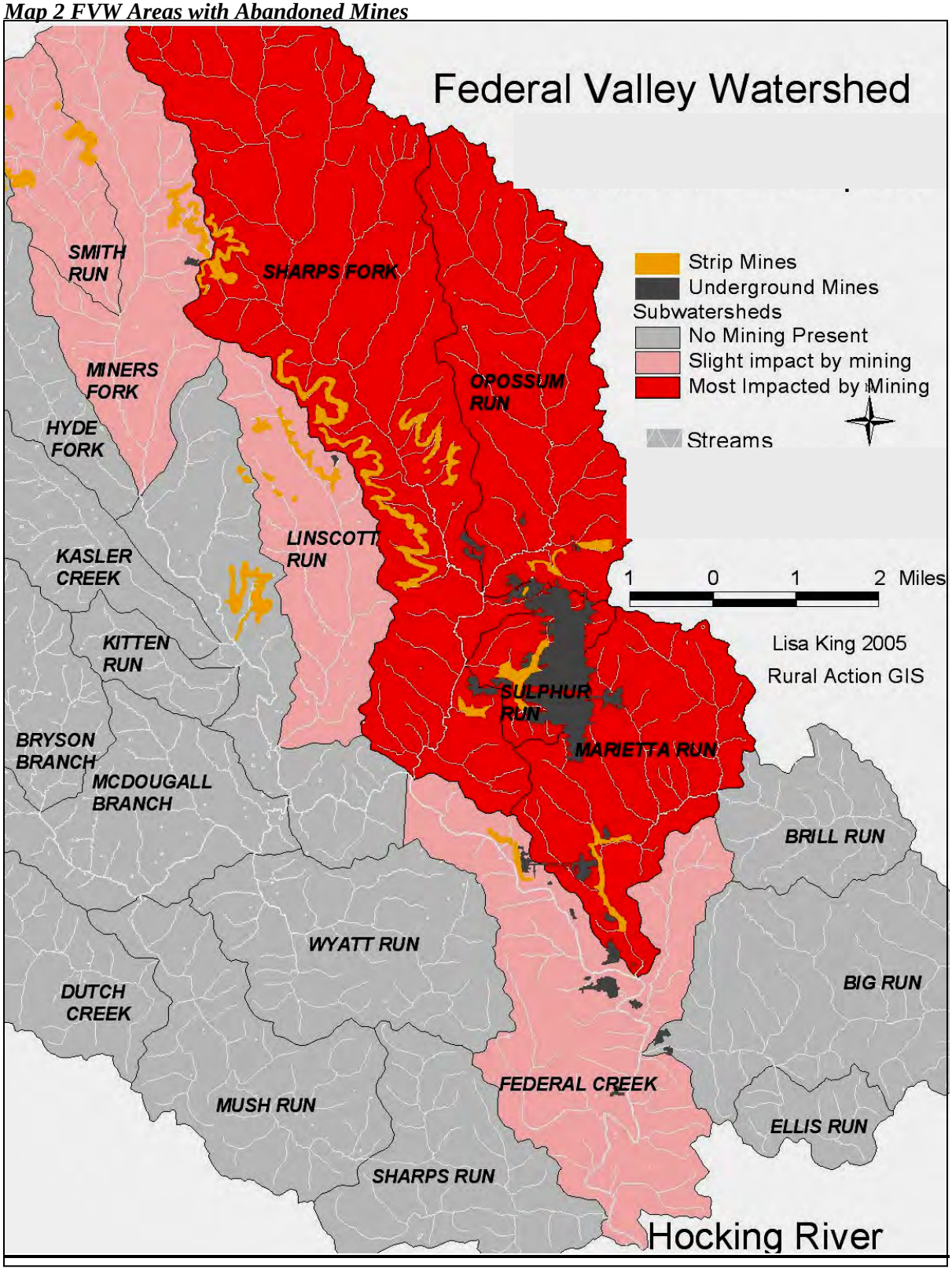


Table 1 Subwatershed Geography

Subshed Name	Flow Direction	Stream Flows Into:	River Mile Stream Flows Into:	Morgan/ Athens/ Washington County	Homer/Rome/ Ames/Bern/ Marion/ Wesley/ Decatur/ Cannan/Dover Union/Trimble Township	Proximity to Towns	Latitude	Longitude	Corning, Ringold, Chesterhill, Jacksonville, Amesville, Cutler, Stewart, Athens Quadranagle	Area Sq. Mile	Stream Length (miles)	Elevation (source)	Elevation (mouth)	Average Fall (ft/mi)	Sq Mi of Under ground Mines	% coverage of under ground mines in shed	Sq. Mile of strip mines	% coverage of strip mines in shed
Federal Creek	South/ SE	Hocking	15.29	M,A,W	H,R,A,B,M,W, DE,C,DO,U,T	Amesville: 0.0 miles, Joy: 1 mile S-SE	39.330082	-81.887753	Co,R,Cu,J,A,Ch,S,A	144.73	23.80	1040	585	19.12	2.25	1.55%	2.09	1.44%
Sharps Run	East	Federal	0.59	A	R/Ca	Stewart: 0.8 miles S			S	5.60	3.60	760	585	48.61		0.00%		0.00%
Big Run	West	Federal	3.79	W,A	R,De,W,B	Kilvert: 1 mile E	39.3552	-81.8783	Cu,Ch,S	11.90	5.50	860	595	48.18	0.03	0.24%	0.00	0.00%
Joe's Run	South	Big Run	0.83	A	R,B	Kilvert			Ch,Cu	0.90	1.90	920	612	162.11		0.00%		0.00%
Ellis Run	North	Big Run	1.60	W,A	De,R	Kilvert: 1.3 miles E,	39.3534459	-81.8510756	Cu	1.60	2.62	755	610	55.39	0.00	0.00%	0.00	0.00%
Wildcat Run	South	Big Run	4.00	W	W	Cutler	39.3604142	-81.8155449	Cu	1.75	2.20	880	650	104.55		0.00%		0.00%
Spruce Run	South	Federal	3.79	A	R,B	Broadwell			S,Ch,Cu		2.17	900	600	138.25	0.00			
Marrietta Run	South	Federal	4.26	*A*	B	Amesville: 2.5 miles E	39.368019	-81.8800396	A,Ch,S	10.10	5.80	890	604	49.31	0.32	3.12%	0.12	1.19%
Brill Run	West	Marietta Run	3.50	*A,W*	W,B	1 mile Bartlett			Ch,Cu	3.24	2.6	880	670	80.77		0.00%		0.00%
Sharps Fork	South	Federal	5.14	M,A	U,H,M,B	Joy in Sharps	39.4025964	-81.9296528	R,A	35.70	14.50	1040	621	28.90	1.15	3.22%	1.09	3.05%
Opossum Run	South	Sharp's Fork	2.83	M,A	M,B	Chesterhill, 0.8 miles E	39.4361753	-81.9123637	A,R	8.95	5.70	908	638	47.37	0.09	1.03%	0.85	9.50%
Starling Run	South	Opposum Run	3.94	M	M	Wrightstown			A		1.16	*890*	*740*	129.31				
Sulphur Run	West	Sharp's Fork	2.90	A	B	Sharpsburg: 0.3 miles NW			A	1.98	2.29	*900*	*640*	113.54	0.89	44.85%	0.13	6.52%
Joy Run	South	Sharp's Fork	6.37	M	M,H	Joy			A	1.12	1.50	820	675	96.67		0.00%		0.00%
McElfresh Run	South	Sharp's Fork	7.23	M	H,M	Joy			R,A	1.75	2.50	860	679	72.40		0.00%		0.00%
McDougall Branch	East	Federal	9.30	A	Do,A	Amesville: 0.3 miles W,	39.396629	-81.9625751	J,A,A/S	37.60	7.90	900	630	34.18	0.58	1.55%	0.08	0.20%
Wyatt Run	North	McDougal	0.50	A	A,R,C,B	New England in subshed	39.3842379	-81.9648203	S,A	6.78	4.90	895	634	53.27		0.00%		0.00%
Bryson Branch	South	McDougal	4.71	*A*	A,H,Do	Amesville: 2.0 miles E-SE	39.3959302	-82.0132625	J,A	7.77	6.48	900	660	37.04	0.00	0.01%		0.00%
Mush Run	North	McDougal	3.00	A	C,R,A	New England in subshed	39.3825448	-81.9897863	S,J,A	13.20	5.30	880	638	45.66	0.00	0.00%	0.00	0.00%
Dutch Creek	East	Mush Run	1.00	Athens	A,C	Athens: 2 miles S	39.3714707	-81.9871663	A,J,S	5.88	4.3	*900*	660	55.81		0.00%		0.00%
Linscott Run	South	Federal	11.93	M/A	H,A,B	Amesville: 0.4 miles S,	39.4027	-81.9602	A	5.04	5.50	910	634	50.18	0.01	0.14%	0.12	2.46%
Ewing Run	South	Linscott Run	1.76	M/A	A,H	Writestown			A	1.32	2.40	920	665	106.25		0.00%		0.00%
Kitten Run	East	Federal Creek	13.94	A	A	Amesville: 1.7 miles NW			J,A	1.55	2.85	*900*	*640*	91.23		0.00%		0.00%
Kasler Creek	South	Federal	14.13	M/A	H,A	Amesville .5 miles S			J,A	3.75	5.01	*940*	*660*	55.89		0.00%		0.00%
Draper's Run	South	Federal	15.99	M/A	H,A				A		2.34	*900*	*660*	102.56				
Hyde Branch	South	Federal	16.21	M	H,T,A	Trimble: 0.5 miles	39.4528746	-81.9904667	Co,J,A,R	6.53	4.60	893	634	56.30	0.00	0.00%	0.63	9.65%
Miners Fork	South	Federal	16.21	M/A	H,A	Joy: 1.3 miles W	39.4528746	-81.9904667	M, A	9.92	6.59	893	660	35.37	0.02	0.15%	0.36	3.61%
Smith Run	South	Miner's Fork	2.40	M	H	Bishopville	39.4815914	-81.995267	C,J,A	2.93	2.21	940	*760*	81.45		0.00%	0.19	6.44%

ABANDONED MINE IMPACTS IN FEDERAL VALLEY

Map 2 FVW Areas with Abandoned Mines



Mining impacts are dispersed and occur in some form in many areas of Federal Creek. The most extensive mining occurred in the area surrounding Sharpsburg and Joy, as well as the area along State Route 329 near Utley (Tick Ridge Rd.,) Phillipsburg (Marietta Run Rd.), and Broadwell (Mayle Ridge Road). Approximately 1.55 percent (2.25 square mile) of the total watershed has been deep mined and approximately 1.44 percent (2.09 square mile) has been surfaced mined for coal. In the Federal Valley Watershed, there are 77 mapped underground mine entries. Subsequent strip mining has obscured many of these. Very few of these entries form acid mine drainage seeps.

Due to high levels of naturally occurring alkalinity in the watershed, the effects of mining are reduced in Federal Valley. Federal Valley has high levels of alkalinity due to the geology of the area, which contains a high occurrence of limestone. This neutralizes much of the acidity that enters Federal Creek due to past mining practices. However, some areas of Federal Creek are negatively affected by mining impacts, mainly in the form of elevated metal or sulfate concentrations. Water chemistry data shows the most heavily impacted areas are within Sharp's Fork and Marietta Run. Sulphur Run in Sharp's Fork is the most impacted subwatershed in Federal Creek. Other impacted tributaries include Opossum Run, numerous unnamed tributaries to Sharp's Fork, Upper Linscott Run, Smith Run, and Miner's Fork. Additionally, AMD enters the Federal Creek mainstem between Tick Ridge Road and Mayle Ridge Road. In most cases, when the contaminated water in the small tributaries enters the larger stream channels, the water is neutralized and diluted so that a problem is not evident in the larger stream channel.

IDENTIFICATION OF THE HYDROLOGIC UNIT

Name: Federal Creek Watershed
11-digit Hydrologic Unit Code (HUC): 05030204090
Tributary To: Hocking River: Ohio River Basin
Drainage Area: 145 square miles
Length: 23.8 miles
Location: Athens, Morgan, and Washington Counties
Quadrangles: Ringgold, Corning, Chesterhill, Amesville, Jacksonville, Cutler, Stewart, and Athens.

WATERSHED DESCRIPTION

Federal Creek is a third order stream. Federal Valley Watershed is identified as UWA 11 digit HUC 05030204090 and is located within three counties: Athens (88 square mile), Morgan (45 square mile), and Washington (12 square mile), a total of 145 square miles. This watershed has been subdivided into nine 14-digit subwatersheds, which has been subdivided into thirteen main sub basins and a total of 20 different basins (both first and second order). There are twelve townships whose boundaries cross into

the watershed: Rome, Ames, Bern, Dover, Trimble, and Canaan in Athens County; Homer, Marion, Fairfield, and Union in Morgan County; and Wesley, and Decatur in Washington County (see map). The largest village in the watershed is Amesville with a population of approximately 250. Smaller towns in the watershed include Sharpsburg, Joy, Kilvert,, New England, Broadwell, Utley, Lathrop, Phillipsburg and Mountville. On the edge of the watershed are the towns of Cutler, Chesterhill, Bishopville, Trimble and Stewart. Federal Creek can be found on the Corning, Ringold, Chesterhill, Jacksonville, Amesville, Cutler, Stewart, and Athens USGS quad sheets.

Federal Creek is a tributary of the Hocking River in southeastern Ohio. The Hocking River Watershed contains approximately 1,199 square miles. Federal Valley Watershed is one of the four largest watersheds in the basin, representing approximately twelve percent of the Hocking River Watershed. Federal Valley Watershed originates in west-central Morgan County and flows in a southeasterly direction into Athens County. The river's confluence with the Hocking River is approximately twelve miles east of Athens, Ohio. The watershed covers an area of approximately 145 square miles, it is 16 miles wide and 18 miles long and the main stem is 23.8 miles long. The latitude ranges from 39°18'00" to 39°35'00" and the longitude ranges from 81°47'30" to 82°2'30".

GEOLOGY

The watershed lies within the Marietta Plateau, characterized as dissected and with high relief. The Marietta Plateau mostly contains fine-grained rocks and commonly contains red shale and soils. Landslides and ancient remnants of the lacustrine, clay-filled Teays drainage system are also common (ODNR, Division of Division of Geological Survey, 1998). An early land system inventory for the nearby Wayne National Forest indicated that the majority of the landscape could be mapped as maturely dissected uplands; the remainder consists of broad river valleys and floodplains (Wester 1977). Typical side slopes have a steepness gradient of 12 to over 40 percent (USDA 1967). The common lithologic types are sandstone, shale, siltstone, limestone, and coal (Cusick and Silberhorn 1977).

The Federal Valley Watershed lies within the Permian and Pennsylvanian geologic systems. Within these two systems, three distinct rock units make up the strata underlying the watershed. These include the Dunkard Group of the Permian system and the Monongahela Group and Conemaugh Group of the Pennsylvanian system (ODNR, Division of Geological Survey 2001).

The Dunkard Group's lithology or rock composition consists of sandstone, siltstone, shale, and slight amounts of limestone and coal (ODNR, Division of Geological Survey, 2001). Permian rocks, which follow immediately above the Pennsylvanian sequence, are the youngest of the coal-bearing rocks in Ohio (Sturgeon,1958). Color for this group tends to be shades of brown, gray, green, and red. The Dunkard Group also typically has a thickness of 600 or more feet and thin to massive bedding. This group features a dominance of siltstone, shale, and sandstone, and has an occurrence of non-marine

limestone. It also features quick vertical and horizontal change in rock type (ODNR, Division of Geological Survey, 2001).

The Monongahela Group, the youngest of the Pennsylvania rocks, has a lithology consisting of shale, siltstone, sandstone, limestone, and coal (Sturgeon, 1958; ODNR, Division of Geological Survey, 2001). The highest alkalinities are associated with the thick freshwater limestone sequences of this group in the Vanport limestone of the lower Allegheny Group (Brady, Hornberger, and Fleeger, 2003). Color for this group tends to be shades of gray, green, and uncommonly red. The Monongahela Group also has a thickness of 350 or more feet and nonbedded to massive bedding. This group features laterally extensive non-marine limestone layers and economic coal beds, such as the Pittsburgh (No. 8) coal bed, a mineable reserve located at the base of the formation (Sturgeon, 1958; ODNR, Division of Geological Survey 2001). Although the overlying strata of the Pittsburgh (No. 8) coal bed contain nine other coal beds, it is the only one that is of a moderate extent (Sturgeon, 1958).

The Conemaugh Group consists of layers of shale, sandstone, siltstone, and mudstone (ODNR, Division of Geological Survey, 2001). Where marine limestones are present, significant alkalinity concentrations occur in this group (Brady, Hornberger, and Fleeger, 2003). The Conemaugh Group also contains many layers of coal beds; however, none of these are sufficiently thick or extensive to be considered a mineable resource. The Conemaugh Group also has a thickness anywhere from 350 to 490 feet and nonbedded to massive bedding. This group is characterized by multicolored mudstones, thin to thick marine limestone, and shale in the lower two-thirds of the unit. It also features quick vertical and horizontal change in rock type, and it is not common to find coal beds in this group (ODNR, Division of Geological Survey 2001).

COAL RESOURCES

The Pittsburgh (No. 8) coal is one of the most extensive and valuable beds in the eastern United States and is the primary coal bed of economic importance in Athens County. Athens County has the richest Pittsburgh coal deposits in Ohio, except for the Belmont field. Two main regions in Athens County have a great extent of the resource: the Federal Creek field in northeastern Athens County and the Shade Creek field in the south-central region of the county. Although production from the Federal Creek field has declined in recent years, it contains the greatest coal reserves of the two economically important areas (Delong 1955). It is for this reason that the Federal Creek field has made the Pittsburgh coal bed famous in Athens County (Sturgeon, 1958).

The Federal Creek field is most extensive in Bern Township of Athens County and contains large reserves in Rome and Ames Townships of Athens County (Sturgeon, 1958). This field, which terminates in Decatur Township of Washington County, also includes parts of Homer and Marion Townships of Morgan County. Although the Pittsburgh coal exists in almost every township in Morgan County, the

extension of the Federal Creek field accounts for all of Morgan County's reserves. Approximately 60 percent of Morgan County's estimated original reserves are within the Federal Creek field in Marion and Homer Townships. Washington County does not contain any parts of the Federal Creek field; however, it does contain two areas of mineable Pittsburgh coal: the eastern Washington field in Aurelius and an area in Decatur Township where the Federal Creek field ends (Delong, 1955). "The Pittsburgh (No. 8) coal bed is of wide areal extent in Morgan County, but, in much of its area of occurrence, it is thin and irregular in thickness. Most of Morgan County's Pittsburgh Coal reserve is found in the southeastern part of the county, where the coal is locally more than 5 feet thick, and where it constitutes a part of the Federal Creek field. There are also small isolated areas of coal 14-24 inches thick in the northeastern and central western parts of Morgan County."

In the Federal Creek field the coal is thin, and is mixed with a carbonaceous shale or limestone, and is overlain by heavy sandstone (Delong, 1955). 42 tests showed an average sulfur of 5.71 percent. It was variable, from 0.9-12.61 percent, in a market that now desires 1-2 percent sulfur. It is also characterized by a double-benched, (lower and upper bench) structure that is divided by clay, several inches to one foot in thickness. The lower bench, more uniform in its thickness, contains slender partings of a pyritic nature. The upper bench is generally superior in quality and also contains slender irregular partings of clay, bone, and pyrite. At Sharpsburg within Bern Township, the Pittsburgh coal thickness has changed laterally from eight feet to a zone of nonbedded, mottled yellow, maroon, and tan clay shale deposited during the Pittsburgh coal forming period (Sturgeon 1958).

MINING HISTORY

Coal was used as a primary energy source by various industries in the 1920's. Other uses of coal at the turn of the century included private homes and railroads. By the 1940's about half of the coal used in the United States was used by electric utilities, with most of the remaining coal being used by industry. In the 1990's electric utilities used over three-quarters of the coal produced, with industry using almost all of the remaining coal (National Energy Foundation, 1995). Coal production has increased over the past 100 years from about 210,000 tons in 1897 to about 22,293,204 tons in 2003 (Office of Surface Mining Reclamation and Enforcement, 2004). Recent estimates suggest that at this rate the United States coal reserves will last at least 500 years.

Three different types of mining techniques have been used in the Federal Valley Watershed. S*trip mining* is used when the coal seam is near to the ground's surface. The soil and rock overburden is removed and the coal is removed before the overburden is replaced. In Federal Valley Watershed there are 2.09 square miles of abandoned strip mines. In *drift mining*, a tunnel is driven into the side of a hill at a coal outcrop. The coal is mined out by following the contour of the bed. Most of the underground mining in the watershed was taken from drift mines. In the Federal Valley Watershed, there are 1.67

square miles of drift mines. A vertical opening is driven into the coal in *shaft mining*. This technique proceeds along the coal seam with excessive depth increasing entry, exit and ventilation hazards. There are .58 square miles of shaft mines in the Federal Valley.

Shaft and deep mines were originally used until the 1940s, before strip mines became more common. From the 1940's to the present, strip mining has replaced underground mining as the dominant method. According to calculations based on digitized layers of surface and underground mines on U.S. Geological Survey 1:24,000, 7.5 minute quadrangles, approximately 2.25 square miles of underground mines and 2.09 square miles of surface mines were established in the Federal Valley Watershed. Coal mining in the Federal Valley Watershed has taken place since the 1870s. The last registered underground mine was abandoned in 1960, and the bulk of the underground mines were abandoned by 1944. There has been a steady decline of coal extraction since that time. In 1966, coal strip mines within the watershed yielded 30,000 tons of coal (USDA, 1967). Most of this strip mining took place in Sharps Fork. During the 1970's, as high sulphur coal became less valuable and transport became more expensive (i.e., lack of railroad transportation), this land use declined. Since 1998, no coal has been extracted from the watershed and most of the land owned by coal companies has been sold.

METHODOLOGY

Watershed Assessment

The assessment of the watershed was based upon data collected during water quality monitoring of selected locations along the main stem of Federal Creek as well as an individual assessment of all subwatersheds with known mine drainage impact, using a three-phased approach. A three-phased approach has become the standard method of watershed characterization for acid mine drainage abatement plans over the past five years. Phase I involves collecting field parameters (including pH, specific conductance, acidity and alkalinity) to provide investigators with a quick snapshot of water quality conditions and to be used as an initial screening. Phase II requires the collection of water quality grab samples analyzed for ODNR Group 1 parameters and discharge measurements at the confluence of all AMD-impacted tributaries identified in Phase I, some net alkaline tributaries, and selected sites along the mainstem, always including the furthest downstream location of the study area. Phase III involves the evaluation of potential project sites within the subwatershed or project area. Additionally, data collected may serve as part of a Total Maximum Daily Load (TMDL) study for the OEPA to assess water quality and aquatic health of Federal Creek and its subwatersheds.

Study Area and Site Identification

The study area for the Federal Creek AMDAT is broken into four subwatersheds and one mainstem section: Sharp's Fork, Sulphur Run, Opossum Run, Marietta Run, and the mainstem of Federal Creek between the old mining towns of Utley and Broadwell. Two additional subwatersheds were studied, Linscott Run and Miner's Fork, but preliminary results did not indicate substantial impairment,

and the investigation of these subwatersheds was abbreviated. Sampling sites were named according to their location within a defined subwatershed or mainstem section.

Table 2 AMD Streams and Input Rivermiles.

Stream	Sample Site Designation	AMD inputs in River Miles
Sharp's Fork	SF	RM 1 to RM 8
Sulphur Run	SR	RM .3 to 1.3
Opossum Run	OR	RM .5 to 1.5
Marietta Run	MR	RM .3 to 2
Federal Creek	FC	RM 4.2 to RM 8
Linscott Run	LR	RM 3 to RM 4
Miner's Fork	MF	RM 2.4 to 4

Site locations were identified on USGS topographic quadrangle sheets, GPS coordinates, and OEPA river mile maps. Drainage areas for water quality sampling sites were calculated using GIS ArcView BASINS tool and Xtools extension.

Phase I- Reconnaissance

The purpose of Phase I is a cost effective way to identify those sources of AMD that should be sampled for further characterization during Phase II. During Phase I, field reconnaissance was conducted to identify sources of water that exhibit AMD characteristics. The areas in which Phase I monitoring were conducted were determined primarily by USGS topographic quadrangles with underground and surface mines depicted on them. Field parameters were tested at the mouth of the subwatershed and at each input to the main stem and marked on a field map.

Field parameters collected included pH, specific conductivity, acidity, dissolved oxygen, and temperature. Specific conductivity and pH values were determined using a Hanna combination pH-specific conductivity probe. When using it for pH and specific conductivity, the probe was inserted into the stream in an area of moving water to a minimum depth marked on the probe. The value was then displayed on the screen of the probe. The value was not recorded until the value displayed on the probe remained constant. Water temperature was also recorded at each site also with the Hanna meter. The meter was calibrated for pH, using a two-point calibration method (pH 4 and pH 7), and one-point calibrated for conductivity (1413 uS/cm) each day it was in use. Dissolved oxygen and temperature were taken using a YSI Dissolved Oxygen meter. A GPS Garmin Etrex was used to record coordinates of each site.

Field acidity values were determined using an in-field high range HACH titration kit. Seven and one-half milliliter samples were collected in a clean test tube and placed in a 25 ml beaker for titration.

One drop of phenolphthalein indicator was added to the sample, which was then titrated using 0.035M Na(OH) that was added to the sample-indicator solution one drop at a time. The solution was mixed after each drop. When the solution turned pink following the addition of a drop of Na(OH) and remained pink after mixing for 30 seconds, the number of drops added to the sample was recorded. The total number of drops of Na(OH) added to the solution was then multiplied by 20 to determine the concentration of acid in milligrams per liter.

In addition to screening the area for AMD sources, phase I screening also involved the screening of the area for points of water loss (e.g. subsidence, sinkholes, etc). However, no subsidence features were found.

All Phase I data for each subwatershed was recorded in the field, entered into an Excel spreadsheet, and data points were entered into ArcView GIS. Phase I data was then evaluated in order to determine areas of AMD impact where further assessment was necessary.

A description of instrumentation and calibration of field equipment is located in Appendix. Due to the alkaline nature of the Federal Valley Watershed, conductivity is often the best indicator of mining impacts in the water. Field reconnaissance of mine openings indicated on ODNR mine maps was also conducted. Field parameters of pond/strip pit water were also measured when ponds were found. All results were marked on field data sheets. Site locations were documented with a GPS unit.

Phase II- Subwatershed Evaluations

Areas designated as requiring further assessment during the phase I screening then underwent a phase II study, where AMD impacted areas were sampled for water quality and flow data in a manner to create a mass balance in small subwatersheds. Impacted sites were sampled to quantify the amount of acid and metal loading into a subwatershed. A qualitative description was recorded for each site and water quality samples and discharge measurements were collected. Phase II data were collected during both high, medium and low flow stages in 2002 and 2003. All Phase II data were entered into an Excel spreadsheet and sample sites recorded on maps. Phase II data were used to determine potential reclamation sites that will require further analysis.

Phase II involved characterizing significant sources of mining impacted waters that flowed into the main stream channel. Water samples collected in Phase II were sent to the ODNR Cambridge Laboratory for Group I analysis, and discharge was measured at high and low flow. Discussions regarding high and low flow acid loading, acidity concentration, and metal loading at each sample point are displayed in Section II under each of the priority subwatershed sections.

Samples for Phase II were collected in a triple-rinsed plastic container and split into one 250 mililiter (mL) sample and one 1 liter (L) sample. The 250 mL sample was acidified with 5 mL 20 percent HNO_3. Water samples collected in the field for laboratory evaluation were preserved at 4 degrees Celsius

until they reached the Department of Mineral Resources Management laboratory in Cambridge, Ohio where they were analyzed. Samples from oxygenated, surface water were not filtered; they were visually checked for turbidity and deemed clear enough for unfiltered analysis. Samples were collected at a minimum of 48 hours after a rain event. At abandoned underground mine seeps, samples were filtered. In many cases, a filtered and unfiltered sample each were collected Additionally, at underground mine seeps, a third filtered sample for ferrous iron analysis was collected in a 125 mL brown bottle and preserved with 20 percent HCl. Parameters measured were ODNR's Group I analysis (pH, total acidity as CaCO3, total alkalinity as CaCO3, specific conductance, total suspended solids, total dissolved solids, sulfate, total iron, total manganese, total aluminum, and hardness). Group I is usually sufficient to prioritize sources based on acidity and metal loads. All data from collected samples were recorded on ODNR laboratory data sheets that were recorded into an Excel spreadsheet.

Discharge was measured for each sample in order to calculate loadings (concentration multiplied by discharge) using methods appropriate to flow volume. Loading is calculated as the product of discharge with acidity, alkalinity or metal concentration and is expressed in lb/day for treatment considerations. In this report, metal loading is the sum of the individual loads of the three Group I metals, iron, manganese and aluminum.

A Swoffer Model 2100 current velocity meter was used for larger discharges. With this method, the stream was divided into intervals of known areas (width and depth) along its cross section, and at those intervals, a depth and velocity measurement is recorded. Velocity measurements multiplied by the area of that interval was used to calculate a discharge measurement. The discharge rate for each site was defined as the sum of the discharge rates at each interval.

A collapsible cutthroat Baski flume was used in very shallow, fast moving streams. The bucket and stop watch method was used for very small discharges.

Phase III

Phase III investigation was to further characterize specific sites that have been identified as the primary acid mine drainage areas, and to collect samples for project design considerations. The subwatersheds that had Phase III sites were Sulphur Run, Marietta Run, the mine seeps on the mainstem of Federal Creek, and Opossum Run. There were also samples taken on the mainstem of Federal Creek and Sharps Fork to determine impact to the receiving bodies of water. The field procedures and flow gathering was the same as in Phase II. However, Group III parameters were gathered also. Most of these samples were filtered. The parameters included in this were (pH, specific conductance, total or dissolved acidity as CaCO3, total or dissolved alkalinity as CaCO3, chloride, sulfate, total or dissolved suspended solids, total dissolved solids, hardness, total or dissolved iron, total or dissolved manganese, total or dissolved aluminum, total or dissolved sodium, and total or dissolved potassium).

Equipment

Table 3. Equipment List

Equipment	Manufacturer	Catalog No.	Calibration
Hanna combo pH-EC probe	Hanna Instruments	4JE-89307	Two-point calibration: Acid Calibration using standard 4.01 and 7.01 solution. A 1413µS/cm calibration solution was used for specific conductivity
HACH Acidity Test Kit	HACH	4JE-100820	
Garmin etrex Vista GPS unit	Garmin	Part# 010-00243-00	
Electric current velocity flow meter	Swoffer Instruments Inc.		See Calibration and Care of the Model 2100 Current Velocity Meter pp.1-3
Collapsible Cutthroat Flume	Baski Inc.		
YSI model 55 Dissolved Oxygen Meter	YSI Inc.	4JE-221302	push-button air calibration with built-in calibration chamber

Long-term Monitoring

Long-term monitoring has been used in The Federal Valley to monitor the health of the mainstem relative to potential mine drainage inputs. Because the acid mine drainage inputs are in both the lower mainstem of Federal Creek and in Sharps Fork, the group monitors both mainstems.

Data has been collected at long-term monitoring sites along the mainstem of Federal Creek, Sharp's Fork, and McDougalll Branch (this is our reference reach, it is above all mine inputs) from August 2002 to February 2005. Some sites have been sampled more than others due to changes in sampling plans. Overall, most AMD effects appear to be ameliorated along the mainstem of the larger sections of streams due to dilution and neutralization from alkalinity. The following boxplots display water chemistry parameters that are often evaluated when looking at mining- related impacts.

Long-term Monitoring Site Descriptions

Listed below are sites where sampling has occurred. Not all of these points should be long-term sites in the future. The point numbers that are bold indicate sites that should remain long-term sites, there are eight total.

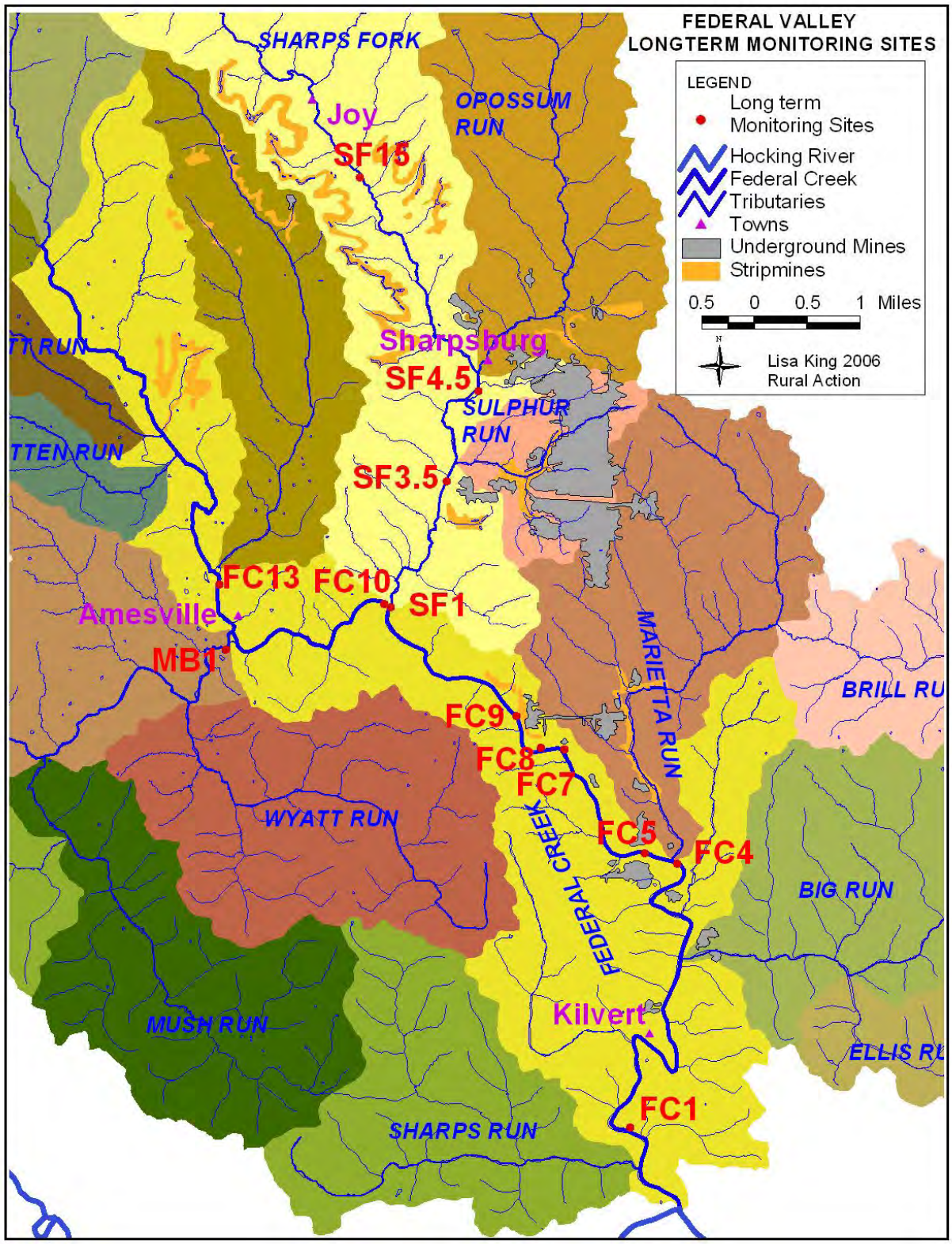
- **FC1** is near the confluence of Federal Creek with the Hocking River, it is at the first bridge on Sharps Run and is slightly up stream of Sharps Run. It is a point on the mainstem of Federal Creek at 1.4 river miles, at 39.33397109 latitude –81.88933924 longitude, and is at an elevation of 615 feet. Federal Creek is a tributary that enters the Hocking River at River Mile 15.29. The area of land above this point is 137.90 square miles and the length of the stream above this point is 14.90 miles.

- **FC4** is at the bridge on State Route 329 near Mayle Ridge Road. This location is below Marietta Run and all other mainstem inputs. This is a point on the mainstem of Federal Creek at 4.50 river miles, at 39.363665627 latitude –81.88104711 longitude, and is at an elevation of 721 feet. Federal Creek is a tributary that enters Hocking River at 15.29 river miles. The area of land above this point is 120.10 square miles and the length of the stream above this point is 11.57 miles.
- FC5 is located above Marietta Run and below all of the 'mainstem seeps'. This site is difficult to get to and often impossible to collect discharge data due to the deep channel. This is a point on the mainstem of Federal Creek at 5.1 river miles, at 39.36699444 latitude –81.87937106 longitude, and is at an elevation of 644 feet. Federal Creek is a tributary that enters Hocking River at 15.29 river miles. The area of land above this point is 120.02 square miles.
- FC 7 is located immediately below the FC-2-Sa seep input. This is a point on the mainstem of Federal Creek at 6.8 river miles, at 39.38278436 latitude –81.89917121 longitude, and is at an elevation of 653 feet. Federal Creek is a tributary that enters Hocking River at 15.29 river miles. The area of land above this point is 108.40 square miles. Due to the location and the deep stream channel, this site is impossible to collect discharge data in times of high flow.
- FC 8 is located above all of the mainstem seeps and is immediately above the FC-2-Sa seep input. This is a point on the mainstem of Federal Creek at 7 river miles, at 39.38300807 latitude –81.90324322 longitude, and is at an elevation of 692 feet. Federal Creek is a tributary that enters Hocking River at 15.29 river miles. The area of land above this point is 108.40 square miles. Due to the location and the deep stream channel, this site is impossible to collect discharge data in times of high flow.
- **FC9** is located above all mainstem mine inputs at the bridge of Tick Ridge Road. This is a point on the mainstem of Federal Creek at 7.5 river miles, at 39.38738728 latitude –81.90759092 longitude, and is at an elevation of 679 feet. The area of land above this point is 108.11 square miles
- **FC10** is located above the confluence with Sharps Fork, near the last bridge on SR-329S before SR 550. This is a point on the mainstem of Federal Creek at 10.00 river miles, at 39.39852188 latitude –81.94612345 longitude, and is at an elevation of 563 feet. Federal Creek is a tributary that enters Hocking River at 15.29 river miles. The area of land above this point is 70.24 square miles.
- FC13 is located at the bridge in Amesville, on State Route 550 near the parking lot of the convenient store. This is a point on the mainstem of Federal Creek at 11.26 river miles, at 39.57280700 latitude –81.95732745 longitude, and is at an elevation of 667 feet. Federal Creek is a tributary that enters Hocking River at 15.29 river miles. The area of land above this point is 32.13 square miles and the length of the stream above this point is 4.94 miles.
- **SF1** is located on Sharps Fork, at the confluence with Federal Creek. This site is at the last bridge on State Route 329S before State Route 550. This is a point on the mainstem of Sharps Fork at 0 river miles, at 39.40243707 latitude –81.92958981 longitude, and is at an elevation of 735 feet. Sharps Fork is a tributary that enters Federal Creek at 9.3 river miles. The area of land above this point is 35.66 square miles

- **SF3.5** is below the confluence of Sulphur Run. This is a point on the mainstem of Sharps Fork at 1.4 river miles, at 39.41873141 latitude -81.91920924 longitude, and is at an elevation of 712 feet. Sharps Fork is a tributary that enters Federal Creek at 9.3 river miles. The area of land above this point is 30.25 square miles and the length of the stream above this point is 10.45 miles.
- SF-4.5 is below the confluence of Opossum Run and above the confluence of Sulphur Run. This is a point on the mainstem of Sharps Fork at 2.82 river miles, at 39.43201480 latitude –81.91384826 longitude, and is at an elevation of 693 feet. Sharps Fork is a tributary that enters Federal Creek at 9.3 river miles. The area of land above this point is 30.25 square miles and the length of the stream above this point is 13.47 miles.
- **SF15** is below the community of Joy, this point marks the area referred to as upper Sharps Fork. SF15 is a point on the mainstem of Sharps Fork at 5.25 river miles, at 39.46135137 latitude -81.93455818 longitude, and is at an elevation of 671 feet. Sharps Fork is a tributary that enters Federal Creek at 9.30 river miles. The area of land above this point is 18.37 square miles.
- **MB1** is a point at the mouth of McDougall Branch. McDougall Branch is considered the reference reach for determining Federal Valley targets. This is a point on the mainstem of McDougall Branch at 0 river miles, at 39.23560500 latitude –81.95704565 longitude, and is at an elevation of 639 feet. McDougall Branch is a tributary that enters Federal Creek at 11.25 river miles. The area of land above this point is 37.60 square miles

The following map will display the location of all sites that have ever been considered long- term monitoring sites.

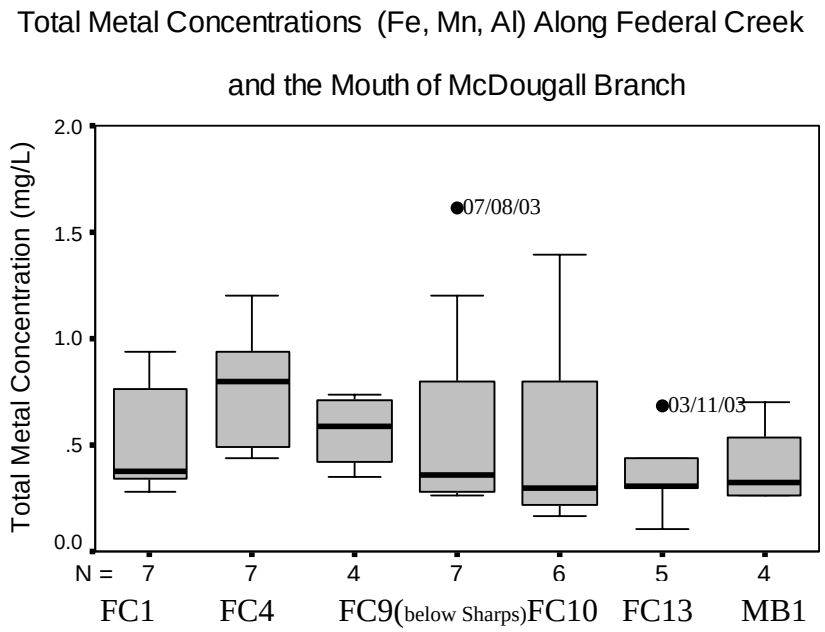
Map 3 Long-term Monitoring Sites

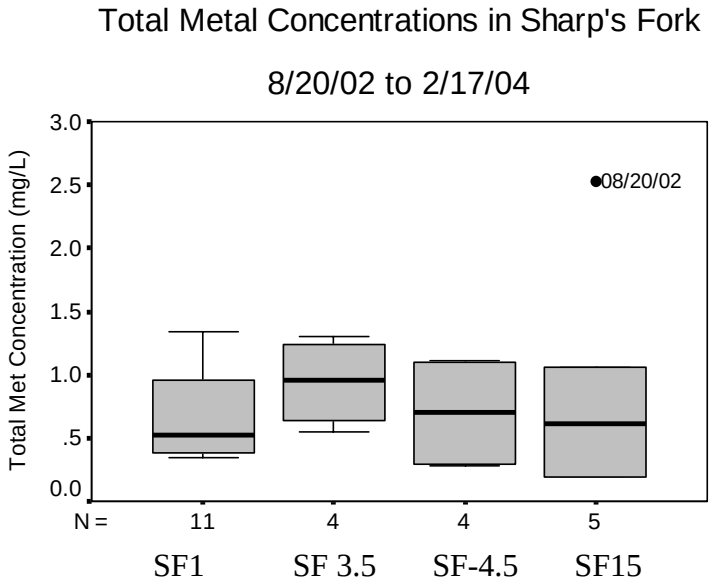


Long-term Total Metal Concentrations

The following box plots display the total metal concentrations along the mainstem of Federal Creek and the mouth of McDougall Branch, and along the mainstem of Sharp's Fork. In this study, total metal concentrations include iron, manganese, and aluminum concentrations. These metals are the most commonly associated with acid mine drainage.

Table 4. Long- Term Monitoring Box Plots





All of these sites are net alkaline in all flow regimes. All of the parameters are below the Federal Valley targets. The box plots above do show an increase in metals at FC4, which is immediately below the mainstem mine drainage inputs and below Marietta Run. This increase drops at FC9, which is above the mainstem mine drainage inputs. In Sharps Fork a detectable increase in metals is observed at SF3.5 which is immediately down stream of Sulphur Run.

Biological Assessments

As part of the OEPA's Total Maximum Daily Load (TMDL) study, in addition to water chemistry data, an assessment of the biological condition of the watershed was conducted. From June 15th to September 30, 2004, aquatic macroinvertebrates, fish, and habitat data were collected by Midwest Biodiversity Institute (MBI) for the calculation of four multi-metric indexes, the Index of Biotic Integrity (IBI), the Invertebrate Community Index (ICI), the Modified Index of Well Being (Miwb), and the Qualitative Habitat Evaluation Index, that rate the overall biologic health of the watershed. For field methods regarding this data refer to MBI's technical report titled "Fish and Macroinvertebrate Study of Federal Creek, 2004".

WATER QUALITY

Acid Mine Drainage Formation

Coal mining disturbs large amounts of geologic material and exposes it to the environment. When this material is exposed to air and water, iron sulfide (pyrite) from the coal deposits is oxidized, resulting in AMD. These conditions lower pH, increase acidity, increase dissolved metals, and lead to an overall degradation of water quality. AMD is a low pH, high sulfate water with high acidity usually due to oxidation of iron, aluminum, and manganese and due to hydrogen ions.

The formation of AMD is primarily a function of the geology, hydrology and mining technology employed at the mine site. AMD is formed by a series of complex geo-chemical and microbial reactions that occur when water comes in contact with pyrite (iron disulfide minerals) in coal, refuse or the overburden of a mine operation. The resulting water is usually high in acidity and dissolved metals. The metals stay dissolved in solution until the pH rises to a level where precipitation occurs.

Four commonly accepted chemical reactions represent the chemistry of pyrite weathering to form AMD. An overall summary reaction is as follows:

$$4\ FeS_2 + 15\ O_2 + 14\ H_2O \rightarrow 4\ Fe(OH)_3 \downarrow + 8\ H_2SO_4$$

Pyrite + Oxygen + Water → "Yellowboy" + Sulfuric Acid

The first reaction in the weathering of pyrite includes the oxidation of pyrite by oxygen. Sulfur is oxidized to sulfate and ferrous iron is released. This reaction generates two moles of acidity for each mole of pyrite oxidized.

$$2\ FeS_2 + 7\ O_2 + 2\ H_2O \rightarrow 2\ Fe^{2+} + 4\ SO_4^{2-} + 4\ H^+ \qquad \textbf{(1)}$$

Pyrite + Oxygen + Water → Ferrous Iron + Sulfate + Acidity

The second reaction involves the conversion of ferrous iron to ferric iron. The conversion of ferrous iron to ferric iron consumes one mole of acidity. Certain bacteria increase the rate of oxidation from ferrous to ferric iron. This reaction rate is pH dependant with the reaction proceeding slowly under acidic conditions (pH 2-3) with no bacteria present and several orders of magnitude faster at pH values near 5. This reaction is referred to as the "rate determining step" in the overall acid-generating sequence.

$$4\ Fe^{2+} + O_2 + 4\ H^+ \rightarrow 4\ Fe^{3+} + 2\ H_2O \qquad \textbf{(2)}$$

Ferrous Iron + Oxygen + Acidity → Ferric Iron + Water

The third reaction that may occur is the hydrolysis of iron. Hydrolysis is a reaction that splits the water molecule. Three moles of acidity are generated as a byproduct. Many metals are capable of undergoing hydrolysis. The formation of ferric hydroxide precipitate (solid) is pH dependant. Solids form if the pH is above about 3.5 but below pH 3.5 little or no solids will precipitate.

$$4\ Fe^{3+} + 12\ H_2O \rightarrow 4\ Fe(OH)_3 + 12\ H^+ \qquad \textbf{(3)}$$

Ferric Iron + Water → Ferric Hydroxide (yellowboy) + acidity

The fourth reaction is the oxidation of additional pyrite by ferric iron. The ferric iron is generated in reaction steps 1 and 2. This is the cyclic and self-propagating part of the overall reaction and takes place very rapidly, and continues until either ferric iron or pyrite is depleted. In this reaction, iron is the oxidizing agent, not oxygen.

$$FeS_2 + 14\ Fe^{3+} + 8\ H_20 \rightarrow 15\ Fe_2+ + 2\ SO_4^{2-} + 16\ H^+ \textbf{(4)}$$

Pyrite + Ferric Iron + Water → Ferrous Iron + Sulfate + Acidity

(PA-DEP website, 2004)

Ohio Water Quality Standards for Water Chemistry

Water chemistry values determined by the USEPA suggest AMD impacts to waters. The parameters include: pH, total dissolved solids (TDS), sulfate, iron, manganese, aluminum, and zinc. The only two standards created by the USEPA are for pH (6.5 to 9) and TDS (1,500 mg/l). Although there are no standards for the other AMD parameters, criteria limits suggest impacts from AMD and are summarized below (Table 5).

Table 5. Water quality values that suggest AMD impacts

(FWPCA, 1968)	Parameter	Criteria Limit
	Iron	> 0.5 mg/l
	Manganese	> 0.5 mg/l
	Aluminum	> 0.3 mg/l
	Conductivity	> 800 uS/cm
	Sulfate	> 74 mg/l
	Alkalinity	< 20 mg/l
	pH	< 6

Besides values that show the presence of AMD, certain other known threshold values exist for the effects of heavy metals associated with AMD on aquatic life. These thresholds (Table 6) are based on literature research and suggest that once parameters reach the limit, aquatic life may be affected. Aquatic species are affected by contaminates in various ways, so these thresholds do not suggest that all aquatic life will be affected, but that some species will be negatively affected.

Table 6. Ohio EPA values as guidelines for analysis of mine drainage systems.
(Ohio EPA 1979)

Parameter	Limit
Iron- total (mg/l)	1.0
Aluminum (mg/l)	0.5
Manganese (mg/l)	0.1

Federal Valley Water Chemistry Restoration Targets

The goal for this plan is to restore AMD- impacted waters in Federal Valley to meet Ohio EPA use designation of warm water habitat (WWH) criteria and wherever possible to meet exceptional water habitat (EWH). To accomplish this goal, water quality targets were established. Table 7 shows a summary of all targets for the Federal Valley Watershed. Included in this table are targets for iron, manganese, aluminum, alkalinity, and sulfate.

The establishment of in-stream numeric targets is a significant component of the AMDAT/TMDL process. The numeric targets serve as a measure of comparison between observed in-stream conditions and conditions that are expected to restore the stream to its designated uses. The AMDAT/TMDL identifies the load reductions and other actions that are necessary to meet the target, thus resulting in the attainment of applicable water quality standards.

Manganese, iron, alkalinity and sulfate target values were derived from "Appendices to Association Between Nutrients and the Aquatic Biota of Ohio and Streams", Ohio EPA Technical Bulletin MAS//1999-1-1. This document will be referred to as the "Association Document". In this document, water chemistry statistics are given for all sites in the Ohio EPA database. This data is displayed by ecoregion, stream size, and IBI range. For the targets in Federal Valley the values from the Western Allegheny Plateau ecoregion (WAP) were used. The stream size that was used is wadeable (20 to 300 square miles). The IBI range used was 40 – 49 (the score range for warm water habitat use designations). The target value used was that of the 75^{th} percentile. The Ohio EPA has found, through correlative analyses, that when water chemistry values were less than the 75^{th} percentile of sites that meet the WWH use designation; these sites are in attainment of the WWH use designation. Therefore, the 75^{th} percentile was used for the watershed target.

Aluminum was not present in the Association Document. For the aluminum target, statistics were calculated by using all of the data from streams in the WAP ecoregion that are located in the WAP coalfields. The mean statistic was used for a target for aluminum.

Because there is no plan to remediate sulfate, it is simply used as an indicator of mine drainage, not a target.

The parameters of iron, manganese, aluminum, alkalinity, and sulfate (indicator), found in the Association Document, or calculated from Ohio EPA data, were used for the Federal Valley targets. In Table 7 these values were compared to the values of the same parameters in a reference stream within Federal Valley. This verified that the targets were realistic and based on water chemistry in Federal Valley. The reference reach used was McDougall Branch. All samples taken near the mouth of McDougall Branch were averaged. These samples are; 16 samples collected during three summer months in 2004 and analyzed by the Ohio EPA, and 6 high/ low flow samples collected between 2002-2003 and analyzed by the ODNR Cambridge Laboratory.

Table 7. Federal Valley Targets

Parameter	**Units**	**Reference Reach**	**Federal Valley Target**	**Source Used**	**Comments**
Iron	mg/L	0.9 McDougall	0.8	The Ohio EPA Association Document	75th percentile of sites in the WAP ecoregion
Aluminum	mg/l	0.6 McDougall	0.5	Ohio EPA data	Mean of all WAP streams with known coal influences.
Manganese	mg/L	0.2 McDougall	0.2	The Ohio EPA Association Document	75th percentile of sites in the WAP ecoregion
Alkalinity	mg/L	166 McDougall	141	The Ohio EPA Association Document	75th percentile of sites in the WAP ecoregion
Sulfate	mg/L	40 McDougall	191	The Ohio EPA Association Document	75th percentile of sites in the WAP ecoregion
The target value from McDougall Creek was from 16 samples taken in 3 months summer of 2004, and 6 high/ low flow samples from 2002-2003					

These targets were then compared to the mouths of Marietta Run, Opossum Run, and Sulphur Run, as well as receiving waters downstream of these streams in Federal Creek and Sharps Fork. These streams have acid mine drainage seeps that are thought to have the biggest impact on any surface water in the watershed. Table 8, a comparison of Federal Valley streams with the targets provides a picture of how these streams are being chemically impacted by mine drainage.

The site on Federal Creek at Mayle Ridge Bridge is located directly below several mine seeps along the mainstem. It is also immediately downstream of the confluence of Marietta Run. Nineteen samples collected at various flow regimes from 2002 to 2005 were averaged for the values displayed table 8. All of the metals are near the target. The highest concentrations occur during low flows where iron and aluminum go over the designated targets.

The site on Marietta Run is below all the recorded seeps near the mouth. Fifteen samples collected at various flow regimes between 2002 and 2005 were averaged for the value displayed in table 8. A sample taken during the fall of 2005, (a low flow condition during a drought conditions), was the first mainstem tributary in the entire Federal Valley Watershed to be net acid. All of the parameters were exceeding target levels, showing a critical condition being met. This sample was collected near the mouth of Marietta Run.

DATE	Location	FLOW cfs	FLOW gpm	COND-LAB	PH-LAB	ALK mg/L	ACIDITY-LAB mg/L	SULFATE mg/L	TOT-FE mg/L	TOT-MN mg/L	TOT-AL mg/L
9/13/02005	Marietta Run, Mouth	n/a	n/a	**1070**	**3.34**	**0**	**85.4**	**547**	**5.47**	**4.01**	**9.17**

The site on Sharps Fork is below the confluence of Sulphur Run and Sharps Fork. Eight samples collected at various flow regimes from 2002 to 2005 were averaged for the values displayed in Table 8. Both manganese and sulfate were above the targets for this watershed. During the low flow of September 2005, iron, manganese and sulfate were all ten times that of the target.

The site on Sulfur Run is at the mouth of Sulfur Run. Eleven samples collected at various flow regimes from 2002 to 2005 were averaged for the values displayed in table 8. Iron concentrations are more than twice that of the target concentration and manganese concentrations are more than three times the target. These values tend to go up during periods of low flow.

The site on Opossum Run is located at the mouth of the stream but above Sharpsburg. Eighteen samples, collected at various flow regimes from 2002 to 2005, were averaged for the values displayed in table 8. Manganese and aluminum both exceed the targets.

Table 8 Mine Impacted watersheds compared to targets

	Iron mg/L total	Manganese mg/L total	Aluminum mg/L total	Net Alkalinity mg/L	Sulfate mg/L total
Target Federal Valley Watershed	**0.80**	**0.20**	**0.50**	**141.00**	**191.00**
Federal Creek, Mayle Ridge Bridge (from 19 samples)	0.76	0.18	0.49	158.18	80.23
Marietta Run, near the mouth (from 15 samples)	0.88	0.53	0.89	119.76	116.35
Sharps Fork, below Sulfur Run (from 8 samples)	0.62	0.33	0.27	150.78	244.38
Sulphur Run, below the tipple (from 11 samples)	1.82	0.75	0.17	139.66	328.00
Opossum Run, at Gifford State Forest (from 18 samples)	0.58	0.25	0.88	189.33	107.34

BIOLOGICAL SURVEYS AND USE DESIGNATIONS

Categories of stream attainability also exist in the form of potential by way of Ohio EPA's "Designated Aquatic Life Uses". These categories are not chemical parameter specific, but instead use the biological integrity of the stream to classify the health of a stream segment. The contaminants that are affecting the biological health of the stream are identified and targeted for restoration so the stream can achieve the highest "designated use" attainment possible. The categories of aquatic life use include Exceptional Warmwater Habitat, Warmwater Habitat, Modified Warmwater Habitat, Limited Resource Water, and Limited Warmwater Habitat. Some streams that do not meet their aquatic life use but have the potential to meet this higher standard are considered non-attaining. Others are considered permanently impacted, so may have limited present use and no hope for higher use. Those waterways are listed as attaining a limited use. These designations describe the existing or potential uses of water bodies (Ohio EPA, 2001).

- Exceptional Warmwater Habitat (EWH) is the most biologically productive environment. These waters support "unusual and exceptional" assemblages of aquatic organisms, which are characterized by a high diversity of species, particularly those that are highly intolerant and/or rare, threatened, endangered, or special status. This use designation represents a protection goal for water resource management efforts dealing with Ohio's best water resources.
- Warmwater Habitat (WWH) defines the "typical" warm water assemblage of aquatic organisms of Ohio streams. It is the principal restoration target for the majority of water resource management efforts in Ohio.
- Modified Warmwater Habitat (MWH) applies to streams with extensive and irretrievable physical habitat modifications, for which the biological criteria for warm water habitat are not attainable. The activities contributing to the modified warm water habitat designation have been sanctioned and permitted by state or federal law. The

representative assemblages are generally composed of species that are tolerant to low dissolved oxygen, silt, nutrient enrichment, and poor habitat quality. The category applies to dammed or channelized rivers, and can be applied to streams affected by AMD.

- Limited Resource Water (LRW) applies to small streams (usually <3 square mile drainage area) and other water courses which have been irretrievably altered to the extent that no appreciable assemblage of aquatic life can be supported; such waterways generally include small streams in extensively urbanized areas, those which lie in watersheds with extensive drainage modifications, those which completely lack water on a recurring annual basis, or other irretrievably altered waterways.
- Coldwater Habitat (CWH) - this use designation is intended for waters which support assemblages of cold water organisms and/or those which are stocked with salmonids with the intent of providing a put-and-take fishery on a year round basis which is further sanctioned by the Ohio DNR, Division of Wildlife; this use should not be confused with the Seasonal Salmonid Habitat (SSH) use which applies to the Lake Erie tributaries which support periodic "runs" of salmonids during the spring, summer, and/or fall. No specific biological criteria have been developed for the CWH use although the WWH biocriteria are viewed as attainable for CWH designated streams.

In determining aquatic life uses, the Ohio EPA surveys fish and macro-invertebrate populations along with chemical and physical water quality parameters throughout a given watershed. The results from the bio-survey at each sampling station are used to calculate a metric score for both fish (IBI and MIwb) and macro-invertebrate (ICI) populations. These scores indicate the biological integrity of that given stretch of a stream.

The Index of Biologic Integrity (IBI) metric is a measure of fish species diversity and species populations. This index gives a score which indicates how much a stream habitat is affected by pollutants, and which types of fish are present. Depending on the pollution tolerance of specific species, the IBI indicates which species are likely to be found and the level of fish diversity in the stream. The modified index of well being (Miwb) is a metric that incorporates four measures of fish communities: numbers of individuals, biomass, and the Shannon Diversity Index based on numbers and weight.

The Invertebrate Community Index (ICI) metric is based on measurements of macro-invertebrate communities living in a stream. Macro-invertebrate studies are important to assess because many insect taxa are known to be either pollution tolerant or intolerant. The presence of certain species indicates the general water quality of an area. This index gives indications about the amount of pollution stressing the stream environment.

Table 9. IBI and ICI scores that suggest Designated Aquatic Life Uses

USE DESIGNATION	IBI	MIwb	ICI	QHEI
Exceptional Warmwater Habitat	50	9.4	46	>80
Warmwater Habitat	44	8.4	34	60
Modified Warmwater Habitat	24	6.2	22	45

A Qualitative Habitat Evaluation Index (QHEI), developed by the Ohio EPA, is also used to characterize physical habitat of the stream at each sampling station. Physical features that affect or are critical for fish and invertebrate communities are evaluated. Some of the features evaluated include: type of substrate, amount and type of riparian cover, channel width, sinuosity, and erosion. QHEI scores over 60 are considered conducive to meeting WWH criteria although they are not used to determine the aquatic life designated use (Ohio EPA, 2001).

AMD Impacts on Stream Health

Acid mine drainage has the potential to effect many different aspects of a stream's biological integrity. The chemical and physical changes to the stream from the AMD result in the impacts on the biological and ecological functions listed in Table 10. AMD is a complex contaminant effecting streams in many different ways. The full scope of these impacts should be considered in any watershed AMD remediation strategy.

Table 10. Major effects of acid mine drainage on stream systems
(Modified from Gray, 1997)

Chemical	Physical	Biological	Ecological
Increased acidity	Substrate modification	Behavioral	Habitat modification
Reduction of pH and buffering capacity	Turbidity	Respiratory	Niche loss
Increase in metal concentrations	Sedimentation	Reproduction	Bio-accumulation in food chain
	Absorption of metal into sediment	Acute and chronic toxicity	Loss of food source
	Decrease in light penetration	Acid-base balance in organisms	Elimination of sensitive species
		Migration or avoidance	Reduction in primary productivity
			Food chain modifications

Federal Valley Use Designations

Ohio EPA has assigned use designations on sites in the Federal Valley Watershed in 1984, 1990, 1995, and 2004. The study in 2004 was the most comprehensive, as it will be used for a watershed- wide TMDL.

The following section is an executive summary of the fish, macroinvertebrate, and habitat survey of the Federal Valley Watershed. It was conducted and written by Mid-west Biodiversity Institute (MBI) and the Center for Applied Bioassessment and Biocriteria (CABB), in 2004. Water quality data collected at biological stations are listed in Appendix 1. Sampling locations are shown on Map 4.

In 2004 MBI analyzed biological assemblage and habitat data at 43 stations in Federal Creek Watershed, with some sites funded by ODNR and others by Ohio EPA. Federal Creek has mostly "excellent" sites (EWH), some impaired to "good" conditions, and some "good" sites (WWH) impaired to fair. Most other watersheds in Ohio have sites with WWH potential ("good") impaired to fair and poor depending on the site and the type of NPS impact (e.g., habitat impairments are generally more severe than sedimentation alone). (MBI 2005). The table below gives all of the use designations for the forty-three sites studied in 2004. The sites that are in bold text represent areas considered impacted by mine drainage.

Map 4 Location of MBI 2004 sites

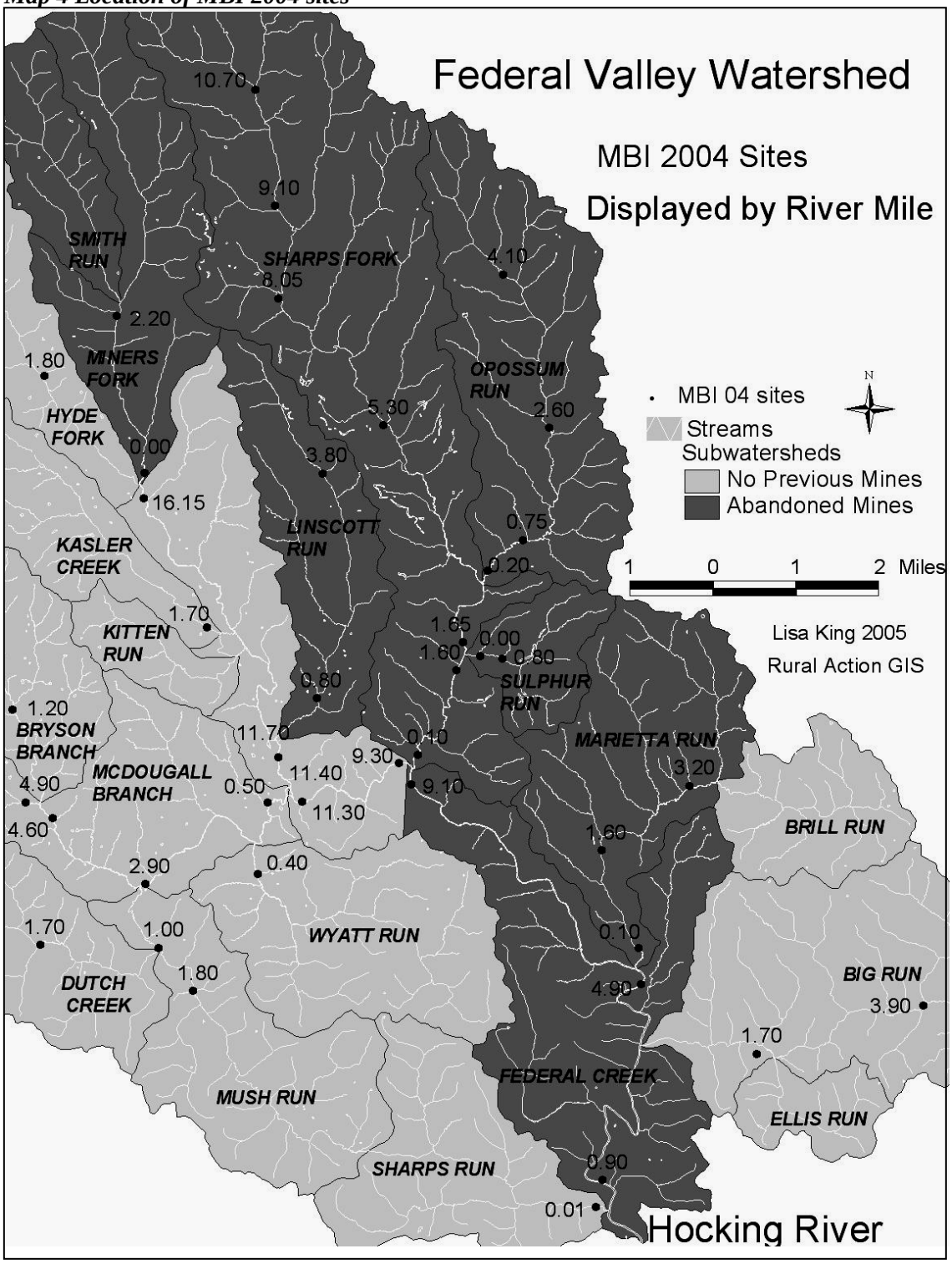


Table 11. Attainment table for streams sampled in the Federal Valley Watershed
Lines in bold are watersheds with abandoned mines present in them.

Station (Map #)	Fish RM	Macro RM	IBI	MIwb	ICI or Narrative Rating	QHEI	Aquatic Life Uses Ex/Rec	Attain-ment Status	Comment
Federal Creek - 2004									
S01100 16.152004	16.15	15.5	52	NA	48	64.5	EWH	Full	Ust Sharps Run
S01100 11.702004	11.70	11.70	48^{ns}	8.90^{ns}	VG^{ns}	51.5	EWH	Full	adj. St. Rt. 329 dst. Linscott Run
S01100 11.302004	11.30	11.40	46^{ns}	9.53	†F*‡	61.0	EWH	Full	St. Rt. 550, upst. McDougalll Branch
S01100 9.302004	**9.30**	**—**	**48^{ns}**	**7.88***	**—**	**66.0**	**EWH**	**Partial**	**ust Sharps Fork**
S01100 9.102004	**9.10**	**—**	**47^{ns}**	**8.90 ^{ns}**	**VG^{ns}**	**56.0**	**EWH**	**Full**	**immediately dst Sharps Fk**
S01100 7.502004	**—**	**7.50**	**—**	**—**	**42*‡**	**—**	**EWH**	**—**	**dst. Sharps Fork**
S01100 4.902004	**4.90**	**4.90**	**48^{ns}**	**7.14***	**34*‡**	**62.0**	**EWH**	**Partial**	**adj. St. Rt. 329 dst. Broadwell**
S01100 0.902004	0.90	0.90	44*	9.50	†MG*	47.5	EWH	Partial	Twp. Rd. 231 (reference site)
Kasler Creek - 2004									
S01101 0.402004	1.75	0.40	46	NA	F*	78.0	None/ WWH	Partial	Mouth
Sharps Run - 2004									
S01110 1.002004	0.01	1.00	44*	NA	VG^{ns}	64.0	EWH	Partial	near mouth, dst. north trib.
Big Run - 2004									
S01130 3.902004	3.90	3.90	50	NA	G*	73.5	EWH	Partial	Co. Rd. 59, dst. Wildcat Run
S01130 1.602004	1.70	1.60	44*	NA	F*	59.0	EWH	Non	upst. Hatch Fork
Sulphur Run - 2004									
S01134 0.802004	**0.80**	**0.80**	**46**	**NA**	**F***	**56.0**	**None WWH**	**Partial**	**Upstream**
S01134 0.102004	**0.01**	**0.10**	**50**	**NA**	**P***	**45.5**	**None WWH**	**Non**	**Mouth**
Marietta Run - 2004									
S01150 3.202004	3.20	3.50	50	NA	E	77.0	WWH	Full	dst. Brill Run
S01150 1.002004	**1.60**	**1.00**	**44**	**NA**	**MG^{ns}**	**75.5**	**WWH**	**Full**	**B Below the 2 Seeps**
S01150 0.102004	**0.10**	**0.10**	**40^{ns}**	**NA**	**VG**	**62.5**	**WWH**	**Full**	**St. Rt. 329, at mouth**

Station (Map #)	Fish RM	Macro RM	IBI	MIwb	ICI or Narrative Rating	QHEI	Aquatic Life Uses Ex/Rec	Attain-ment Status	Comment
Sharps Fork - 2004									
S01160 10.702004	10.70	10.70	50	NA	E	80.5	WWH/ EWH	**Full**	upst. Co. Rd. 85, upst. east trib
S01160 9.102004	9.10	9.10	50	NA	VG^{ns}	69.5	WWH/ EWH	Full	Co. Rd. 14
S01160 8.502004	8.05	8.50	54		VG^{ns}	67.0	WWH/ EWH	Full	Ust TR64
S01160 5.202004	**5.30**	**5.20**	**50**	**NA**	**VG^{ns}**	**66.5**	**WWH/ EWH**	**Full**	**lane dst. Tharp Hollow**
S01160 2.602004	**—**	**2.60**	**—**	**—**	**VG^{ns}**	**—**	**WWH/ EWH**	**Full**	**Dst Opossum Adj 550**
S01160 1.652004	**1.65**	**—**	**48^{ns}**	**8.83***	**-**	**65.5**	**WWH/ EWH**	**Partial**	**Ust Sulphur Run**
S01160 1.602004	**1.60**	**1.60**	**46^{ns}**	**8.31***	**G***	**55.5**	**WWH/ EWH**	**Partial**	**Dst Sulphur Run**
S01160 0.012004	**0.01**	**0.10**	**56**	**8.31***	**38^{ns}**	**—**	**WWH/ EWH**	**Partial**	**St. Rt. 329, at mouth**
Opossum Run - 2004									
S01161 4.102004	4.10	4.10	24*	NA	E	59.0	EWH	Partial	Ust Starling Run
S01161 2.602004	**2.60**	**2.60**	**44***	**NA**	**VG^{ns}**	**69.5**	**EWH**	**Partial**	**Twp. Rd. 6, at compressor station**
S01161 0.752004	**0.75**	**0.80**	**48^{ns}**	**NA**	**G***	**56.0**	**EWH**	**Partial**	**State Forest**
S01161 0.202004	**0.20**	**0.20**	**52**	**NA**	**VG^{ns}**	**59.0**	**EWH**	**Full**	**Joy Rd., near mouth**
McDougalll Branch - 2004									
S01170 4.902004	4.95	4.90	48	NA	G	57.5	WWH	Full	2nd lane upst. Bryson Branch
S01170 4.502004	4.50	4.60	50	NA	VG	59.5	WWH	Full	just dst. Bryson Branch
S01170 2.402004	2.90	2.90	46	8.25	†G	69.5	WWH	Full	dst. Mush Run (reference site)
S01170 0.502004	0.50	0.50	49	8.80	48	66.0	WWH	Full	lane off St. Rt. 550
Wyatt Run - 2004									
S01171 0.402004	0.40	0.40	42*	NA	E	62.5	EWH	Partial	lane near mouth
Mush Run - 2004									
S01172 1.802004	1.80	1.80	52	NA	G*	63.0	EWH	Partial	lane dst. Riley Run
S01172 1.002004	1.00	1.00	50	NA	G*	66.5	EWH	Partial	Dutch Creek Rd.

Station (Map #)	Fish RM	Macro RM	IBI	MIwb	ICI or Narrative Rating	QHEI	Aquatic Life Uses Ex/Rec	Attain-ment Status	Comment
Bryson Branch - 2004									
S01174 1.202004	1.20	1.40	44*	NA	G*	68.5	EWH	NON	Howard Rd.
Dutch Creek- 2004									
S01176 1.702004	1.70	1.70	34*	NA	G	76.5	None/ WWH	Partial	Dutch Creek Rd. at Twp. Rd. 216
Linscott Run - 2004									
S01180 3.702004	**3.80**	**3.70**	**38***	**NA**	**VG ^{ns}**	**68.0**	**EWH**	**Partial**	**Upstream Site**
S01180 0.802004	0.80	0.80	50	NA	MG*	73.5	EWH	Partial	St. Rt. 329
Hyde Fork - 2004									
S01190 1.802004	1.80	1.80	48^{ns}	NA	MG*	69.0	EWH	Partial	lane off St. Rt. 329
Miners Fork - 2004									
S01192 2.202004	**2.25**	**2.20**	**44***	**NA**	**G***	**56.5**	**EWH**	**Non**	**Wrightstown Rd.**
S01192 0.102004	0.05	0.10	46^{ns}	NA	G*	58.5	EWH	Partial	St. Rt. 329, at mouth

Ecoregion Biocriteria: Western Allegheny Plateau (WAP)

Index and Site Type	WWH	EWH	MWH	LRW-AMD
IBI – Wading & Headwater	**44**	**50**	**24/24**	**18**
Mod. Iwb - Wading	**8.4**	**9.4**	**6.2/5,5**	**4.0**
ICI/Narrative	**36/G**	**46/E**	**22/30**	**8/MF**

Footnotes

a - A qualitative narrative evaluation based on best professional judgment and sampling attributes such as community composition, EPT taxa richness, and QCTV scores were used when quantitative data were not available (E-exceptional, G-good, MG-marginally good, F-fair, P-poor, VP-very poor); for Moxahala Creek a draft Qualitative ICI index was also used.

b - Attainment status is given for existing use designations, except where a use designation change is recommended, in which case, the attainment status for the recommended use is given.

c - Limited Resource Water - acid mine drainage (LRW-AMD) benchmarks based on best professional judgment driven by the need to protect against acutely toxic stream conditions. Macroinvertebrate qualitative only data were evaluated based on densities of EPT taxa on the natural substrates (see Methods Section), a narrative VP* or P* indicates departure from the benchmark.

na - MIwb not applicable at headwater sites (< 20 mi^2).

† - HD sampler set, but not retrieved due to flood flows destroying samplers.

‡ - Dry conditions in August followed by flooding conditions in September likely influenced assemblage conditions (data excluded from attainment decision)

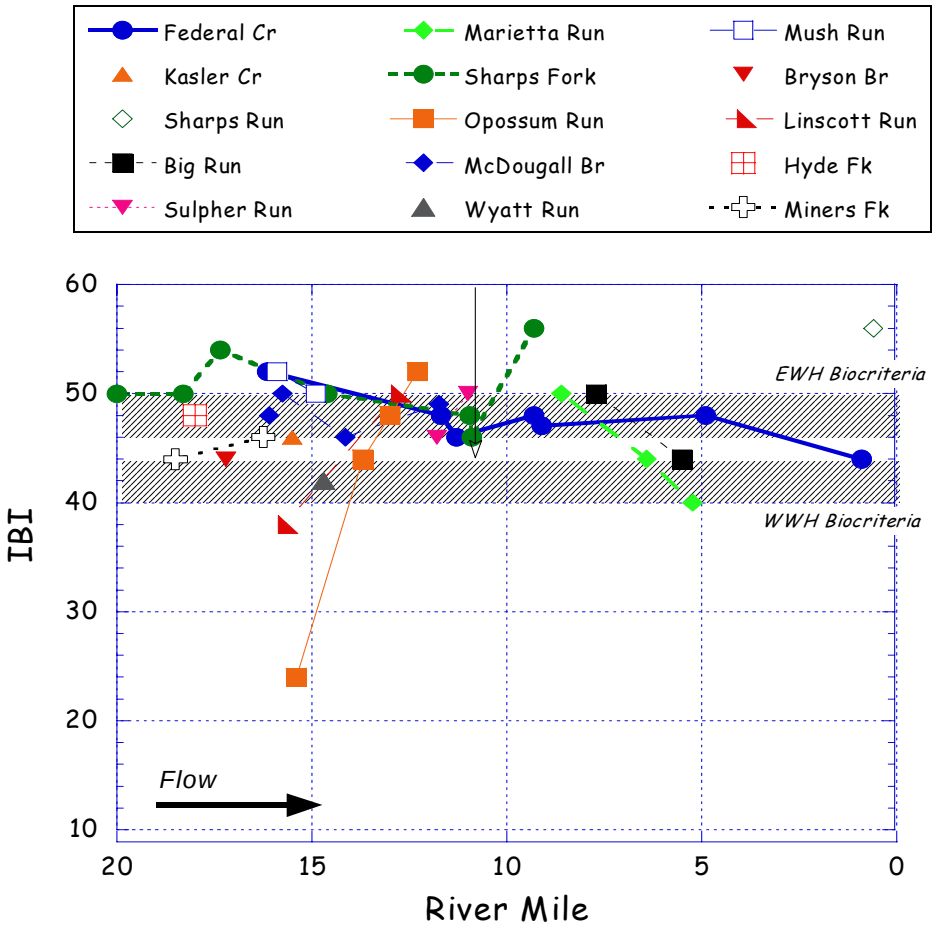
ns - Nonsignificant departure from biocriteria (<4 IBI or ICI units, or <0.5 MIwb units).

* - Indicates significant departure from applicable biocriteria (>4 IBI or ICI units, or >0.5 MIwb units). Underlined scores are in the Poor or Very Poor range.

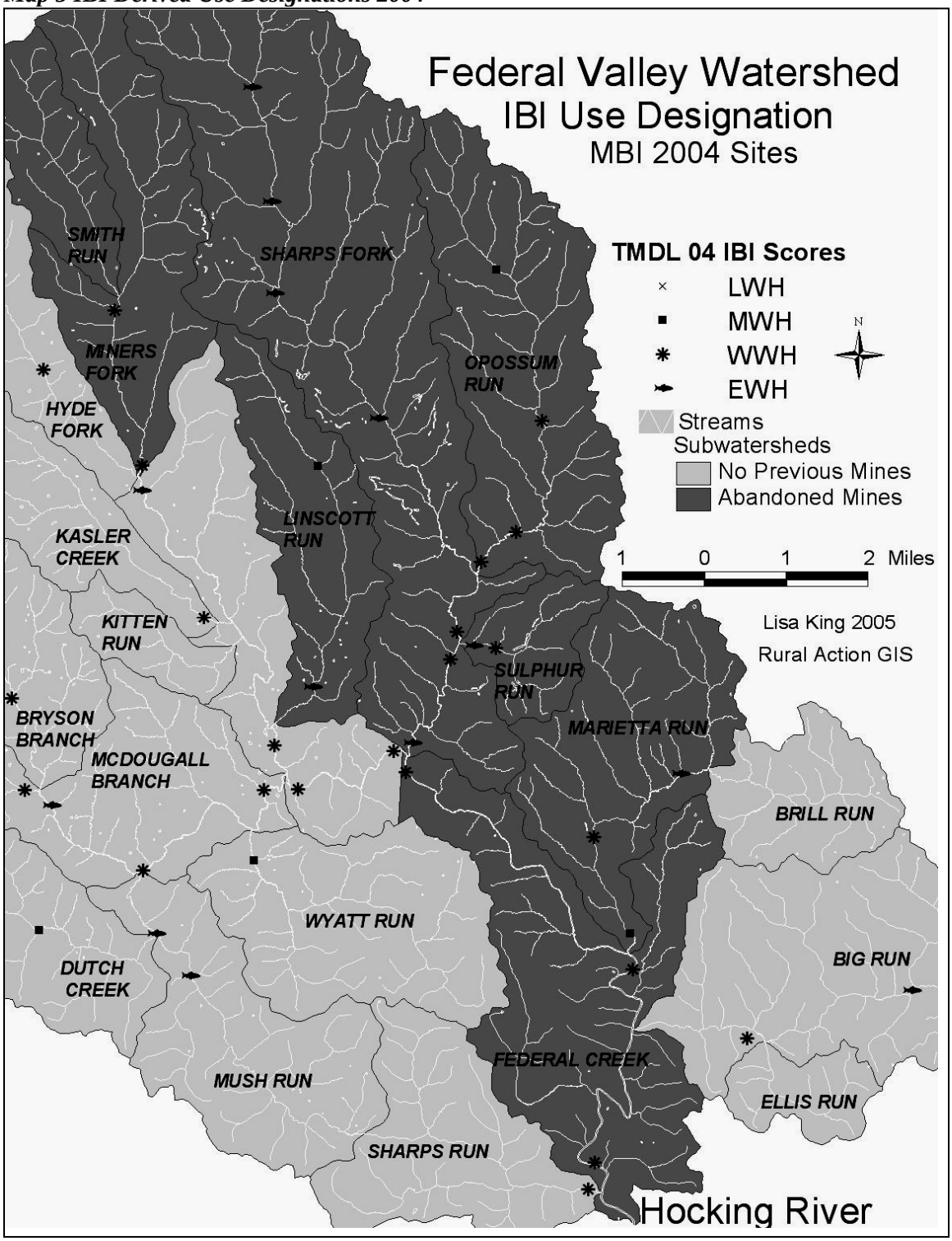
In general, the biological assemblages in Federal Creek Watershed are in relatively good condition although some reference areas have appeared to decline in biological and habitat quality since first sampled by Ohio EPA in the mid-1980s. Most sites have intact channel habitats although silt and sand above what is thought to be background levels often degrade habitats and potentially limit better assemblages. Some of this is related to encroachment into stream riparian buffers which are primary barriers from adjacent land uses (MBI, 2005).

Only three of the IBI scores in the entire Federal Creek Watershed scored at less than a "good" rating (< 40) and only one of these was rated poor (Opossum Run at RM 4.1). The Opossum Run site is relatively small in size (2.3 square mile), is dominated by bedrock and has a macroinvertebrate assemblage rated as excellent. Another site that was rated as fair (upper Linscott Run site) is also small and also has very good macroinvertebrate communities (MBI, 2005).

Figure 1. IBI scores of streams sampled in the Federal Creek Watershed during 2004.



Map 5 IBI Derived Use Designations 2004



Habitat Analysis for Federal Creek.

Although a major focus of this report is to identify mining impacts in the Federal Creek Watershed and to differentiate the relative contribution of mine drainage compared to other stressors, it is essential to understand the other stressors that are limiting aquatic life. Various data types help in the assessment of Nonpoint Source (NPS) stressors. As with AMD impacts, biological signatures help in categorizing and attributing various NPS stressors as limiting factors to biological integrity. Water chemistry is also important (e.g., nutrients, dissolved oxygen, total suspended solids and TDS, BOD, etc.). For habitat and sediment related impacts a key tool is the QHEI and its subcomponents.

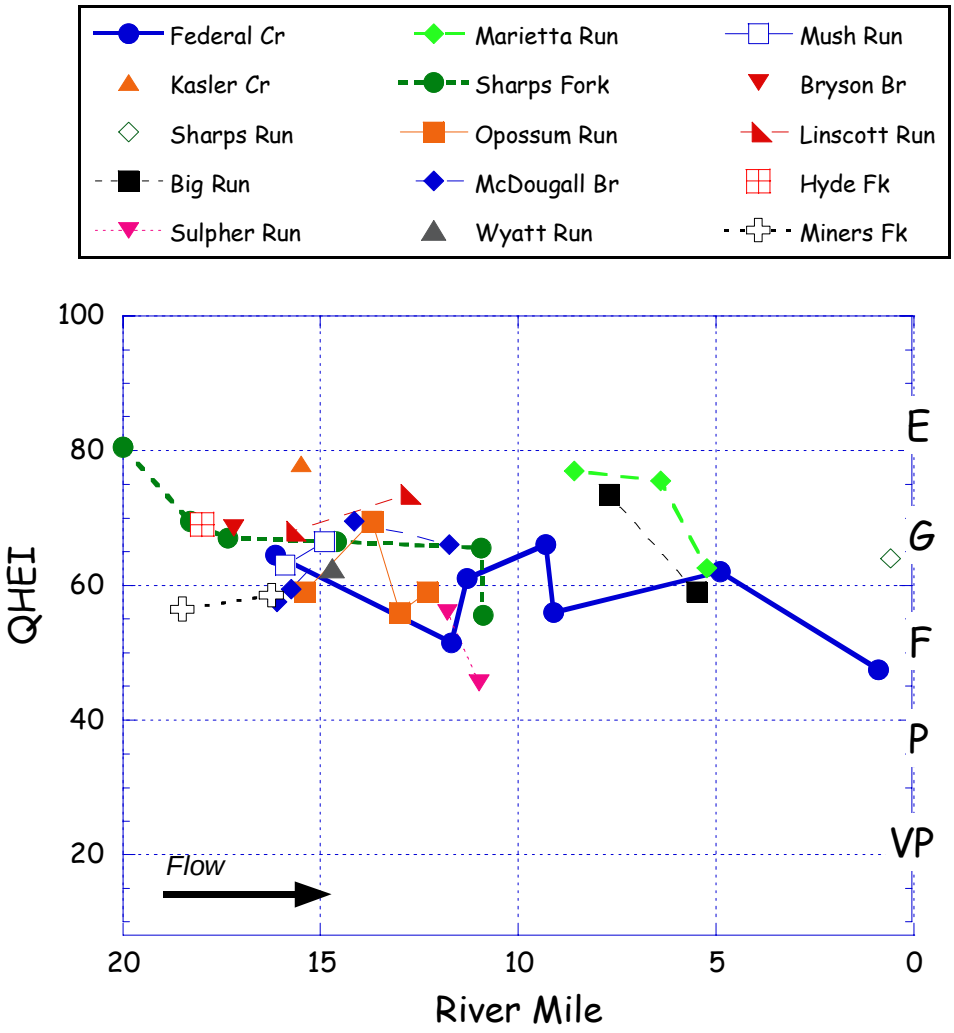
The Qualitative Habitat Evaluation Index (QHEI) is a physical habitat index designed to provide a quantified evaluation of the general lotic stream habitat characteristics that are important to fish communities. The QHEI is composed of six principal metrics including substrate quality, in stream cover, channel morphology, riparian zone and bank erosion, pool/glide riffle/run quality, and gradient/drainage area. The maximum possible QHEI score is 100. Each metric is scored individually and then summed to provide the total QHEI score (OEPA Biocriteria/QHEI CD, 2003).

Fine sediments have been identified as a moderate to severe problem in many watersheds in Ohio (Ohio EPA, 2000, 2002). A study by the USGS identified the nearby Leading Creek Watershed as having among the highest export of fine sediment in Ohio (Antilla and Tobin, 1978). Table 11 summarizes mean QHEI and metric scores for the sites in the Federal Creek Watershed; longitudinal patterns in the overall QHEI scores are illustrated in Figure 2. Habitat quality ranged from fair (scores 46-59) to excellent (scores > 75). As mentioned earlier, there is some evidence that habitat conditions may have declined somewhat in Federal Creek. All three sites from 1984 and 1990 had QHEI scores in the 70s-80 (very good-excellent) while 2004 samples averaged a score of 58 (47.5 [fair] – 66 [good]) and had no sites score above 70.

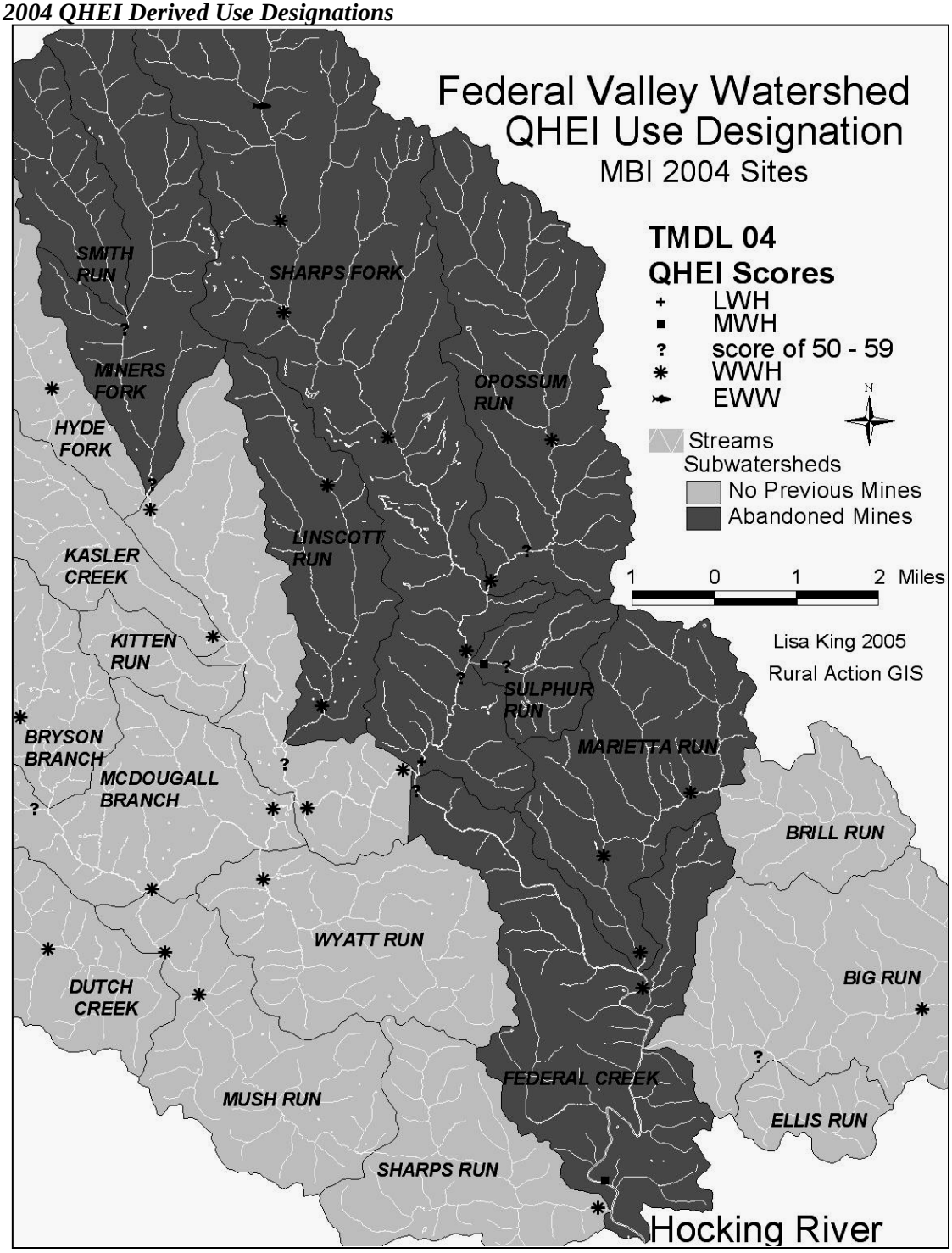
Recent assessments were characterized as having more sand and fine sediments than earlier assesments. The mouth of Sulphur Run is the only mine-impacted subwatershed to be ranked a Modified Warmwater Habitat with the QHEI score. Both Sulphur Run sites scored less then the EPA QHEI target of 13 for substrate. It is noteworthy that there is no farming and few home developments or logging operations in this watershed. The mouth of Marietta Run also scored less then 13 for the substrate component. The mouth of Marietta Run has a large shifting mound of silt that covers the entire channel. Below the mouth of Marietta Run, in the mainstem of Federal Creek, is a silt island that has trees growing on it. Marietta Run has no farming and almost no home development in the subwatershed. Above the area that has been mined, the substrate and the QHEI scores are very good. The watershed group concludes that this fine sediment choked stream is caused by previous mine activity. Oppossum Run, at Gifford State Forest, is an area of past mine activity and a site where the substrate and QHEI are low. However,

due to the farming above this point, at this point in time there is no way to differentiate between mine sediment and farming sediment.

FIGURE 2. QHEI VS MILES FROM THE CONFLUENCE OF FEDERAL CREEK WITH THE HOCKING RIVER FOR SITES SAMPLED BY MBI DURING 2004.

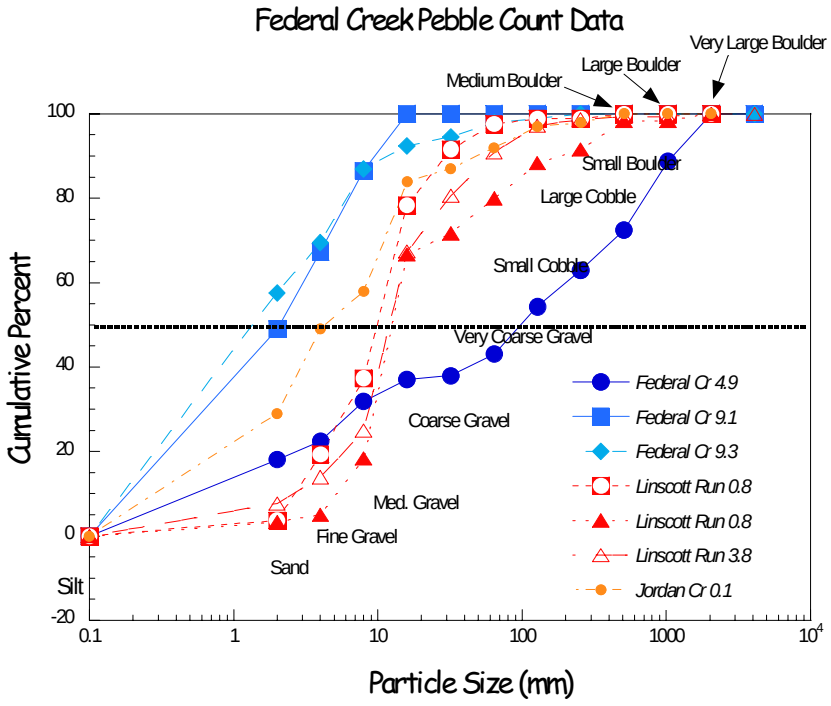


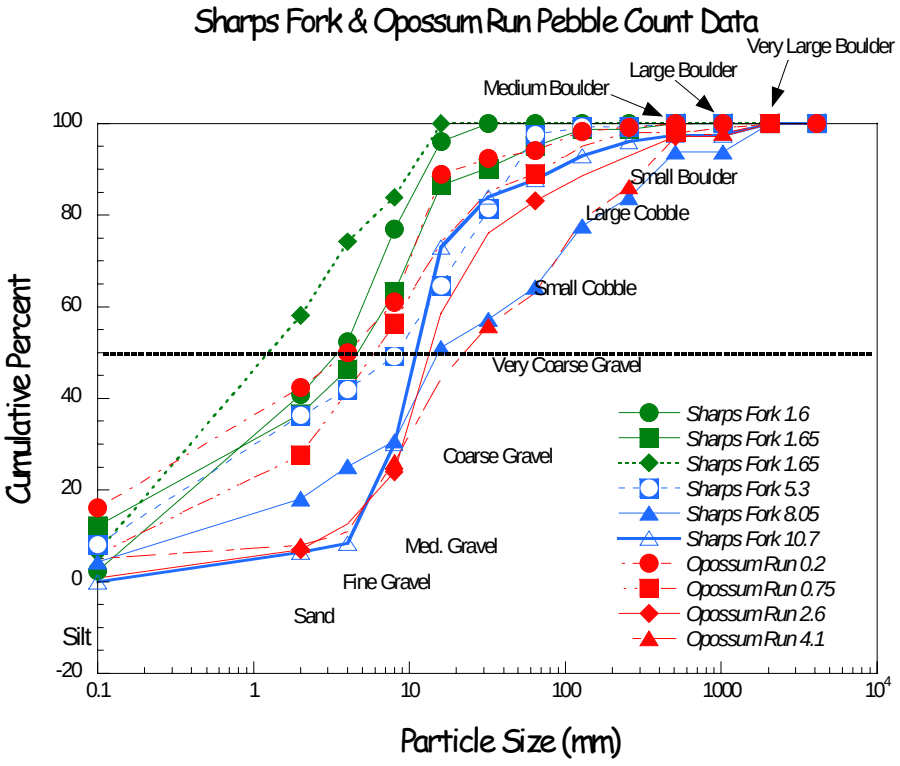
Map 6 2004 QHEI Derived Use Designations

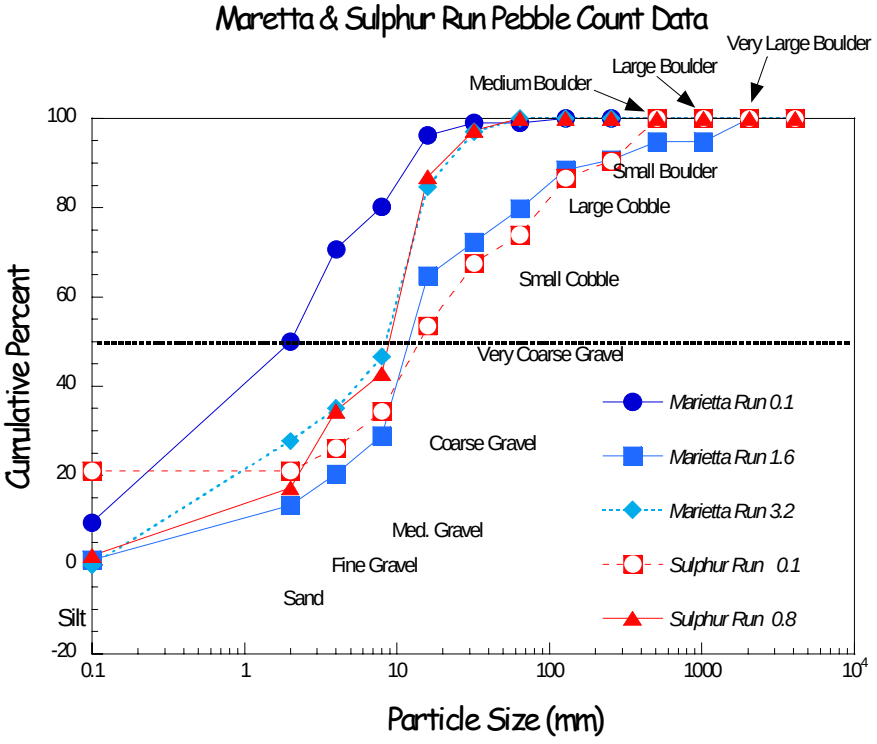


A Pebble Count is another way to investigate habitat quality. A pebble count is used to sample the surface particle size distribution of gravel-bed rivers. This allows an estimate of the distribution of substrates on the surface of the stream bottom by size and category. Unimpacted streams in Ohio typically have a coarse (gravel, cobble, some times boulders) particle size as the median. As erosion increases in a watershed the percent of fine materials in the steam bottom can increase. Figure 3 illustrates Pebble Count cumulative frequency plots for streams in the watershed with known mining. These streams are Federal Creek and Linscott Run (top), Sharps Fork and Opossum Run (center), and Marietta Run and Sulphur Run (bottom). The chart curves to the left have more fines and curves to the right are more dominated by coarser materials. Sandy rather than silty sediments are more a problem in the Federal Creek Watershed at most sites. The Federal Creek sites and river mile 9.1 and 9.3 both have greater than 50 percent of surface bed materials as sand. No strong trends exist between fine substrates as measured by the pebble counts at individual sites and biological performance, however, adjacent higher quality patches of habitat can compensate for localized sediment impacts. If the extent of fine substrate export to Federal Creek increases the biological could decline. As it is now, the IBI scores were only marginally attaining the EWH and further stress could cause impairment. Only Sulphur Run at its mouth had extremely silty conditions (Figure 3, bottom) and this coincided with mining impacts and the only poor macroinvertebrate assemblage rating in the watershed.

Figure 3. Zig-zag pebble counts
COLLECTED IN FEDERAL CREEK AND LINSCOTT RUN (TO RIGHTP), SHARPS FORK AND OPOSSUM RUN (TOP LEFT) AND THE MARIETTA RUN AND SULPHUR RUN (BOTTOM) DURING 2004. MBI 2005




Sharps Fork & Opossum Run Pebble Count Data
Very Large Boulder
Large Boulder
Medium Boulder
Small Boulder
Large Cobble
Small Cobble
Very Coarse Gravel
Coarse Gravel
Med. Gravel
Fine Gravel
Sand
Silt
Cumulative Percent
Particle Size (mm)
Sharps Fork 1.6
Sharps Fork 1.65
Sharps Fork 1.65
Sharps Fork 5.3
Sharps Fork 8.05
Sharps Fork 10.7
Opossum Run 0.2
Opossum Run 0.75
Opossum Run 2.6
Opossum Run 4.1


Maretta & Sulphur Run Pebble Count Data
Very Large Boulder
Large Boulder
Medium Boulder
Small Boulder
Large Cobble
Small Cobble
Very Coarse Gravel
Coarse Gravel
Med. Gravel
Fine Gravel
Sand
Silt
Cumulative Percent
Particle Size (mm)
Marietta Run 0.1
Marietta Run 1.6
Marietta Run 3.2
Sulphur Run 0.1
Sulphur Run 0.8

SECTION II BASIN ASSESSMENTS AND RESTORATION STRATEGY

Section II is organized into sections by each subwatershed that has abandoned mine lands in the Federal Valley Watershed. The section will begin with priority subwatersheds (subwatersheds with the most mine impacts). Each section will begin with a map of the area. The text will begin with a geography background, a brief description of mining impacts in the watershed, and a table of underground mine information for each subwatershed. For subwatersheds that have proposed mine drainage remediation, a description of the water chemistry, geography, and treatment strategies will follow. After the remediation section, mine drainage impact to the subwatershed will be described, beginning with a description of the biological investigation, sediment information (if available), water chemistry at the mouth of the subwatershed, and chemistry along the mainstem of the subwatershed. The final section is a description of the sample points in the subwatershed.

SULPHUR RUN BASIN ASSESSMENT

Map 7 Sulphur Run

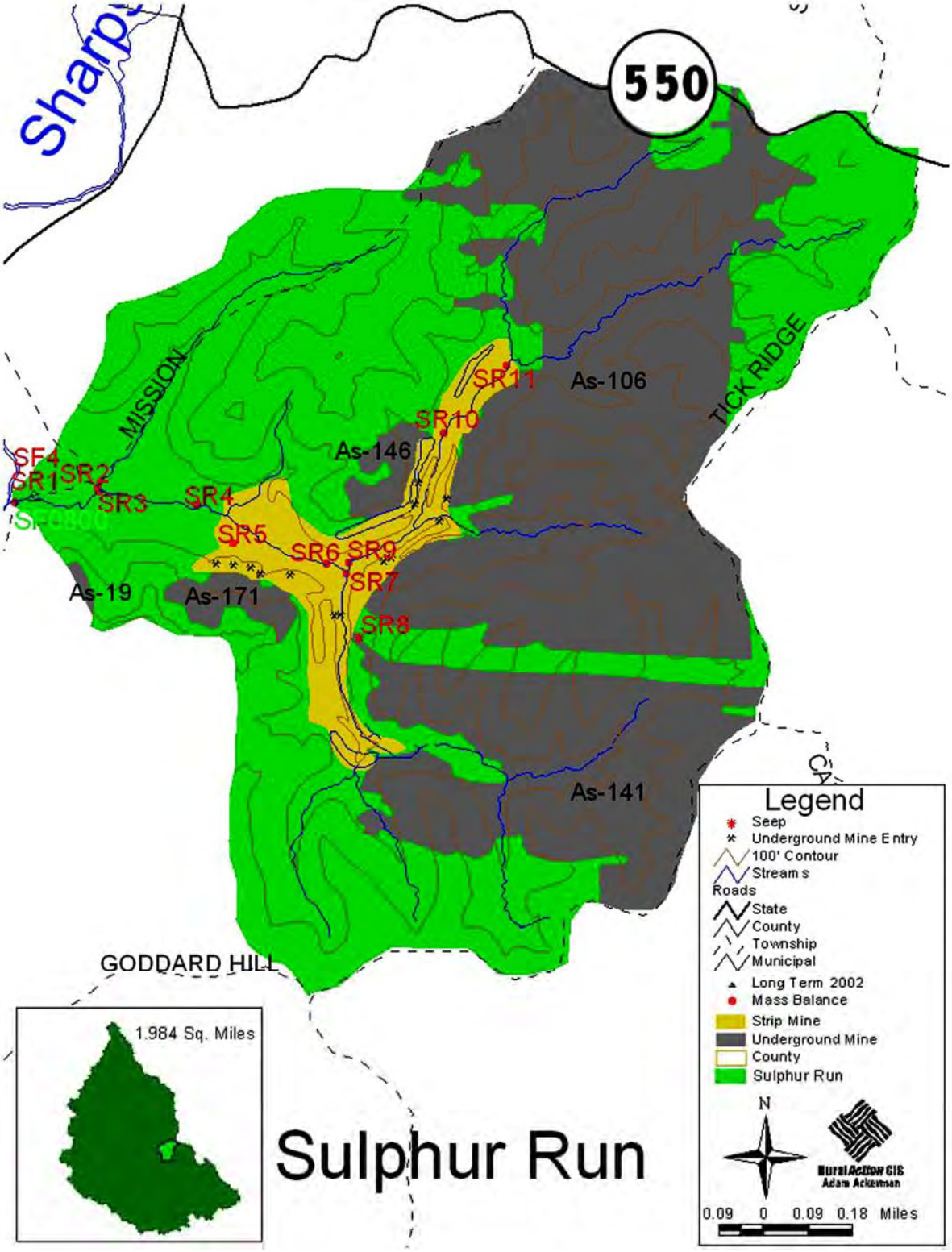


Photo of Sulphur Run

Geography Background

Sulphur Run occupies the east- central portion of the watershed, flows in a west/southwest direction, and enters Sharps Fork at river mile 2.9 . Sulphur Run is located in the southeastern portion of Sharp's Fork. It is located in Athens County, crossing Bern Township and is near the village of Sharpsburg (0.3 miles to the southeast). This subwatershed can be found on the Amesville USGS quad sheets. Sulphur Run has a drainage area of 1.98 square miles, and a stream length of 3.46 miles. Abandoned mining impacts are widespread in Sulphur Run, and include AMD generated from abandoned surface mining, underground mine discharges, and gob piles. In this subwatershed there are 0.89 square miles that have underground mines, which is 44.85 percent of the land in the entire subwatershed that has been mined underground. In this subwatershed there is 0.1 square. mile that has been strip-mined, which is 6.52 percent of the land in the entire subwatershed that has been strip-mined.

The natural stream channel has been severely disturbed by strip mining and refuse piles, and currently by beaver ponds. There is a significant amount of orange iron flocculant covering the bottom of the stream throughout the basin. Diffuse AMD sources permeate much of the area, and distinct measurable sources are few. As such, identification of distinct sources of AMD within Sulphur Run is difficult, and rating of AMD sources is defined more by areas of diffuse AMD sources rather than discrete sources. The mainstem splits into a north and a south branch midway upstream. The mainstem of Sulphur Run is the channel that begins at Sharps Fork, continues upstream to the previously mentioned split, and includes the north branch.

Mining Impacts In Brief

A summary of conclusions will be presented first and then the details of these conclusions will be provided subsequently. Sulphur Run subwatershed is the most heavily impacted area of Federal Valley Watershed by previous mining activity. Impact refers to topography, surface water chemistry, stream habitat, biotic integrity, and sediment. Mining impacts from underground mine seeps, strip mining, and strip mine spoil are seen throughout the subwatershed.

The chemistry in this stream exhibits the most mine drainage impact of any stream in Federal Valley, including all streams with a flow consistently over 100 gpm (the measured flow in Sulphur Run ranged from 550 to 1600 gallons per minute). Although there are significant impacts in this subwatershed, the alkalinity concentrations remain high and the pH along the mainstem remains between 6.7 and 8.06. At high flow the conductivity in the mainstem ranges from 356 uS/cm above the mine area to 688 uS/cm in the mine impacted area, and in low flow conditions the conductivity ranges from 473 uS/cm above mine impacts to 1340uS/cm in the mine- impacted area. Because of the naturally high pH the only treatment necessary would be retention.

This stream is a tributary of Sharps Fork, an Exceptional Warmwater Habitat stream. Sulphur Run contributes a percentage of the total known load of AMD components into Sharps Fork. This percentage of the entire AMD load into Sharps Fork is a combined metal load of 33 percent in high flow and 74 percent in low flow, and a sulfate load of 21 percent in high flow and 47 percent in low flow to Sharps Fork. Although Sharps Fork is an Exceptional Warmwater Habitat stream, it is only partially attaining this use designation downstream of Sulphur Run. The site immediately downstream of Sulphur Run scores lower on IBI and ICI than any of the other eight sites in this subwatershed.

Because Sulphur Run is a small subwatershed and the treatment needed for the impacted water is retention wetlands, it is recommended to utilize wetlands below all of the mine impacts. This should improve the water for the lower half of the subwatershed and would greatly affect loading in Sharps Fork.

Table 12 Sulphur Run underground mine information

Mine number	Mine Name	Date Abandoned	Type	Coal elevation
AS-19	Carbon (Schuler #2) Schuler Coal Co.	1923	Coal, Drift	697’ to 712’
AS-106	Black Diamond, Black Diamond Coal Company	1924	Coal, Drift	
AS-141	Black Diamond #2, Black Diamond Coal Company	1944	Coal, Drift	
AS-146	Amesville, Amesville Coal Co.	1948	Coal, Drift	699’
AS-171	Price (AS-520) Lee T. Jenkins	1951	Coal, Drift	675’

Remediation and Description of Proposed Treatment Area

This is a net alkaline stream, characterized by a Pittsburgh Seam #8 underground and surface mine complex. The only apparent requirement is oxidation and settlement. The landowner of this site, Wallace Fischer, is interested in having a treatment wetland on his property. The treatment site would be located at river mile 0.5. This site is very accessible by vehicle. It is located in the area of a large cement tipple. This tipple has potential historic interest because it is Ohio’s largest cement tipple. The landowner is interested in the historic significance of this structure but is worried about safety and liability issues

associated with this structure. One proposed idea is to surround the tipple with the treatment wetland, which would limit public access to the structure but keep the structure for the public to view from a distance. This could make a good site for the public to see mine treatment and a historic mine structure.

SR-6 is a point on the mainstem of Sulphur Run at 0.5 river miles, at 39.42081397 latitude, 81.90972302 longitude, and is at an elevation of 694 feet. Sulphur Run is a tributary that enters Sharps Fork at 1.7 river miles. The area of land above this point is 1.33 square miles and the length of the stream above this point is 1.37 miles.

Access

The proposed treatment area is above a gated private driveway. In order to access this area it is necessary to get permission from the landowner Wallace Fisher. Generally, it is best to e-mail him in advance at wfischer@frognet.net. He is supportive of Federal Valley's work on his land and of a remediation project. To find the location turn on Lathrop Rd. off of S.R. 329, just west of Sharpsburg. Follow the road less than 500 ft to a driveway/ small road that goes to the left. Wallace often works in the house on the corner of this driveway. If you continue past the house, you will come to a trailer with a gate. Continue past the gate to a place with a driveway on the right and a culvert crossing the stream on the left. This is the location. The driveway on the right is Wallace Fischer's parents' home and the road continues to Wallace's family home. The culvert crosses the stream to a field that will lead to the tipple.

Water Chemistry in treatment area

Table 13 water chemistry in treatment area

Values that are bold exceed the targets set for Federal Valley

Not Filtered														
Site number	DATE	LOCATION	FLOW type	FLOW cfs	FLOW gpm	COND-LAB uS/cm	PH-LAB	ALK mg/L	ACIDITY-LAB mg/L	SULFate mg/L	TOT-FE mg/L	TOT-MN mg/L	TOT-AL mg/L
SR-4	9/13/2005	Below the tipple, above the trailer	low	N/a	N/a	**1820**	6.63	68.2	8.98	**980**	**2.65**	**1.51**	<.05
SR-5.5	6/29/2004	Below the tipple, at the culvert	high	1.67	748.65	**1130**	7.1	150	6.62	**447**	**9.09**	**0.89**	<0.25
SR-5.5	5/3/2004	Below the tipple, at the culvert	med	2.47	1107.26	**836**	7	141	9.1	**291**	**4.47**	**0.62**	<0.25
SR-4	4/22/2003	Below the tipple, above the trailer	high	2.98	1336.35	**688**	7.5	126	6.3	**210**	**2.28**	**0.38**	0.37
SR-4	8/26/2003	Below the tipple, above the trailer	low	1.38	621.29	**1090**	7.3	152	10.5	**404**	**4.2**	**0.98**	<0.25
SR-6	4/22/2003	Above the tipple	high	1.70	763.24	**659**	7.5	136	5.82	186	**2.61**	**0.41**	<0.25
SR-6	8/26/2003	Above the tipple	low	0.85	381.62	**1060**	7.3	171	10.4	**356**	**17.7**	**0.95**	0.36

Table 14 displays loadings at the suggested treatment site, located between SR-4 and SR-6, see the map at the beginning of the chapter. (This site is below all mine inputs, it should represent 100 percent of all loadings into Sulphur Run). This table does not include the lowest flow and most recent chemistry taken on September 13, 2005 because flow was not taken on that day, the results of analysis on this day can be seen above. This most recent water sample shows the highest levels ever recorded at this site.

Table 14 Average Metal loadings in treatment area.

	Average high flow	**Average low flow**	Average Lbs/day
METAL LOAD lbs/day combined Fe and Mn- (Al is not detectable)	58.07	64.15	61.11
SULFATE LOAD lbs/day	3617.08	3513.89	3565.49

Remediation Recommendations for Sulphur Run

The recomended remediation requirement is oxidation and settlement.

Estimated cost by ODNR for the treatment

Mobilization/ Clearing	$7,727
Rock Dam(s)	33,792
Revegetation	9,000
Road Elevation	8,720
Engineering	14,810
Total	$74,049

Pre and Post Treatment Sampling

It is recommended that six samples, once per month, be analyzed of Group I parameters to fully characterize the high and low flow chemistry. These six samples should be taken both immediately downstream of the treatment site and at the mouth of Sulfur Run. This six-month sampling will provide the needed pre-reclamation water quality data to determine effectiveness of the restoration.

ODNR Cambridge Lab sample analysis $110 x 12 samples	$1320
Staff time collecting samples, 48 hours @ 30$/hr	$1440
Travel $0.42/mile, total miles 50 miles	$ 21

Post-construction water quality monitoring should be conducted at least two to four times a year and biological monitoring once a year downstream of the restoration project. Multiple sites downstream should be established to provide data on water quality and biological improvements made over a given

distance from the treatment site. Post-construction monitoring should begin within 6 months of completion.

AMD Impact to Sulphur Run

Biology Investigation for Sulphur Run

Table 15 Biology Data for Sulphur Run

MBI 2005 For information on the entire watershed see section I.

Sulphur Run - 2004

Station	Fish RM	Macro RM	IBI	MIwb	ICI or Narrative Rating	QHEI	Aquatic Life Uses Ex/Rec	Attain-ment Status	Comment
S01134 0.802004	0.80	0.80	46	NA	F*	56.0	None WWH	**Partial**	Upstream
S01134 0.102004	0.01	0.10	50	NA	P*	45.5	None WWH	**Non**	Mouth

Ecoregion Biocriteria: Western Allegheny Plateau (WAP)

Index and Site Type	WWH	EWH	MWH	LRW-AMD
IBI – Wading & Headwater	44	50	24/24	18
Mod. Iwb - Wading	8.4	9.4	6.2/5,5	4.0
ICI/Narrative	36/G	46/E	22/30	8/MF

Footnotes

a - A qualitative narrative evaluation based on best professional judgment and sampling attributes such as community composition, EPT taxa richness, and QCTV scores were used when quantitative data were not available (E-exceptional, G-good, MG-marginally good, F-fair, P-poor, VP-very poor); for Moxahala Creek a draft Qualitative ICI index was also used.

b - Attainment status is given for existing use designations, except where a use designation change is recommended, in which case, the attainment status for the recommended use is given.

c - Limited Resource Water - acid mine drainage (LRW-AMD) benchmarks based on best professional judgment driven by the need to protect against acutely toxic stream conditions. Macro-invertebrate qualitative only data were evaluated based on densities of EPT taxa on the natural substrates (see Methods Section), a narrative VP* or P* indicates departure from the benchmark.

na - MIwb not applicable at headwater sites (< 20 mi^2).

† - HD sampler set, but not retrieved due to flood flows destroying samplers.

‡ - Dry conditions in August followed by flooding conditions in September likely influenced assemblage conditions (data excluded from attainment decision)

ns - Nonsignificant departure from biocriteria (<4 IBI or ICI units, or <0.5 MIwb units).

* - Indicates significant departure from applicable biocriteria (>4 IBI or ICI units, or >0.5 MIwb units). Underlined scores are in the Poor or Very Poor range.

Sulphur Run was the only tributary where acute influences of AMD were observed, and in this case only strongly in the macro-invertebrates (Table 3). This was the only site that had a poor macro-invertebrate assemblage in the entire watershed. The dichotomy between the fish and macro-invertebrates was related to the episodic nature of the impacts and the fact that impacts were not especially extensive. Fish assemblages in such small streams have a strong recolonization potential if there is a good nearby refuge for re-invasion. Sharps Fork, into which Sulphur Run flows, is a high quality stream and is being recommended to be upgraded to an EWH aquatic life use.

Sediment Study Sulphur Run 2004

Metal concentrations (mg/kg) in sediments were collected from Federal Creek tributaries in 2004. Values preceded by a (<) were below the reporting limit. Those preceded by (*) exceeded the threshold effect concentration (TEC) described by MacDonald, et.al. (2000). Values preceded by (#) exceeded Ohio-specific Sediment Reference Values (SRV's).

Table 16 Sulphur Run values from OEPA sediments study **2004 TMDL**

Sulphur Run @ RM 0.5, below tipple @ culvert

Al	Ba	Ca	Cr	Cu	Fe	Pb	Mg	Mn
34,600	231	5260	41	21.9	**#68,300**	<32	4480	1050
Ni	K	Na	Sr	Zn	Hg	As	Cd	Se
***<32**[1*]	7600	<3950	150	91	0.076	**#*30.4**	0.194	2.42

Note: The detection limit is higher than the limit of 22.7, and therefore could be a violation, but cannot be determined.

Water Chemistry at the Mouth of Sulphur Run

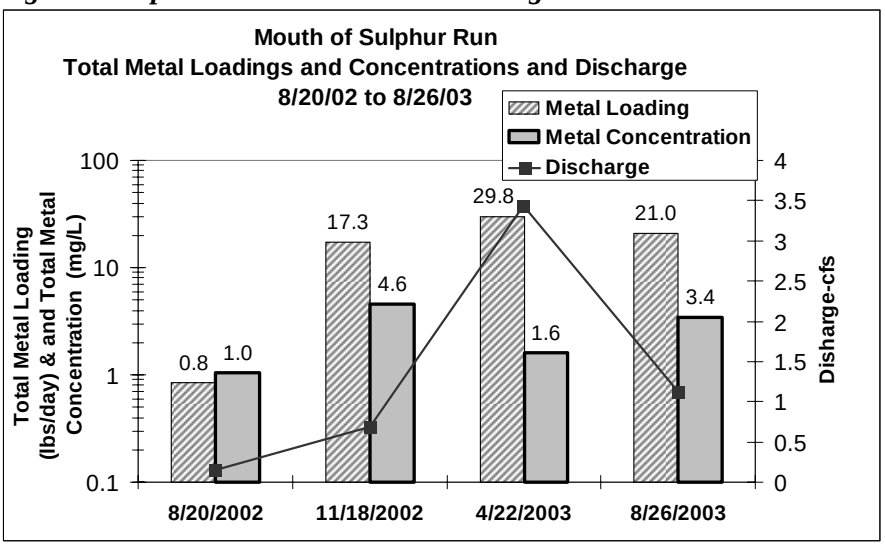
The graph below displays discharge, total metal concentrations and loadings measured at the mouth of Sulphur Run over the course of a year. Total metal concentrations were highest on the 11/18/02 sampling date. The total metal loading of Sulphur Run ranged from 0.85 lbs/day at the lowest flow on 8/20/02, to 29.8 lbs/day at the highest flow on 4/22/03. The load was 17.3 lbs/day on 11/20/03 and 21.0 lbs./day on 8/19/03. The average metal load from Sulphur Run over the period of 8/20/03 to 8/19/03 is 17.2 lbs/day, making it the most significant contributor of metal loadings into Sharp's Fork.

The site on Sulfur Run is at the mouth of Sulfur Run. Table 17 shows the data from that site. This table includes the laboratory conductivity values. This site has values higher than the target values. All of these sites are higher than the target conductivity of 600 uS/cm. All but one reading is above the target for iron, 1.1 mg/L, and the average is 2.02 mg/L. All but one site is above the target for manganese of 0.3 mg/L, where the average is 0.7 mg/L. All but 5 sites are above the target for sulfate of 204 mg/L where the average is 282mg/L. Aluminum is never above the target of 0.5 mg/L.

Table 17 Sulphur Run Mouth Chemistry Data
(bold values are above FVWG targets)

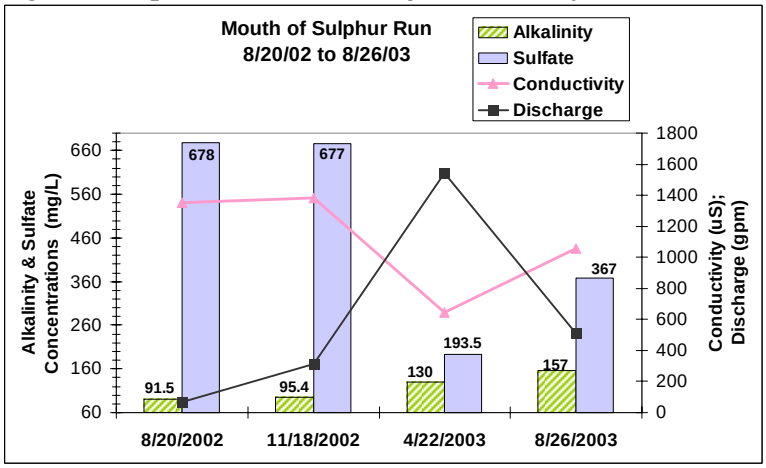
Lab	Date	Alkalinity mg/L	Sulfate mg/L	Iron mg/L	Manganese mg/L	Aluminum mg/L	Conductivity uS/cm/cm
ODNR	8/20/2002	**92**	**678**	0.35	**0.70**	<0.250	**1350**
ODNR	11/18/2002	**95**	**677**	**3.12**	**1.50**	<0.250	**1380**
ODNR	4/22/2003	**130**	189	**1.31**	**0.36**	<0.25	**646**
ODNR	5/19/2003	142	**231**	**2.45**	**0.63**	0.31	**740**
ODNR	8/26/2003	157	**367**	**2.56**	**0.90**	<0.25	**1050**
ODNR	10/7/2003	151	**402**	**2.63**	**0.89**	<0.25	**1010**
	Average	149	**282**	**2.02**	**0.70**	0.31	**898**

Figure 4 Sulphur Run Mouth Metal Loadings and Concentrations



The following graph shows alkalinity and sulfate concentrations, specific conductivity, and discharge on these same sampling events.

Figure 5 Sulphur Run Mouth Sulfate, Alkalinity, and Conductivity

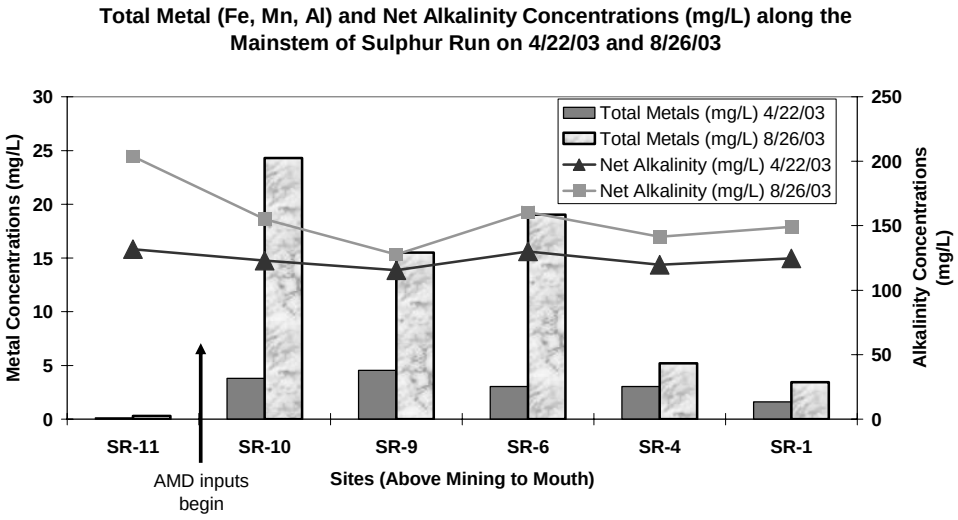


Overall, the mouth of Sulphur Run shows a trend of increasing conductivity and sulfate, as well as decreasing alkalinity, with decreasing flow. Conductivity values peak at 1380uS/cm on 11/18/02, while the lowest value is 648uS/cm on 4/22/03, the highest flow date. Sulfate values are highest on 8/20/02 and 11/18/02, at 678 and 677 mg/L, and lowest on 4/22/02 at 193.5 mg/L. The lower flow dates of 8/20/02 and 11/18/02 exhibit the lowest alkalinity values of 91.5 and 95.4 mg/L respectively. Alkalinity values were highest on the 8/26/03 sampling date at 157 mg/L. On all sampling dates, the pH values fell between 7.3 and 7.7. The neutral pH and high alkalinities facilitate rapid precipitation of metals contained in the AMD occurring throughout Sulphur Run. Sulphur Run is characteristically orange, with iron precipitate covering the stream channel in a thick flocculent layer.

Mainstem Sulphur Run

The chart below displays the metal concentrations and alkalinity concentrations along the mainstem of Sulphur Run on the Phase II sampling dates of 4/22/03 and 8/26/03. Site locations can be seen on the map at the beginning of this section.

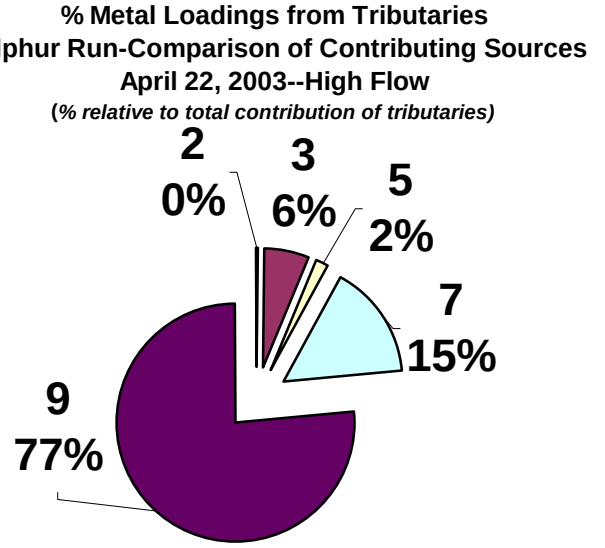
Figure 6 Sulphur Run Chemistry along the Mainstem

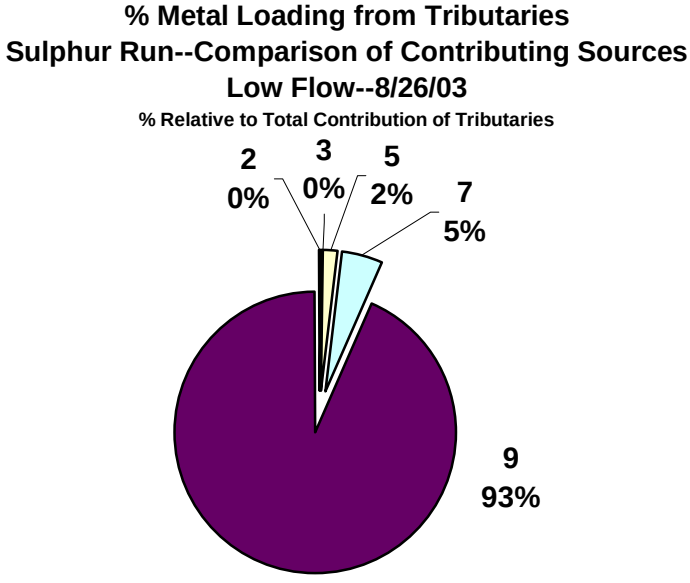


Samples were unfiltered for both sampling dates. Although metal concentrations shown may not be solely dissolved metal concentrations, the huge increase in metal concentrations below site SR-11 is apparent. Additionally, the precipitation of metals along the mainstem is also apparent in the steady drop of concentrations below site SR-6M. Many beaver ponds and dams exist along the mainstem, which may facilitate retention of precipitated metals in the stream channel. Alkalinity concentrations remain high along the mainstem. The pH along the mainstem remains between 6.7 (SR-10M, 8/26/03) and 8.06 (SR-11M, 4/22/03 and 8/26/03). At high flow the conductivity ranges from 356 uS/cm (SR-11M) to 688

uS/cm (SR-4M), and at the low flow situation the conductivity ranges from 473 uS/cm (SR-11M) to 1340uS/cm (SR-9M).

Figure 7 Sulphur Run percent of Metal Loadings from Tributaries, High and Low Flow
Stream numbers correspond with site numbers on the map at the beginning of this section.





The most significant source of metal loading in Sulphur Run is the section represented by SR-9, which is the mouth of the north fork of the two tributaries that form Sulphur Run. This north fork is considered the mainstem in this study. Identification of a discrete point source within this segment is not

possible, as nearly the entire stream segment contains numerous and diffuse seeps from strip mining. Additionally, approximately 1000 feet from the beginning of the seeping area begins a series of beaver ponds, surrounded by high walls on either side.

Tributary 7, the second most significant loader, contains the high volume seep, SR-8-S. Each of these contributors will be discussed in detail in the following section.

On both sampling dates, the metal inputs to Sulphur Run exceeded the metal output at the mouth of Sulphur Run. Precipitation and retention of metals along the Sulphur Run stream channel is visible.

Investigation of Sulphur Run

Phase I

A phase I water quality investigation was conducted of Sulphur Run subwatershed on 4/3/03 and 4/4/03. Mining disturbances are widespread throughout the 2 square mile drainage area of Sulphur Run. Preliminary field observations identified multiple acid mine seeps coming from unreclaimed surface mining and one major discharge from an abandoned underground mine contributing to the mainstem of Sulphur Run. Strip pits from surface mining and multiple gob piles were also identified throughout Sulphur Run.

Phase II

A phase II water quality investigation was conducted in Sulphur Run on 4/22/03 and 8/26/03. This information was used for the characterizations above. Six mainstem points were sampled, extending from the area above all mining to the mouth of Sulphur Run (SR-11, SR-10, SR-9, SR-6, SR-4, SR-1). One major abandoned underground mine seep was sampled (SR-8-S), and four tributaries (SR-7, SR-5, SR-3, SR-2). The major seep flows into one of the tributaries (SR-7), hence the contribution of SR-7 includes the input of SR-8-S. Site SR-8-S (seep) is associated with mine number As141.

Phase III

A phase III water quality investigation was conducted in Sulphur Run on 6/29/2004 and 5/3/2004. SR-5.5 is a new site taken below the tipple on the mainstem, at the culvert. It is slightly upstream of SR-4 from phase II. This site is closer to where the treatment site is proposed. SR-9.5 was also added. This site is on the mainstem below the location of what was a large beaver pond during phase II. Now this beaver dam is gone and this location is in a channel with large amounts of loose sediment that previously was the bottom of a pond. Additionally the sites from phase II of SR-9, SR-8, SR-10 and SR-11 were analyzed on these days.

Individual Site Descriptions

SR-9—North Fork of Sulphur Run

SR9 is a point on the mainstem of Sulphur Run at 0.72 river miles, at 39.42021945 latitude -81.90541715 longitude, and is at an elevation of 738 feet. Sulphur Run is a tributary that enters Sharps

Fork at 1.9 river miles. The area of land above this point is 0.39 square miles and the length of the stream above this point is 1.25 miles.

Access: SR-9 is a mainstem sampling site above the confluence of SR-7. Wallace Fisher owns the land. The site is accessible by foot, or by ATV.

Site Description: SR-9 represents the contribution of the widespread, diffuse seeps occurring along the mainstem of Sulphur Run. Above SR-9, Sulphur Run is characterized by numerous, diffuse seeps permeating the banks. Sampling discrete sources is further confounded by the presence of numerous beaver dams and high walls. The entire area has been greatly disturbed by strip mining, and the topography and drainage are very unnatural. The area above SR-9 appears to be the main contributor of the metal loadings to Sulphur Run.

SR-9 Metal and Sulfate Loadings 4

SR-9-S	Spring Flow	Base Flow	Average
Metal Load (lbs/day)	32.0	39.1	35.6
% Metals Contribution	77%	93%	85%
Sulfate Load (lbs/day)	1295.7	1385.7	1340.7
% Sulfate Contribution	49%	70%	59.5%

% indicated in table represents % contribution relative to total loading of five sampled tributaries

SR-7—South Fork Sulphur Run (mainstem)

SR7 is at 0 river miles, at 39.42001065 latitude -81.90547625 longitude, and is at an elevation of 731 feet. This is a tributary that enters Sulphur Run at 0.72 river miles. The area of land above this point is 0.77 square miles and the length of the stream above this point is 0.4 miles.

Access: SR-7 is the mouth of the south fork of Sulphur Run, considered a tributary in this study. The property is owned by Wallace Fisher, and is accessible by foot or ATV. Advanced permission to enter the land must be received every time sampling is done.

Site Description: SR-7 represents the AMD impacts along this major tributary. AMD impacts include the contributions of SR-8-S, as well as the diffuse seeps that occur along the tributary between SR-8-S and SR-7. These diffuse seepages cannot be quantified due to their abundance, widespread nature, and low volume. They can be characterized as acidic, highly conductive trickles from the disturbed banks of Sulphur Run.

SR-7 Metal and Sulfate Loadings

SR-7-S	Spring Flow	Base Flow	Average
Metal Load (lbs/day)	6.43	1.95	4.19
% Metals Contribution	15%	5%	10%
Sulfate Load (lbs/day)	838.9	545.0	692.0
% Sulfate Contribution	31%	28%	29.5%

% indicated in table represents % contribution relative to total loading of five sampled tributaries

The area represented by SR-7 appears to be the second largest contributor of AMD within the Sulphur Run Watershed. Most of the AMD generated within this section appears to come from SR-8-S, a large abandoned underground mine discharge.

SR-8-S—Abandoned Underground Mine Discharge

SR-8-S is a seep that enters Sulphur Run at 0.73 river miles, at 39.41806069 latitude -81.90497015 longitude, and is at an elevation of 664 feet. This seep is associated with mine # As141.

Access: SR-8-S is located on Wallace Fisher's property, approximately 500 feet from the landowner's residence. It is accessible by foot.

Site Description: SR-8-S is an abandoned underground mine discharge. The discharge exits in four places within a twenty-five foot section at the base of a high wall. The discharge drains directly into the south branch of Sulphur Run (considered a tributary in this study), at which point the stream is a beaver/strip pit pond. The dam of this pond is approximately 100 feet downstream of the mine discharge. Below the dam, the tributary reforms a stream channel.

Location/Access: SR-6- mainstem

SR-6 is a point on the mainstem of Sulphur Run at 0.7 river miles, at 39.42009103 latitude -81.90618787 longitude, and is at an elevation of 750 feet. Sulphur Run is a tributary that enters Sharps Fork at 1.7 river miles. The area of land above this point is 1.5 square miles and the length of the stream above this point is 1.37 miles.

Access: To access this point, drive to Wallace Fisher's house and park in his parking area. Then walk down the hill north of the parking area toward the creek. A split in the stream will be obvious if using a GPS unit.

Site Description: SR-6 is located below the confluence of SR-9 and SR-7, and above another beaver pond, which has broken since the sampling period. A large coal tipple is also located downstream of this point.

SR-5—Tributary

SR-5 is at 0 river miles, at 39.42081397 latitude -81.90972302 longitude, and is at an elevation of 694 feet. This is a tributary that enters Sulphur Run at 0.5 river miles. The area of land above this point is less than 0.14 square miles. This small tributary is not mapped, therefore the stream length above this point in not available.

Access: SR-5 is a tiny tributary that passes under the Fisher's driveway before entering Sulphur Run between the mainstem sampling points of SR-6 and SR-4. The sampling site is located where Ray Fisher's driveway enters into the Fisher road/driveway. The sampling site is accessible by vehicle.

Site Description: The source of SR-5 has not yet been determined. It is believed to originate behind or near Ray Fisher's residence. Water appears to be coming from under Ray Fisher's new home. It may be associated with abandoned mine openings associated with As-171, or it may originate from strip mine refuse. Ray Fisher's residence sits on top of mining refuse.

SR-5 Metal and Sulfate Loadings

SR-5	Spring Flow	Base Flow	Average
Metal Load (lbs/day)	0.77	0.66	0.72
% Metals Contribution	2%	2%	2%
Sulfate Load (lbs/day)	56.9	32.3	44.6
% Sulfate Contribution	2%	2%	2%

% indicated in table represents % contribution relative to total loading of five sampled tributaries

SR-5.5- Mainstem

SR-5.5 is at 0.5 RM at 39.42081397 latitude -81.90972302 longitude, and is at an elevation of 694 feet. The area of land above this point is 1.6 square miles and the length of the stream above this point is 1.5 miles.

Access: SR-5.5 can be accessed by going through the gate at the trailer to a location on the road with a driveway to the right and a culvert driveway to the left. The road continues straight ahead. The sample point is in the stream, below the culvert and below the tributary of SR-5.

Description: This site is very similar to SR-4 in that it is downstream of the tipple and the SR-5 tributary. It is slightly upstream of SR-4; closer to the tipple and the proposed treatment site.

SR-4- Mainstem

SR-4 is a point on the mainstem of Sulphur Run at 0.4 river miles, at 39.42192969 latitude -81.91104652 longitude, and is at an elevation of 648 feet. Sulphur Run is a tributary that enters Sharps Fork at 1.7 river miles. The area of land above this point is 1.68 square miles and the length of the stream above this point is 1.67 miles.

Access: This point is located at the trailer and below the gate. This point is easily accessed even if the gate is locked. The creek is behind the dumpster.

Description: SR-4 is along the mainstem, below a section of beaver dams and massive stream braiding.

SR-3: Tributary

SR-3 is at 0 river miles, at 39.42248449 latitude -81.91462384 longitude, and is at an elevation of 707 feet. This is a tributary that enters Sulphur Run at 1.21 river miles. The area of land above this point is 0.031 square miles. This small tributary is not mapped, and therefore the stream length above this point in not available.

Access: SR-3 is a small tributary that flows into Sulphur Run downstream of the mainstem site SR-4. It is approximately 100 feet from the road.

Site Description: The sources contributing to tributary SR-3 have not yet been determined. SR-3 runs along the base of a hillside where mine complexes As-171 are located. This area has also been strip-mined. This tributary flows behind Wallace Fisher's trailer and it appears to be created by the earth moving and strip mining in the area, as it is not visible on any map.

SR-3 Metal and Sulfate Loadings

SR-3	Spring Flow	Base Flow	Average
Metal Load (lbs/day)	2.47	0.02	1.2
% Metals Contribution	6%	0%	3%
Sulfate Load (lbs/day)	440.1	4.6	222.4
% Sulfate Contribution	16%	0%	8%

% indicated in table represents % contribution relative to total loading of five sampled ributaries

SR-3 appears to play a more significant role during high flow conditions than low flow conditions.

SR-2-Tributary

SR-2 is at 0 river miles, at 39.4224549 latitude -81.91481679 longitude, and is at an elevation of 631 feet. This is a tributary that enters Sulphur Run at 0.2 river miles. The area of land above this point is 0.20 square miles and the length of the stream above this point is 0.9 miles.

Access: SR-2 enters the mainstem of Sulphur Run approximately 50 feet below where SR-3 enters the mainstem. It passes through a culvert under the Fisher's Road before entering Sulphur Run. It enters Sulphur Run from the northern side of the stream. This site is accessible by car.

Site Description: We do not believe SR-2 is affected by AMD, and as such, will not be described in detail. It is a small tributary with a high alkalinity, low metal concentrations, low conductivity, and low sulfate concentrations. It was sampled as it is one of the larger tributaries to enter Sulphur Run.

SR-1- Mainstem, at the mouth

SR1 is a point on the mainstem of Sulphur Run at 0 river miles, at 39.42204989 latitude -81.91785313 longitude, and is at an elevation of 690 feet. Sulphur Run is a tributary that enters Sharps Fork at 1.7 river miles. The area of land above this point is 1.98 square miles and the length of the stream above this point is 2.0 miles.

Access: SR-1 can be accessed by staying on Lathrop Rd. There is a location where there are several trailers and other various cars, etc. Park near the stream on the culvert. This site is below the culvert, although sometimes it is easier to take samples above the culvert.

Site Description: This is the mouth of Sulphur Run. It includes all water in Sulphur Run including all of the mine inputs.

MARIETTA RUN BASIN ASSESSMENT

Map 8 Marietta Run

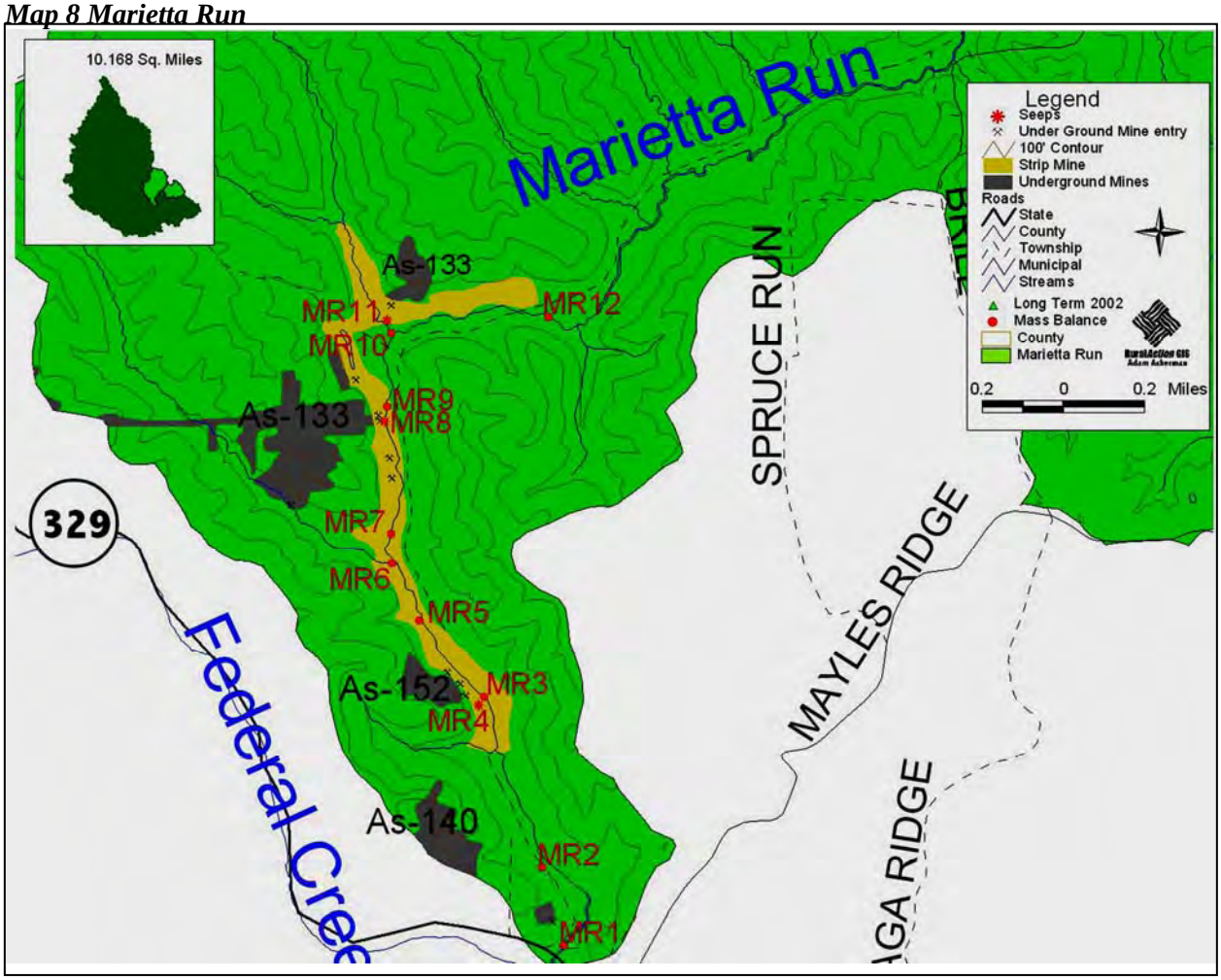


Photo of MR 8

Geography Background

Marietta Run occupies the east- central portion of the watershed and flows in a south/southwest direction, entering Federal Creek at 4.26 river miles. It is located in Athens and Washington counties, spanning Bern and Wesley Townships and is north of Kilvert and Broadwell. This subwatershed can be found on Amesville, Chesterhill and Stewart USGS quad sheets. Marietta Run has a drainage area of 6.92 square miles, and a stream length of 9.2 miles. Abandoned mining impacts are present in Marietta Run and include AMD generated from abandoned surface mining, underground mine discharges and gob piles. In this subwatershed, there are 0.32 square miles (3.10 percent) that has been mined underground. Additionally, in this subwatershed, there is 0.1 square mile (1.18 percent) that has been strip-mined. Abandoned mining impacts are widespread in the lower portion of the watershed, and include AMD generated from abandoned surface mining, underground mine discharges, and waste piles.

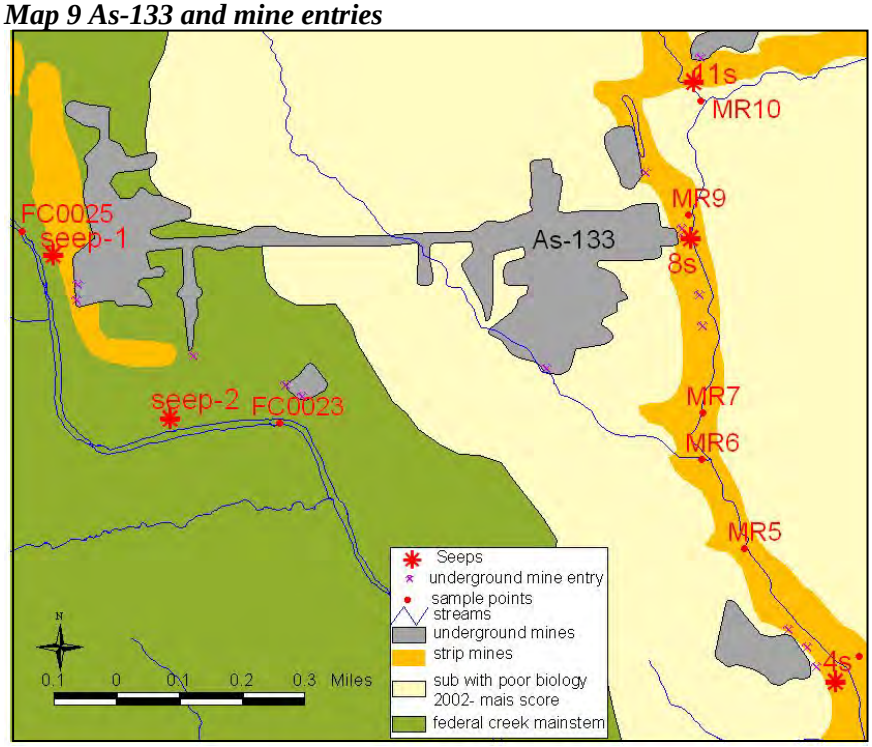
Mining Impacts In Brief

All recorded abandoned mines are in the first 2 river miles of this subwatershed. There is only one residence in the entire basin. The subwatershed is almost entirely wooded (mature forest cover), including the areas of abandoned mines. There is no agriculture in this subwatershed. In the areas where mining has taken place, the habitat is good. During low flow Marietta Run is orange with a thick flocculent material in the bottom that begins at the largest underground mine seep referred to as MR-8-S. This subwatershed has three distinct underground mine seeps, where MR-8-S is the major source of AMD in the entire watershed. The subwatershed is classified as Warm Water Habitat, however the scores drop at and below the area of abandoned mines. The mine impacts in this subwatershed are not severely impacting the water quality or biotic integrity, except in the reaches previously noted. There are tributaries of Marietta Run that have Exceptional Warm Water Habitat use designations. Currently the subwatershed is largely undisturbed by present human activity. This leads the watershed group to believe that with treatment of one major underground mine seep, and possibly one other less contaminated area, this stream could achieve an exceptional warm water rating.

MR-8-S is by far the most significant source of AMD pollution in Marietta Run, contributing an average of 76% of the metal loading to Marietta Run. MR-10 is the second most significant contributor, contributing an average of 14 percent of the metal loadings to Marietta Run. MR-6, a tributary, is ranked third, with an average of 6.5 percent of the metal loadings to Marietta Run.

In a subsequent section on the mainstem of Federal Creek, an underground mine seep referred to as FC-2-S will be discussed. It is interesting that MR-8s, MR-6 and FC-2-S are all from the same mine complex.

Map 9 As-133 and mine entries



The mainstem of Marietta Run is being episodically impacted by mine drainage. In September 2005, a filtered sample was taken on the mainstem below all of the mine drainage inputs. This was a low flow period proceeded by unusually low flows for several months. The sample was filtered because of the high amount of orange flocculent in the stream. There was no flow possible because of the lack of current in the area. The results of this sample along with other samples taken at this site can be seen in the table below. It is important to note that the water is net acidic on 9/13/05. This is unusual in Federal Valley, where there has never been a net acidic sample in any mainstem of any of the mine-impacted subwatersheds. All of the results for the sample on 9/13/2005 are dissolved, whereas on the other two days they are total. All chemical parameters were unusually high. This demonstrates the impact that mine drainage periodically has on this otherwise high quality creek.

Table 18 Marietta Run Mouth Chemistry

DATE	FLOW cfs	FLOW gpm	COND-LAB	PH-LAB	ALK mg/L	ACIDITY-LAB mg/L	SULFATE mg/L	FE mg/L	MN mg/L	AL mg/L
9/13/02005	n/a	n/a	**1070**	**3.34**	**0**	**85.4**	**547**	**5.47**	**4.01**	**9.17**
5/13/2003	17.592	7895.627	315	7.78	101	3	56.8	.8	**0.181**	0.488
9/30/2003	3.616	1622.779	408	7.77	142	5.36	50.2	**1.0**	**0.382**	0.409

A combination of the water coming from Marietta Run and the Federal Creek mainstem seeps could be having an impact on the biotic integrity of Federal Creek. The entire mainstem of Federal Creek

has been assigned an exceptional warm water habitat. The site immediately downstream of Marietta Run and the 'mainstem seeps' is only partially attaining this score, with an ICI of 34 and a MIwb of 7.14. The next site above this site on Federal Creek, located above all of the mining impacts, is fully attaining the EWH, with an ICI score of 42 and a Miwb score of 8.9. A chemistry sample was analyzed at this site on the same low flow day of 9/13/2005. The results of that sample are provided below. At times of low flow, chemical parameters rise, occasionally approaching or going above the targets set for this watershed. These periodic events of elevated chemical parameters could be the cause of this site only partially attaining its EWH use designation. Addressing the major seeps in Marietta Run could make a significant difference in Federal Creek under low flow regimes.

DATE	FLOW cfs	FLOW gpm	COND-LAB	PH-LAB	ALK mg/L	ACIDITY-LAB mg/L	SULFATE mg/L	TOT-FE mg/L	TOT-MN mg/L	TOT-AL mg/L
9/13/05	n/a	n/a	**771**	7.13	132	7.68	**236**	0.488	**1.370**	0.125

Table 19. Marietta Run underground mine information

Mine number	Mine Name	Date Abandoned	Type	Coal elevation
AS-133	Utley, Jennings Coal	1922	Coal, Drift	
AS-140	Mae Rudy of Federal ValleyJ.F. Schuller and Sons	1915	Coal, Drift	
AS-152	Young (As508) Joe Ralph Young	1950	Coal, Drift	

Remediation and Description of Proposed Treatment Area

Two potential projects in Marietta Run were examined for treatment. The first is MR-8-S, an underground mine seep that contributes 76 percent of the metal loading to Marietta Run. MR-10 is the second most significant contributor, contributing an average of 14 percent of the metal loadings to Marietta Run. These two areas are very close together.

MR-8-S

This site is an AMD discharge located approximately 25 feet from the mainstem of Marietta Run and is associated with mine complex As-133. The discharge is located at an abandoned underground mine opening, flows across an old roadbed, and then into Marietta Run. The discharge was measured at 0.09 cfs (high flow) on 5/13/03, and 4/19/04 and 0.02 cfs (low flow) on 6/14/04 and 8/9/04It consists of a series of collapsed underground mine entries that discharge to a narrow haul road. The discharge points occur where Marietta Run comes up against the embankment leaving little working room. The AMD is strongly acidic with a net acidity of 200 to 300 mg/L. Iron is largely ferrous and is around 75 mg/L.

Location: MR-8-S is a seep that enters Marietta Run at 1.57 river miles, at 39.38714605 latitude -81.8877569 longitude, and is at an elevation of 733 feet. This seep is associated with mine # As 133.

Access: MR-8-S is a seep that enters Marietta Run at RM 1.5. The site is accessible on foot by parking on Marietta Run Road and crossing the floodplain (approximately 500 feet) and then crossing Marietta Run, where orange, seeping water can be seen on the bank. Another access is via an old mine road located directly in front of the mine seep and traveling adjacent to Marietta Run. This road is passable using a four-wheel drive vehicle or ATV.

Water Chemistry of the Mine Seep

From high and low flow samples, the average pH was found to be 3.86, the average net acidity concentration was 319 mg/L, the average specific conductivity was 1320 uS, and the average sulfate concentrations was 741.5 mg/L. The total metal concentration at high flow is 120.7 mg/L, having a composition of 96.4 mg/L iron (ferrous iron equals 90.6 mg/L), 4.01 mg/L Mn, and 20.3 mg/L Al. At low flow, the total metal concentration is 135.6 mg/L, with a composition of 109.0 mg/L Fe (88 mg/L ferrous iron), 3.21 mg/L Mn, and 23.4 mg/L Al. As displayed in the table below, MR-8-S discharged an average of 83.8 lbs/day of metals into the Marietta Run mainstem, accounting for an average of 76 percent of the metal loading of the tributaries.

Table 20 MR-8-S Net Acid, Metal, and Sulfate Loadings

MR-8-S	High Flow	Low Flow	Average
Metal Load (lbs/day)	58.6	109.0	83.8
% Metals Contribution	62	90	76
Acid Load (lbs/day)	263.6	150.6	207.1
Sulfate Load (lbs/day)	383.4	557.7	470.6
% Sulfate Contribution	25	64	45.5

Table 21 Data from MR-8-S

(bold indicates above FVWG TARGET)

Site number	Filtered	DATE	FLOW cfs	FLOW gpm	DISSOLVED O2 %	DISSOLVED O2 mg/L	COND-LAB	PH-LAB	ALK mg/L	ACIDITY-LAB mg/L	SULFATE mg/L	DIS-FE mg/L	DIS-MN mg/L	DIS-AL mg/L
MR-8-S	f	5/13/2003	0.09	40.50	4.6	0.5	**1390**	3.88	**0**	310	**789**	**96.4**	**4.01**	**20.3**
MR-8-S	f	9/30/2003	0.15	66.97	3.2	0.3	**1250**	3.84	**0**	328	**694**	**109**	**3.21**	**23.4**
MR-8-S	f	4/19/2004	0.09	41.52	7.2	0.8	**954**	3.88	**0**	182	**522**	**75.9**	**2.30**	**12.5**
MR-8-S	f	4/27/2004	0.02	10.86	2.8	0.3	**988**	3.59	**0**	211	**535**	**72.5**	**2.11**	**12.2**
MR-8-S	f	6/14/2004	0.03	14.05	nr	nr	**943**	4.04	**0**	184	**515**	**69**	**2.32**	**11.1**
MR-8-S	f	8/9/2004	0.02	10.86	1.3	0.2	**856**	3.55	**0**	3.55	**512**	**74.6**	**2.08**	**10.7**

Remediation Recommendations for Marietta Run:

The site needs alkalinity, oxidation, and settlement time. To get adequate treatment space, it should be possible to redirect the AMD upstream along the haul road by adjusting the grade. This will

bring the AMD to a flood plain/bar along Marietta Run whose surface is only about 2 feet above the water table. Much like MR-10 the flats along the creek will be regularly swept by flooding so surface structures should be kept to a minimum.

The site will need an oxidizing wetland. For a nominal flow of 60 gpm and an incoming iron concentration of 75mg/L, a wetland of 2.8 acres would be required. There are two options for acquiring alkalinity on this site: Option 1 would construct a slag leach bed in the flood plain into which about 5 gpm of non- polluted water would be fed. This could either be a channel cut from Marietta Run or a collection of shallow groundwater in the flood plain.

Slag Leach Bed	-1/8 EAF slag
Variable size	
INPUT:	
Inflow	5gp
Depth	2ft
Design factor	20

DISCHARGE TO BE TREATED:

Acidity	250mg/L
Flow	50gpm
Acid load	150 lb/day
Acid load	27.5 tpy
OUTPUT:	
Infiltration rate	0.08gpm/sq.ft.
Required surface area	1319.51 sq.ft.
Side length	36.33 ft.
Resulting alkalinity	1000.00mg/L
Alkaline load generation	60.00lbs/day
Alkaline load generation	11.00tpy
Required slag	198.41 tons
Life	6.03 years

The other option for acquiring alkalinity would be to construct a J-trench arrangement, on the two sides facing the upstream and lateral sides of the flood plain surrounding the wetland on two sides. This latter option would intercept and utilize the groundwater seeping through the floodplain water table and add alkalinity prior to entering the aerobic wetland.

ODNR Cost estimate MR-8-S

Mobilization/Clearing	$9,790
Steel Slag Leach Bed	5,970
Earthwork	45,017
Revegetation	1,500
Spillway(s)	12,778
Engineering	18,264
Total	**$93,819**

Pre and Post Treatment Sampling MR-8-S

It is recommended that three samples, once per month, for six months, be analyzed of Group I parameters to fully characterize the high and low flow chemistry. These three samples should be taken both at the seep and immediately upstream and downstream of the treatment site. This six-month sampling will provide the needed pre-reclamation water quality data to determine effectiveness of the restoration.

ODNR Cambridge Lab sample analysis, $110 x 18 samples	$1980
Staff time collecting samples, (10hrs*6days) 60 hours @ 30$/hr	$1800
Travel, $0.42/mile, total miles 60 miles (10 miles per day)	$ 25.20
Total	**$3805.20**

Post-construction water quality monitoring should be conducted at least two to four times a year with biological monitoring once a year downstream of the restoration project. Post-construction monitoring should begin within 6 months of completion.

MR-10, (11.5, and 11S)

This site consists of a high wall that is likely connected with extensive underground works. There is a large pit lake between the high wall and the original haul road. Downstream of the haul road are two primary seeps (MR-11.5 and MR11-S) that exit the floodplain and travel by channels for 200 yards where they join into one channel that travels toward Marietta Run. This channel is referred to as MR-10. The MR-11.5 is net alkaline (100mg/L alkalinity) and has the highest flow: 0-200 gpm. MR-11-S has a flow around 10 gpm, is net neutral with about 38 mg/L ferrous iron. Marietta Run's water quality is good in this area but the stream bottom is stained by metal flocculent downstream of this site. The objective is to prevent metal precipitation in Marietta Run.

Location: MR-10 is at 0 river miles, at 39.39029303 latitude -81.88742314 longitude, and is at an elevation of 644 feet. This tributary enters Marietta Run at 1.81 river miles. The area of land above this point is 0.85 square miles and the length of the stream above this point is 5.46 miles.

MR11-S is a seep that enters Marietta Run at 1.81 river miles, at 39.39075328 latitude -81.88763369 longitude, and is at an elevation of 619 feet. This seep is associated with mine # As133.

Access: MR-10 is a tributary on the northwest side of Marietta Run. It is located at RM 1.81. AMD water enters Marietta Run from a diffuse group of inputs that are on Jim Milligan's property. This site could be reached by a vehicle, with permission of the landowner (Mike Milligan). Mr. Milligan's email contact is mike@jmmarch.com. The site is accessible by foot, either by walking down a gated haul road, or by parking on Marietta Run, coming down the hill, and crossing the creek.

Water Chemistry in treatment area

MR-10 was sampled at the mouth to determine the input of MR11-S into Marietta Run. The metal, sulfate, and acid concentrations are greatly reduced at the mouth of MR-10 compared to MR11-S.

MR-10 has an average net alkalinity of 129.0 mg/L, an average pH of 7.5, an average conductivity of 470.5 uS, and an average sulfate concentration of 87.5 mg/L. Total metal concentrations are 2.7 mg/L (1.25 mg/L Fe, 0.578 mg/L Mn, and 0.906 mg/L Al) at high flow and 4.9 mg/L (2.24 mg/L Fe, 2.68 mg/L Mn) at low flow. The chart below displays the sulfate and metal loading of MR-10.

Table 22. MR-10 Metal and Sulfate Loadings

MR-10	High Flow	Low Flow	Average
Metal Load (lbs/day)	22.8	5.3	14.1
% Metals Contribution	24	4	14
Sulfate Load (lbs/day)	508.9	122.5	315.7
% Sulfate Contribution	34	14	24

Table 23. Water chemistry for Marietta Run Sites

Site number	Filtered	DATE	FLOW cfs	FLOW gpm	COND-LAB	PH-LAB	ALK mg/L	ACIDITY-LAB mg/L	SULFATE mg/L	FE mg/L	MN mg/L	AL mg/L
MR-10	nf	5/13/2003	1.55	696.37	351	7.59	112	4.79	60.9	**1.3**	**0.58**	0.91
MR11-S	f	5/13/2003	0.02	9.34	**1260**	5.94	41.6	110	**625**	**32.5**	**7.10**	0.66
MR-10	nf	9/30/2003	0.20	89.52	590	7.34	160	9.15	114	**2.2**	**2.68**	<0.25
MR11-S	f	9/30/2003	0.01	2.25	**1060**	6.13	58.6	72.3	**464**	**39.7**	**5.88**	<0.25
MR-10	nf	4/19/2004	1.17	526.90	352	7.34	122	3.48	49.8	0.5	**0.49**	<0.25
MR-11.5	nf	4/19/2004	624.58	624.58	347	7.54	121	2.86	42	0.4	**0.49**	<0.25
MR11-S	f	4/19/2004	0.01	2.24	**943**	5.78	47	64.9	**218**	**24.4**	**3.91**	<0.25
MR-10	nf	6/14/2004	2.22	997.41	446	7.55	146	5.49	77.4	**1.1**	**1.25**	<0.25
MR-11.5	nf	6/14/2004	0.23	102.33	457	7.49	147	5.04	77.8	**0.9**	**1.13**	<0.25
MR11-S	f	6/14/2004	0.00	0.02	**930**	6.11	50.9	79.9	**433**	**31.6**	**3.03**	<0.25
MR-10	nf	8/9/2004	0.00	0.02	569	7.02	177	7.02	140	0.9	**1.98**	<0.25
MR-11.5	nf	8/9/2004	0.01	5.07	568	7.26	175	7.26	140	**1.1**	**1.88**	<0.25
MR11-S	f	8/9/2004	0.00	0.56	**783**	5.71	57.7	5.71	**361**	**31.3**	**2.69**	<0.25

From available water quality data, MR-10 appears to be the second largest AMD contributor to Marietta Run. (MR-8-S is the largest). The contributions of MR-10 appear to be more significant at high flow periods. The source of AMD in MR-10 appears to be MR11-S. However, the stream channel and surrounding area is quite disturbed from unreclaimed strip mining.

Remediation Recommendations for MR-11-S and MR-11.5:

Water treatment needs include oxidation of ferrous iron and settlement of the resulting ferric hydroxide flocculants. There is no need for additional alkalinity. Therefore, an oxidizing wetland is recommended. Given a nominal flow of 100 gpm and 38mg/L of ferrous iron, a 2.4 acre wetland is recommended. Since the ground is near saturation, it might be best to consider constructing a road/berm around the perimeter and tie it into the road embankment on the upstream side rather than trying to

excavate the entire area. Maximum depth of the pond should not exceed three feet. The embankments should be designed to withstand periodic flooding and occasional cleanout of flood debris will probably be needed.

ODNR cost estimate for site MR 11

MR 11S

Mobilization/Clearing	$1281
Revegetation	1500
Spillway	660
Earthwork	6,379
Engineering	2,455
Total	**12, 275**

MR-11.5

Mobilization/Clearing	$2,893
Revegetation	1,500
Earthwork	11,410
Spillway	6,379
Engineering	5,545
Total	**$27,727**

Pre and Post Treatment Sampling MR-11S

It is recommended that six samples, once per month, be analyzed of Group I parameters to fully characterize the high and low flow chemistry. Samples should be taken at MR 11s and MR-11.5, downstream of the treatment site, and both upstream and downstream of MR-10 on Marietta Run. This six-month sampling will provide the needed pre-reclamation water quality data to determine effectiveness of the restoration. If this project were done at the same time as MR-8-S then one of the samples would be eliminated.

ODNR Cambridge Lab sample analysis, $110 x 24 samples	$2640
Staff time collecting samples, 48 hours @ 30$/hr	$1440
Travel, $0.42/mile, total miles 50 miles	$ 21

Post-construction water quality monitoring should be conducted at least two to four times a year with biological monitoring once per year downstream of the restoration project. Multiple sites downstream should be established to monitor water quality and biological improvements over a given distance from the treatment site. Post-construction monitoring should begin within 6 months of wetland completion.

AMD Impact to Marietta Run

Biology

Table 24. Biology Data for Marietta Run - 2004

Marietta Run									
Station (Map #)	Fish RM	Macro RM	IBI	MIwb	ICI or Narrative Rating	QHEI	Aquatic Life Uses Ex/Rec	Attain-ment Status	Comment
S01150 3.202004	3.20	3.50	50	NA	E	77.0	WWH	**Full**	dst. Brill Run
S01150 1.002004	1.60	1.00	44	NA	MG^{ns}	75.5	WWH	**Full**	B Below the 2 Seeps
S01150 0.102004	0.10	0.10	40^{ns}	NA	VG	62.5	WWH	**Full**	St. Rt. 329, at mouth

Ecoregion Biocriteria: Western Allegheny Plateau (WAP)				
Index and Site Type	**WWH**	**EWH**	**MWH**	**LRW-AMD**
IBI – Wading & Headwater	**44**	**50**	**24/24**	**18**
Mod. Iwb - Wading	**8.4**	**9.4**	**6.2/5.5**	**4.0**
ICI/Narrative	**36/G**	**46/E**	**22/30**	**8/MF**

Footnotes

a - A qualitative narrative evaluation based on best professional judgment and sampling attributes such as community composition, EPT taxa richness, and QCTV scores were used when quantitative data were not available (E-exceptional, G-good, MG-marginally good, F-fair, P-poor, VP-very poor); for Moxahala Creek a draft Qualitative ICI index was also used.

b - Attainment status is given for existing use designations, except where a use designation change is recommended, in which case, the attainment status for the recommended use is given.

c - Limited Resource Water - acid mine drainage (LRW-AMD) benchmarks based on best professional judgment driven by the need to protect against acutely toxic stream conditions. Macroinvertebrate qualitative only data were evaluated based on densities of EPT taxa on the natural substrates (see Methods Section), a narrative VP* or P* indicates departure from the benchmark.

na - MIwb not applicable at headwater sites (< 20 mi^2).

† - HD sampler set, but not retrieved due to flood flows destroying samplers.

‡ - Dry conditions in August followed by flooding conditions in September likely influenced assemblage conditions (data excluded from attainment decision)

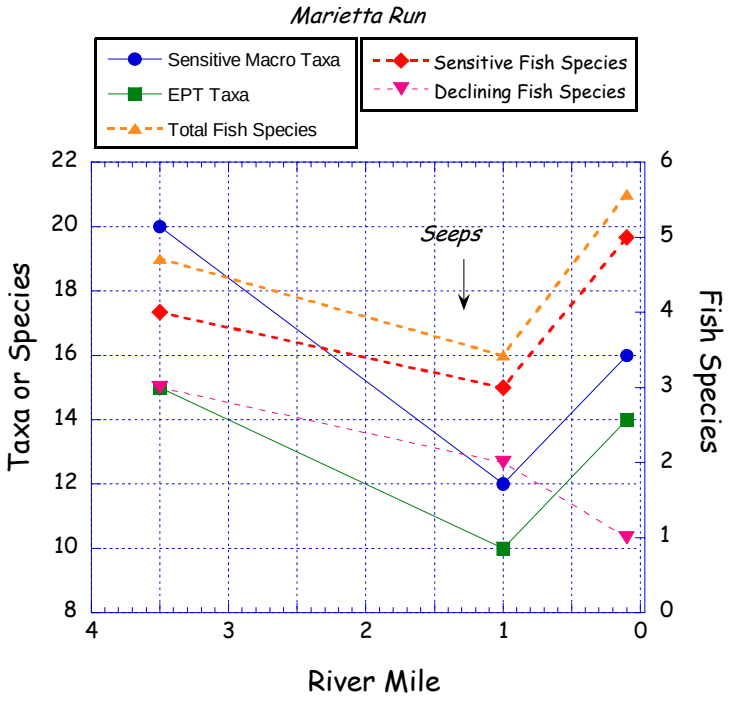
ns - Nonsignificant departure from biocriteria (<4 IBI or ICI units, or <0.5 MIwb units).

* - Indicates significant departure from applicable biocriteria (>4 IBI or ICI units, or >0.5 MIwb units). Underlined scores are in the Poor or Very Poor range.

Marietta Run has some mining related seeps that discharge into it, however impacts seemed relatively minimal. All sites met the WWH aquatic life use. The macroinvertebrate assemblages did decline below the seeps, but still attained the WWH biocriteria. In the fish assemblage, Redside Dace (*Clinostomus elongates*) were not found downstream of the seep although they were abundant at the upstream site. Redside Dace are considered an "intolerant" fish and indicators of high quality, small streams. Their absence could be related to episodic water quality impacts. This same upstream to

downstream pattern was mirrored in changes in total, declining, and sensitive fish species richness (Figure 5). Habitat quality was excellent at the two most upstream sites, but only rated good near the mouth. Macroinvertebrate assemblages showed a similar pattern to the fish. Sensitive macroinvertebrates and EPT taxa declined below the seeps (Figure 8), but these sources were not severe enough to result in a change to non-attainment in the overall index scores.

Figure 8. Biological sensitivity indicators vs. river mile for Marietta Run



2004 Sediment Study

Metal concentrations (mg/kg) in sediments were collected from Federal Creek tributaries in 2004. Values proceeded by a (<) were below the reporting limit. Those preceded by (*) exceeded the threshold effect concentration (TEC) described by MacDonald, et.al. (2000). Values preceded by (#) exceeded Ohio-specific Sediment Reference Values (SRV's).

Table 25 Marietta Run values from OEPA sediments study 2004 TMDL

EPA sediments study 2004 TMDL

Marietta Run @ RM 1.5 @ Marietta Run Rd.

Al	Ba	Ca	Cr	Cu	Fe	Pb	Mg	Mn
29,600	228	3740	31	13.6	27,200	<23	4190	1040
Ni	K	Na	Sr	Zn	Hg	As	Cd	Se
<23	6210	<2830	62	66.8	0.047	***14.1**	0.137	1.16

for standards see section on sediment study at the beginning of the document.

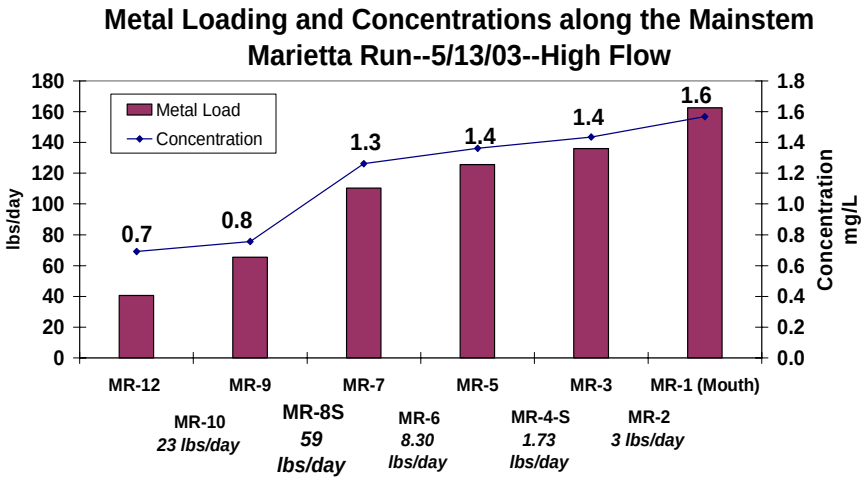
Mainstem of Marietta Run

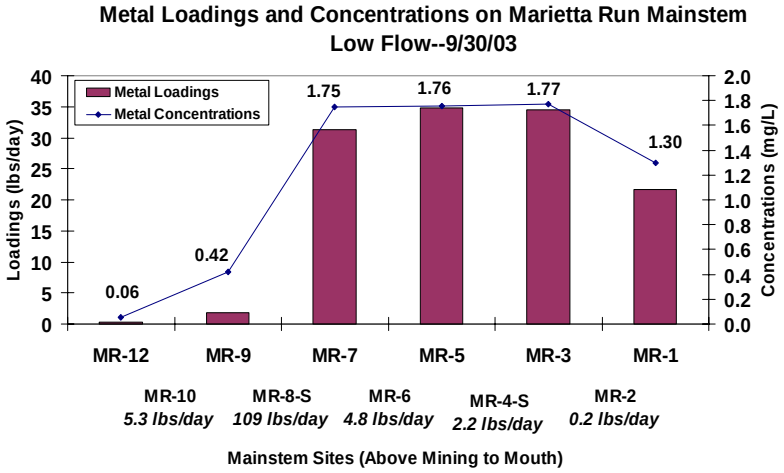
As demonstrated in the figure below, the additive effect of each AMD input is reflected in the metal concentrations of the mainstem sampling points, which begin at MR-12, an area above the mining,

and end at MR-1, the mouth of Marietta Run. The impact of MR-8-S appears the most severe, and is evident on both the 5/13/03 and 9/30/03 sampling dates. According to water chemistry data collected on 5/13/03, MR-8-S contributed 59 lbs/day of metals to Marietta Run. MR-8-S enters between sites MR-9 and MR-7, with MR-7 being the downstream location. The metal load increases from 65 lbs/day at the MR-9 location to 110 lbs/day at the MR-7 location. Metal concentrations increase from 0.8 mg/L to 1.3 mg/L. During low flow, the impact of MR-8-S is even more severe, with the metal load increasing from 1.9 lbs/day at MR-9 to 31.3 lbs/day at MR-7, and the concentration increasing from 0.4 mg/L to 1.7 mg/L.

During high flow, the increase between MR-3 and MR-1 is unexplained by the small loading of tributary MR-2. The metal load increases from 135.9 lbs/day to 162.5 lbs/day at the mouth. The concentration increases from 1.43 to 1.56 mg/L. There may be significant missing inputs in this section, as much of this area has been strip-mined. However, during low flow, this section shows the opposite trend of decreasing metal loads and concentrations between MR-3 and MR-1. (The discharge was measured to be lower at the mouth, but concentration was also reduced.)

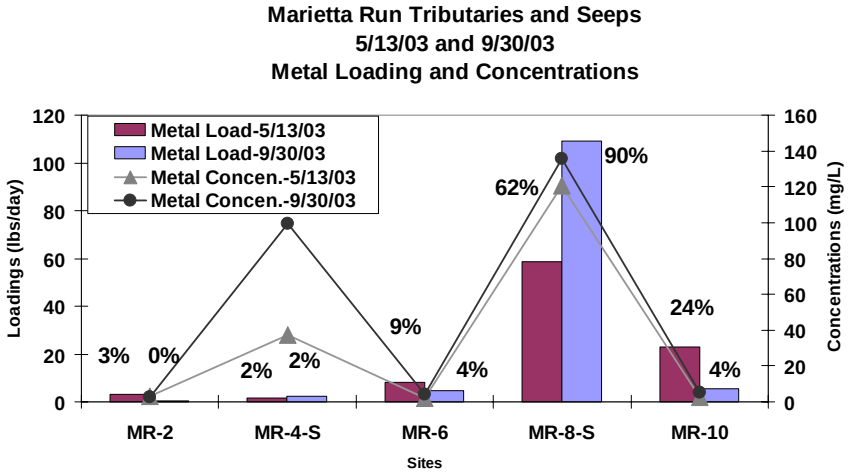
Figure 9. Marietta Run Loading and Concentrations along Mainstem





The relative percentages of metal loadings are presented in the figure below. MR-8-S is by far the most significant source of AMD pollution in Marietta Run, contributing an average of 76 percent of the metal loading to Marietta Run. MR-10 is the second most significant contributor, contributing an average of 14 percent of the metal loadings to Marietta Run. MR-6, a tributary, is ranked third, with an average of 6.5 percent of the metal loadings to Marietta Run. The source(s) of AMD contributing to MR-6 have not yet been identified. MR-4-S, an underground seep, plays a small part in the metal loadings to Marietta Run, contributing an average of 2 percent of the metal loadings. MR-2, a tributary fed by a series of strip pits, as well as unknown sources likely due to strip mining, appears to be the smallest contributor to the metal loadings of Marietta Run. The strip pits feeding MR-2 are net alkaline, with a neutral pH.

Figure 10 Metal Loadings and Concentrations for Marietta Run Tributaries.



Percentages indicated in figure relative to loading of tributaries.

Investigation of Marietta Run

A phase I water quality investigation was conducted in the Marietta Run subwatershed on 3/10/03, 3/14/03, and 4/30/03. Preliminary field observations identified strip pits and multiple gob piles from surface mining in Marietta Run. These strip pits did not show poor water quality. Three acid mine discharges from underground mines into the mainstem of Marietta Run were identified.

A phase II water quality investigation was conducted in Marietta Run on 5/13/03 and 9/30/03; three tributaries, three seeps, and five mainstem sites were sampled. Site MR-4-S (seep) is associated with mine number As152. Sites MR-8-S (seep) and MR11-S (seep) are associated with mine number As133. Numerous sources of acid mine drainage were found. Three AMD affected tributaries and three seeps were documented, as well as numerous gob piles and strip-mined areas, and diffuse, trickling seeps along the mainstem. The information relating to the loadings are presented above.

A phase III water quality investigation was conducted on 4/19/2004, 6/14/2004, and 8/9/2005. The sites were on the mainstem of Marietta Run below and above both MR-8-S and MR-10. Additionally samples were taken at both seeps.

Individual Site Descriptions

Listed below is a detailed description for the six AMD contributors in Marietta Run.

MR-6—Tributary MR-6 is at 0 river miles, at 39.38204801 latitude -81.88747091 longitude, and is at an elevation of 686 feet. This is a tributary that enters Marietta Run at 1.13 river miles. The area of land above this point is 0.56 square miles and the length of the stream above this point is 1.3 miles.

Location/Access: MR-6 is a small tributary that enters on the northwest side of Marietta Run. It is located on private property. This site is accessible by foot.

Site Description: MR-6 is a small tributary which may be impacted by AMD. The tributary has an average net alkalinity of 115.4 mg/L, an average pH of 7.65, an average conductivity of 500.5 uS, and an average sulfate concentration of 117.5 mg/L. It contributes an average of 21 percent of the sulfate load, and an average of 6.5 percent of the metal load into Marietta Run. The total metal concentration appeared high at both high and low flow, having values of 2.18 mg/L and 4.35 mg/L respectively. However, these samples were unfiltered. The TSS was 12.0 mg/L at high flow, and 16.0 mg/L at low flow

MR-4-S Seep: is a seep that enters Marietta Run at 0.8 river miles, at 39.37749613 latitude -81.88282952 longitude, and is at an elevation of 503 feet. This seep is associated with mine # As 152.

Access: MR-4-S located on the west side of Marietta Run, approximately 1 mile from the mouth. It is located approximately 20 feet from Marietta Run Rd., just below the first bridge crossing of Marietta Run Rd. over Marietta Run. It is located approximately where an abandoned underground mine is located on the mining map, but the opening of the mine is not visible.

Site Description: MR-4-S is a very low volume seep, having a discharge of 0.009 cfs at high flow and 0.004 cfs at low flow. This seep exhibits an average net acidity of 243.5 mg/L, and average pH of 4.00, and average sulfate load of 586 mg/L, and an average conductivity of 911.5. The total metal concentration at high flow is 37.08 mg/L, having a composition of 21.8 mg/L iron (ferrous iron equals 20.2 mg/L), 1.48 mg/L Mn, and 13.8 mg/L Al. At low flow, the metal concentration nearly triples, having a total concentration of 99.26 mg/L, with a composition of 57.3 mg/L Fe (45.0 mg/L ferrous iron), 2.66 mg/L Mn, and 39.3 mg/L Al. Overall, most of the AMD parameters are greatly increased at low flow, indicating possible dilution at high flow. The acidity concentration rises from 129 mg/L at high flow to 358 mg/L at low flow, the sulfate concentration rises from 413 mg/L at high flow to 759 mg/L at low flow, and the conductivity rises from 673 mg/L at high flow to 1150 mg/L at low flow. The acid, metal, and sulfate load to Marietta Run is displayed in the chart below.

MR-4-S Metal, Net Acid, and Sulfate Loadings

MR-4-S	High Flow	Low Flow	Average
Metal Load (lbs/day)	1.73	2.17	1.95
% Metals Contribution	2%	2%	2%
Acid Load (lbs/day)	6.02	7.82	6.92
Sulfate Load (lbs/day)	19.28	16.58	17.93
% Sulfate Contribution	1%	2%	1.5%

MR-2: AMD- impacted tributary

MR2 is at 0.0 river miles, at 39.37109328 latitude -81.88067269 longitude, and is at an elevation of 505 feet. This is a tributary that enters Marietta Run at 0.3 river miles. The area of land above this point is 0.044 square miles. This small tributary is not mapped therefore the stream length above this point in not available.

Access: MR-2 is a tributary on the west side of Marietta Run. It forms a ditch, which runs along the road for approximately one-quarter mile, and then flows through a culvert under Marietta Run Rd. before entering the mainstem. MR-2 collects input from strip mine ponds and strip-mined land.

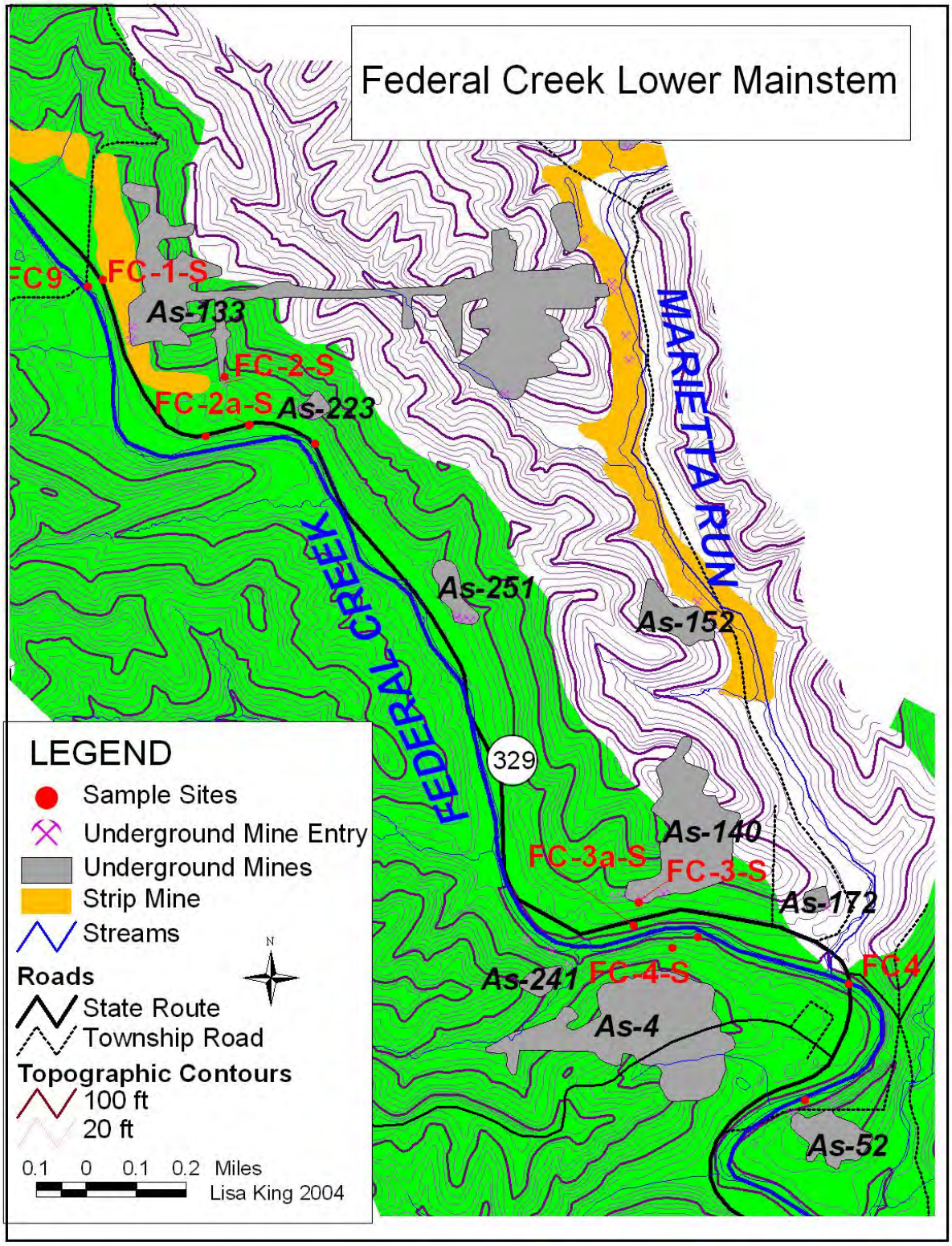
Site Description:MR-2 is a small volume input into Marietta Run, having a discharge of 0.197 cfs on 5/13/03 and a discharge of 0.015 cfs at on 9/30/03. The discharge had an average net alkaline value of 123.5 mg/L, and an average pH of 7.7. AMD is indicated in the discharge by the somewhat elevated average conductivity of 770 uS, and an average metal concentration of 2.7 mg/L (unfiltered). MR-2 does not appear to be a very significant metal or sulfate loader to Marietta Run, as shown in the table below.

MR-2 Metal and Sulfate Loadings

MR-2	High Flow	Low Flow	Average
Metal Load (lbs/day)	3.15	0.20	1.68
% Metals Contribution	3%	0%	1.5%
Sulfate Load (lbs/day)	233.0	25.9	129.5
% Sulfate Contribution	15%	3%	9%

FEDERAL CREEK LOWER MAINSTEM BASIN ASSESSMENT

Map 10 Federal Creek Lower Mainstem, in proximity to seeps



Geography Background

Lower Federal Creek occupies the southern portion of the watershed, flows in a south/southeast direction, entering the Hocking River at 15.29 river miles. It is located in Athens (61 percent), Morgan (31 percent), and Washington (8 percent) counties, crossing Homer, Rome, Ames, Bern, Marion, Wesley, Decatur, Canaan, and Dover Townships. The towns in the Federal Creek Watershed are Amesville, Kilvert, Joy, New England, Cutler, and Sharpsburg. Federal Creek can be found on the Corning, Ringold, Chesterhill, Jacksonville, Amesville, Cutler, Stewart, and Athens USGS quad sheets. Federal Creek has a drainage area of 144.73 square miles, and a stream length of 23.8 miles. In this watershed there are 2.25 square miles that have underground mines, which is 1.55 percent of the land in the entire watershed that has been mined underground. Additionally, in this watershed there are 2.09 square miles that have been strip-mined, which is 1.44 percent of the land in the entire watershed that has been strip-mined.

The stretch of Federal Creek between RM 4.8 and 8 (Tick Ridge Bridge to above Mayle Ridge Bridge) is an area affected by surface and underground mining. State Route 329 parallels the mainstem of Federal Creek during this stretch, and numerous gob piles are visible from the road. Four distinct areas within this stretch were found to contribute AMD directly into the mainstem of Federal Creek. Most of the watershed drains to this point, and this investigation was conducted to assess the impact of these small volume AMD discharges on the mainstem of Federal Creek.

Mining Impacts In Brief

The stretch of Federal Creek between river mile 4.8 and 8.0 (Tick Ridge Bridge to above Mayle Ridge Bridge) is an area affected by surface and underground mining. In this area there are four distinct mine seeps entering the Federal Creek mainstem.

The water coming into the Federal Creek mainstem from these seeps could be having an impact on the biotic integrity of Federal Creek. The entire mainstem of Federal Creek has been designated as an Exceptional Warm Water Habitat. The site immediately downstream of the ‘mainstem seeps’ is only partially attaining this score, with an ICI of 34 and a MIwb of 7.14. The next site above this site on Federal Creek, located above all of the mining impacts is fully attaining the EWH, with an ICI score of 42 and a Miwb score of 8.9. Chemistry was analyzed at this site on the same low flow day of 9/13/2005. The results of that day are included below. At times of low flow, these parameters rise, occasionally approaching or going above the targets set for this watershed. These periodic events of elevated mine drainage parameters could be the cause for this site only partially attaining its EWH use designation. Addressing the major seeps on Federal Valley could make a significant difference in Federal Creek under low flow regimes.

DATE	FLOW cfs	FLOW gpm	COND-LAB	PH-LAB	ALK mg/L	ACIDITY-LAB mg/L	SULFATE mg/L	TOT-FE mg/L	TOT-MN mg/L	TOT-AL mg/L
9/13/05	n/a	n/a	**771**	7.13	132	7.68	**236**	0.488	**1.370**	0.125

This report will discuss the water chemistry of all four seeps in this stretch. These sites are all easy to access and are very visible from State Route 329 and the mainstem of Federal Creek. Only one of the seeps (FC-2-S) will have information regarding remediation. This seep produces the highest discharge of water, and has the worst chemistry. FC-3-S has the second highest discharge and metal loadings. It is also associated with a cavernous opening that is dangerous to the public. FC-4-S does not have as much discharge and the metal loadings rank third of these three seeps. FC-4-S has a high visual impact and it is probably the best-known acid mine drainage discharge in the watershed.

Table 26. Federal Creek Mainstem Underground Mine Information

Mine number	Mine Name	Date Abandoned	Type	Coal elevation
AS-4	Broadwell Federal Coal Co.	1910		Coal Seam is 5'-8' in thickness
AS-52	Big Four Big Four Coal Co.	1916	Coal, Drift	
AS-133	Utley Jennings Coal	1922	Coal, Drift	
AS-140	Mae Rudy of Federal Valley J.F. Schuler & Son	1915	Coal, Drift	
AS-172	Broadwell (AS 522) Young & Hixon	1952	Coal, Drift	
AS-223	Harkins & White	1931	Coal, Drift	619.1'
AS-241	Smith Pioneer Coal Co.	1933	Coal, Drift	671.64
AS-251	#8 Van Dyke (As-509) Harry Van Dyke	1946	Coal, Drift	

Remediation and Description of Proposed Treatment Area

FC-2-S is a seep that enters Federal Creek at 6.9 river miles, at 39.38345826 latitude -81.90131103 longitude, and is at an elevation of 763 feet. This seep is associated with mine # As133. This mine drainage originates in a small pool approximately 500 feet from State Route 329. This pool drains into a channel that cuts directly across the floodplain to a culvert under State Route 329 and into Federal Creek. The channel is a small tributary to Federal Creek. The tributary lies in a deep channel that is lined with orange (iron) precipitate. There is a sample location in this channel referred to as FC-2-Sa. A nearby water impoundment does not drain to the channel that also contains acidic water.

Table 27 Water Chemistry of FC-2-S and FC-2-Sa

site number	filtered	DATE	LOCATION	FLOW cfs	FLOW gpm	COND-LAB	PH-LAB	ALK mg/L	ACIDITY-LAB mg/L	SULFATE mg/L	FE mg/L	MN mg/L	AL mg/L
FC-2-S	f	4/20/2004	actual seep	0.01	3.79	3610	2.4	0	1523	2453	291	7.35	123.0
FC-2-S	f	6/15/2004	actual seep	0.01	4.40	4140	2.5	0	1181	2889	395	8.14	157.0
FC-2-S	f	8/10/2004	actual seep	0.01	4.40	3860	2.3	0	1941	3005	414	8.03	174.0
FC-2Sa	nf	7/8/2003	Tributary	0.01	4.58	1820	3.0	0	290	881	27.4	3.09	24.8
FC-2Sa	nf	10/20/2003	Tributary	0.01	5.06	1970	2.9	0	423	1136	44.5	3.59	37.5

The table below shows metal and sulfate loadings into Federal Creek from data collected at the channel near the confluence with Federal Creek.

Table 28 Metal and Sulfate Loads FC-2-Sa

	medium flow	low flow	Average Lbs/day
METAL LOAD lbs/day combined Fe, Mn, Al	5.20	3.04	4.12
SULFATE LOAD lbs/day	68.98	48.42	58.70

Remediation Recommendations for FC-2-S

Cost Estimate

Mobilization/ Clearing	10,798
Limestone Leach Bed	12,031
Open Limestone Channel	2,813
Wetland	52,278
Grass Ditch	4,869
Engineering	20,697
Total	**$103,486**

Pre and Post Treatment Sampling FC-2-S

It is recommended that three samples, once per month, for six months, be analyzed of Group I parameters to fully characterize the high and low flow chemistry. These 18 samples should be taken immediately downstream of the treatment site and at both up stream and downstream sites on Federal Creek. This six-month sampling will provide the needed pre-reclamation water quality data to determine effectiveness of the restoration.

ODNR Cambridge Lab sample analysis, $110 x 18 samples	$1980
Staff time collecting samples, 48 hours @ 30$/hr	$1440
Travel, $0.42/mile, total miles 50 miles	$ 21

Post-construction water quality monitoring should be conducted twice a year, and biological monitoring once, downstream of the restoration project. Post-construction monitoring should begin within 6 months of completion.

AMD Impacts to Federal Creek

Biology Investigation for Lower Federal Creek

This table represents the 2004 data for the lower section of Federal Creek. Information on the entire watershed is provided in Section I. The first two lines in the table are sites that are above all the mine seeps located on Federal Creek. The third line represents the site located immediately downstream of the mainstem seeps. Although both locations are achieving Exceptional Warmwater Habitat, the site below the mine seeps is only partially attaining this use designation. This is because of the very low score in macroinvertbrates. This lowering of attainment could be related to periodic mine- related impacts to Federal Creek.

Table 29 Biology Data for Federal Creek Mainstem in Area of Seeps

sampled by MBI in the Hocking River watershed during 2004.

Station (Map #)	Fish RM	Macro RM	IBI	MIwb	ICI or Narrative Rating	QHEI	Aquatic Life Uses Ex/Rec	Attain-ment Status	Comment
S01100 9.102004	9.10	—	47[ns]	8.90 [ns]	VG[ns]	56.0	EWH	**Full**	immediately dst Sharps Fk
S01100 7.502004	—	7.50	—	—	42*‡	—	EWH	—	dst. Sharps Fork
S01100 4.902004	4.90	4.90	48[ns]	7.14*	34*‡	62.0	EWH	**Partial**	adj. St. Rt. 329 dst. Broadwell

Ecoregion Biocriteria: Western Allegheny Plateau (WAP)

Index and Site Type	WWH	EWH	MWH	LRW-AMD
IBI – Wading & Headwater	**44**	**50**	**24/24**	**18**
Mod. Iwb - Wading	**8.4**	**9.4**	**6.2/5,5**	**4.0**
ICI/Narrative	**36/G**	**46/E**	**22/30**	**8/MF**

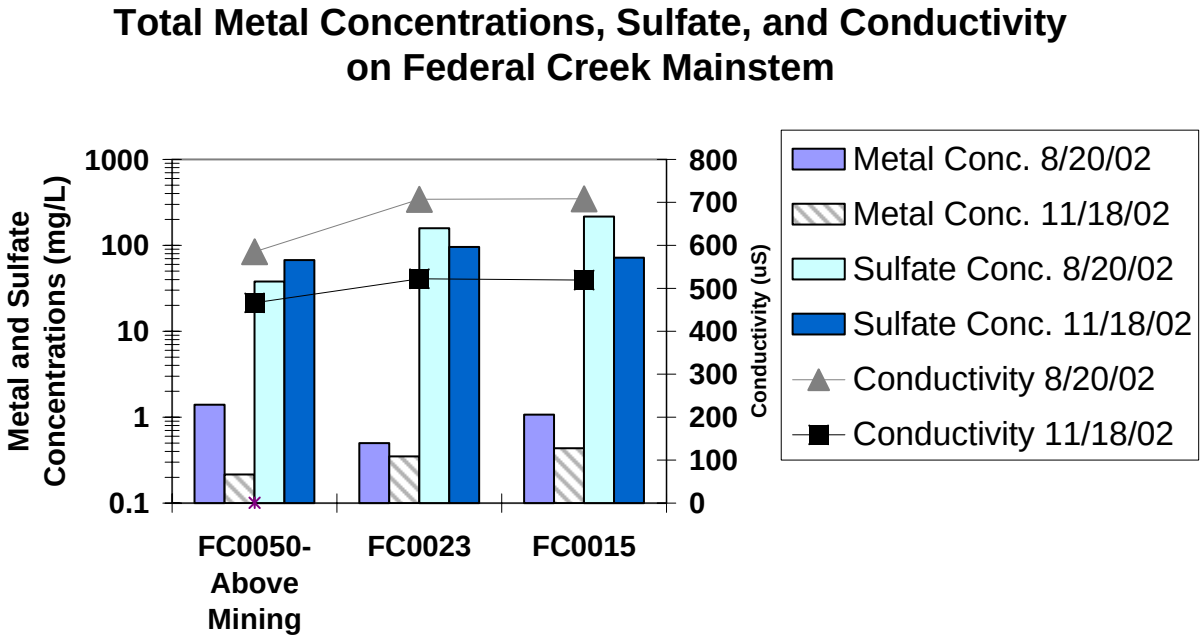
Footnotes

a - A qualitative narrative evaluation based on best professional judgment and sampling attributes such as community composition, EPT taxa richness, and QCTV scores were used when quantitative data were not available (E-exceptional, G-good, MG-marginally good, F-fair, P-poor, VP-very poor); for Moxahala Creek a draft Qualitative ICI index was also used.
b - Attainment status is given for existing use designations, except where a use designation change is recommended, in which case, the attainment status for the recommended use is given.
c - Limited Resource Water - acid mine drainage (LRW-AMD) benchmarks based on best professional judgment driven by the need to protect against acutely toxic stream conditions. Macroinvertebrate qualitative only data were evaluated based on densities of EPT taxa on the natural substrates (see Methods Section), a narrative VP* or P* indicates departure from the benchmark.
na - MIwb not applicable at headwater sites (< 20 mi^2).
† - HD sampler set, but not retrieved due to flood flows destroying samplers.
‡ - Dry conditions in August followed by flooding conditions in September likely influenced assemblage conditions (data excluded from attainment decision)
ns - Nonsignificant departure from biocriteria (<4 IBI or ICI units, or <0.5 MIwb units).
* - Indicates significant departure from applicable biocriteria (>4 IBI or ICI units, or >0.5 MIwb units). Underlined scores are in the Poor or Very Poor range.

Water Chemistry on the Mainstem of Federal Creek

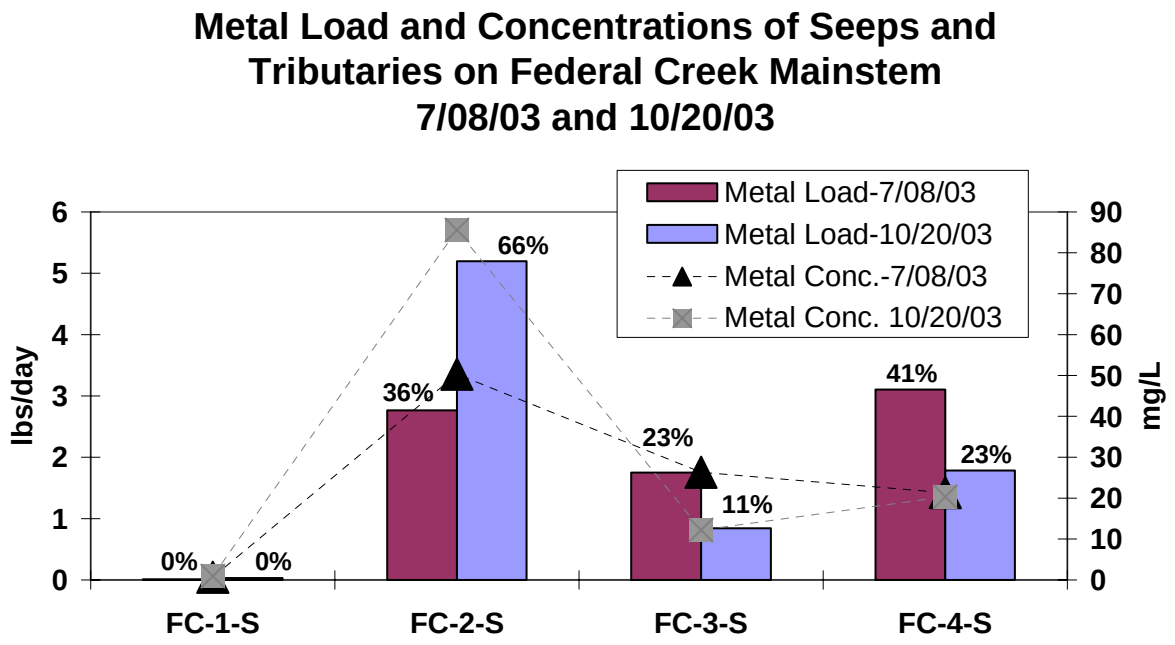
The section of Federal Creek receiving direct AMD input from mining sources is characterized by a deep channel with steep banks. In this section, Federal Creek contains a large volume of water, as its drainage area is large and it is approaching the mouth. The AMD inputs into Federal Creek have comparatively very low volume. The graph below displays the conductivity levels and sulfate and total metal concentrations taken at three points along Federal Creek in 2002. FC0050, the first set of bars on the graph, is above the majority of mining in Federal Creek. FC0023 is a point below FC-2-S. FC0015 is a point below all four AMD seeps along the mainstem, as well as the large tributary, Marietta Run. Water chemistry exhibits only a small increase in metal concentrations, conductivity, and sulfate concentrations. Sulfate concentrations are highest on 8/20/02, when discharge was lowest. Concentrations rise from the pre-mining levels of 37.9 mg/L to 158 mg/L at FC0023, and then rise further to 216 mg/L at FC0015. On this same date, metal concentrations are highest above the mining area. Conductivity values rise from 585 uS at FC0050 to 707 uS at FC0023 to 708 uS at FC0015.

Figure 11. Metal Concentrations for Mainstem Seeps



The following graph shows the total metal loading and total metal concentrations at a low (7/08/03) and high (10/20/03) flow sampling date. FC-2-S and FC-4-S are the largest contributors of the four tributaries/seeps sampled.

Figure 12. Metal Concentrations for Mainstem Seeps



Investigation of Federal Creek

Phase I

A phase I water quality investigation was conducted on the stretch of Federal Creek between river mile four and eight (Tick Ridge Bridge to above Mayle Ridge Bridge) in April 2003 and again in April 2004. Eight underground mines were investigated. Only four of these were found to contribute mine drainage directly into the mainstem of Federal Creek. Preliminary field observations also identified impoundments of water resulting from strip mining and multiple gob piles.

Phase II

A phase II water quality investigation was conducted in this section of the lower mainstem of Federal Creek on 7/8/2003 and 10/20/2003. This information was used for the characterizations above. Four of the mainstem mine drainage seeps were sampled above their confluence with Federal Creek. These sites are referred to as FC-1-S, associated with strip mining and possibly associated with underground mine AS 133; FC-2-Sa, associated with underground mine AS133; FC-3-Sa, associated with underground mine AS140; and FC-4-S associated with underground mine AS4. Further, samples were taken from the Federal Creek mainstem (FC-4 immediately downstream of all mine drainage; FC-9 immediately above all mine drainage).

Phase III

A phase III water quality investigation was conducted in this area on 4/20/2005, 6/15/2005, and 8/10/2005. For this phase, filtered samples were taken at FC-2-S and FC-3-S. The locations of these

samples were moved to locations where the mine drainage is coming out of the ground. Additionally, filtered samples were taken from FC4S and an unfiltered sample was taken from FC-3-S. Further, samples were taken from the Federal Creek mainstem (FC-4 immediately downstream of all mine drainage; FC-9 immediately above all mine drainage).

Individual Site Descriptions

FC-1-S:

Location/Access: FC-1-S is located approximately 50-100 feet downstream of Tick Ridge Rd. FC-1-S is a seep that enters Federal Creek at 7.5 river miles, at 39.38757587 latitude -81.90705414 longitude, and is at an elevation of 623 feet. This seep is associated with mine # As133. It is accessible by vehicle and can be easily seen from the bridge at Tick Ridge.

S**ite Description:** FC-1-S is a small tributary draining land that has been surface mined. Additionally, abandoned mine openings are indicated by the mining quadrangle. The mined land lies to the northeast of State Route 329. FC-1-S passes through a culvert under State Route 329 approximately 50 feet before it enters Federal Creek. The source of AMD to this tributary is from an area that has been strip-mined. It is not possible to determine if the mine drainage is from dispersed strip-mine sources or if it is from a mine entry to mine AS133 that has been destroyed in the strip-mining.

FC-1-S is a small volume, net alkaline tributary. Under higher flow conditions, on the 7/08/03 sampling date, the discharge of FC-1-S was 0.003 cfs. On the lower flow condition sampling date, 10/20/03, discharge of FC-1-S was measured at 0.006 cfs, which is twice the discharge on 7/08/03. For the 7/08/03 sampling date, FC-1-S had a conductivity of 1260 uS, a pH of 6.93, a net alkalinity of 130 mg/L, and a sulfate concentration of 502 mg/L. Total metal concentrations were 0.658 mg/L. On the 10/20/03 sampling date, FC-1-S had a conductivity of 1290 uS, a pH of 6.75, a net alkalinity of 148 mg/L, and a sulfate concentration of 557 mg/L. Total metal concentrations were 0.924 mg/L.

Of the four tributaries sampled, FC-1-S contributed an average of 0 percent of the metal loadings and 9 percent of the sulfate loadings.

FC-2-S

FC-2-S is a seep that enters Federal Creek at 6.9 river miles, at 39.38345826 latitude -81.90131103 longitude, and is at an elevation of 763 feet. This seep is associated with mine # As133. This mine drainage originates in a small pool approximately 500 feet from State Route 329. This pool drains into a channel that cuts directly across the floodplain to a culvert under State Route 329 and into Federal Creek. The channel is a small tributary to Federal Creek. The tributary lies in a deep channel that is lined with orange iron precipitate. There is a sample location in this channel referred to as FC-2-Sa. There is a nearby water impoundment that does not drain to the channel that also contains acidic water.

Access: FC-2-S enters Federal Creek at approximately 5.55 RM (about 0.5 mile below Tick Ridge Bridge). The channel passes through a culvert under State Route 329 approximately 50 feet before its confluence with Federal Creek. The sampling location is accessible by vehicle. The actual seep is approximately 500 feet from the road. The seep can be found by following the two-foot wide channel filled with orange water.

FC-3-S:

Location/Access: FC-3-Sa is a tributary that enters Federal Creek at 5.5 river miles, at 39.36873000 latitude -81.88738000 longitude, and is at an elevation of 700 feet. FC-3-S is located at the mine entry, 39.368381 latitude and _81.88749338 longitude. This water is associated with mine # As140. FC-3-Sa is the drainage of an underground mine As 140 that crosses a coal refuse pile located on S.R. 329 north of Phillipsburg. The drainage passes through a culvert under State Route 329 approximately 100 feet from its confluence with Federal Creek. The gob pile is just above the community of Phillipsburg. The site is accessible by vehicle.

FC-3-S is a low volume, net acidic input into Federal Creek. Discharge was measured at 0.012 cfs on both 7/08/03 and 10/20/03. On 7/08/03, the pH was 3.7, the net acid concentration was 120 mg/L, conductivity was 885 uS, and the sulfate concentration was 885 mg/L. Metal concentrations were 11.3 mg/L Fe, 1.22 mg/L Mn, and 13.8 mg/L Al. On 10/20/03, the pH was 4.7, the net acid concentration was 42 mg/L, the conductivity was 653 uS, and the sulfate concentration was 275 mg/L. Metal concentrations were 7.4 mg/L Fe, 0.41 mg/L Mn, and 4.37 mg/L Al. The metal load was 1.75 lbs/day on 7/08/03, and 0.84 lbs/day on 10/20/03, giving an average of 1.30 lbs/day, OR-17 percent of the average metal load of the four tributaries sampled along the mainstem. The sulfate load was 58.8 lbs/day on 7/08/03 and 19.0 lbs/day on 10/20/03, giving on average of 38.9 lbs/day, or 23.5 percent of the average total sulfate load of the four tributaries. The acid load was 8.0 lbs/day on 7/08/03 and 2.9 lbs/day on 10/20/03.

FC-4-S: Underground Mine Seep

Location/Access: FC-4-S is a seep that enters Federal Creek at 5.4 river miles, at 39.36809273 latitude -81.88596301 longitude, and is at an elevation of 678 feet. This seep is associated with mine # As 4. FC-4-S is located on private property owned by Don Schierholt. This site is approximately 200 feet downstream from the confluence of FC-3-Sa. The site is accessible by foot. A four wheel drive road exists on the property that runs behind the seep site. The seep is approximately 500 feet downhill from the road.

Site Description: FC-4-S is an underground mine seep believed to be associated with mine complex As4. The mine opening is not visible, but the location of the seep is distinct. The seep is marked by a distinct area of saturated ground that continues to widen to form a triangle shaped area of saturated

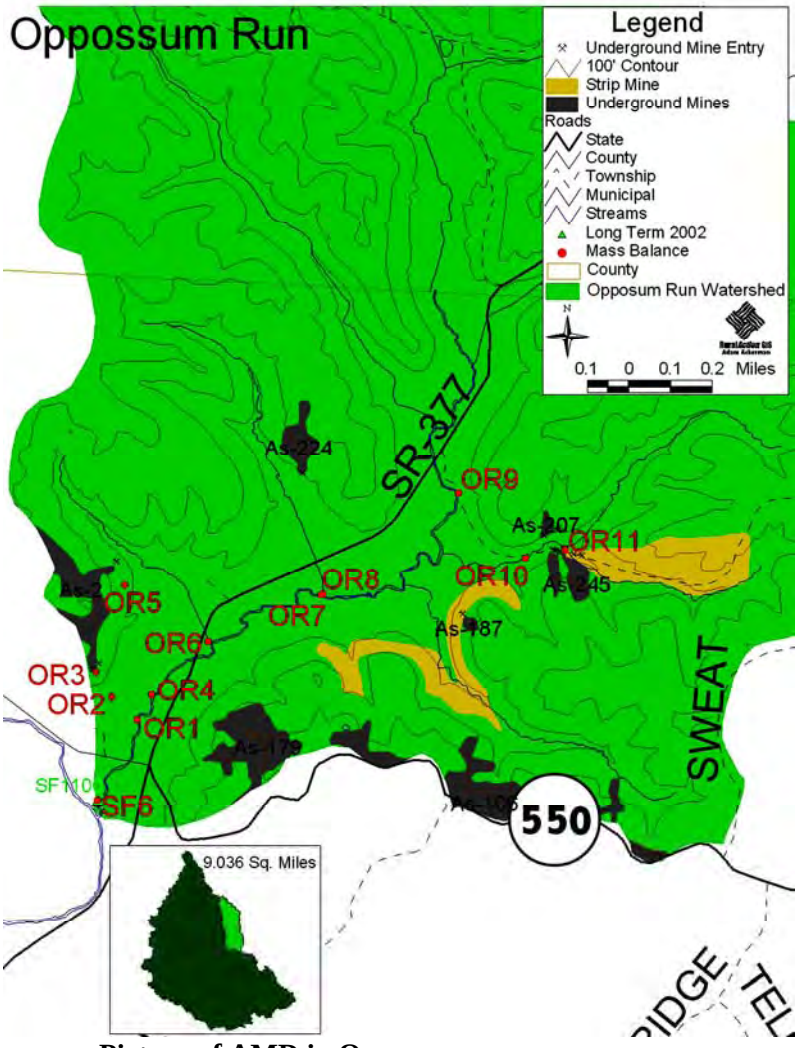
ground. This area then forms a pool of water, which then discharges across a large area, approximately a half of an acre in size.

FC-4-S is a low volume, net acidic input into Federal Creek. Discharge was measured at 0.027 cfs on 7/08/03 and 0.016 cfs on 10/20/03. Discharge at this site is difficult to measure, and the figures obtained more accurately represent the volume of water discharged by the seep as opposed to the volume of water entering Federal Creek. Discharge was not taken where the seep originates, as the ground is saturated to a depth of at least three feet, making measurement by pipe and bucket or flume not feasible. Additionally, more water appears to be discharged with distance from the point of origination. This area continues to widen, and the point below which water is no longer released is approximately 25 feet wide. The water flowing over this area is very shallow with a depth of less than one inch. This area then continues to widen into a large triangle shaped area, which is encrusted with a black and orange coating. Discharge was taken at the base of this triangle, where the water forms three distinct channels (two during low flow). However, one of these channels appears to dry up before reaching Federal Creek. Additionally, when looking at this area from the Federal Creek mainstem, subsurface seepages are apparent across the length of the bank. During the 10/20/03 sampling period, discharge of the Federal Creek mainstem was measured above and below this seep. However, the contribution of the seep could not be ascertained from this data (higher cfs on mainstem upstream of seep than downstream). On the 7/08/03 sampling date, the mainstem was too deep to be measured with available methods.

On 7/08/03, the pH was 3.64, the net acid concentration was 73 mg/L, conductivity was 963 uS, and the sulfate concentration was 435 mg/L. Metal concentrations were 11.9 mg/L ferrous iron, 4.3 mg/L ferric iron, 1.85 mg/L Mn, and 3.29 mg/L Al. On 10/20/03, the pH was 5.65, the net acid concentration was 48.6 mg/L, the conductivity was 730 uS, and the sulfate concentration was 340 mg/L. Metal concentrations were 16.3 mg/L ferrous iron, 1.9 mg/L ferric iron, 1.12 mg/L Mn, and 1.02 mg/L Al. The metal load was 3.1 lbs/day on 7/08/03, and 1.8 lbs/day on 10/20/03, giving an average of 2.45 lbs/day, or 32 percent of the average metal load of the four tributaries sampled along the mainstem. The sulfate load was 63.3 lbs/day on 7/08/03 and 29.8 lbs/day on 10/20/03, giving on average of 46.6 lbs/day, or 28.5 percent of the average total sulfate load of the four tributaries. The acid load was 10.6 lbs/day on 7/08/03 and 6.3 lbs/day on 10/20/03.

OPOSSUM RUN BASIN ASSESSMENT

Map 11 Opossum Run



Picture of AMD in Opossum

Site OR11

Gob Pile on R. Spaulding's land

Geography Background

Opossum Run occupies the northeastern portion of the watershed, flows in a southern direction and enters Sharps Fork at river mile 2.83. Opossum Run is located in Morgan and Athens counties, crossing Marion and Bern townships, and the village of Sharpsburg is located at the confluence. This subwatershed can be found on Amesville and Ringgold USGS quadrangle sheets. Opossum Run has a drainage area of 9.04 square miles, and a stream length of 7.6 miles. In this subwatershed there is 0.10 square mile or1.02 percent that has underground mines. In this subwatershed there is 0.99 square mile or 9.4 percent that has been strip-mined.

The mouth of Opossum Run enters Sharps Fork in the community of Sharpsburg. The areas impacted by past mining are small and are within the first one and a half river miles. Part of the impacted area is on Gifford State Forest. Two small tributaries have the most mine drainage. The first one is on Bob Spaulding's land. Mr. Spaulding allowed the watershed group to do a phase I assessment of the area. After that time he refused the group access to his land. The second largest contributor of acid mine drainage is the next tributary to the west that enters Opossum Run at 1.5 river miles. This tributary is generally orange in color. In places, the stream has been strip-mined and there is a significant amount of braided flow.

Mining Impacts In Brief

In Opossum Run there are two discrete underground mine seeps that presently do not appear to impact the mainstem. On Gifford State Forest, two small areas have previously been mined and cause a very small tributary to appear white and orange. These areas do not appear to have much impact on the mainstem. Two tributaries to the east of the mainstem do have impact. Of the tributaries, the watershed group only has access to a site that enters Opossum Run at 1.5 river miles. This tributary is referred to as OR-10.

OR-10 is a tributary discharging into the mainstem, and water quality samples taken here represent the mining impacts of OR-11, as well as the contributions of strip mines and a possible underground mine discharge in the region. This tributary contributes a metal load (combined iron, manganese, and aluminum) of 79 to 84 metal loads to Opossum Run. The discharge from this tributary ranges from 0.1 to 1.8 cfs. During high flow, 52 percent of the metal load in this stream comes from one tributary, referred to as OR-11. OR-11 contributes 100 percent of the metal load in this tributary during periods of low flow. Opossum Run achieved an Exceptional Warmwater Habitat use designation in 2004. However, the site immediately downstream of OR-10 is only partially achieving this use designation.

Opossum Run is a tributary of Sharps Fork, an Exceptional Warmwater Habitat stream. Opossum Run contributes a combined metal load of 10 percent to 13 percent and a sulfate load of 26 percent to Sharps Fork. Although Sharps Fork is an Exceptional Warmwater Habitat stream, it is only partially attaining this use designation downstream of Opossum Run and Sulphur Run.

Table 30 Opossum Run underground mine information

Mine number	Mine Name	Date Abandoned	Type	Coal elevation
AS-2	(Schuler #3) J.F. Schuler & Sons	1915	Coal, Drift	750' to 764'
AS-179	Gilchrist (AS 522) Gilchrist Coal Co.	1957	Coal, Drift	709'
AS-187	Elliott (As 575) Robert Withem, formerly Robert Jenkins and Frank Elliott)	1960	Coal, Drift	
AS-207	Armstrong #1, #2 J.W. & B.C. Armstrong	1933	Coal, Drift	
AS-224	Harris Lyle E. Harris Coal	1931	Coal, Drift	
AS-245	Armstrong (AS-514) Vernon Seaton	1948	Coal, Drift	

Remediation and Description of Proposed Treatment Area

OR-10 is a tributary that is a net alkaline stream. The only requirement is oxidation and settlement of metals.

Location

OR-10 is at 0.12 river miles, at 39.44322249 latitude -81.89470131 longitude, and is at an elevation of 747 feet. This is a tributary that enters Opossum Run at 1.15 river miles. The area of land above this point is 0.5 square mile and the length of the stream above this point is 0.85 miles

Access

The sample site for OR-10 lies along a tributary to Opossum Run. This tributary runs along a non-maintained township road that is accessible for State Route 377 approximately 1.5 miles north from Sharpsburg, and it is accessible by vehicle. The first 0.1 river mile of this stream is located on Bob Spaulding's land, who is not willing to allow Federal Valley staff onto his land. The part of the tributary that has abandoned mine impacts is east of Mr. Spaulding's pasture, next to the 'non-maintained' road.

Water Chemistry

During high flow, on the 5/12/03 sampling date, discharge at OR-10 was measured at 1.84 cfs. The pH was 7.8, the sulfate concentration was 64.2 mg/L, the specific conductivity was 355 uS, and metal concentrations were 1.46 mg/L Fe, 0.116 mg/L Mn, and 0.572 mg/L Al. TDS and TSS were 214 mg/L and 35 mg/L respectively. During low flow, on the 8/25/03 sampling date, discharge at OR-10 was measured at 0.143 cfs. The pH was 7.2, the sulfate concentration was 165 mg/L, the specific conductivity was 595 uS, and metal concentrations were 4.67 mg/L Fe, 0.394 mg/L Mn, and 0.1.83 mg/L Al TDS and TSS were 404 mg/L and 18 mg/L respectively. The metal and sulfate loadings on these two dates are displayed in the chart below.

OR-10 Metal and Sulfate Loadings

OR-10	Spring Flow	Base Flow	Average
Metal Load (lbs/day) of Opossum Run	21.2	5.3	13.3
% Metals Contribution of Opossum Run	79	84	81.5
Sulfate Load (lbs/day)	636.1	127.5	381.8
% Sulfate Contribution	41	59	50

% indicated in table represents % contribution relative to total loading of four sampled tributaries.

Treatment Recommendations

This is a net alkaline, underground and surface mined stream. The only requirement is oxidation and settlement of metals.

Estimated cost by ODNR for the treatment for site OR-10

Mobilization/ Clearing	$9.092
Revegetation	3,000
Spillway	6,379
Earthwork	51,235
Engineering	15,154
Total	**$84,860**

Pre- and Post- Treatment Sampling

It is recommended that six samples, once per month, be analyzed of Group I parameters to fully characterize the high and low flow chemistry. These six samples should be taken immediately downstream of the treatment area. This six-month sampling will provide the needed pre-reclamation water quality data to determine effectiveness of the restoration.

ODNR Cambridge Lab sample analysis, $110 x 6 samples	$ 660
Staff time collecting samples, 48 hours @ 30$/hr	$1440
Travel, $.42/mile, total miles 50 miles	$ 21

Post-construction water quality monitoring should be conducted at least two to four times a year and biological monitoring once per year downstream of the restoration project. Post-construction monitoring should begin within six months of completion.

AMD Impact to Opossum Run

Biology Investigation for Opossum Run

This table represents data for Opossum Run 2004 only. Information on the entire watershed is found in Section I.

Table 31 Biology Data for Opossum Run

Attainment table by MBI in the Hocking River watershed during 2004.

Station (Map #)	Fish RM	Macro RM	IBI	MIwb	ICI or Narrative Rating	QHEI	Aquatic Life Uses Ex/Rec	Attain-ment Status	Comment
S01161 2.602004	2.60	2.60	44*	NA	VG^{ns}	69.5	EWH	**Partial**	Twp. Rd. 6, at compressor station
S01161 0.752004	0.75	0.80	48^{ns}	NA	G*	56.0	EWH	**Partial**	State Forest
S01161 0.202004	0.20	0.20	52	NA	VG^{ns}	59.0	EWH	**Full**	Joy Rd., near mouth

Ecoregion Biocriteria: Western Allegheny Plateau (WAP)

Index and Site Type	**WWH**	**EWH**	**MWH**	**LRW-AMD**
IBI – Wading & Headwater	**44**	**50**	**24/24**	**18**
Mod. Iwb - Wading	**8.4**	**9.4**	**6.2/5.5**	**4.0**
ICI/Narrative	**36/G**	**46/E**	**22/30**	**8/MF**

Footnotes

a - A qualitative narrative evaluation based on best professional judgment and sampling attributes such as community composition, EPT taxa richness, and QCTV scores were used when quantitative data were not available (E-exceptional, G-good, MG-marginally good, F-fair, P-poor, VP-very poor); for Moxahala Creek a draft Qualitative ICI index was also used.
b - Attainment status is given for existing use designations, except where a use designation change is recommended, in which case, the attainment status for the recommended use is given.
c - Limited Resource Water - acid mine drainage (LRW-AMD) benchmarks based on best professional judgment driven by the need to protect against acutely toxic stream conditions. Macroinvertebrate qualitative only data were evaluated based on densities of EPT taxa on the natural substrates (see Methods Section), a narrative VP* or P* indicates departure from the benchmark.
na - MIwb not applicable at headwater sites (< 20 mi^2).
† - HD sampler set, but not retrieved due to flood flows destroying samplers.
‡ - Dry conditions in August followed by flooding conditions in September likely influenced assemblage conditions (data excluded from attainment decision)
ns - Nonsignificant departure from biocriteria (<4 IBI or ICI units, or <0.5 MIwb units).
* - Indicates significant departure from applicable biocriteria (>4 IBI or ICI units, or >0.5 MIwb units).
Underlined scores are in the Poor or Very Poor range.

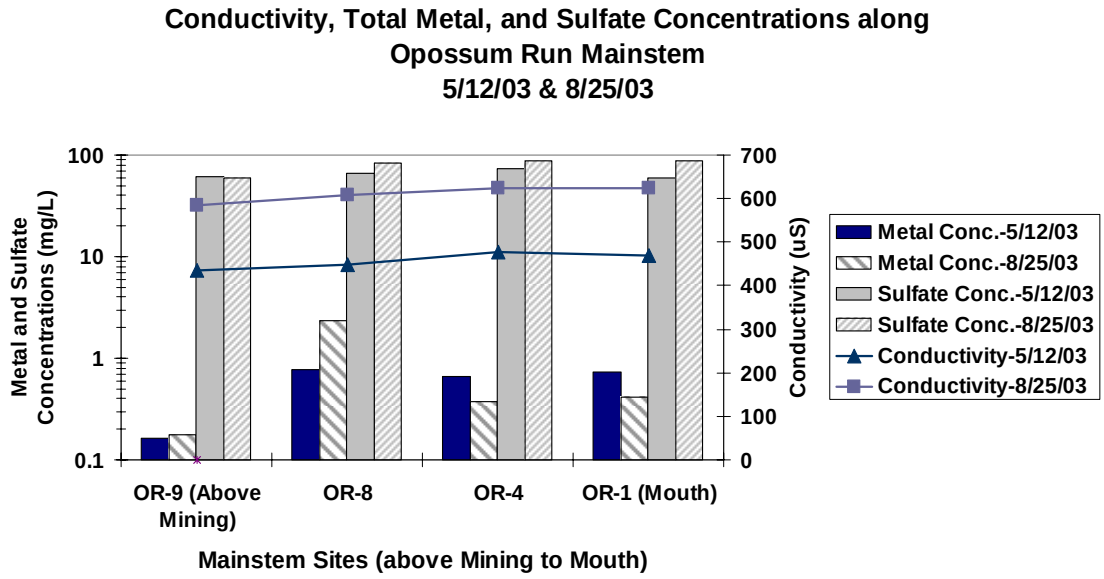
The first site listed in the table above is OR-10, located above abandoned mine sites. The middle site in the table is immediately downstream from OR-10. The bottom site in the table is at the mouth of Opossum Run near Sharpsburg. Although this stream has a use designation of Exceptional Warmwater Habitat it is only partially meeting that designation downstream of OR-10. The site immediately

downstream of OR-10 has a score that achieves a Modified Warmwater Habitat designation for QHEI, and the macroinvertebrate score only achieved a 'good'. The other two sites have a 'very good' macroinvertebrate score and the QHEI scores would achieve a Warmwater Habitat designation.

Mainstem

The mainstem of Opossum Run remains net alkaline along its entirety, with alkalinity values ranging from 173 mg/L above mining to 155 mg/L below mining impacts at high flow, and values of 211 mg/L above mining to 192 mg/L below mining at low flow. The pH remains in the range of 7.8 to 8.0. Water chemistry appears be affected by AMD sources, primarily metals. The graph below displays some AMD parameters along the mainstem.

Figure 13 Conductivity, Metal, Sulfate Concentrations for Mainstem Opossum Run

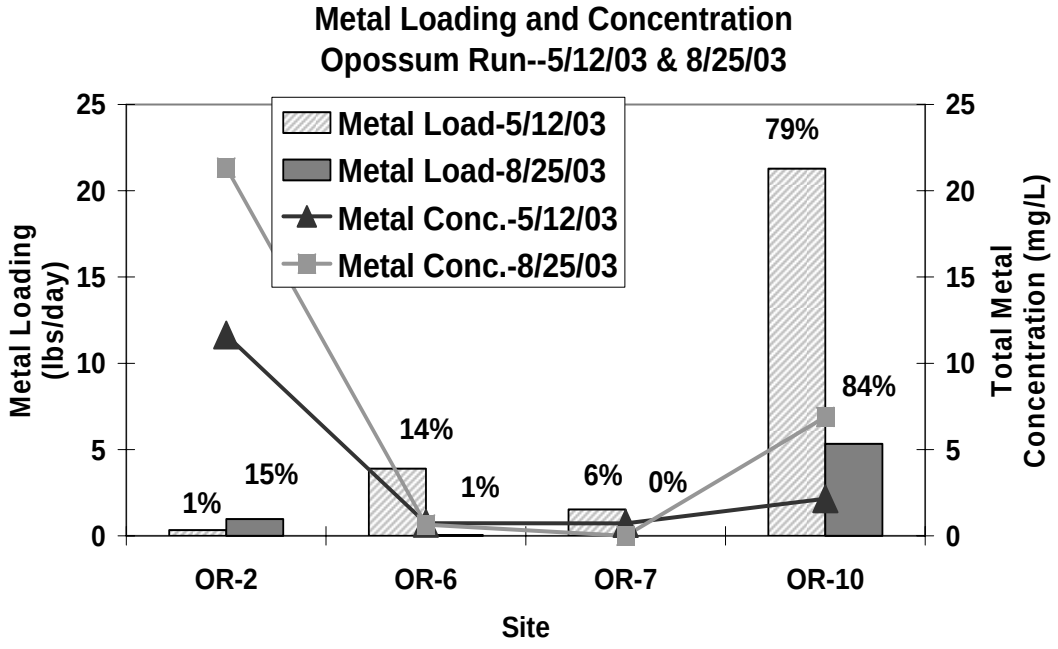


Site OR-9 is located above all abandoned mine sites on the mainstem, and site OR-1 is below all mining, towards the mouth. Metal concentrations increase at site OR-8. OR-10 discharges into Opossum Run between OR-9 and OR-8. Additionally, a small tributary draining a large section of strip-mined land discharges into the mainstem above site OR-8 and below where OR-10 discharges. However, the landowner of this section of land has denied access. Mining impacts in this section appear to have a large impact on the mainstem of Opossum Run. Below OR-8, metal concentrations decrease, but do not decrease to the low levels that occurred above the mining area. Sulfate concentrations rise slightly downstream of OR-9, but remain within the range of 59 mg/L to 89 mg/L during both high and low flow. Conductivity levels increase slightly as AMD inputs are added to the mainstem. Conductivity values range from 434 uS (OR-9) to 478 uS (OR-4) at high flow and 584 uS (OR-9) to 625 uS (OR-1) at low flow.

The water chemistry results of specific sites will be discussed in the following section. Phase II samples were unfiltered at all sites except the underground mine seeps OR-3 and OR-5. Hence, because pH is above 7 and alkalinity is high for all tributary and mainstem samples except OR-2, high metal concentrations likely overestimate the amount of dissolved metals. However, these values are used to determine priority sites, and further sampling for remediation design can use filtered samples.

The bar chart below displays the metal loadings and concentrations of the four tributaries discharging into the mainstem. OR-2 was included although its drainage may not reach the mainstem. Of these four tributaries, OR-10 is by far the largest contributor of metals to Opossum Run. OR-2 would be the second largest contributor of the 4 tributaries, however, OR-2 does not appear to discharge directly into the mainstem. The AMD carried by tributary OR-2 may completely dissipate in the field/wetland adjacent to Opossum Run. Although an abandoned underground mine discharges highly contaminated AMD into OR-6, OR-6 does not appear to have a large impact on the mainstem of Opossum Run. Each of these sites will be discussed in detail in the following section.

Figure 14 Metal Loading for Opossum Run Tributaries



% indicated in graph represents % contribution relative to total loading of sampled tributaries

Investigation of Opossum Run

Phase I

Phase I reconnaissance was conducted during March and April of 2003, in which the field parameters conductivity, pH, alkalinity, and acidity were measured. Evidence of past mining was found in many locations in the lower portion of Opossum Run. Two underground mine seeps, numerous gob piles,

and five affected tributaries were documented. Preliminary field observations identified strip pits and gob piles from surface mining, located in the first three river miles. Only one strip pit showed poor water quality. Two acid mine discharges coming from underground mines were also identified. Field parameters did not show a significant impact from surface/underground mining to the lower mainstem of Opossum Run, although some tributaries did show a significant physical impact (metal precipitation).

Phase II

A phase II water quality investigation was conducted in Opossum Run on 5/12/03 and 8/25/03 Water samples were analyzed for Group 1 parameters and discharge was measured at eleven locations within Opossum Run. The eleven locations include four mainstem sampling sites (OR-1, OR-4, OR-8, OR-9), five tributaries (OR-2, OR-6, OR-7, OR-10, and OR-11) and two abandoned underground mine seeps (OR-3, OR-5). Of the five tributaries, only three discharge directly into the mainstem. OR-2 appears to enter a slightly marshy area where it dissipates before entering Opossum Run, and OR-11 discharges into OR-10, which subsequently enters the mainstem. The four tributaries, OR-2, OR-6, OR-7, and OR-10, were assessed to determine relative percent contribution of metal and sulfate loadings. There is no visible connection between OR-2 and the mainstem of Opossum Run. The underground mine seep, OR-3, discharges into OR-2. The underground mine seep, OR-5, discharges into OR-6. Sites OR-3-S (seep) and OR-5-S (seep) are associated with mine number As2.

Phase III

A phase III water quality investigation was conducted in Opossum Run on 5/4/04 and 6/28/04. Water samples were analyzed for Group II parameters and discharge was measured at five locations. These locations include mainstem sites at the mouth of Opossum Run (OR-1); immediately downstream of the abandoned mine areas (OR-8); and above all mine impacts (OR-9). There are also sites located on (OR-10) and the main AMD impacted tributary of OR-10 (OR-11).

Individual Site Descriptions

OR-10—AMD tributary

OR-10 is at 0.12 river miles, at 39.44322249 latitude -81.89470131 longitude, and is at an elevation of 747 feet. This is a tributary that enters Opossum Run at 1.15 river miles. The area of land above this point is 0.50 square miles and the length of the stream above this point is 0.85 miles

Location/Access: The sample site for OR-10 lies along a tributary to Opossum Run. This tributary runs along a unmaintained township road that is accessible for State Route 377 approximately 1.5 miles north from Sharpsburg, and it is accessible by vehicle.

Site Description: OR-10 is a tributary discharging into the mainstem, and water quality samples taken here represent the mining impacts of OR-11, as well as the contributions of strip mines and a possible underground mine discharge in the region.

OR-10 Metal and Sulfate Loadings

OR-10	Spring Flow	Base Flow	Average
Metal Load (lbs/day)	21.2	5.3	13.3
% Metals Contribution	79	84	81.5
Sulfate Load (lbs/day)	636.1	127.5	381.8
% Sulfate Contribution	41	59	50

% indicated in table represents % contribution relative to total loading of four sampled tributaries.

OR-11—Tributary

OR-11 is at 0.15 river miles, at 39.44349892 latitude -81.89291915 longitude, and is at an elevation of 721 feet. This is a tributary that enters Opossum Run at 1.15 river miles. The area of land above this point is 0.22 square miles and the length of the stream above this point is 0.6 miles.

Access: The sample site for OR-11 lies along a tributary to Opossum Run. This tributary runs along an unmaintained township road that is accessible for State Route 377 approximately 1.5 miles north from Sharpsburg, and it is accessible by vehicle. OR-11 is located at an old bridge confluence of OR-11 and OR-10. This bridge is no longer passable by vehicles. Hence, OR-11 is located when road becomes impassable by vehicles. The land is owned by Dorrit Pruiss.

Site Description: OR-11 is located at the mouth of a small tributary to OR-10. This tributary drains an area that has been strip-mined. The stream is orange with iron precipitate.

OR-8—Mainstem Sampling Site

OR-8 is a point on the mainstem of Opossum Run at 0.8 river miles, at 39.44196805 latitude -81.90384815 longitude, and is at an elevation of 678 feet. Opossum Run is a tributary that enters Sharps Fork at 2.83 river miles. The area of land above this point is 8.53 square miles and the length of the stream above this point is 4.8 miles

Access: OR-8 is a mainstem sampling site on the border of Gifford State Forest and private land owned by Bob Spaulding. OR-8 is approximately 200 feet from State Route 377, and lies across the road from the Gifford State Forest Hunter's Parking Lot.

Site Description: OR-8 is included in this section to discuss the effects of strip-mined land owned by Bob Spaulding, which the group has not been granted permission to study. In March 2003, the group was granted permission to conduct Phase I reconnaissance. However, no further permission to access the land has been granted. A large portion of this land has been strip-mined, and numerous and extensive gob piles cover the area. Additionally, the mine map indicates an underground mine opening; however, the group was unable to locate it.

OR-8 exhibits the highest metal concentrations along the mainstem at both high and low flow. Total metal concentrations at this site were 0.78 mg/L at high flow and 2.4 mg/L at low flow. Specific conductivity values were 448 uS and 607 uS on 5/12/02 and 8/25/03, respectively. Sulfate concentrations

remained low at 65.9 mg/L on 5/12/03 and 84 mg/L on 8/25/03. FVWG is unable to sample between the inputs of OR-10 and the inaccessible piece of strip-mined land. Hence, water quality samples collected at OR-8 represent the impacts of all AMD additions between OR-9 and OR-8. These impacts are likely attributable to OR-11, OR-10, and the inaccessible piece of strip-mined land.

OR-7-Tributary

OR-7 is at 0 river miles, at 39.44200954 latitude -81.90376684 longitude, and is at an elevation of 674 feet. This tributary enters Opossum Run at 0.8 river miles. The area of land above this point is 0.28 square miles and the length of the stream above this point is 1.0 miles.

Access: OR-7 is a tributary located on the eastern border of Gifford State Forest. It runs parallel to a drive that leads to the Hunter's Parking lot, then passes through a culvert under State Route 377, and enters Opossum Run approximately 200 feet from State Route 327. Sampling was conducted at the mouth of the tributary. The tributary is accessible by vehicle approximately 200 feet from its confluence with Opossum Run.

Site Description: OR-7 drains an area on Gifford State Forest that has been strip-mined. A mine opening is indicated on the map, but the group was not able to locate this opening. A large gob pile exists adjacent to the tributary, approximately 1000 feet from the mouth. A small tributary runs on the south end of the gob pile, through a culvert under the Gifford State Forest Road, and enters tributary OR-7. AMD is believed to originate in this area, although the extent of AMD is believed to be quite small.

OR-7 Metal and Sulfate Loadings

OR-7	Spring Flow	Base Flow	Average
Metal Load (lbs/day)	1.53	0.0	0.77
% Metals Contribution	6%	0%	3%
Sulfate Load (lbs/day)	177.8	6.9	92.4
% Sulfate Contribution	11%	3%	7%

% indicated in table represents % contribution relative to total loading of four sampled tributaries

OR-6: Tributary:

OR-6 is at 0 river miles, at 39.44037918 latitude -81.9088912 longitude, and is at an elevation of 627 feet. This is a tributary that enters Opossum Run at 0.5 river miles. The area of land above this point is 0.19 square miles and the length of the stream above this point is 0.6 miles.

Access: OR-6 is the mouth of small tributary that enters Opossum Road at RM .5. The tributary passes under State Route 377 approximately 200 feet from its confluence with Opossum Run, which is located on the eastern side of State Route 377, near the Gifford State Forest Headquarters. This site is a short walk from the road. **Site Description:** OR-6 is a tributary located on the western edge of Gifford State Forest. OR-6 was sampled at the mouth to ascertain the amount of AMD entering Opossum Run. OR-5-S is the primary source of AMD contributing to OR-6, and will be discussed subsequently. OR-5-S

is an abandoned underground mine opening that discharges into OR-6. Numerous small seepages trickle out of the hillside on which OR-5-S is located. These additional seepages are the additional AMD inputs into OR-6. They are widespread and diffuse.

OR-6 Metal and Sulfate Loadings

OR-6	Spring Flow	Base Flow	Average
Metal Load (lbs/day)	3.9	0.04	1.97
% Metals Contribution	14	1	7.5
Sulfate Load (lbs/day)	704.0	19.5	361.8
% Sulfate Contribution	46	9	27.5

% indicated in table represents % contribution relative to total loading of four sampled tributaries

Of the four tributaries compared, OR-6 is the highest contributor of sulfate during high flow, however it becomes much less significant at low flow. OR-6 is the second largest contributor of metals at high flow, but again, during low flow conditions, its role becomes slight. The contributions of OR-6 can be attributed to OR-5-S, as well as the widespread, diffuse, trickling seepages that occur in the area of OR-5-S.

OR-5-S-Underground Mine Seep:

OR-5-S is a seep that enters Opossum Run at 0.42 river miles, at 39.44237533 latitude -81.9126209 longitude, and is at an elevation of 770 feet. This seep is associated with mine # As 2.

Access: OR-5-S is located approximately 1500 feet northwest from the Gifford State Forest Headquarters on State Route 377.

Site Description:

OR-5-S is a low volume discharge from an abandoned underground mine opening associated with mine complex As-2. Discharge was measured at 0.007 cfs on 5/12/03 and 0.004 cfs on 8/25/03. OR-5-S is located on a hillside adjacent to the tributary OR-6, approximately 300 feet from the stream. Additional widespread trickling seeps are located on this hillside. These seeps were not included in the discharge measurements as they do not form distinct channels, and collect in small pools at the base of the hillside or filter into the ground. Discharge for OR-5-S was measured in the most distinct channel that drains into tributary OR-6. Samples for OR-5-S were filtered.

OR-5-S exhibits the most severe levels of the AMD parameters of all sites within Opossum Run. However, much of this AMD pollution appears to be naturally remediated before entering the Opossum Run mainstem. The tributary OR-6 maintains a high pH and high alkalinity along its entirety.

OR-2—Tributary

Access: OR-2 is located on private property owned by Chuck Blythe. It lies at the eastern border of the Blythe property, adjacent to the western edge of Gifford State Forest, approximately 200 feet from

Opossum Run mainstem. The site is accessible by foot. Parking is closest near the gravel piles at Sharpsburg.

Site Description: OR-2 is located on a small channel flowing towards Opossum Run. This channel drains an area with an abandoned underground mine, and includes the discharge of OR-3-S. OR-3-S is located on the side of a hill, and is associated with mine complex As-2. The hillside also contains numerous, widespread, diffuse trickling seeps. This drainage collects at the base of the hill. Gifford State Forest has channelized this drainage so that it joins with the discharge of OR-3-S, and this forms OR-2. OR-2 appears to dry up into a field or possible wetland area approximately 150 feet before entering Opossum Run. This situation appeared to exist during both high flow and low flow sampling.

The drainage of OR-2 is a small volume, and appears not to enter Opossum Run. However, this drainage is highly acidic and highly conductive, and because the ultimate fate of the drainage remains unknown, it was included in this study.

If the contributions of OR-2 are considered to enter Opossum Run, at high flow OR-2 contributes 1 percent of the total metal load and 2 percent of the total sulfate load. At low flow, OR-2 contributes 15 percent of the metal load and 29 percent of the sulfate load. These figures give an average of 8 percent of the metal load and 15.5 percent of the sulfate load contributed by the four tributaries in this study. This would rank OR-2 third in importance in Opossum Run. However, the discharge of OR-2 appears to dissipate into a field before reaching Opossum Run. No evidence of the effect of OR-2 is seen on the mainstem below where OR-2 would enter.

OR-3-S—Underground Mine Seep

OR-3-S is a seep that enters Opossum Run at 0.3 river miles, at 39.43935315 latitude -81.91391758 longitude, and is at an elevation of 764 feet. This seep is associated with mine # As 2.

Access: OR-3-S is located on private property owned by Chuck Blythe. It is located on a hillside approximately 1000 feet from Opossum Run. The hillside is covered with thick shrubby growth and access is difficult. It is accessible by foot.

Site Description: OR-3-S is defined by a small pool of water that drains into a channel, eventually forming OR-2. This small pool of water may represent the old mine opening. This site is associated with mine complex As-2. Downhill and to the west of this site, numerous, diffuse seeps scatter across the slope of the hillside. These trickling seeps collect in a channel at the bottom of the hillside. This channel joins with the drainage of OR-3-S and forms the channel called OR-2.

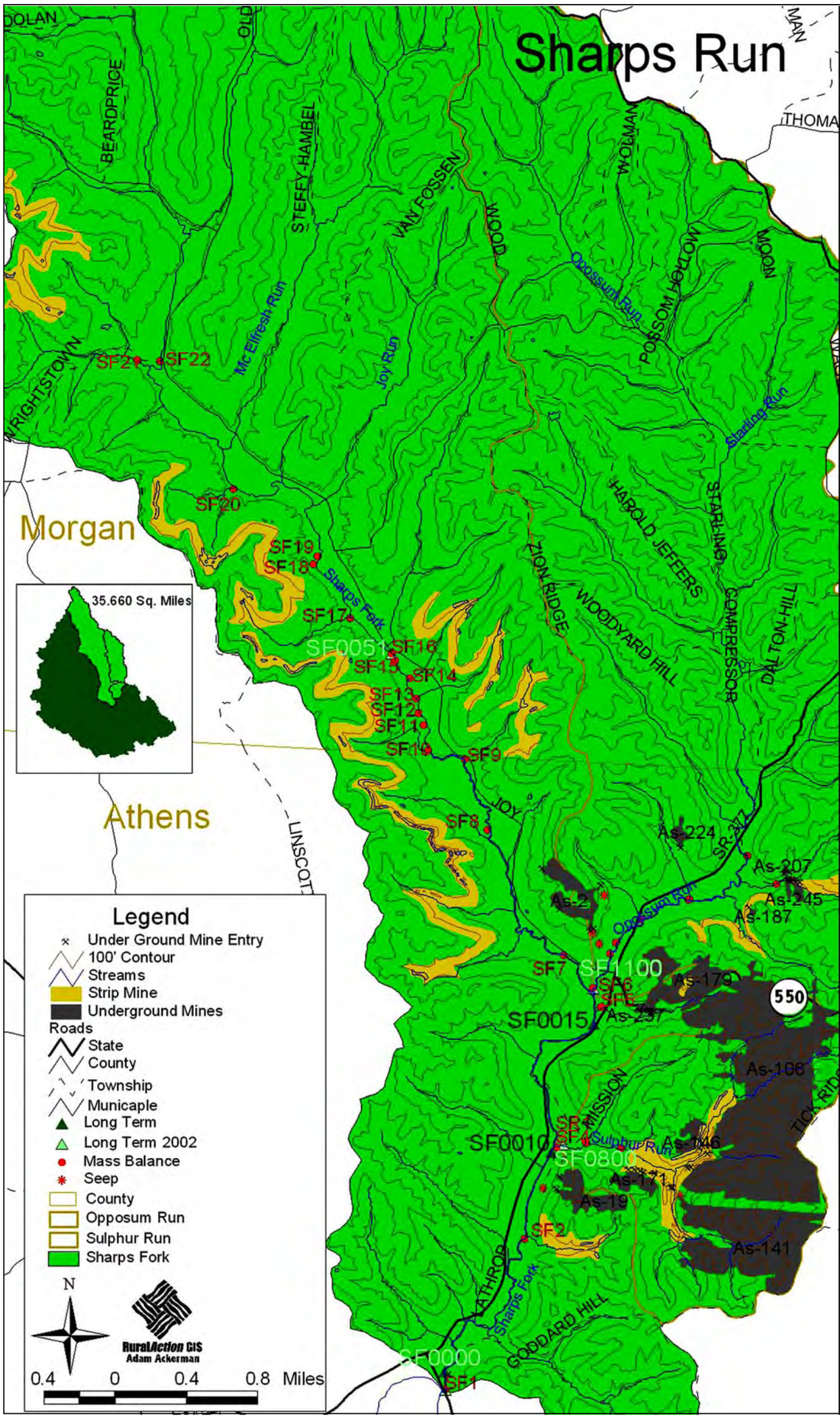
SHARP'S FORK BASIN ASSESSMENT

SF-19 tributary north of the Joy area, high acid and low flow

SF-10 tributary south of the Joy area, high acid and low flow

SF 1 mainstem at the mouth

Map 12 Sharps Fork



Geography Background

Sharp's Fork occupies the northeast portion of the watershed, flows in a south/southeast direction, entering Federal Creek at 5.14 river miles. This subwatershed represents nearly a third of the area of the Federal Valley Watershed. It is located in Morgan and Athens counties, crossing Union, Homer, Marion and Bern Townships. The towns of Sharpsburg and Joy are in the Sharp's Fork subwatershed. This subwatershed can be found on Ringgold and Amesville USGS quad sheets. Sharp's Fork has a drainage area of 35.7 square miles, and a stream length of 15.2 miles. Abandoned mining impacts are widespread in the southern two-thirds of Sharp's Fork and include AMD generated from abandoned surface mining, underground mine discharges, and gob piles. Within Sharp's Fork, two subwatersheds are impacted: Sulphur Run and Opossum Run. Many mining related impacts also occur along the mainstem and in unnamed tributaries of the mainstem. In this subwatershed, 1.15 square miles have underground mines, which is 3.22 percent of the land in the entire subwatershed. Additionally, in this subwatershed 1.09 square miles have been strip-mined, which is 3.06 percent of the land in the entire subwatershed.

Mining Impacts In Brief

AMD impacts in Sharp's Fork are diffuse, originating in several small tributaries along the mainstem, as well as the contributions of the larger subwatershed Opossum Run, and the severely affected subwatershed Sulphur Run. In Sharp's Fork, for high flow three sites stand out. The mouth of Sulphur run represents 33 percent of the metal contribution in high flow and 74 percent in low flow. Opossum Run represents 13 percent in low flow, and 9 percent in high flow for metal concentrations. A site near Wrightstown Ridge Road, known as Anderson Hollow, represents 34 percent of metal concentrations in high flow but only 3 percent in low flow. Other than the previously discussed remediation sites in Sulphur Run and Opossum Run, no other areas within Sharp's Fork are being recommended for remediation.

Table 32 Sharps Fork underground mine information

Mine number	Mine Name	Date Abandoned	Type	Coal elevation
AS-2	(Schuler #3) J.F. Schuler & Sons	1915	Coal, Drift	750’ to 764’
AS-19	Carbon (Schuler #2) Schuler Coal Co.	1923	Coal, Drift	697’ to 712’
AS-106	Black Diamond, Black Diamond Coal Company	1924	Coal, Drift	
AS-141	Black Diamond #2, Black Diamond Coal Company	1944	Coal, Drift	
AS-146	Amesville, Amesville Coal Co.	1948	Coal, Drift	699’
AS-171	Price (AS-520) Lee T. Jenkins	1951	Coal, Drift	675’
AS-179	Gilchrist (AS 522) Gilchrist Coal Co.	1957	Coal, Drift	709’
AS-187	Elliott (As 575) Robert Withem, formerly Robert Jenkins and Frank Elliott)	1960	Coal, Drift	
AS-207	Armstrong #1, #2 J.W. & B.C. Armstrong	1933	Coal, Drift	
AS-224	Harris Lyle E. Harris Coal	1931	Coal, Drift	
AS-245	Armstrong (AS-514) Vernon Seaton	1948	Coal, Drift	
As-237	Montgomery Bert Montgomery	1937	Coal, Drift	727”

AMD Impact to Sharp's Fork

Biology Investigation for Sharp's Fork

This table represents data for Sharp's Fork 2004 only. Information on the entire watershed is found in Section I.

Table 33 Biology Data for Sharps Fork

Station (Map #)	Fish RM	Macro RM	IBI	MIwb	ICI or Narrative Rating	QHEI	Aquatic Life Uses Ex/Rec	Attain-ment Status	Comment
S01160 8.502004	8.05	8.50	54		VG[ns]	67.0	WWH/ EWH	**Full**	Ust TR64
S01160 5.202004	5.30	5.20	50	NA	VG[ns]	66.5	WWH/ EWH	**Full**	lane dst. Tharp Hollow
S01160 2.602004	—	2.60	—	—	VG[ns]	—	WWH/ EWH	**Full**	Dst Opossum Adj 550
S01160 1.652004	1.65	—	48[ns]	8.83*	-	65.5	WWH/ EWH	**Partial**	Ust Sulphur Run
S01160 1.602004	1.60	1.60	46[ns]	8.31*	G*	55.5	WWH/ EWH	**Partial**	Dst Sulphur Run
S01160 0.012004	0.01	0.10	56	8.31*	38[ns]	—	WWH/ EWH	**Partial**	St. Rt. 329, at mouth

Ecoregion Biocriteria: Western Allegheny Plateau (WAP)

Index and Site Type	WWH	EWH	MWH	LRW-AMD
IBI – Wading & Headwater	**44**	**50**	**24/24**	**18**
Mod. Iwb - Wading	**8.4**	**9.4**	**6.2/5, 5**	**4.0**
ICI/Narrative	**36/G**	**46/E**	**22/30**	**8/MF**

Footnotes

a - A qualitative narrative evaluation based on best professional judgment and sampling attributes such as community composition, EPT taxa richness, and QCTV scores were used when quantitative data were not available (E-exceptional, G-good, MG-marginally good, F-fair, P-poor, VP-very poor); for Moxahala Creek a draft Qualitative ICI index was also used.

b - Attainment status is given for existing use designations, except where a use designation change is recommended, in which case, the attainment status for the recommended use is given.

c - Limited Resource Water - acid mine drainage (LRW-AMD) benchmarks based on best professional judgment driven by the need to protect against acutely toxic stream conditions. Macroinvertebrate qualitative only data were evaluated based on densities of EPT taxa on the natural substrates (see Methods Section), a narrative VP* or P* indicates departure from the benchmark.

na - MIwb not applicable at headwater sites (< 20 mi^2).

† - HD sampler set, but not retrieved due to flood flows destroying samplers.

‡ - Dry conditions in August followed by flooding conditions in September likely influenced assemblage conditions (data excluded from attainment decision)

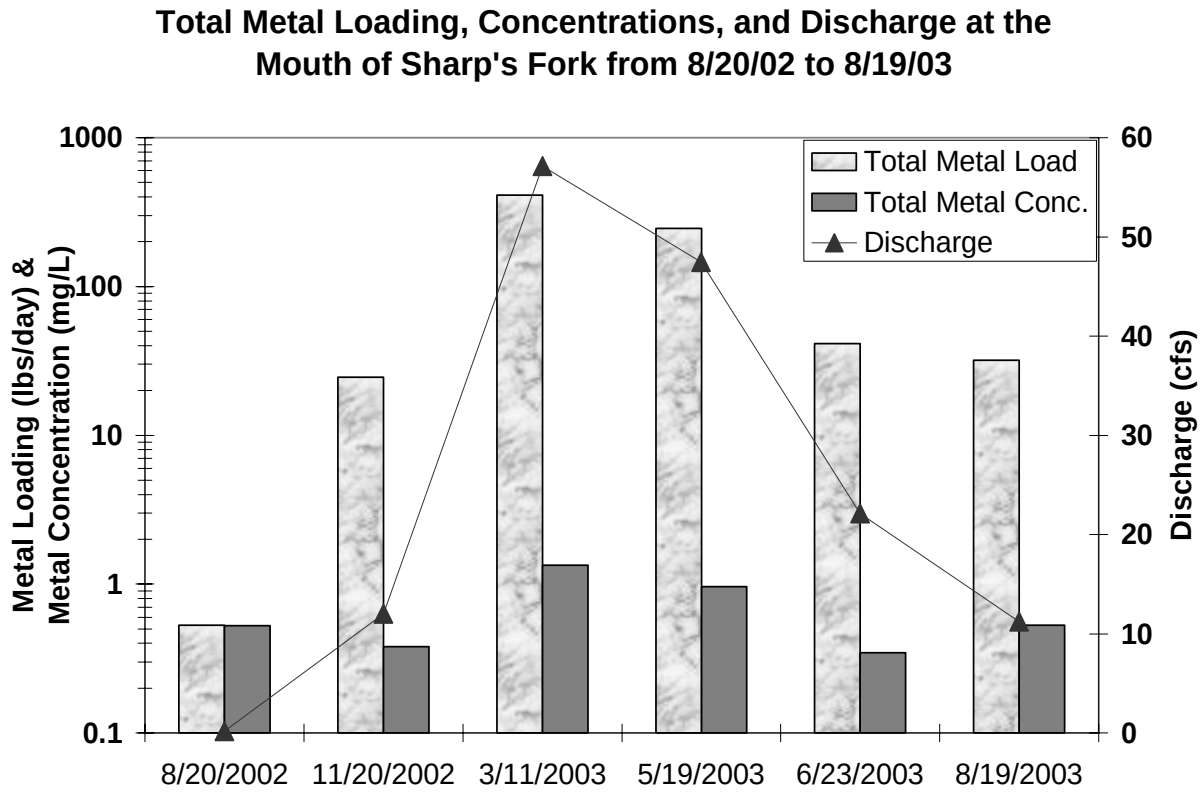
ns - Nonsignificant departure from biocriteria (<4 IBI or ICI units, or <0.5 MIwb units).

* - Indicates significant departure from applicable biocriteria (>4 IBI or ICI units, or >0.5 MIwb units). Underlined scores are in the Poor or Very Poor range.

Sharp's Fork had been designated as a WWH stream based on limited data near the mouth in 1990. More extensive data was collected for this study and the prevalence of IBIs above or close to the EWH range of 50, coupled with VG-E macroinvertebrate communities despite a dry August and flooding in September, 12-18 EPT taxa and very good habitat conditions support a change to an EWH aquatic life use. It is noteworthy that Sharp's Fork use designation was only partially attaining in the sites downstream of Opossum Run and Sulphur Run. These two subwatersheds are addressed separately.

The Mouth of Sharp's Fork

Figure 15 Metal Loading, Concentrations and Discharge Mouth of Sharps Fork

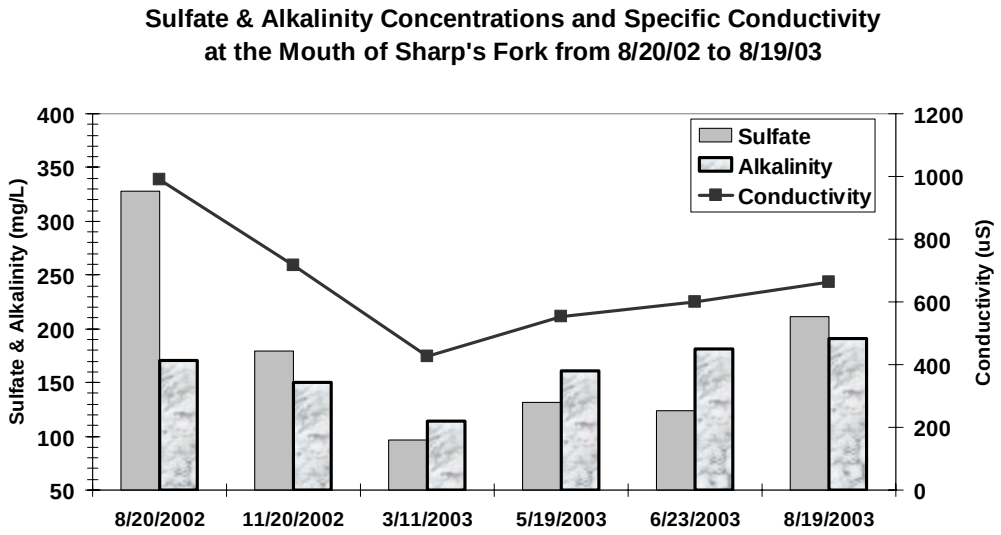


Water quality data was collected at the mouth of Sharp's Fork six times from 8/20/02 to 8/19/03. Metal concentrations and loadings were highest at high flow, with a high concentration of 1.34 mg/L on 3/11/03, a loading of 411.3 lbs/day, and a discharge of 57.1 cfs. Metal loading was lowest on 8/20/02 (0.53 lbs/day), the date which also had the lowest flow (0.19 cfs). Metal concentrations were lowest on 6/23/03 at 0.34 mg/L. This date had the third highest metal loading and discharge rate (41.2 lbs/day and 21.2 cfs) during this time.

Figure 16 displays the specific conductance and sulfate and net alkalinity concentrations for these same sampling days. Conductivity values were highest when discharge was lowest, peaking at 991uS on 8/20/03, while the lowest value of 426 uS was on 3/11/03, a high flow period. Net alkalinity values

reached a low value of 107 mg/L on 3/11/03, but otherwise remained between 145 mg/L and 186 mg/L, with the high value occurring on 8/19/03. Sulfate values reached a high value of 328 mg/L on 8/20/03, and a low value of 96 mg/L on 3/11/03. PH values remained between 7.8 and 8.0. Overall, from the available data, the mouth of Sharp's Fork exhibits a water chemistry moderately impacted by AMD, characterized by a high conductivity, yet also a high net alkalinity and neutral pH.

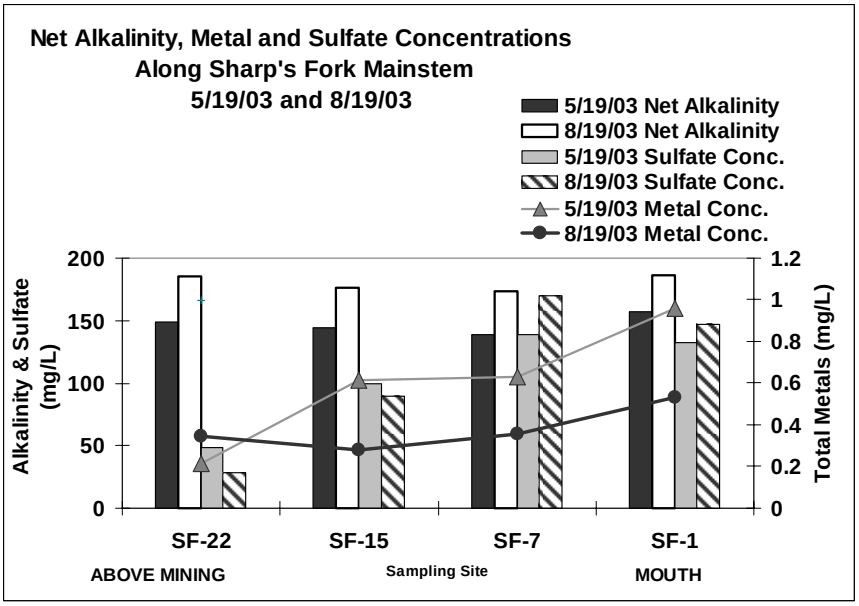
Figure 16 Sulfate, Alkalinity and Conductivity Mouth of Sharps Fork



Mainstem

The entire length of Sharp's Fork has a high net alkalinity (see Figure 17). The pH remains between 7.8 and 8.0 for both high and low flow. The concern of the abandoned mine drainage is primarily that of metal pollution.

Figure 17 Alkalinity, Metal and Sulfate Concentrations Mainstem Sharps Fork



Discharge in cubic feet per second on 5/19/03 (high flow) and 8/19/03 (low flow)

	SF-22	SF-15	SF-7	SF-1
5/19/03	11.0	14.6	18.3	47.5
8/19/03	1.5	2.9	3.5	11.2

Water quality data collected on 5/19/03 (high flow) and 8/19/03 (low flow) reflect a stable net alkaline condition along the length of Sharp's Fork. Values range from 138 mg/L (SF-7) to 157 mg/L (SF-1) at high flow, and 173 mg/L (SF-7) to 186 mg/L (SF-1) at low flow. Net alkalinity appears to show a slight decrease in concentrations as Sharp's Fork moves through the middle section, and then an increase in the lower section near the mouth; however, net alkalinity levels never fall below 138 mg/L on these two dates. Sulfate and metal concentrations increase between SF-22, the area above mining, and SF-1, the mouth of Sharp's Fork. Sulfate concentrations are highest at SF-7, reaching values of 138 mg/L at high flow and 170 mg/L at low flow. Metal concentrations are highest at SF-1, reaching 0.96 mg/L at high flow and 0.53 mg/L at low flow.

A mass balance was conducted for Sharp's Fork to prioritize remediation efforts, and the percent contributions of the 18 sampled inputs are presented in pie charts below. The percent metal and sulfate contributions are based on the sum of the load of the sampled tributaries.

As shown in the pie charts below, of the 18 tributaries/inputs studied, four contributed 86 percent of the total metal loading during high flow, and two contributed 87 percent of the total metal loading at low flow. Each of the remaining tributaries act as minor contributors during both high and low flow, never contributing more than 3 percent of the total metal loadings on these sampling dates. During high flow, Sulphur Run (SF-4) and Wrightstown Road. Tributary (SF-21), are the major contributors at 34 percent and 33 percent, respectively, followed by Opossum Run (SF-6) at 10 percent, and SF-2 at 9 percent. During low flow, Sulphur Run (SF-4) is by far the largest contributor at 74 percent, followed by Opossum Run (SF-6) at 13 percent. The contributions of Wrightstown Road tributary (SF-21) and SF-2 are reduced to 3 percent and <1 percent, respectively. All other tributaries act as minor contributors during both high and low flow, never contributing more than 3 percent.

Figure 18 Sharps Fork percent Metal Contributions High Flow

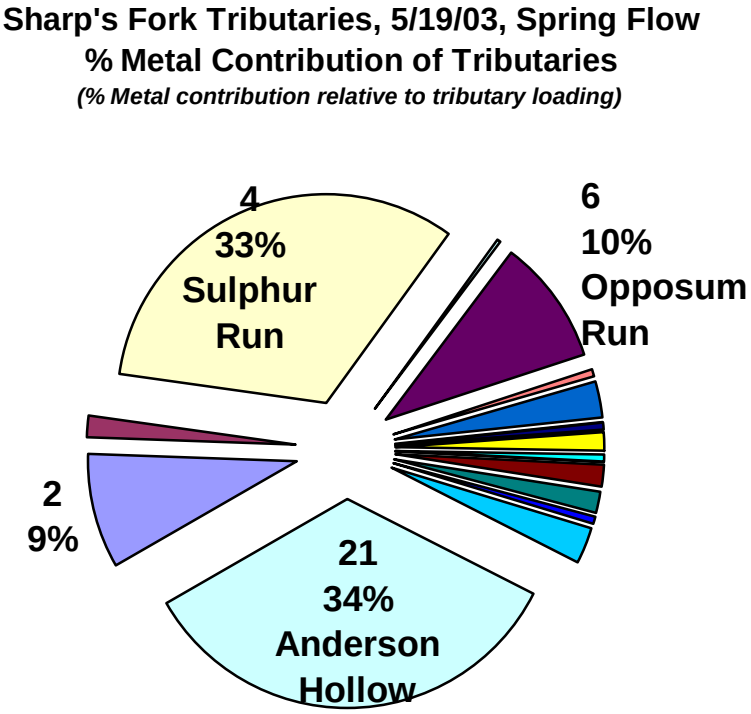
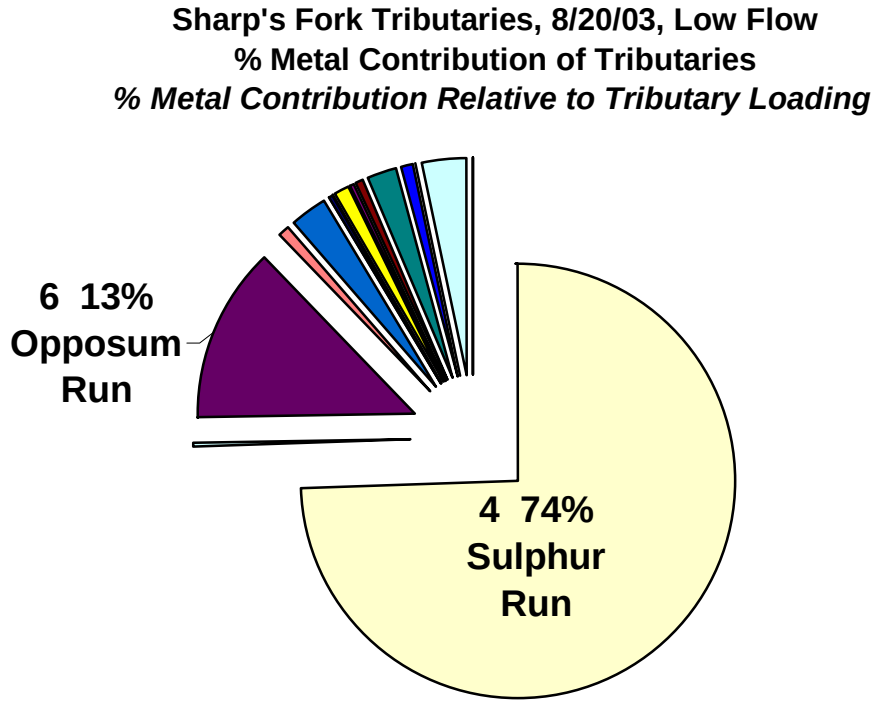


Figure 19 Sharps Fork percent Metal Contributions Low Flow



Investigation of Sharp's Fork

Phase I

A phase I water quality investigation was conducted in the Sharp's Fork subwatershed on 4/11/03, 4/15/03, 4/28/03, and 5/2/03. Preliminary field observations identified strip pits from surface mining and acid mine discharges in Sharp's Fork. Multiple tributaries flowing into the mainstem of Sharp's Fork from surface mining areas were found to have high conductivity readings. One acid mine discharge was found contributing to the main stem of Sharp's Fork (abandoned underground mine (As-19) located below Sulphur Run).

Phase II

A phase II water quality investigation was conducted in Sharp's Fork on 5/19/03 and 8/19/03; seventeen tributaries, one seep, and four mainstem sites, and 5 sites within Anderson Hollow were sampled. Site SF-3-S (seep) is associated with mine number As19.

Table 33 lists the all sampling sites within Sharp's Fork for the Phase II high and low flow sampling, which include 4 mainstem sites, 17 tributaries, and 1 seep. Map 12 shows the location within Sharp's Fork.

Table 34 Sharps Fork sample locations

Sample Site	Location/Type of Sample Site	River Mile at which Tributary/Seep enters Sharp's Fork
SF-1	Mouth of Sharp's Fork	Enters Federal Ck. At RM 9.3
SF-2	Tributary	1.16
SF-3	Underground Mine Seep	1.4
SF-4	Mouth of Sulphur Run	2.9
SF-5	Tributary	2.79
SF-6	Mouth of Opossum Run	2.83
SF-7	Mainstem Sharp's Fork	3.1
SF-8	Tributary	4.07
SF-9	Tributary	4.5
SF-10	Tributary	4.7
SF-11	Tributary	4.9
SF-12	Tributary	5
SF-13	Tributary	5.01
SF-14	Tributary	5.15
SF-15	Mainstem of Sharp's Fork	5.25
SF-16	Tributary	5.3
SF-17	Tributary	5.5
SF-18	Tributary	5.98
SF-19	Tributary	6
SF-20	Tributary	7
SF-21	Tributary	8.0
SF-22	Mainstem of Sharp's Fork	8.01
AN 0- AN-6	Anderson Hollow, Tributary of Sharp's Fork	8.0

Individual Site Descriptions

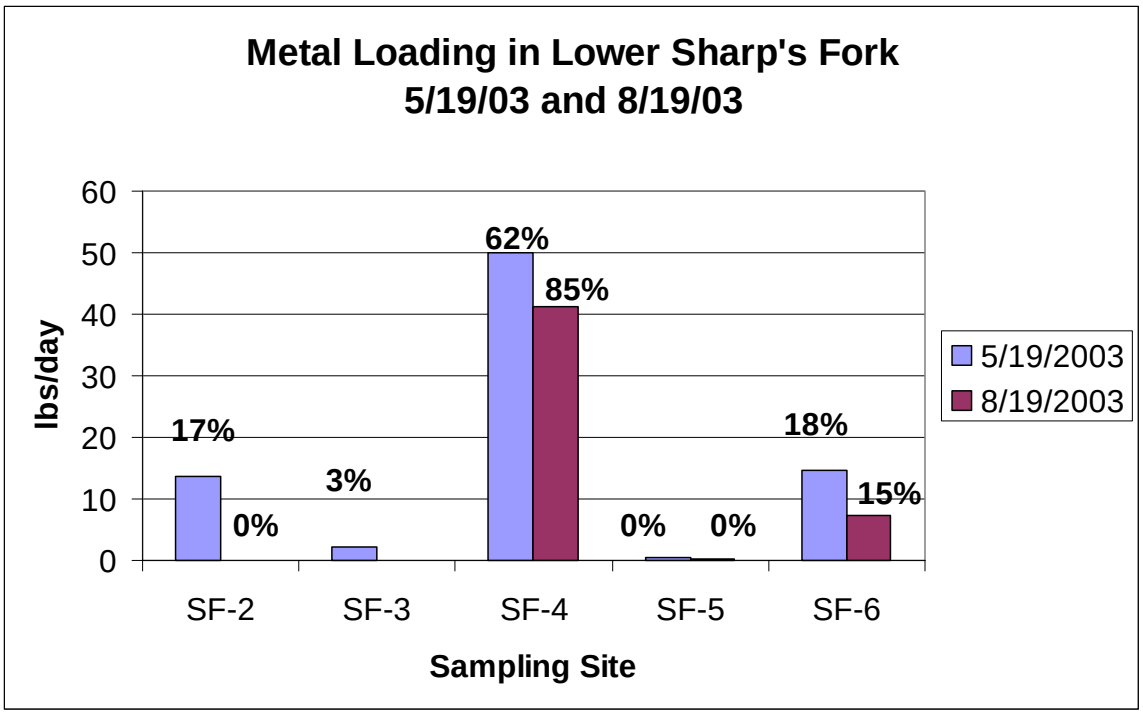
Due to the size of Sharp's Fork, the basin was broken into three sections designated lower, middle and upper. The individual site descriptions along with some analysis of the water chemistry will be presented in these sections.

Lower Section of Sharp's Fork

The lower section of Sharp's Fork is designated as starting at SF-7 (RM 9.3) and extending to the mouth of Sharp's Fork. In this section, the mouths of four tributaries, including the mouths of the subwatersheds Opossum Run and Sulphur Run, and one seep were sampled for Group 1 parameters.

The following graph presents the metal loading of the 5 sampled inputs in terms of both loadings and percent contribution relative to the total loading of the 5 inputs. According to data collected on 5/19/03 and 8/19/03, which represent high and low flow, respectively, Sulphur Run, SF-4, is by far the most significant contributor to the lower section of Sharp's Fork, contributing 62 percent of the metal load at high flow, equivalent to 50.0 lbs/day, and 85 percent at low flow, equivalent to 41.3 lbs/day. Opossum Run, SF-6, is the second largest contributor, contributing an average of 16.5 percent of the metal contribution, equivalent to 11.0 lbs/day (14.7 lbs/day at high flow, 7.3 lbs/day at low flow). SF-2 is an important contributor at high flow, contributing 13.7 lbs/day, OR-17 percent, yet becomes negligible during low flow. Discharge data for SF-3 was not included in the 8/19/03 data (due to loss of discharge data), but can be assumed to be quite small.

Figure 20 Metal Loading Contributions in Lower Sharps Fork



% indicated in graph represents % contribution relative to total loading of sampled tributaries

Site Descriptions For the Lower Section of Sharp's Fork

This section discusses each tributary/seep individually, and gives recommendations for the future.

SF-1 is a point on the mainstem of Sharp's Fork at 0 river miles, at 39.40243707 latitude -81.92958981 longitude, and is at an elevation of 735 feet. Sharp's Fork is a tributary that enters Federal Creek at 9.3 river miles. The area of land above this point is 35.66 square miles and the length of the stream above this point is 12.4 miles.

SF-2--Tributary:

SF-2 is at 0 river miles at 39.4146625 latitude - 81.92121838 longitude, and is at an elevation of 731 feet. This is a tributary that enters Sharp's fork at 1.16 river miles. The area of land above this point is 0.24 square miles and the length of the stream above this point is 0.7 miles. The AMD appears to originate from large gob piles surrounded by beaver/strip ponds. Numerous sources of AMD continue to contribute to the stream as it travels downstream, originating in a series of refuse piles surrounded by strip/beaver ponds. Hence, SF-2 represents a region of surface mining contributing AMD, and not a discrete source.

Access: SF-2 enters Sharp's Fork at 1.16(river miles). It is located on land owned by the Brown Energy Company of Dayton, OH, and is accessible only by foot travel.

Discharge at SF-2 was measured at 0.912 cfs at high flow and 0.07 cfs at low flow, giving an average discharge of 0.491 cfs. SF-2 contributed 17 percent of the metal load within the lower section of Sharp's Fork at high flow and 0 percent at low flow. Total metal concentrations for SF-2 were 2.8 mg/L at high flow and 0.17 mg/L at low flow. The average pH and conductivity are 7.6 and 889.5 uS respectively. SF-2 contributed 14 percent of the sulfate load at high flow and 2 percent of the sulfate load at low flow within the lower section of Sharp's Fork. Sulfate concentrations were 272 mg/L at high flow and 268 mg/L at low flow, giving an average of 270 mg/L. The average net alkalinity for SF-2 was 218.4 mg/L.

SF-3-S—Underground Mine Seep:

Access: SF-3-S is located at the end of Lathrop Mission Road, behind a house on private property. The site is accessible by vehicle. Drive past the Lathrop Mission to a house and the seep is on the hill to the left of the house.

SF-3-S is a seep that enters Sharp's Fork at 1.4 river miles, at 39.41873141 latitude -81.91920924 longitude, and is at an elevation of 712 feet. This seep is associated with mine # As19.

Site Description: SF-3-S is an AMD discharge associated with abandoned mine complex As19**.** No mine entrance is visible, but a large waste/gob pile against the hillside may cover the mine opening. Samples were collected from a small pool of acidic, highly conductive water on top of the gob pile. Additional water seepages appear to come out of the gob pile. Water drains down and through the gob

pile in various trenches, and then reforms a channel at the base of the hill. The entire gob pile is covered with orange and white precipitate. The gob pile is located approximately 250 feet from Sharp's Fork.

From available water quality data, SF-3 appears to be a low volume, highly acidic seep. At high flow, discharge was 0.003 cfs. Low flow discharge is not available (due to loss of data), but was visibly assessed at the time of sample collection as less than high flow discharge. On 5/19/03, the pH was 4.4, the net acid concentration was 358 mg/L, conductivity was 2490 uS, and the sulfate concentration was 1671 mg/L. Metal concentrations were 11 mg/L Fe (III), 137 mg/L Fe (II), 3.33 mg/L Mn, and 16.5 mg/L Al. On 8/19/03, the pH was 4.48, the net acid concentration was 300 mg/L, the conductivity was 2480 uS, and the sulfate concentration was 1709 mg/L. Metal concentrations were 6 mg/L Fe (III), 115 mg/L Fe (II), 3.33 mg/L Mn, and 14.7 mg/L Al. On 5/19/03, the metal load was 2.31 lbs/day (3 percent of lower section load), the sulfate load was 22.9 lbs/day (less than 1 percent of the lower section load), and the acid load was 4.92 lbs/day. No loadings could be calculated for 8/19/03.

SF-4—Sulphur Run:

SF-4 is the mouth of Sulphur Run at 0 river miles, at 39.42204989 latitude -81.91785313 longitude, and is at an elevation of 690 feet. This tributary enters Sharp's fork at 1.9 river miles. The area of land above this point is 2.0 square miles and the length of the stream above this point is 0.8 miles.

Access: SF-4 is the mouth of Sulphur Run, which enters Sharp's Fork at 1.9. The mouth of Sulphur Run is located off Lathrop Mission Road, before the church, at a cluster of trailers, and is accessible by vehicle.

Site Description: Sulphur Run drains approximately 2.2 square miles. Much of the drainage area has been surface mined and/or overlays abandoned underground mines.

From available water quality data, Sulphur Run appears to be the largest contributor of sulfate and metal loadings to Sharp's Fork. Sulphur Run contributed 62 percent of the metal loadings within the lower section of Sharp's Fork during high flow, and 85 percent during low flow. When compared with the metal loadings of all 18 sampled inputs to Sharp's Fork, Sulphur Run contributed 33 percent during low flow and 74 percent during high flow. Sulphur Run also appears to be the most significant sulfate loader overall. During high flow, Sulphur Run contributed 36 percent of the sulfate loadings in the lower section of Sharp's Fork, and 21percent of the total sulfate loadings in Sharp's Fork. During low flow, Sulphur Run contributed 62 percent of the sulfate loadings in the lower section of Sharp's Fork, and 47 percent of the total sulfate loadings in Sharp's Fork.

SF - 4	High Flow	Low Flow	Average
Metal Load (lbs/day)	50.04	41.30	45.67
% Metal Contribution*	62	85	73.5
% Metal Contribution in SF**	33	74	53.5
Sulfate Load (lbs/day)	3405.72	3396.21	3400.96
% Sulfate Contribution*	36	62	49
% Sulfate Contribution in SF**	21	47	34

*** % Contribution in Upper Section of Sharp's Fork** % Contribution in Entire AMD region of Sharp's Fork**

SF-5—Tributary:

SF-5 is at 0 river miles, at 39.43336998 latitude -81.91307503 longitude, and is at an elevation of 609 feet. This is a tributary that enters Sharp's fork at 2.79 river miles. The area of land above this point is 0.22 square miles and the length of the stream above this point is 0.8 miles.

Access: SF-5 is the mouth of a tributary that enters Sharp's Fork at 2.79 RM. This is the tributary that was mined by the Gilchrist family. The sample site is where SF-5 passes through a culvert under State Route 550, below Wayne Gilchrist's BP station and is accessible by vehicle. Wayne Gilchrist was not interested in granting us access to do a phase I survey of his subwatershed.

Site Description: SF-5 is a tributary that appears to be slightly impacted by AMD. AMD discharge from mine complex As-179 may be entering SF-5. Access to the land drained by SF-5 was denied to the group by landowner, so field reconnaissance of AMD sources was not possible. The mouth of SF-5 was sampled to determine if these unknown sources are significant.

Conductivity and sulfate were moderately elevated during both high and low flow. Metal concentrations were low, and net alkalinity and pH were high. Discharge at SF-5 was 0.354 cfs on 5/19/03 (high flow) and 0.12 cfs on 8/19/03 (low flow). On the 5/19/03 sampling date, conductivity, sulfate, and total metal concentrations were 959 uS, 159 mg/L, and 0.19 mg/L respectively. The pH was 7.88, and the net alkalinity was 202.8 mg/L. On the 8/19/03 sampling date, conductivity, sulfate, and total metal concentrations were 958 uS, 155 mg/L, and 0.23 mg/L respectively. The pH was 7.71, and the net alkalinity was 255.3 mg/L.

SF-6—Opossum Run

SF-6 is at the mouth of Opossum Run at 0 river miles, at 39.43463313 latitude -81.91365145 longitude, and is at an elevation of 630 feet. This is a tributary that enters Sharp's fork at 2.83 river miles. The area of land above this point is 9.04 square miles and the length of the stream above this point is 5.7 miles.

Access: The mouth of Opossum Run is located near the intersection of Joy Road. and State Route 377 in Sharpsburg. To access this point follow the creek up stream from the Joy Road Bridge behind the Township Trustee building.

Site Description: Sample site SF-6 is located on the mainstem of Opossum Run, slightly upstream of the Joy Road. Bridge over Opossum Run. It is below all AMD impacts in Opossum Run, approximately 1500 feet upstream from the mouth of Opossum Run.

Opossum Run drains approximately 9 square miles. Abandoned underground mines, unreclaimed strip mines, and gob piles occur in the drainage basin. There are 0.10 square miles of abandoned underground mines representing 1.03 percent of the subwatershed. There are 0.9 square miles of strip mines representing 9.5 percent of the subwatershed.

From available water quality data, Opossum Run appears to be the second largest contributor of sulfate loadings and the third largest contributor of metal loadings to Sharp's Fork Opossum Run contributed 18 percent of the metal loadings within the lower section of Sharp's Fork during high flow, and 15 percent during low flow. When compared with the metal loadings of all 18 sampled inputs to Sharp's Fork, Opossum Run contributed 10 percent during high flow and 13 percent during low flow. Opossum Run also appears to be the second most significant sulfate loader. During high flow, Opossum Run contributed 46 percent of the sulfate loadings in the lower section of Sharp's Fork, and 26 percent of the total sulfate loadings in Sharp's Fork. During low flow, Opossum Run contributed 34 percent of the sulfate loadings in the lower section of Sharp's Fork, and 26 percent of the total sulfate loadings in Sharp's Fork.

SF - 6	High Flow	Low Flow	Average
Metal Load (lbs/day)	14.69	7.29	10.99
% Metal Contribution*	18	15	16.5
% Metal Contribution in SF**	10	13%	11.5
Sulfate Load (lbs/day)	4299.04	1870.52	3084.78
% Sulfate Contribution*	46	34	40
% Sulfate Contribution in SF**	26	26	26

*** % Contribution in Upper Section of Sharp's Fork ** % Contribution in Entire AMD Sharp's Fork**

Middle Section of AMD impacted area in Sharp's Fork

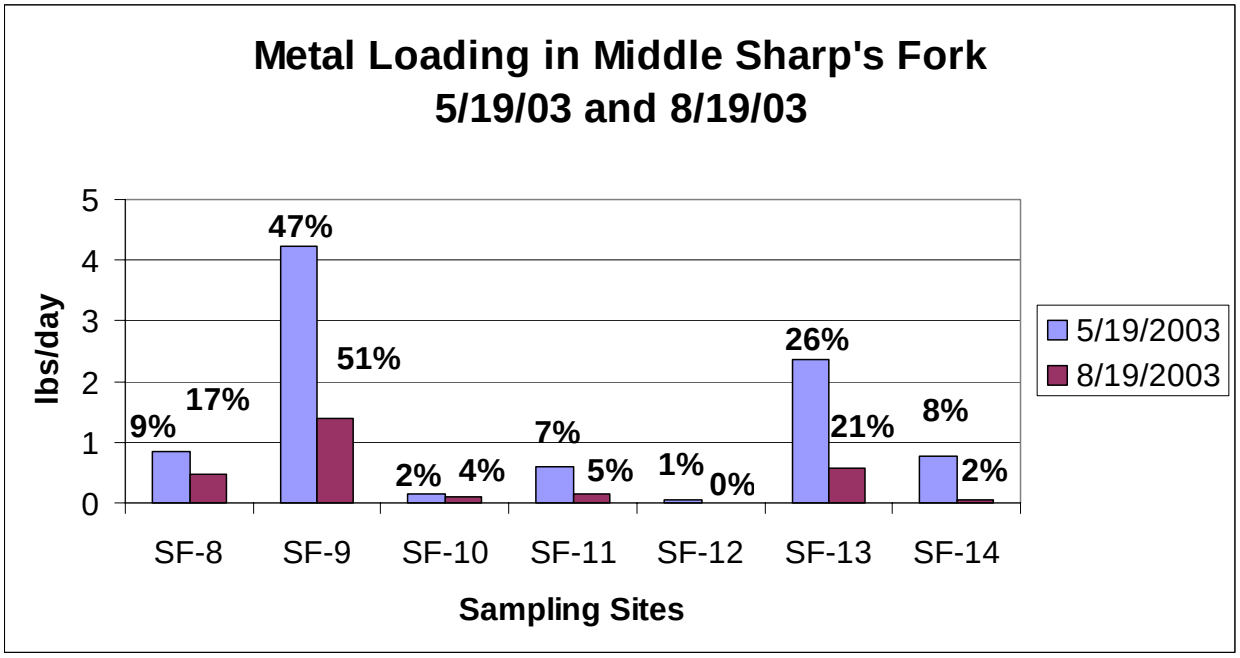
The middle section of the AMD affected area of Sharp's Fork begins at SF-15, a sample site on the mainstem, and extends down to SF-7. (The middle section extends from RM 3.1 to RM 5.25. This area drains 20.94 square miles, however 18.37 square miles are part of the upper section that will be described later. The mouths of seven tributaries into this section were sampled for Group 1 parameters on 5/19/03 and 8/19/03.

The overall high flow metal load of 14.12 lbs/day from this section is only a small proportion, 6 percent, of the total metal load within Sharp's Fork. Many low volume tributaries of low to moderate AMD loading characterize this area.

The graph below displays the metal loadings (lbs/day) and percentage contributions of the seven tributaries sampled in the middle section of Sharp's Fork. During both high and low flow, SF-9 is the

dominant contributor of metals, and SF-13 is the next largest contributor. The relative roles of the tributaries remain the same in both the high and low flow sampling.

Figure 21 Metal Loading Contributions in Middle Sharps Fork



% indicated in graph represents % contribution relative to total loading of sampled tributari

Individual Site Descriptions for Middle Section Sharp's Fork

SF-8-Tributary:

SF8 is at 0 river miles, at 39.44769398 latitude -81.92483811 longitude, and is at an elevation of 597 feet. This tributary enters Sharp's fork at 4.07 river miles. The area of land above this point is 0.27 square miles and the length of the stream above this point is 0.8 miles.

Access: SF-8 is a small tributary located on the west side of Sharp's Fork. It is located on land owned by Donnie Stevens, and is accessible by foot or ATV 0.1 to 0.2 miles from the road. Donnie Stevens provides access upon prior notification.

Site Description: SF-8 is a low volume tributary with elevated levels of conductivity, sulfate, and total metals. SF-8 had an average pH of 7.7 and an average net alkalinity of 150.4 mg/L. SF-8 ranked third in the middle section of Sharp's Fork in terms of both metal and sulfate loadings. When compared with all 18 inputs measured in Sharp's Fork, SF-8 contributed, on average, less than 1 percent of the metal loadings and 3 percent of the sulfate loadings.

SF-9-Tributary:

SF-9 is at 0 river miles, at 39.44769398 latitude -81.9271433 longitude, and is at an elevation of 634 feet. This is a tributary that enters Sharp's fork at 4.5 river miles. The area of land above this point is 0.33 square miles and the length of the stream above this point is 0.7 miles.

Access: SF-9 is a the mouth of a tributary that passes under a bridge on Old Grade Road., near the Athens County/Morgan County line. The bridge is approximately 100 feet from the mouth of the tributary. The sample site is accessible by vehicle.

Site Description: SF-9 is the mouth of a small tributary which drains a strip-mined area, and not a discrete source of AMD. The strip-mined area has not yet been assessed. The tributary appears to be moderately impacted by AMD, and has elevated conductivity levels and sulfate and metal concentrations. The discharge was 0.25 cfs on 5/19/03 (high flow), and 0.13 cfs on 8/19/03 (low flow). At high flow, conductivity, sulfate, and metal concentrations were 812 uS, 367 mg/L, and 3.16 mg/L, respectively. At low flow, these same parameters measured 839 uS, 378 mg/L, 1.99 mg/L, respectively. Aluminum was the dominant metal at this site, having a concentration of 1.77 mg/L at high flow and 0.94 mg/L at low flow. The site had an average pH of 7.3 and an average net alkalinity of 54.2 mg/L. The net alkalinity at this site is low for Sharp's Fork.

According to available water quality data, SF-9 appears to be the largest contributor of sulfate and metals in the middle section of Sharp's Fork, contributing an average of 49 percent of the metal load and 24.5 percent of the sulfate load (*relative to the 7 tributaries sampled in the middle section*). When compared with all eighteen sources within Sharp's Fork, SF-9 contributed an average of 3 percent of the total metals (Rank-fifth), and 3.5 percent of the total sulfate loading (Rank-seventh).

SF-10—Tributary:

SF-10 is at 0 river miles, at 39.45421787 latitude -81.93099042 longitude, and is at an elevation of 664 feet. This tributary enters Sharp's fork at 4.7 river miles. The area of land above this point is 0.16 square miles and the length of the stream above this point is 0.6 miles.

Access: SF-10 is the mouth of a small tributary that enters Sharp's Fork at RM 4.7. It is located to the west of Sharp's Fork. It is accessible by foot. GPS would be useful to find this site.

Site Description: SF-10 is the mouth of a small tributary draining land that has been strip-mined, and may not represent a discrete source of AMD. The strip-mined area has not yet been assessed, and it may contain numerous seeps.

SF-10 is characterized by a low discharge with high conductivity and elevated sulfate and metal concentrations. SF-10 has a neutral pH, with a high net alkalinity. Discharge was 0.026 cfs on 5/19/03 (high flow) and 0.01 cfs on 8/19/03 (low flow). At high flow, the conductivity, sulfate, and metal concentrations were 1110 uS, 467 mg/L, and 1.06 mg/L, respectively. At low flow, these parameters measured 1240 uS, 504 mg/L, and 1.7 mg/L respectively. The average pH was 7.4 and the average net alkalinity was 167.4 mg/L.

According to available water quality data, SF-10 contributed an average of 3 percent of the metal load and 3 percent of the sulfate load relative to the seven inputs sampled in the middle section of Sharp's

Fork. SF-10 was ranked sixth out of the seven inputs in the middle section for both metal and sulfate loading. When compared to all eighteen inputs into Sharp's Fork, SF-10 contributed less than 1 percent of both the average sulfate and metal load.

SF-11-Tributary:

SF-11 is at 0 river miles, at 39.45623565 latitude -81.93138722 longitude, and is at an elevation of 660 feet. This tributary enters Sharp's Fork at 4.9 river miles. The area of land above this point is .02 square miles. This small tributary is not mapped therefore the stream length above this point in not available.

Access: SF-11 is the mouth of a small tributary that enters Sharp's Fork at RM 4.9. It is located to the west of Sharp's Fork. It is accessible by foot.

Site Description: SF-11 is the mouth of a small tributary draining land that has been strip-mined, and may not represent a discrete source of AMD. The strip-mined area has not yet been assessed, and it may contain numerous diffuse seeps.

SF-11 is also characterized by a low discharge with high conductivity and elevated sulfate and metal concentrations. SF-11 has a neutral pH, with a high net alkalinity. Discharge was 0.08 cfs on 5/19/03 (high flow) and 0.03 cfs on 8/19/03 (low flow). At high flow, the conductivity, sulfate, and total metal concentrations were 1820 uS, 1062 mg/L, and 1.37 mg/L, respectively. At low flow, these parameters measured 2060 uS, 1129 mg/L, and 0.89 mg/L respectively. The average pH was 7.8 and the average net alkalinity was 177 mg/L.

According to available water quality data, SF-11 contributed an average of 6 percent of the metal load and 20 percent of the sulfate load relative to the seven inputs sampled in the middle section of Sharp's Fork. Of the seven inputs in the middle section, SF-11 was ranked fourth highest contributor of metals and the second highest contributor of sulfate. When compared with all eighteen inputs into Sharp's Fork, SF-11 contributed, on average, less than 1 percent of the metal load and 3 percent of the sulfate load (Rank-ninth).

SF-12—Tributary:

SF-12 is at 0 river miles, at 39.45719537 latitude -81.93196457 longitude, and is at an elevation of 662 feet. This is a tributary that enters Sharp's Fork at 5 river miles. The area of land above this point is 0.47 square miles. This small tributary is not mapped therefore the stream length above this point in not available.

Location/Access: SF-12 is the mouth of a small tributary that enters SF at RM 5. It is located to the west of Sharp's Fork. It is accessible by foot. GPS would be useful to find this site.

Site Description: SF-12 is the mouth of a small tributary draining land that has been strip-mined, and may not represent a discrete source of AMD. The strip-mined area has not yet been assessed, and it may contain numerous diffuse seeps.

SF-12 is also characterized by a very low discharge with high conductivity, elevated sulfate, and slightly elevated metal concentrations. SF-12 has a neutral pH, with a high net alkalinity. Discharge was 0.017 cfs on 5/19/03 (high flow) and 0.0002 cfs (0.09 gpm) on 8/19/03 (low flow). At high flow, the conductivity, sulfate, and metal concentrations were 1410 uS, 803 mg/L, and 0.65 mg/L, respectively. At low flow, these parameters measured 1380 uS, 752 mg/L, and 1.1 mg/L respectively. The average pH was 7.5 and the average net alkalinity was 96.4 mg/L.

According to available water quality data, SF-12 contributed an average of 0.5 percent of the metal load and 1.5 percent of the sulfate load relative to the 7 inputs sampled in the middle section of Sharp's Fork. Of the -seven inputs in the middle section, SF-12 was ranked the least important contributor of both metal and sulfate loadings.

SF-13-Tributary:

SF-13 is at 0 river miles, at 39.45836683 latitude -81.93212098 longitude, and is at an elevation of 693 feet. This tributary enters Sharp's fork at 5.01 river miles. The area of land above this point is 0.30 square miles and the length of the stream above this point is 0.8 miles.

Access: SF-13 is the mouth of a small tributary that enters Sharp's Fork at RM 5.01. It is located to the east of Sharp's Fork, and passes through a culvert under Old Grade Road. It is possible to park at the culvert and follow the stream to the mouth on foot.

Site Description: SF-13 is near the mouth of a small tributary draining land that has been strip-mined, and may not represent a discrete source of AMD. The strip-mined area has not yet been assessed, and it may contain numerous diffuse seeps.

SF-13 is characterized by a low discharge with high conductivity, and elevated sulfate and metal concentrations. SF-13 has a neutral pH, and is net alkaline. Discharge was 0.141 cfs on 5/19/03 (high flow) and 0.03 cfs on 8/19/03 (low flow). At high flow, the conductivity, sulfate, and metal concentrations were 1180 uS, 568 mg/L, and 3.12 mg/L, respectively. At low flow, these parameters measured 1350 uS, 815 mg/L, and 3.13 mg/L respectively. The average pH was 7.5 and the average net alkalinity was 72.9 mg/L.

According to available water quality data, SF-13 contributed an average of 23.5 percent of the metal load and 17 percent of the sulfate load relative to the 7 inputs sampled in the middle section of Sharp's Fork. Of the seven inputs in the middle section, SF-13 was ranked the second highest contributor of metal loadings and the fourth highest contributor of sulfate loadings. When compared with all 18

inputs into Sharp's Fork, SF-13 contributed 1.5 percent of the average total metal loading (Rank-seventh) and 2.5 percent of the average sulfate loading (Rank-tenth).

SF-14-Tributary:

SF-14 is at 0 river miles, at 39.46002192 latitude -81.93282078 longitude, and is at an elevation of 698 feet. This tributary enters Sharp's fork at 5.15 river miles. The area of land above this point is 0.17 square miles and the length of the stream above this point is 0.9 miles.

Access/Location: SF-14 is the mouth of a small tributary that enters Sharp's Fork at RM 5.15. It is located to the east of Sharp's Fork, and passes through a culvert under Old Grade Road. It is accessible by vehicle. It is possible to park at the culvert and follow the stream to the mouth on foot.

Site Description: SF-14 is the near the mouth of a small tributary draining land that has been strip-mined, and may not represent a discrete source of AMD. The strip-mined area has not yet been assessed, and it may contain numerous diffuse seeps.

SF-14 is characterized by a low discharge with high conductivity, and elevated sulfate and slightly elevated metal concentrations. SF-14 has a neutral pH, and is net alkaline. Discharge was 0.112 cfs on 5/19/03 (high flow) and 0.02 cfs on 8/19/03 (low flow). At high flow, the conductivity, sulfate, and metal concentrations were 1180 uS, 568 mg/L, and 3.12 mg/L, respectively. At low flow, these parameters measured 1350 uS, 815 mg/L, and 3.13 mg/L respectively. The average pH was 7.5 and the average net alkalinity was 72.9 mg/L.

According to available water quality data, SF-14 contributed an average of 5 percent of the metal load and 14.5 percent of the sulfate load relative to the 7 inputs sampled in the middle section of Sharp's Fork. Of the 7 inputs in the middle section, SF-14 was ranked the fifth highest contributor of metal loadings and the fifth highest contributor of sulfate loadings. When compared to all eighteen inputs sampled in Sharp's Fork, SF-14 contributed less than 1 percent of the average total metal loadings and 2 percent of the average sulfate loadings (Rank-eleventh).

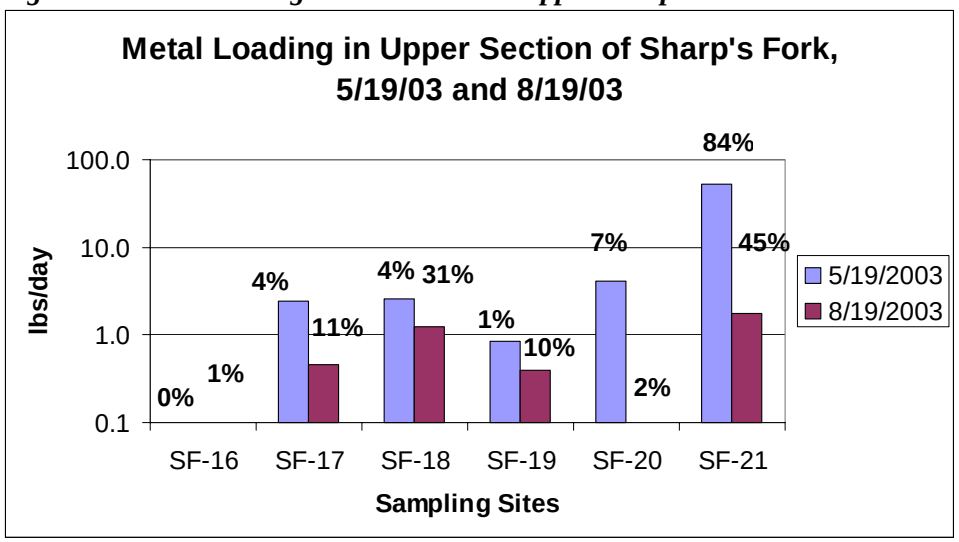
Upper Section of AMD impacted area of Sharp's Fork

The upper section begins with SF 15. SF15 is a point on the mainstem of Sharp's Fork below Joy and Tharp Hollow, at 5.25 river miles, at 39.46135137 latitude -81.93455818 longitude, and is at an elevation of 671 feet. Sharp's Fork is a tributary that enters Federal Creek at 9.3 river miles. The area of land above this point is 18.37 square miles and the length of the stream above this point is 1.0 miles.

The upper section of the AMD affected portion of Sharp's Fork begins at a sampling point on the mainstem (SF-22) above the Wrightstown Road Bridge, and extends down to a sampling point on the mainstem (SF-15) approximately 0.5 miles below Joy. The mouths of 6 tributaries into this upper section of Sharp's Fork were sampled for Group 1 parameters.

During both high and low flow, the metal inputs from these six tributaries exceeded the calculated metal load for the upper section. During high flow, the metal inputs exceeded the downstream output by 26.6 lbs/day, and during low flow, the metal inputs exceeded the downstream output by 2.38 lbs/day. This indicates that metals are being retained along the flow path in this area, most likely due to metal precipitation, adsorption, and sedimentation.

Figure 22 Metal Loading Contributions in Upper Sharps Fork



% indicated in graph represents % contribution relative to total loading of sampled tributaries.

Of the six tributaries sampled in this section of Sharp's Fork, SF-21, Anderson Hollow, is the heaviest loader under both high and low flow conditions. SF-21 metal loading is 52.1 lbs/day under high flow and 1.8 lbs/day under low flow conditions. The relative roles of the other tributaries change from high to low flow. Although SF-20 is the second largest contributor of metals during high flow, with a metal loading of 4 lbs/day, at low flow conditions SF-20 becomes a minor contributor, with a metal loading of 0.07 lbs/day. SF-18 is the third largest contributor at high flow, but becomes a much larger contributor at low flow. The importance of SF-17 and SF-19 also increases from high to low flow. SF-16 remains a negligible contributor under both flow conditions.

Individual Site Description

SF-21: Wrightstown Rd. Anderson Hollow Tributary

SF-21 is at 0 river miles, at 39.48590448 latitude -81.96105581 longitude, and is at an elevation of 464 feet. This tributary enters Sharp's fork at 7.26 river miles. The area of land above this point is 0.92 square miles and the length of the stream above this point is 0.9 miles.

Access: SF-21 enters Sharp's Fork approximately 35 meters downstream of the Wrightstown Road Bridge over Sharp's Fork. The section leading to the mouth parallels Wrightstown Road. To access, the mouth of this tributary, it is necessary to park on Wrightstown Road and walk a short way. This

tributary is very small so that will help to distinguish it from the mainstem of Sharp's Fork. The land is owned by Craig and Sherrie Downs, who are supportive of any monitoring and reclamation efforts.

Description: Along the main channel of SF-21, there is visible white and black coating on the streambed sediments downstream of the confluence of the mining tributaries. These two tributaries were sampled during Phase I reconnaissance for field parameters, and were sampled for Group I parameters during Phase II sampling in summer of 2004. The area drained by SF-21 was strip-mined. There were six sites sampled within Anderson Hollow in 2004.

SF-21 appears to be a significant source of metal loading in Sharp's Fork, contributing an average metal loading of 26.94 lbs/day, which is 64.5% of the loading in the upper section of Sharp's Fork, and 18.5% of the loading in the AMD affected area of the Sharp's Fork subwatershed. Aluminum, and manganese to a lesser degree, dominate the metal load, and the high flow metal loading appears to be more significant than the low flow metal loading, both in terms of percent contribution to the upper section of Sharp's Fork and to the entire AMD affected area of Sharp's Fork. During spring flow, the Al concentration was 10.4 mg/L, thus contributing an Al load of 40.74 lbs/day, and the Mn concentration was 2.2 mg/L, contributing a Mn load of 8.63 lbs/day. Fe concentrations were much lower at 0.69 mg/L, contributing 2.71 lbs/day. During low flow, the concentrations and loadings were less, with an Al concentration of 2.06 contributing 0.98 lbs/day, Mn concentration of 1.59 mg/L contributing 0.76 lbs/day, and Fe concentration of 0.09 mg/L contributing 0.04 lbs/day.

Although SF-21 is net alkaline during both high and low flow (66 mg/L and 17.7 mg/L CaCO3, respectively), the net alkalinity is far below typical alkalinity values for the area. The pH of the tributary is also lower than typical values for Sharp's Fork, with an average pH of 6.77. Tributary 21 also appears to be a significant source of sulfate for this section.

Tributary 21	High Flow	Low Flow	Average
Metal Load (lbs/day)	52.1	1.78	26.94
Sulfate Load (lbs/day)	1835.6	178.28	1006.9
Acidity (mg/L)	10.4	7	8.7
Net Alkalinity (mg/L)	17.70	66.00	41.85
Discharge (cfs)	0.728	0.088	0.408
pH	6.49	7.05	6.77
% Metal Contribution*	84	45	64.5
% Metal Contribution in SF**	34	3	18.5

* % Contribution in Upper Section of Sharp's Fork** % Contribution in Entire AMD region of Sharp's Fork

SF- 20 – AMD affected tributary:

SF20 is at zero river miles, at 39.47545208 latitude -81.95114957 longitude, and is at an elevation of 713 feet. This tributary enters Sharp's fork at seven river miles. The area of land above this point is 0.28 square miles and the length of the stream above this point is 0.4 miles.

Access: SF- 20 is the mouth of a tributary that enters Sharp's Fork at RM 7**.** Sampling was conducted at the mouth, which is a short walk from a gas access road off Old Grade Road north of Joy. The land is owned by Marshall and Betty Lowe.

Description: SF-20 drains an approximate area of .284 square miles. The land is affected by strip mining and has not been investigated. The discharge at high flow was 0.352 cfs, and 0.078 cfs at low flow. The average pH was 7.36, and the average conductivity was 1175 uS. SF-20 is net alkaline, with an average net alkalinity concentration of 89.6 mg/L. Metal loadings were 4.06 lbs/day at high flow and 0.07 lbs/day at low flow. Although SF-20 was the second largest contributor of metals in the upper section of Sharp's Fork during high flow, the contribution value was low at 7 percent. At low flow, the metal contribution of SF-20 dropped to 2 percent. SF-20 is the second largest contributor of sulfate, contributing an average of 31 percent of the sulfate load in the upper section of Sharp's Fork. SF-20 contributes 8 percent of the sulfate load at high flow for the entire AMD region of Sharp's Fork, and 4 percent at low flow.

SF - 20	Low Flow	High Flow	Average
Metal Load (lbs/day)	0.07	4.06	2.07
Sulfate Load (lbs/day)	1266.2	258.3	762.3
% Metal Contribution*	7	2	4.5
% Metal Contribution in SF**	3	0	1.5

*** % Contribution in Upper Section of Sharp's Fork**

**** % Contribution in Entire AMD region of Sharp's Fork**

SF-19 – AMD affected tributary:

SF-19 is at 0 river miles, at 39.46994525 latitude -81.94241244 longitude, and is at an elevation of 729 feet. This is a tributary that enters Sharp's Fork at 6 river miles. The area of land above this point is 0.06 square miles. This small tributary is not mapped therefore the stream length above this point in not available.

Access: SF-19 is the mouth of a small tributary that enters Sharp's Fork at approximately RM 6. It is located on Marshall and Betty Lowe's land, and accessible by foot.

Description: SF-19 drains an approximate area of 0.063 square miles. The AMD impact is due to stripmining of this area. The discharge is 0.026 cfs at high flow and 0.004 cfs at low flow. At high flow, SF-19 has a pH of 4.43, a net acid concentration of 47.6mg/L, and an acid loading of 6.69 lbs/day. At low flow, SF-19 has a pH of 4.24, a net acid concentration of 54.1 mg/L, and an acid load of 1.46 lbs/day. At high flow the metal load is 0.86 lbs/day, which accounts for 1 percent of the metal load, and at low flow the metal load is 0.04 lbs/day, which accounts fOR-10 percent of the metal load in the upper section of Sharp's Fork. When ranked with all tributaries sampled for Sharp's Fork, SF-19 contributed 1 percent of the metal load at both low and high flow.

SF-19	Low Flow	High Flow	Average
Metal Load (lbs/day)	0.04	0.86	0.45
Acid Load (lbs/day)	1.46	6.69	4.08
% Metal Contribution*	1	10	5.5
% Metal Contribution in SF**	1	1	1

*** % Contribution in Upper Section of Sharp's Fork** % Contribution in Entire AMD region of Sharp's Fork**

SF-18 – AMD affected tributary:

SF-18 is at 0 river miles, at 39.46930328 latitude -81.94287387 longitude, and is at an elevation of 712 feet. This tributary enters Sharp's Fork at 5.98 river miles. The area of land above this point is 0.03 square mile. This small tributary is not mapped, therefore the stream length above this point in not available.

Access: SF-18 is at the mouth of a small tributary that enters Sharp's Fork at RM5.98. It is located on Marshall and Betty Lowe's land, and is accessible by foot.

Description: SF-18 has a drainage area of 0.03 square miles. The specific sources of AMD have not been evaluated. The discharge of SF-18 is 0.017 cfs at high flow and 0.006 cfs at low flow. The average pH was 3.2, and the average conductivity was 2080 uS. At low flow, the net acid concentration was 243 mg/L, contributing an acid load of 7.9 lbs/day, and at high flow, the net acid concentration was 192 mg/L, contributing an acid load of 17.8 lbs/day. SF-18 has a high average aluminum concentration at 26.45 mg/L (Fe-2.82, Mn-3.58), and is the second largest contributor of metals in the upper section of Sharp's Fork. The percent metal load contribution increased significantly during low flow. When compared to all eighteen inputs into Sharp's Fork, SF-18 contributed 2 percent of the average metal load (Rank-sixth) and less than 1 percent of the average sulfate load.

SF-18	Low Flow	High Flow	Average
Metal Loading (lbs/day)	1.23	2.58	1.91
Acid Loading (lbs/day)	7.9	17.8	12.85
% Metal Contribution*	4	31	17.5
% Metal Contribution in SF**	2	2	2

*** % Contribution in Upper Section of Sharp's Fork** % Contribution in Entire AMD region of Sharp's Fork**

SF-17 – AMD impacted tributary

SF-17 is at 0 river miles, at 39.46494117 latitude -81.93898114 longitude, and is at an elevation of 720 feet. This tributary enters Sharp's fork at 5.5 river miles. The area of land above this point is 0.34 square miles and the length of the stream above this point is 0.8 miles.

Access: SF-17 is a small tributary on the west side of Sharp's Fork. It is accessible by foot.

Site Description: SF-17 is the mouth of a small tributary draining land that has been strip-mined, and may not represent a discrete source of AMD. The strip-mined area has not yet been assessed, and it may contain numerous diffuse seeps.

SF-17 is characterized by a low discharge with high conductivity and elevated sulfate and metal concentrations. SF-17 has a neutral pH and is net alkaline. Discharge was 0.365 cfs on 5/19/03 (high flow) and 0.084 cfs on 8/19/03 (low flow). At high flow, the conductivity, sulfate, and total metal concentrations were 1180 uS, 625 mg/L, and 1.22 mg/L, respectively. At low flow, these parameters measured 1200 uS, 491 mg/L, and 1.00 mg/L respectively. The average pH was 7.7 and the average net alkalinity was 89.5 mg/L.

According to available water quality data, SF-17 contributed an average of 7.5 percent of the metal load and 28.5 percent of the sulfate load relative to the 7 inputs sampled in the middle section of Sharp's Fork. Of the 7 inputs in the middle section, SF-17 was ranked third highest contributor of both metals and sulfate. When compared with all eighteen inputs into Sharp's Fork, SF-17 contributed ranked eighth in terms of both metal and sulfate loadings. On average, SF-17 contributed 1percent of the metal load and 1.5 percent of the sulfate load.

SF-16-AMD impacted input

SF-16 is at 0 river miles, at 39.46204648 latitude -81.9346762 longitude, and is at an elevation of 578 feet. This is a tributary that enters Sharp's Fork at 5.3 river miles. The area of land above this point is 0.11 square mile. This small tributary is not mapped therefore the stream length above this point in not available.

Access/Location: SF-16 is located on the west side of Sharp's Fork, approximately 0.5 mile downstream of Joy. The sample site is located approximately 200 feet from Old Grade Road.

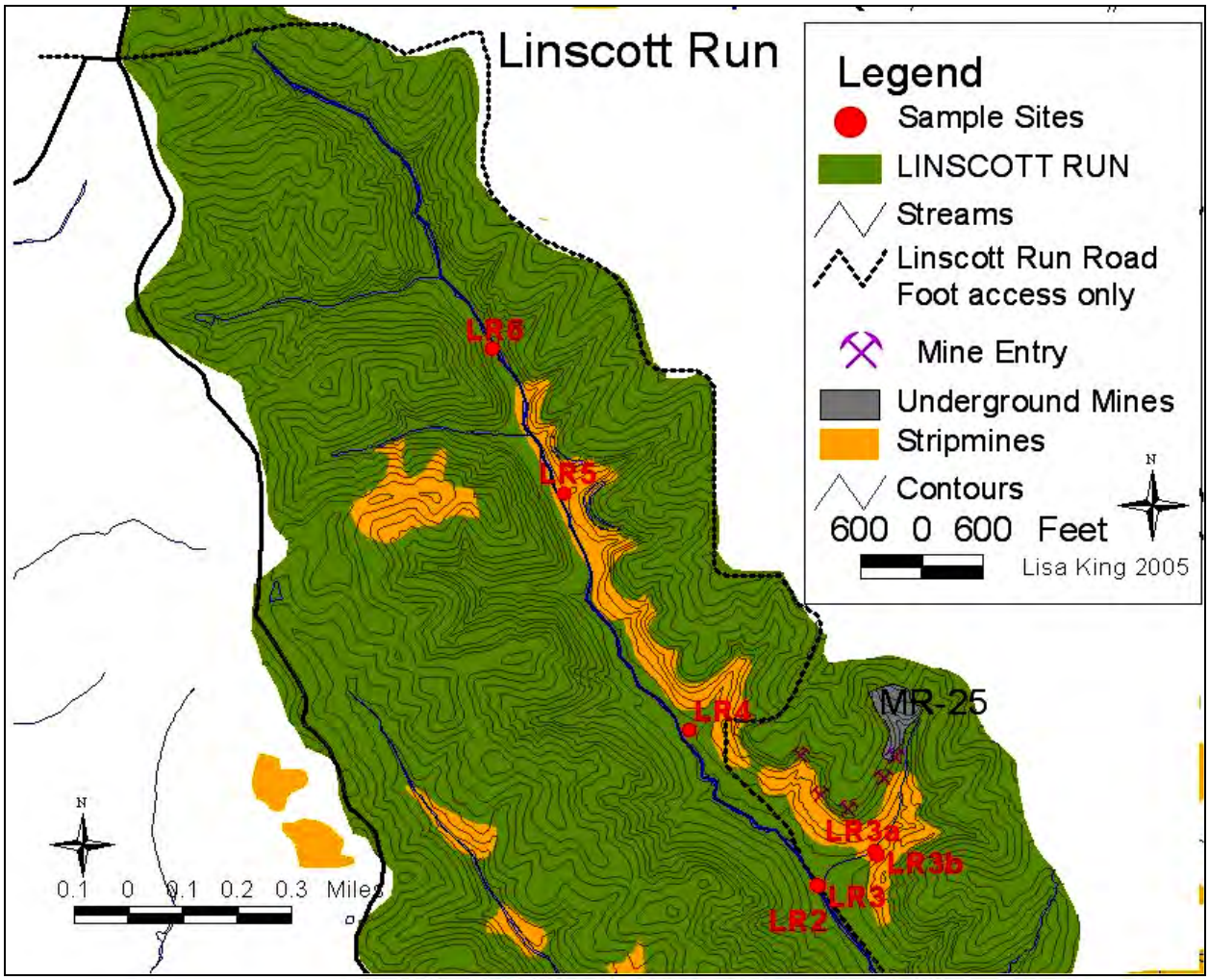
Site Description: SF-16 is a very low volume input into Sharp's Fork, contributing 0.004 cfs (2 gpm) on 5/19/03 and 0.007 cfs (3.2 gpm) on 8/19/03. The 8/19/03 had a higher discharge than the 5/19/03 sampling date, which is the opposite trend of the other sites within Sharp's Fork.

SF-16 is characterized by a neutral pH and a high net alkalinity. SF-16 also has a high conductivity, and moderately elevated levels of sulfate and metals. On the 5/19/03 sampling date, SF-16 had a conductivity of 748 uS, sulfate concentrations of 305 mg/l, and a total metal concentration of 0.72 mg/L. On the 8/19/03 sampling date, SF-16 had a conductivity of 1530 uS, sulfate concentrations of 791 mg/l, and a total metal concentration of 1.16 mg/L. AMD parameters appear to become more severe on the 8/19/03 sampling date, although the discharge was higher.

SF-16 ranks as the lowest contributor in the upper section of Sharp's Fork, contributing only 0.5 percent of the total metal loading and 2 percent of the total sulfate loading.

LINSCOTT RUN BASIN ASSESSMENT

Map 13 Linscott Run



Pictures of Linscott Run

Stobert Mine, low flow high acid

Geographic Background

Linscott Run occupies the central portion of the watershed and flows in a southern direction, entering Federal Creek at 11.93 river miles. It is located in Athens and Morgan Counties, crossing Homer, Bern, and Ames Townships and is near Amesville (0.4 miles north). This subwatershed can be found on the Amesville USGS quad sheets. Linscott Run has a drainage area of 5.06 square miles, and a stream length of 8.4 miles. In this subwatershed, 0.01 square mile has been underground mined, representing 0.14 percent of the total land. Additionally, in this subwatershed, there is 0.12 square mile that has been strip-mined, which is 2.5 percent of the total land.

Mining Impacts In Brief

Linscott Run only has abandoned mines in the northern quarter of the subwatershed. Mining has taken place between river mile 3.8 and 5.0. Impact of mine drainage has been determined to be negligible to the mainstem of Linscott Run. No further study of this area is recommended at this time.

Table 35 Linscott Run underground mine information

Mine number	**Mine Name**	**Date Abandoned**	**Type**	**Coal elevation**
MN-25	Stobert	1951	underground	

AMD Impacts to Linscott Run

Biology Investigation for Linscott Run

Table 36 Biology Data for Linscott Run

by MBI in the Hocking River watershed during 2004.

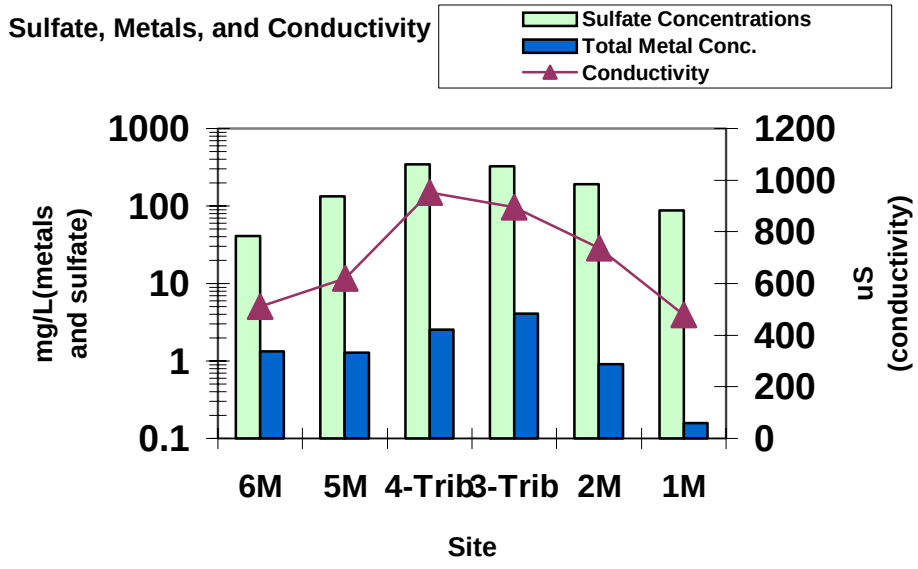
Station (Map #)	Fish RM	Macro RM	IBI	MIwb	ICI or Narrative Rating	QHEI	Aquatic Life Uses Ex/Rec	Attain-ment Status	Comment
Linscott Run									
S01180 3.70204	3.80	3.70	38*	NA	VG ns	68.0	EWH	**Partial**	Upstream Site
S01180 0.80204	0.80	0.80	50	NA	MG*	73.5	EWH	**Partial**	St. Rt. 329

Ecoregion Biocriteria: Western Allegheny Plateau (WAP)					
Index and Site Type	**WWH**	**EWH**	**MWH**	**LRW-AMD**	
IBI – Wading & Headwater	**44**	**50**	**24/24**	**18**	
Mod. Iwb - Wading	**8.4**	**9.4**	**6.2/5,5**	**4.0**	
ICI/Narrative	**36/G**	**46/E**	**22/30**	**8/MF**	

Mainstem Linscott Run

In the chart below the average combined metals (iron, magnesium, and aluminum), sulfate, and conductivity are displayed. Site 1M is at the mouth of Linscott Run, 3.8 river miles from the abandoned mines. Site 2M is on the mainstem just below the abandoned mines. The underground mine and some strip mining are located on the tributary labeled 3 in the chart. The tributary labeled 4 originates in a strip-mined area. 6M is on the mainstem located above all of the abandoned mines. Mine drainage is diffuse throughout this upper area. Some of the mainstem sites and the tributaries 3 and 4 do have metal and sulfate parameters above the Federal Valley Targets. However the mainstem site that is below all of the mining located at river mile 3.8 has all of the parameters below the target during both low and high flow. The biological study of this site shows that the macroinvertebrates scored a 'very good'. The IBI score was low, scoring a modified water habitat, but the drainage basin is only 1.2 square miles above this point, which possibly could affect the ability of fish to live in this area. In the biological study conducted by MBI, fine sediments are listed as the cause of impairment in this stream, perhaps some of that is from abandoned mines but there is also farming and development in this watershed.

Figure 23 Metal, Sulfate and Conductivity Linscott Run



Investigation of Linscott Run

A phase I water quality investigation was conducted in the Linscott Run subwatershed on 4/14/03. Preliminary field observations identified strip pits and gob piles from surface mining in the headwaters of Linscott Run. An underground mine was also identified at the headwaters but was not impacting the tributary. Field parameters did not show a significant impact from surface/underground mining in Linscott Run. A phase II water quality investigation was conducted in Linscott Run on 5/14/03 and 9/30/03; two tributaries and four mainstem sites were sampled.

Individual Site Descriptions

Location LR-1 is a point on the mainstem of Linscott Run at 0.0 river miles, at 39.40865736 latitude -81.95916971 longitude, and is at an elevation of 629 feet. Linscott Run is a tributary that enters Federal Creek at 11.93 river miles. The area of land above this point is 5.06 square miles and the length of the stream above this point is 5.8 miles.

Access to LR-1, located at the intersection of Linscott Run Road and State Route 329 is accessible by parking and walking twenty feet.

Location: LR-2 is a point on the mainstem of Linscott Run at 3.74 river miles, at 39.45364891 latitude -81.94955206 longitude, and is at an elevation of 794 feet. Linscott Run is a tributary that enters Federal Creek at 11.93 river miles. The area of land above this point is 1.30 square miles and the length of the stream above this point is 2.0 miles.

Access to LR-2 requires driving north on Linscott Run, past the last house on the left.

Location LR-3 is at 0 river miles, at 39.45363642 latitude -81.94952155 longitude, and is at an elevation of 744 feet. This is a tributary that enters Linscott Run at 3.78 river miles. The area of land above this point is 0.137 square miles and the length of the stream above this point is 0.403 miles.

Access to LR-3 requires walking from the car as a culvert has rusted that makes the road impassable. The tributary should be visible flowing toward Linscott Run on the right. Marshall and Betty Lowe own this land.

Location: LR-3a is at 0.15 river miles, at 39.45457092 latitude -81.94759078 longitude, and is at an elevation of 735 feet. This tributary enters Linscott Run at 3.78 river miles. The area of land above this point is 0.04 square mile. This small tributary is not mapped, therefore the stream length above this point in not available.

Access to LR-3a requires following LR 3 to a location where a tributary diverges from the left, cutting through coal refuse. This tributary is LR-3a.

Location: LR-3b is at 0.15 river miles, at 39.45445835 latitude -81.94751057 longitude, and is at an elevation of 738 feet. This tributary enters Linscott Run at 3.78 river miles. The area of land above this point is 0.12 square mile and the length of the stream above this point is 0.3 miles.

Access to LR-3b requires following LR 3 to a location where a tributary diverges from the left. LR-3b is located immediately upstream of this tributary.

Location of LR-4 is at 0.0 river miles, at 39.45788889 latitude 81.95390655 longitude, and is at an elevation of 772 feet. This tributary enters Linscott Run at 4.2 river miles. The area of land above this point is 0.06 square miles. This small tributary is not mapped therefore the stream length above this point in not available.

Access to LR-4 requires walking 0.5 river miles up stream from LR-3. In this vicinity, a tributary will be visible originating in the strip-mined area to the left.

Location: LR-5 is a point on the mainstem of Linscott Run at 4.7 river miles, at 39.46430155 latitude -81.95811871 longitude, and is at an elevation of 817 feet. Linscott Run is a tributary that enters Federal Creek at 11.93 river miles. The area of land above this point is 0.68 square miles and the length of the stream above this point is 1.1 miles.

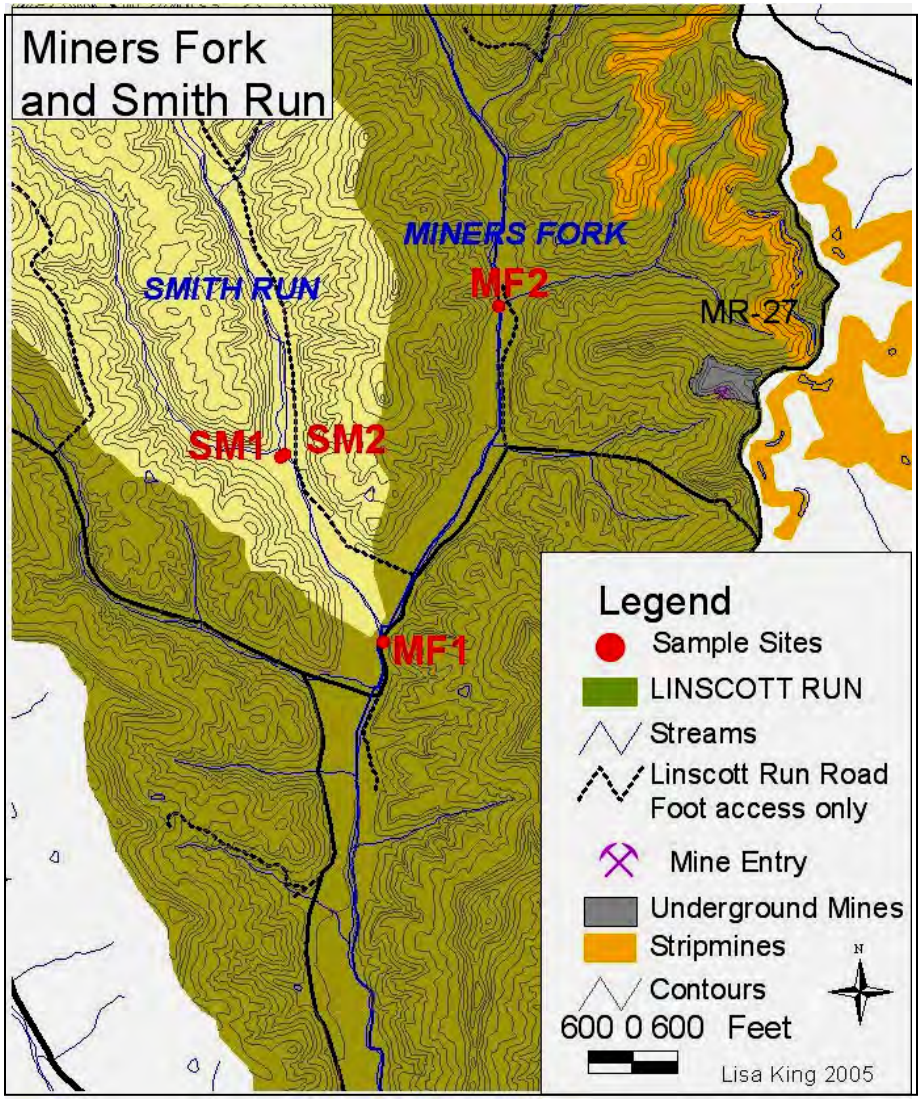
Access to LR-5 requires walking up Linscott Run. This site is located on the mainstem below an area with diffuse mine seeps originating in the bank of the stream.

Location: LR-6 is a point on the mainstem of Linscott Run at 5 river miles, at 39.46822914 latitude -81.96058877 longitude, and is at an elevation of 843 feet. Linscott Run is a tributary that enters Federal Creek at 11.93 river miles. The area of land above this point is 0.44 square miles and the length of the stream above this point is 0.8 miles.

Access to LR-6 requires walking up Linscott Run. This site is located on the mainstem above all mining impacts.

MINERS FORK/ SMITH RUN BASIN ASSESSMENT

Map 14 Miners Fork/ Smith Run



Pictures of Miners Fork

Geography Background

Smith Run occupies the northwest portion of the watershed and flows in a southeast direction, entering Miners Fork at 2.4 river miles. It is located in Morgan County, crosses Homer Township, and is near Glouster (2 miles W). This subwatershed can be found on Corning, Ringgold, Amesville, and Jacksonville USGS quad sheets. Smith Run has a drainage area of 2.93 square miles, and a stream length of 3.5 miles. There are no underground mines in this subwatershed, but there are 0.19 square miles that have been strip-mined, which is 6.4 percent of the land in the entire subwatershed.

Miners Fork occupies the northwest portion of the watershed and flows in a south/southeast direction, entering Federal Creek at 16.21 river miles. It is located in Athens and Morgan Counties, crossing Homer and Ames Townships and is near Joy (1.3 miles E). This subwatershed can be found on Corning, Ringold, Amesville, and Jacksonville USGS quad sheets. Miners Fork has a drainage area of 7.02 square miles, and has a stream length of 6.6 miles. In this subwatershed, there 0.02 square mile that has underground mines, which is 0.2 percent of the land in the entire subwatershed. Additionally, in this subwatershed there are 0.4 square miles that have been strip-mined, which is 3.6 percent of the land in the entire subwatershed.

Mining Impacts in Brief

Miners Fork only has abandoned mines in the northern quarter of the subwatershed. Mining has taken place between river mile 2.4 and 4.0. Impact of mine drainage has been determined to be negligible to the mainstem of Miners Fork. No further study of this area is recommended at this time.

Table 37 Miners Fork underground mine information

Mine number	Mine Name	Date Abandoned	Type	Coal elevation
MN-227	Hogsett	1969	underground	

AMD Impacts to Miners Fork

Biology Investigation

Table 38 Biology Data for Miners Fork

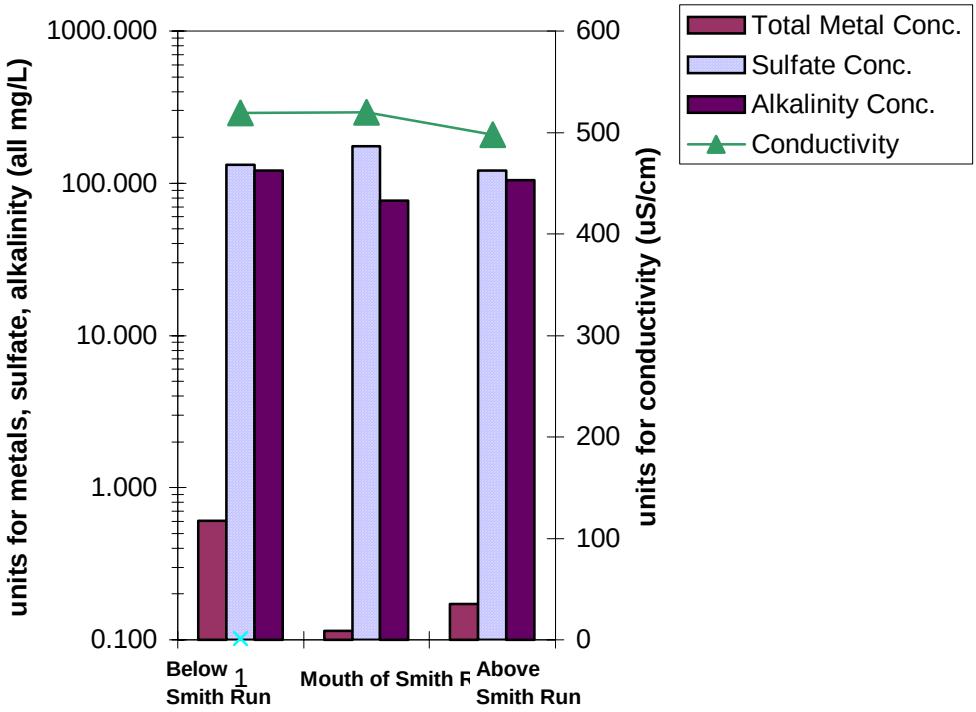
by MBI in the Hocking River watershed during 2004.

Station (Map #)	Fish RM	Macro RM	IBI	MIwb	ICI or Narrative Rating	QHEI	Aquatic Life Uses Ex/Rec	Attain-ment Status	Comment
S01192 2.202004	2.25	2.20	44*	NA	G*	56.5	EWH	**Non**	Wrightstown Rd.
S01192 0.102004	0.05	0.10	46^{ns}	NA	G*	58.5	EWH	**Partial**	St. Rt. 329, at mouth

Mainstem Miners Fork

In the chart below the average combined metals (iron, magnesium, and aluminum), sulfate, alkalinity, and the conductivity are displayed. There is data from three sites, Miners Fork below Smith Run, Miners Fork above Smith Run and the mouth of Smith Run. There is strip mining and one small underground mine in this area (see map at the beginning of section). All parameters are below the Federal Valley Watershed target. Miners Fork is not attaining its Exceptional Warmwater Habitat use designation at the site below Smith Run. Miners Fork is partially attaining its Exceptional Warmwater Habitat use designation at the site at the mouth of Miners Fork.

Figure 24 Metal, Sulfate and Conductivity Miners Fork



Investigation of Smith Run and Miners Fork

Smith Run

A phase I water quality investigation was conducted in the Smith Run subwatershed on 5/9/03 and 5/22/03. Preliminary field observations identified surface mining in the headwaters of Smith Run. Field parameter data collected did not show a significant impact from surface mining on the mainstem of Smith Run. A phase II water quality investigation was conducted in Smith Run on 9/30/03; one tributary site and one mainstem site were sampled.

Miners Fork

A phase I water quality investigation was conducted in the Miners Fork subwatershed on 5/22/03. Preliminary field observations identified surface mining and 2 tributaries flowing into the mainstem of

Miners Fork with high conductivity readings. A phase II water quality investigation was conducted in Miners Fork on 9/30/03; two mainstem sites were sampled.

Individual Site Description

Location/Access: SM1 is a point on the mainstem of Smith Run at 0.5 river miles, at 39.49038737 latitude -81.99947468 longitude, and is at an elevation of 717 feet. Smith Run is a tributary that enters Miners Fork at 2.4 river miles. The area of land above this point is 2.84 square miles and the length of the stream above this point is 3.1 miles.

Location/Access: SM2 is at 0.45 river miles, at 39.49029987 latitude -81.99965162 longitude, and is at an elevation of 714 feet. This tributary enters Smith Run at 0.52 river miles. The area of land above this point is 0.611 square miles and the length of the stream above this point is 1.577 miles.

Location/Access: MF1 is a point on the mainstem of Miners Fork at 2.4 river miles, at 39.48357062 latitude -81.99492171 longitude, and is at an elevation of 648 feet. Miners Fork is a tributary that enters Federal Creek at 16.21 river miles. The area of land above this point is 7.23 square miles and the length of the stream above this point is 4.7 miles.

Location/Access: MF2 is a point on the mainstem of Miners Fork at 3.1 river miles, at 39.49575741 latitude -81.98944456 longitude, and is at an elevation of 753 feet. Miners Fork is a tributary that enters Federal Creek at 16.21 river miles. The area of land above this point is 3.69 square miles and the length of the stream above this point is 4.0 miles.

FUNDING OPPORTUNITIES

Ohio Department of Natural Resources, Division of Mineral Resources Management

1) Federally Funded Abandoned Mine Land Program: Federal excise taxes on coal are returned to the State of Ohio for reclamation of abandoned mine land sites that adversely affect the public's health and safety.
2) Acid Mine Drainage Set-Aside Program: Up to ten percent of Ohio's federal excise tax monies are set aside for acid mine drainage abatement. Priority is given to leveraging these funds with watershed restoration groups and other governmental agencies.
3) State Abandoned Mine Land Program: State excise taxes on coal and industrial minerals are dedicated to reclamation projects that improve water quality in impacted streams. Priority is given to leveraging these funds with partners.

Office of Surface Mining (OSM), Reclamation and Enforcement

1) Appalachian Clean Streams Initiative: The mission of ACSI is to facilitate and coordinate citizens groups, university researchers, the coal industry, corporations, the environmental community, and local, state, and federal government agencies that are involved in cleaning up streams polluted by acid mine drainage. OSM provides funds for ACSI projects on an annual basis.
2) Direct grants to Watershed Groups: A grant process for directly funding citizen watershed group efforts to restore acid mine drainage impacted streams on a project basis.

Environmental Protection Agency

1) EPA Section 319 Non-point Source Grant Program: Funding is available for planning, education and remediation of watershed pollution problems including acid mine drainage.
2) Office of Water – Watershed Protection and Flood Prevention/PL566 Program: This program provides technical and financial assistance to address resources and related economic problems on a watershed basis that address watershed protection, flood prevention, water supply, water quality, erosion and sediment control, wetland creation and restoration, fish and wildlife habitat enhancement, and public recreation. Technical assistance and cost sharing with varied amount are available for implementation of NRCS-authorized watershed plans.

United States Army Corps of Engineers

1) Section 905b – Water Resource Development Act (86): Recent additions to the Army Corps conventional mission include a habitat restoration grant program for the completion of feasibility studies and project construction where a Federal interest can be verified. A principle non-federal sponsor must be identified for this cost-share program.
2) Flood Hazard Mitigation and Ecosystem Restoration Program/Challenge 21: This watershed based program assists in groups involved in mitigating flood hazards and restoration of riparian ecosystems. Assistance is provided nonstructural solutions in flood-prone areas, while retaining traditional measures where appropriate. Cost-share between federal and local governments Federal share is 50 percent for studies and 65 percent for project implementation, up to a maximum federal allocation of $30 million.
3) Section 206 Aquatic Ecosystems Restoration Project under the Water Resources Development Act of 1996. Annual appropriation of $25 million. The maximum Federal cost-share is $5 million. 100% federal for study costs, 35% of the study costs are recovered from the non-federal sponsor during the first year. Both programs have a 65/35 cost-share ratio during construction.

United States Fish and Wildlife Service

1) Partners for Fish and Wildlife Program: This program assists private landowners by providing technical and financial assistance to establish self-sustaining native habitats.

2) Clean Water Action Plan Fund: The purpose of this fund is to restore streams, riparian areas and wetlands resulting in direct and measurable water quality improvements.
3) Five Star Challenge Restoration Grants: The purpose of this program is to provide modest financial assistance to support community-based wetland and riparian restoration projects that build diverse partnerships and foster local natural resource stewardship.

Ohio Division of Wildlife

1) Wildlife Diversity Fund: This fund financially assists with research, surveys (biological or sociological), management, preservation, law enforcement, education, and land acquisition.

Lindbergh Foundation

1) Lindbergh Grants: This program financially assists organizations that are making significant contributions toward the balance between technology and nature through the conservation of natural resources. The Lindbergh Grants provides a maximum grant of $10,580. The program is considered a provider of seed money and credibility for pilot projects that subsequently receive larger sums from other sources.

The Acorn Foundation

1) The Acorn Foundation supports projects dedicated to building a sustainable future for the planet and to restoring a healthy global environment. The Acorn Foundation funds community-based projects which; preserve and restore habitats supporting biological diversity and wildlife; advocate for environmental justice, particularly in low-income and indigenous communities; and prevent or remedy toxic pollution.

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APPENDIX 1 LOCATIONS OF 2004 TMDL SITES

RM	Stream	Description	AMD Site	Longitude	Latitude
0.4	Big Run	Mouth		-81.87615071	39.35453558
1.7	Big Run	downstream Ellis Run		-81.85298534	39.35228221
3.9	Big Run	Downstream Wildcat Hollow		-81.81555166	39.36049324
1.2	Bryson Branch	Haward Rd and Bryson Rd		-82.01967258	39.41301881
0.9	Federal Creek	Sharps Run Bridge near mouth		-81.88776437	39.33049033
4.9	Federal Creek	Near Mayle Ridge Bridge, Broadwell	x	-81.87891421	39.36457212
9.1	Federal Creek	below Sharps Fork	x	-81.93014312	39.3996047
9.3	Federal Creek	above Sharps Fork		-81.93303532	39.40327681
11.3	Federal Creek	Below McDougall- Amesville		-81.9547213	39.39671365
11.4	Federal Creek	550 bridge Amesville, above McDougall		-81.95543977	39.40100986
11.7	Federal Creek	Below Linscott Run, above Amesville		-81.96005221	39.40447895
16.15	Federal Creek	below Hyde/Miners		-81.98986145	39.44968809
1.8	Hyde Fork	past Cable farm		-82.01217378	39.47096845
1.7	Kassler Creek	on Hines Farm		-81.97584139	39.42703701
0.8	Linscott Run	above cows,		-81.95134785	39.41463674
3.8	Linscott Run	below mining	x	-81.94972013	39.45379513
0.1	Marietta Run	Near Mouth	x	-81.87942319	39.37083327
1.6	Marietta Run	Below large seep	x	-81.88751349	39.38792547
3.2	Marietta Run	down stream Brill Run, above all mining		-81.86767976	39.39898941
0.5	McDougall Branch	SR 550, east of Amesville		-81.96254154	39.39664177
1.7	McDougall Branch	Below Brawley		-81.97344724	39.39425973
2.9	McDougall Branch	below Mush- SR-690 bridge- refrence site		-81.99002849	39.38255809
4.6	McDougall Branch	below Bryson Branch		-82.01077139	39.39402234
4.9	McDougall Branch	above Bryson Branch, below Lucas farm		-82.01681383	39.39687976
0	Miners Fork	near mouth	x	-81.98979365	39.45404123
2.2	Miners Fork	below Smith Run	x	-81.99574966	39.48139389
1	Mush Run	below Dutch Creek		-81.98714129	39.37140986
1.8	Mush Run	above dutch creek, near Mush Run Rd.		-81.979447	39.36382399
0.2	Opossum Run	bridge in Sharpsburg	x	-81.91274194	39.43662386
0.75	Opossum Run	Gifford St Forest	x	-81.90475611	39.44194719
2.6	Opossum Run	Compressor Rd		-81.89865416	39.46144488
4.1	Opossum Run	Possum Hollow Rd		-81.90886118	39.48817714
0.1	Sharps Fork	Near mouth		-81.92863457	39.40468926
1.6	Sharps Fork	below Sulphur	x	-81.91982814	39.41938486
1.65	Sharps Fork	Above Sulphur below Opossum	x	-81.91844598	39.42426327
5.3	Sharps Fork	Below Joy, in Lowes land	x	-81.93593346	39.46205327
8.05	Sharps Fork	below anderson hollow, near writes town	x	-81.95943852	39.484315
9.1	Sharps Fork	mountville area, mountville Rd, C-4		-81.9601315	39.50035074
10.7	Sharps Fork	Pounds Rd.		-81.96433305	39.52062165
0	Sulphur Run	Mouth	x	-81.91449105	39.42174663
0.8	Sulphur Run	below tipple, Culvert	x	-81.90960248	39.42136614
0.4	Wyatt Run	Emma Wyatt Rd bridge		-81.96478186	39.38410863