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of Engineers
Huntington District

Hocking River Basin, Ohio Monday Creek Subbasin Ecosystem Restoration Project

Final Feasibility Report and Environmental Assessment



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U.S. Army Corps of Engineers
Huntington District
Huntington, West Virginia

HOCKING RIVER BASIN, OHIO
MONDAY CREEK SUBBASIN
ECOSYSTEM RESTORATION PROJECT

FINAL FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

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1.0 EXECUTIVE SUMMARY

In accordance with the requirements of the National Environmental Policy Act (NEPA), the U.S. Army Corps of Engineers, Huntington District has prepared this Final Feasibility Report and Environmental Assessment pursuant to an adopted resolution in March 1996, requesting the Assistant Secretary of the Army to study and recommend for implementation ecosystem restoration projects that relate to former resource extraction activities. This report is an evaluation of the Monday Creek Watershed stream ecosystem and the potential impacts to the natural, physical, and human environment associated with the proposed ecosystem restoration alternatives.

The Monday Creek Watershed (HUC 05030204 060) is located entirely within the State of Ohio in the counties of Hocking, Athens and Perry. Monday Creek drains a 116 square mile (724,240 acres) area in the unglaciated portion of the Allegheny Plateau region of southeastern Ohio. The main stem of Monday Creek runs 27 miles before eventually emptying into the Hocking River. The watershed comprises roughly 10 percent of the Hocking River system, which itself is part of the Greater Ohio River Watershed.

Problems identified in the watershed include impacts to 235 acres of the aquatic ecosystem from past coal mining activities. Underground mining has caused the generation of Acid Mine Drainage (AMD) and subsidence impacts in the watershed that have affected the flora and fauna of the watershed. This report identifies sources of AMD and locations of subsided areas and recommends restoration alternatives that will restore the aquatic ecosystem.

Detailed project studies included consideration of a number of AMD restoration alternatives including limestone leach beds, slag leach beds, limestone dumping, aerobic wetland complexes, limestone ponds, open limestone channels, low head dams, diversions, inundation, mine sealing, limestone drains and limestone dosers. Various alternatives were found to effectively reduce acidity and metals entering the ecosystem. More detailed evaluations determined that combinations of the alternative methods were functional in abating the impacts of AMD. These alternatives along with the No Action alternative have been evaluated in detail and the results documented in this report and in the Environmental Assessment (EA).

Project formulation determined seven Plan Combinations were considered to be the "Best Buy Plans." Plan Combination 6 was identified as the National Ecosystem Restoration Plan (NER). The Recommended Plan is Plan Combination 6, the NER Plan, and addresses AMD impacts in seven of the major subwatersheds within Monday Creek and includes connectivity of the aquatic resources with the headwaters. The Recommended Plan successfully reduces the toxic concentrations of iron, aluminum, acidity, and increases pH which meet the water quality thresholds in the mainstem of Monday Creek. The minimum resource requirements considered necessary to support the aquatic ecosystem will exist in 98% of the watershed except for Monkey Hollow.

Plan Combination 6 would have construction of project features in each of the eight subwatersheds significantly affected by the AMD in Monday Creek. The project consists of 178 total restoration structures located within the following eight subwatersheds locations: Jobs Hollow, Dixie Hollow, Rock Run, Monkey Hollow, Lost Run, Snake Hollow, Coe Hollow, and Snow Fork (which is comprised of Salem Hollow, Sycamore Hollow, Spencer Hollow, Brush Fork, Long Hollow, Whitmore Cemetery and Orbiston). Proposed structures include open limestone channels, low head dams, limestone leach beds, slag leach beds, aerobic wetlands and dosers. Other forms of construction activities involve the closure of stream-capturing subsidences, re-routing dissipating streams, and either breaching or removal of spoil blocks. The Recommended Plan is expected to

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result in significant benefits to the aquatic ecosystem from headwaters to Monday Creek's confluence with the Hocking River.

In addition to evaluating the ecosystem restoration measures for the Monday Creek watershed and the surrounding area, the natural resources that will be impacted by these alternatives have been examined. This document includes a detailed description of the existing environment in the watershed and describes impacts anticipated from the final restoration alternatives considered, including the No Action alternative.

The Ohio Department of Natural Resources (ODNR) is serving as the Non-Federal sponsor for the project. Based on Section 103 of Public Law 99-662, the Non-Federal share has been calculated to be 35% of the total fully funded project cost of \$18.7 million or \$6.8 million. The ODNR will be responsible for obtaining necessary real estate agreements (Lands, Easements, Rights-of-way, Relocations, and Disposal areas, or LERRD) as well as Operation and Maintenance (O&M) of the completed project.

The EA for the Monday Creek Feasibility Study is an integrated part of this report. A Public Meeting was held on June 21 and 22, 2004, to gain input from interested agencies, organizations, and the general public concerning aspects of the study, issues and impacts to be addressed in the report, and alternatives that should be analyzed. To further provide for the public input, as required by NEPA, this report will be circulated to state and federal resources agencies, interested groups, and the public for comment during April-May 2005. Comments received will be incorporated in this final version of the document.

2.0 INTRODUCTION

This report presents the results of the Monday Creek Sub-Basin Ecosystem Restoration Project Feasibility Study and Environmental Assessment. This feasibility study was conducted with Ohio Department of Natural Resources (ODNR) as the local sponsor on a 50/50 percent cost sharing basis. The U.S. Forest Service Wayne National Forest (WNF) is participating as a cooperating agency under the National Environmental Policy Act. Forty percent of the watershed is a part of the Wayne National Forest. Other knowledgeable and interested parties involved with this study include the U.S. Fish and Wildlife Service, Ohio Environmental Protection Agency (OEPA), Ohio University (OU), U.S. National Energy and Technology Laboratory (NETL), West Virginia University (WVU) and members of the Monday Creek Restoration Project (MCRP). These agencies participated in an interagency committee which developed the objectives for the proposed restoration work, provided needed data and field studies, and contributed technical expertise during plan formulation.

Acid Mine Drainage (AMD) is one of the largest non-point pollutant sources in southeastern Ohio. AMD results when aluminum and sulfide minerals in rocks are exposed to oxidizing conditions (air and water). Iron sulfides common in coal regions are predominantly pyrite and marcasite (FeS_2), although other metals may be combined with sulfide as well. The sulfide minerals become exposed to oxidizing conditions during mining activities. In underground mines, these minerals are exposed to oxygen and water once the coal is removed.

The primary products of AMD formation, acidity and iron, impact water resources by lowering pH and coating stream bottoms with iron hydroxide, forming the familiar orange color called "yellow boy." Iron hydroxide flocculent increases siltation/sedimentation of the streams causing severe acid loadings and metal precipitants from AMD have greatly impacted the aquatic and terrestrial biological community and in some areas have left sections of the mainstem of Monday Creek and its tributaries unable to support aquatic life. The upper reaches of the watershed, primarily the Little Monday Creek sub-basin, are not significantly impacted by AMD and have relatively healthy aquatic ecosystems that support an existing Western Allegheny Plateau warm water ecosystem. Small pockets of relatively diverse fish and macroinvertebrate populations exist in areas where tributaries have good water quality. However, these healthy ecosystems do not contribute to the Hocking River ecosystem because of the poor water quality of Monday Creek and other tributaries.

Another problem associated with abandoned coal mines is subsidence. Subsidence impacts occur in the watershed when underground mine voids that are close to the surface collapse. The collapsed overburden captures surface water into the mine voids, allowing contact with sulfide minerals and oxygen, thus generating AMD within the watershed. Subsidence can take the form of large gaping holes in the stream bed or of hidden underground cracks that allow surface water to dissipate into the underground mine workings, thus continuing the generation of AMD.

Within the Monday Creek Watershed, approximately 16% of the streams (45 of 107 stream miles) are physically polluted with metal precipitants and 41% (111 stream miles) are chemically polluted with acidity (USDA, 1985). Approximately 82 of the 107 miles (77%) of streams assessed by Ohio EPA during the 2001 biological and water quality surveys were found to be impaired due to AMD from both a water quality issue and a siltation/sedimentation issue. From the headwaters of

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mainstem Monday Creek and the majority of Snow Fork, aquatic habitat is degraded primarily due to intolerable pH levels and increased sedimentation that results in the lack of aquatic organism or decreased diversity within the ecosystem. Furthermore, Monday Creek and its tributaries are listed on Ohio's 303(d) list for AMD pollutants, specifically pH and metals.

Primary sources of AMD in the watershed are located in eight subwatersheds of Monday Creek. These subwatersheds include Dixie Hollow, Jobs Hollow, Rock Run, Lost Hollow, Monkey Hollow, Snake Hollow, Coe Hollow and Snow Fork.

In addition, Monday Creek contributes 10% of the flow to the Hocking River. Previous surveys of the Hocking River performed by the Ohio EPA indicate that the Hocking River is being impacted by Monday Creek with increased aluminum concentrations and lower pH values.

2.1 STUDY AUTHORITY

Recognizing the concerns of Federal and state agencies, local officials, and individuals, the U.S. House of Representatives Committee on Transportation and Infrastructure adopted a resolution in March 1996, requesting the Secretary of the Army "to review the report of the Chief of Engineers on the Ohio River and Tributaries, published as House Document 306, 74th Congress, First Session, and other pertinent reports, to,

"determine whether modifications are warranted to solve a variety of water and related resource problems in the Hocking River Basin with priority given to Sunday and Monday Creek sub-basins. Special emphasis shall be given to the need for environmental restoration of lands and waters that have been impacted by resource extraction and other land uses. This study is to be conducted in consultation with the Hocking Conservancy District."

2.2 PURPOSE AND NEED

The purpose of the feasibility study is to conduct a thorough investigation of the previous mining activity impacts which includes AMD and subsidence issues, to develop alternative plans to address these problems and to select the optimum plan based on the projected benefits and costs.

The organization of this feasibility study reflects the Corps' six-step Civil Works Planning Process and is organized chronologically as the study process was completed. The feasibility report serves to document the findings of the feasibility study. The results are based upon the analysis of both data collected during the feasibility study and historical data accumulated from previous studies and/or other sources. Technical designs for this study include biological, engineering, and economic evaluations of various alternatives along with required real estate and planning evaluations. This report includes a draft Environmental Assessment (EA) which was integrated into the Feasibility Study. Sections of this report required for compliance with the National Environmental Policy Act (NEPA) are noted in the Table of Contents. The report includes a technical appendix for each recommended project site and includes the calculations, detailed designs, and a list of issues to be addressed or verified in the next design phase.

The goal of this project is to sufficiently restore both the structural and functional components of the ecosystem to a less degraded state downstream of the AMD discharges and to

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minimize runoff into the existing abandoned mine complexes. The restoration objective is to restore the degraded Monday Creek ecosystem to self sustaining conditions generally consistent with the functioning ecosystem designated as Warm Water Habitat by the Ohio Environmental Protection Agency. The physical impacts from man, such as clearing of the riparian corridor, stream crossings and siltation would not allow a sustainable Exceptional Warm Water Habitat ecosystem to occur since cold water species would not reproduce and sustain the ecosystem. Figure 2-1 displays a conceptual goal of the project.

Potential measures to achieve ecosystem restoration need to address the limiting factors that include the amount of dissolved and suspended metal loadings and improve the buffering system of the streams. Creation of wetlands and riffle and pool complexes will increase species and habitat diversity throughout the watershed. These measures, as well as measures discussed further should permit the eventual reestablishment of viable fish and macroinvertebrate populations and to restore the missing function of the stream in its broader watershed and landscape setting.

The watershed supports several types of aquatic habitats including seeps, creeks, ponds, mine pits, and wetlands. Many of these habitats have been identified as having reduced pH levels and high concentrations of dissolved metals (ATC 2000). When pH decreases below 5.0, which is typical of the waters in the area, most types of algae and rooted aquatic plants can no longer survive. Increased acid levels in fresh water can affect microorganisms responsible for the decomposition of organic material such as leaves and detritus. Reduction of these microorganisms in turn may lead to a reduction of aquatic invertebrate populations that utilize decomposed organic material and feed upon microorganisms.

Variations in acid levels can weaken aquatic invertebrates, making them vulnerable to disease and parasites (KESAB 2002). Changes in pH can also affect the growth and development of aquatic larvae and eggs. The majority of aquatic invertebrates that could potentially occur include mayflies, caddisflies, stoneflies, dragonflies, damselflies, and beetles. These invertebrates will not survive in waters with pH levels below 4.5. In addition to the increase in stress due to the reduced food supply (i.e. aquatic invertebrates), most fish species cannot survive in waters with pH levels below 4. Low pH levels damage gills and increase sodium levels in fish blood to above normal levels.

Metal toxicity caused by AMD produces an added detrimental effect on aquatic biota. Small amounts of these metals can stress fish or even cause death, especially in young, developing fish. Large amounts of metal precipitants can settle on a stream bottom and smother the few invertebrates that may be acid tolerant.

Reduction of the acidity and metal concentrations will have substantial and beneficial effects on the ecological potential of the stream, and the vitality of its aquatic habitat. Upstream portions of Monday Creek do support aquatic life, although the headwaters are biologically disconnected from other sections of the watershed due to the acidity and metal concentrations emanating from downstream areas. However, due to clearing of the riparian corridor and general siltation, exceptional warm habitat ecosystem would not be viable in the watershed. Reduction of acidity and metal loadings should also enhance the chemical, physical and biological integrity of the Hocking River aquatic ecosystem and the fisheries habitat.

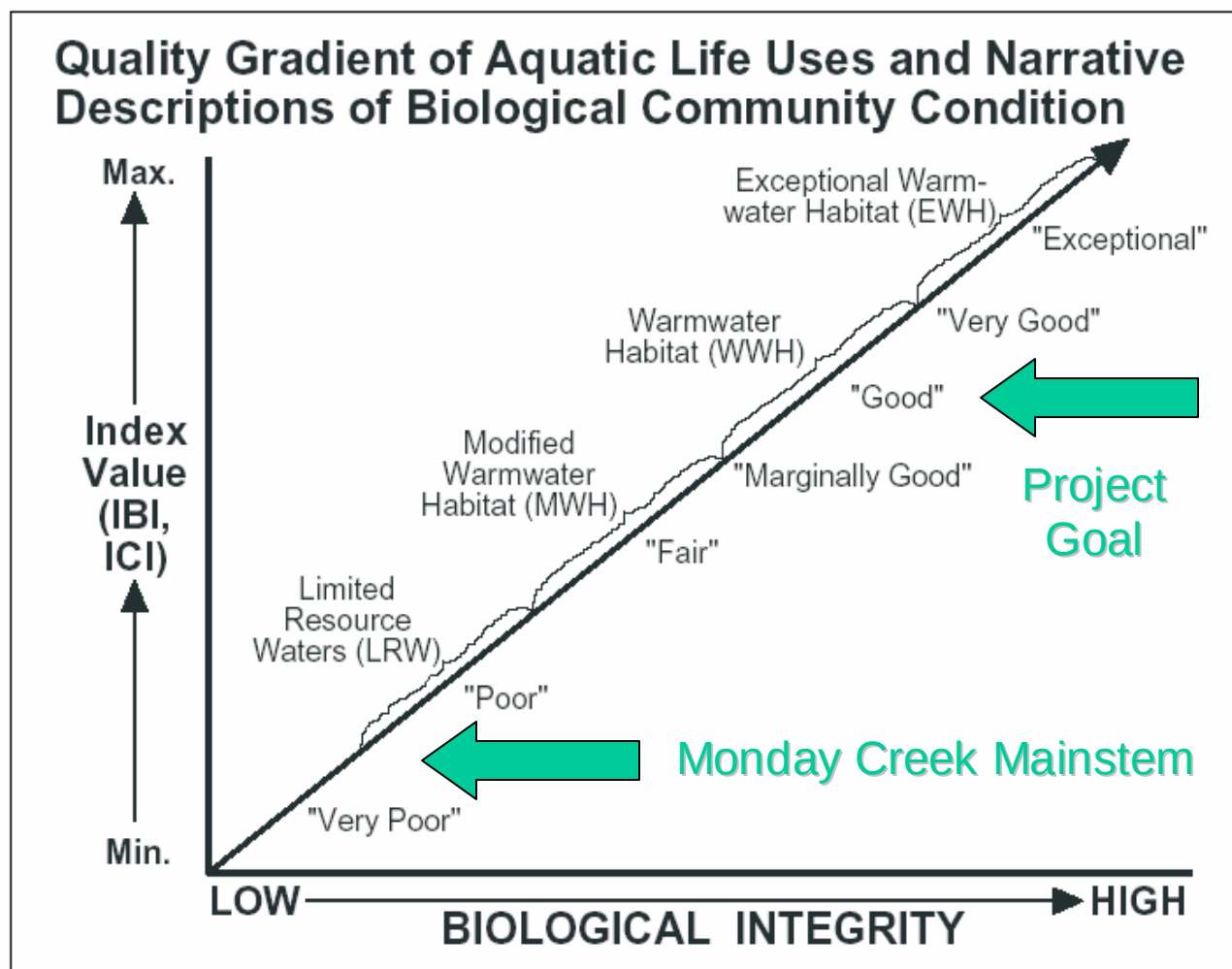


Figure 2-1 Quality Gradient of Aquatic Life Uses and Narrative Descriptions of Biological Community Index

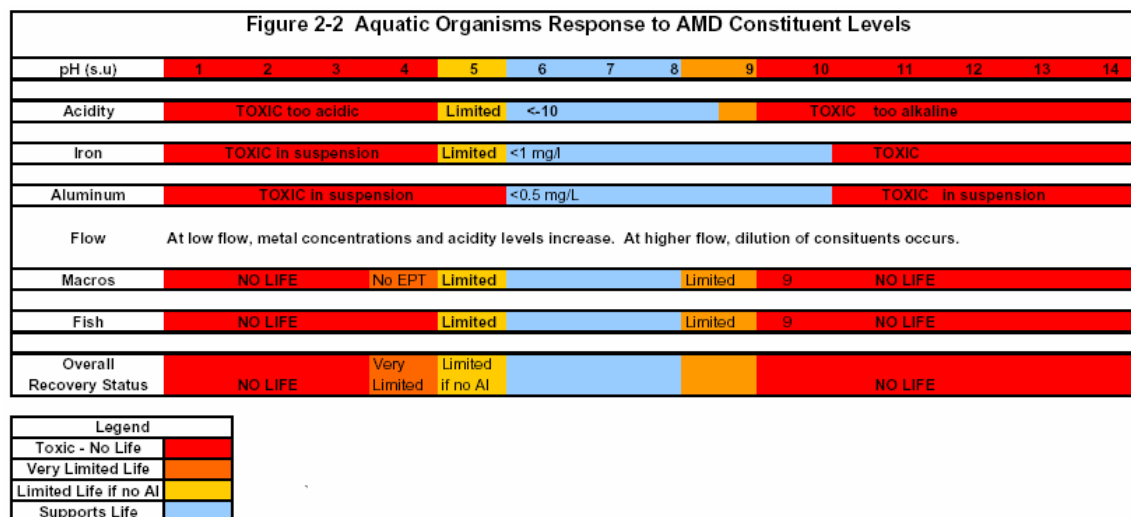
Constraints

The constraints for the project goal include the size of the watershed and the numerous acid mine drainage features in the watershed that are impeding the improvement of the ecosystem. A recent field investigation of the lands belonging to the Wayne National Forest indicated that there are over 3,000 physical mine related features attributed to past mining practices within their property in the watershed. These features include, but are not limited to open portals, building foundations, low and high volume seeps, slumps, gob piles and subsidence features. It would be difficult to address all these features; however, some features do not significantly impact the ecosystem. This study addresses those features (seeps and subsidences) which are substantially degrading the ecosystem.

The second constraint is the limited window of opportunity to address the AMD constituents through the physical construction of restoration alternatives. As shown in Figure 2-2, the complexity of the interactions of the chemical constituents of acidity, pH, iron and aluminum, in addition to flow, limit the types of restoration alternative that would be effective in achieving restoration of both

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macroinvertebrates and fish populations to a sustainable level. Chapter 4 of this report details the formulation process of how these limitations were addressed.



Another constraint is the issue of project features located on other federal agency lands. However, this feasibility report looks past the boundaries of agency lands and instead looks at a watershed approach for restoration of the waters of the Monday Creek Watershed.

The Wayne National Forest (WNF) does not have a Federal mandate or mission in ecosystem restoration, unlike the Corps. The WNF does receive funding each year to perform maintenance activities in the Forest as outlined in their 5-Year Forest Plan. WNF uses this funding to fix trails, maintain comfort stations, and, when possible, install treatments for AMD. Wayne National Forest personnel also completed a Potentially Responsible Party (PRP) search for former mining companies under Comprehensive Environmental, Response, Compensation, and Liability Act (CERCLA), but were unable to identify any current companies which could be held liable for the clean up of the streams. Therefore, there is no pollution or compliance responsibility existing in the basin. The Wayne National Forest is addressing some AMD problems through their 5-Year Forest Plan in other areas of the watershed, which are independent of this study's recommendations. Due to the size of the watershed, their efforts in the watershed would only enhance our recommendation of restoration alternatives.

Under current regulations, the Corps can perform work within another Agency's jurisdiction, as long as the cost for the work is paid for by the Agency. This is called Work For Others and would apply in this case with work on the U.S. Forest Service property in Monday Creek.

Below is a summary of different Federal Mandates that may be used to aid in the AMD cleanup effort in the watershed.

- Congress has designated the Department of the Interior's Office of Surface Mining as the Federal authority responsible for addressing coal mining "contamination" problems such as acid mine drainage/acid rock drainage through the Abandoned Mine Land Program (AML). However, OSM does not perform these duties but have delegated to the State to perform the work in Ohio. The ODNR receives its AML funding from OSM.

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- USEPA's Abandon Mine Lands (AML) program defines AML as those lands, waters, and surrounding watershed contaminated or scarred by extraction, benefaction or processing of ores and minerals including uranium, copper, iron, lead, and zinc, phosphate but does not include coal.
- Coal mining properties may be applicable to EPA's Brownfields Cleanup and Redevelopment due to the abandoned strip mines, mining building and processing facilities. This program also includes watersheds and water quality fixes.
- EPA may, under the Non-Point Source (NPS) Program, improve and protect habitat through a mixture of water quality and/or technology based programs; regulatory and/or non-regulatory programs by providing financial, technical, and educational assistance. However, this program typically focuses on groundwater issues.
- The Corps history of involvement in AMD restoration includes the following
 - o EPA & DOD HTRW Cleanup, 1980
 - o Coal Mine Restoration in the 1990s
 - o Water Resources Act of 1996
 - o Penn Mine, CA cost-sharing, 1997
 - o Restoration of Abandoned Mine Sites Program (RAMS) Support for Other Agencies, 1998
 - o WRDA 1999 & 2000
 - o Appropriations 2001, 2004
 - o General Investigation Authorities
 - o Section 560 Abandoned Non-Coal Mine Restoration
 - o CAP – Section 206, Section 1135, Section 22
 - o Beneficial Use of Dredge Material, Section 204
 - o Specific Restoration Projects, Sections 539, 502, and 595
 - o Brownsfields Projects

2.3 STUDY AREA

Monday Creek Watershed, located in the unglaciated portion of the Allegheny Plateau region of southeastern Ohio, is a 116 square mile (74,240 acres) area encompassing Monday Creek and its associated tributaries (HUC 05030204 060). The main stem of Monday Creek runs 27 miles before eventually emptying into the Hocking River. The watershed drains roughly 10 percent of the Hocking River system, which itself is part of the Greater Ohio River Watershed. Documentation of Monday Creek impacts to the Hocking River are noted in the *Biological and Water Quality Study of the Hocking River Mainstem and Selected Tributaries* (1991) by OEPA, "Monday Creek contributed significant amounts of sulfates, manganese and aluminum..." to the Hocking River and "aluminum which averaged 10,772 ug/l clearly influenced the Hocking River downstream." Some 79.5 miles of the 270 stream miles in the watershed are perennial streams. The two main tributaries to the 27-mile mainstem of Monday Creek are Little Monday Creek (14.3 mi.) and Snow Fork (10.7 mi.). The Monday Creek Watershed lies in the heart of Ohio's Appalachian coal region in Athens, Hocking and Perry counties. Figure 4 is a map of the Monday Creek basin.

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AMD has degraded the habitat of Monday Creek and impaired its aquatic ecosystem functions to the point that the warm water habitat community has essentially been eliminated in most of the streams within the watershed. Components of the ecosystem include physical, biological, ecological and chemical. AMD negatively affects all of these components including both aquatic and terrestrial.

Species diversity and abundance have been identified as problems in the aquatic and terrestrial ecosystems of the Monday Creek watershed. Pollution tolerant aquatic species of fish and macroinvertebrate populations are dominant in the ecosystem and are generally found in the mainstems of Monday Creek and Snow Fork. Pollution sensitive species such as bass and darters, stoneflies and caddisflies, are found only in small areas which are disconnected both laterally and longitudinally from the rest of the watershed. Because of the lack of biodiversity, the aquatic and terrestrial habitats are not as complex as a self sustaining ecosystem.

Structural degradation of the ecosystem is a result of the dissolved and suspended constituents from AMD in the stream. Concentrations of iron and aluminum occur at levels that are toxic to aquatic species and pH and acidity levels adversely affect vertebrate and invertebrate life. Suspended sediments deposited on the streambed may harden or cover existing coarse substrates, negatively affecting substrate dependent aquatic species. The functional characteristics of the ecosystem are impaired through removal of most of its biotic components, which affects adjacent riparian and upland areas as well. For example, the lack of fish, macroinvertebrates and vegetation in Monday Creek inhibits the utilization of these adjacent areas by terrestrial species dependent upon aquatic organisms as a food source.

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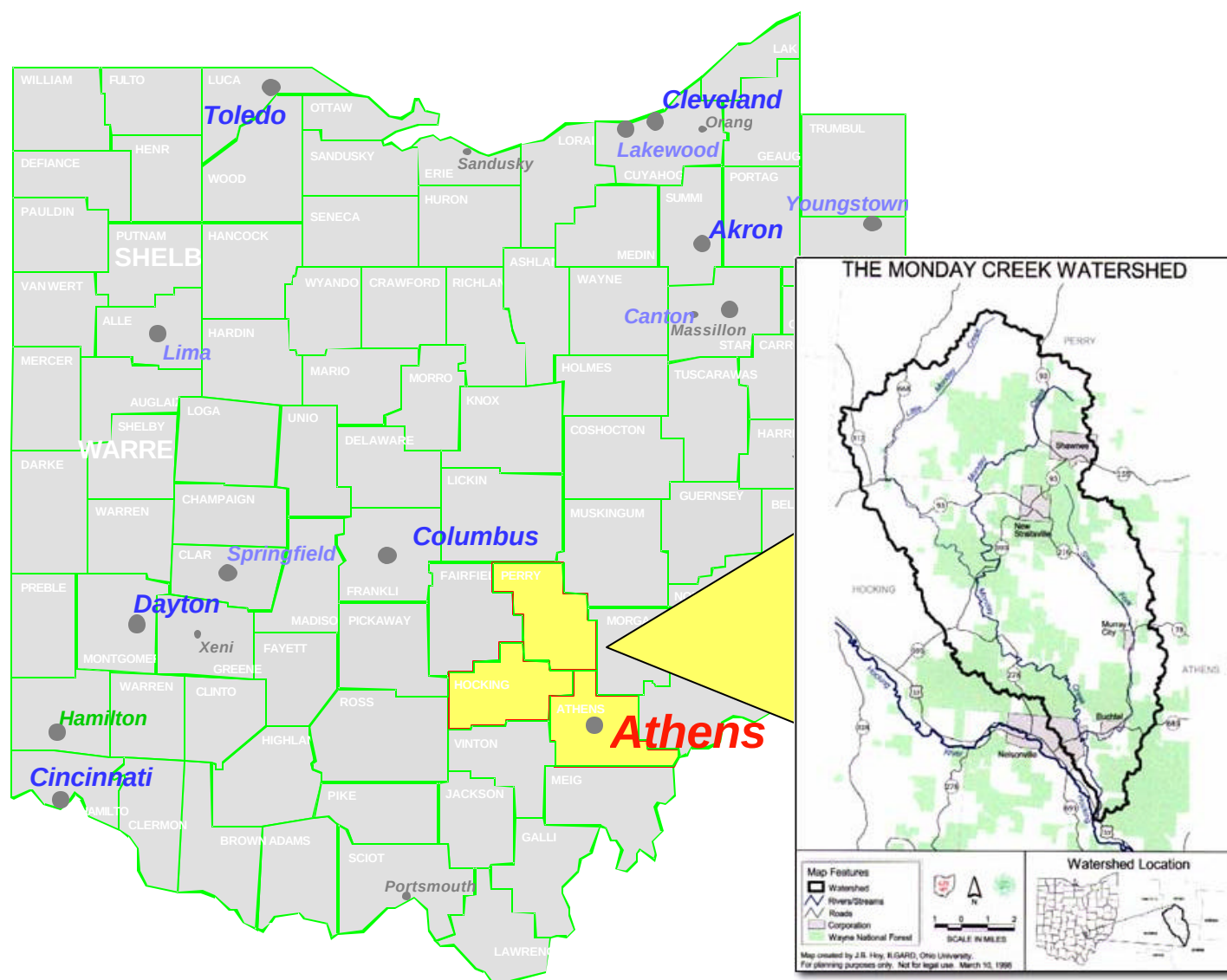


Figure 2-4 Monday Creek Watershed

2.4 PUBLIC INVOLVEMENT

A number of public concerns have been identified during the course of the study. Initial concerns were expressed in the study authorization. Additional input was received through coordination with the study sponsor, Ohio Department of Natural Resources, coordination with other state, local and Federal agencies including U.S. Fish and Wildlife Service, U.S. Forest Service, National Energy Technology Laboratory, Office of Surface Mining, Ohio Environmental Protection Agency, Rural Action of Southern Ohio, and the Institute for Local Government Administration and Rural Development (ILGARD). In addition, members from Ohio University and West Virginia University participated as technical advisors to the project.

Public involvement of the study included the entities cited above, in addition to outreach efforts by the Monday Creek Restoration Project, the local watershed group, through monthly meetings and newsletters. Two public meetings were held in June 2004 to educate the public on the proposed work in the watershed in conjunction with this feasibility study.

As seen in Prior Studies and Reports listed in Section 2.6, the local communities and educational institutions are committed to restoration of the lands surrounding their communities.

As is typical in the Appalachian region, increased mechanization in the coal industry has led to a slow decline in population. This project could provide temporary positive economic impacts by construction activities in the region.

2.5 PRIOR STUDIES AND REPORTS

Seven prior studies and reports were identified in the preliminary stages of the feasibility study. Below is a short summary of each study and the agency that authored it.

Expedited Reconnaissance Study, Hocking River Basin, Ohio, Environmental Restoration Study Section 905(b) (WRDA 86) Preliminary Analysis, August 1997. The purpose of the Reconnaissance Study was to evaluate the potential Federal interest in existing watershed problems associated with ecosystem and environmental restoration in Athens, Hocking, Fairfield and Perry counties, Ohio, with a primary focus on Sunday and Monday Creek sub-basins. The Reconnaissance Study recommended a feasibility study that would employ a comprehensive, watershed based approach to developing plans for aquatic ecosystem restoration throughout the Sunday and Monday Creek sub-basins.

Watershed Integrity Analysis for the Wayne National Forest in Support of the USDA Forest Service East-Wide Watershed Assessment by the U.S. Department of Agriculture, 2002. Approximately 40.1 percent of the Monday Creek Watershed is located on National Forest Service lands. The integrity analysis ranked Monday Creek Watershed first in number of point sources and percentage of impaired stream miles. The analysis also ranked Monday Creek second in recreational pressure, percentage of riparian cover over streams, and percentage of wetlands still intact. However, overall out of the 16 watersheds contained in the National Forest System lands, Monday Creek ranked tenth indicating it has higher vulnerability to degradation and more stressors in the watershed.

Monday Creek Watershed Acid Mine Drainage Abatement and Treatment Plan by Borch et al. was prepared in 1997 for the U.S. Office of Surface Mining, ODNR and Natural Resources

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Conservation Service. The report identified problems and specific restoration alternative strategies at six sites within the watershed.

Monday Creek Watershed Acid Mine Drainage Abatement and Treatment Plan II (incomplete) was prepared in April 1999 for the U.S. Office of Surface Mining, ODNR and Natural Resources Conservation Service by Borch and Shimala. This report identified 14 more sites within subwatersheds of Monday Creek and suggested reclamation strategies.

Biological and Water Quality Study of the Hocking River Mainstem and Selected Tributaries by Ohio Environmental Protection Agency (1991). This study evaluated potential impacts associated with major municipal waste water treatment plants in Lancaster, Logan, and Athens. It also evaluated biological and chemical water quality conditions to document current conditions, recommended appropriate aquatic life use designations, pinpointed problem areas and assessed trends of the Hocking River.

Assessment and Treatment of Areas in Ohio Impacted by Abandoned Mines. USDA Soil Conservation Service. 1985. #M6313. This report inventoried areas in Southeastern Ohio that are impacted by past mining activities.

Draft Report, Biological and Water Quality Study on Monday and Sunday Creeks, for Total Maximum Daily Loads Program, Field Data, Ohio Environmental Protection Agency, 2002. Raw sampling data compiled from field investigations that occurred during the 2002 sampling events.

Existing Projects

Both state and federal agencies have constructed various projects in the Monday Creek Watershed that have reduced flooding and improved recreational opportunities. In addition, the ODNR and the WNF, as well as local groups, have been active in the watershed.

U. S. Army Corps of Engineers

The Corps has two major projects in the Hocking River Watershed, the Athens Local Protection Project (flood damage reduction) and the Tom Jenkins Dam-Burr Oak Reservoir (flood damage reduction, water supply and recreation). The Athens project consisted of a channel modification project of the Hocking River in Athens, Ohio, authorized by Congress in 1965, and completed in 1971. The project shortens the Hocking River by about 1,400 feet. The channel bottom was widened from its former width of 120-140 feet to 215 feet. The modified channel is about 26,000 feet in length.

The Tom Jenkins Dam-Burr Oak Lake is located on the East Branch of Sunday Creek. The project is operated for flood damage reduction in the Sunday Creek valley and as a unit of a coordinated system for flood protection in the Hocking and Ohio River valleys. The reservoir also includes storage for water supply use and recreational facilities.

Existing Programs by Other Agencies

Several agencies and organizations have programs to protect and restore the Monday Creek Watershed. They were identified early in the study process to develop a comprehensive scope of potential solutions to the problems and needs of the area.

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U.S. Forest Service, Wayne National Forest

The Wayne National Forest (WNF) owns approximately 40% of the land in the Monday Creek watershed and has developed a *5-Year Forest Service Reclamation Management Plan* (5-Year Plan) for the entire forest. The 5-Year Plan includes (as funding is available) the construction of alternatives within the WNF as well as other activities that include safety issues dealing with the abandoned mine properties, trail maintenance and forest management. WNF has designated projects that would address some of the water resource problems and needs. The U.S. Forest Service does not have a federally mandated mission that includes ecosystem restoration activities. However, the guiding principles used by the USFS include utilizing an ecological approach to the multiple-use management of the National Forests. Below is a list of their completed projects.

Majestic Mine

-Closed a subsidence to limit water infiltration into underground mines and constructed an open limestone channel to add alkalinity to the water

Happy Hollow Pond

-In conjunction with USACE, constructed a diversion ditch to prevent acid water from entering pond and add alkalinity with a limestone leach bed (LLB)

Jobs 13 Gob Pile

-Regraded and vegetated a 2 acre spoil (gob) pile

Essex Subsidence

-Closed 3 subsidences and put water back into existing stream channel

***Essex Portal**

-Backfilled open mine portal

Long Hollow

-Closed 8 subsidences to limit infiltration of water into underground mines

***Orbiston North**

-Closed 3 subsidences to limit infiltration of water into underground mines

***Snake Hollow**

-Partnered with Ohio Department of Natural Resources (ODNR) and installed AMD restoration alternative systems, closed subsidences and regraded a gob pile

Reclamation Project

***Big Four Watershed
Restoration Project**

-Partnered with Monday Creek Restoration Project (MCRP) – funding from Ohio Department of Transportation (ODOT) and installed limestone channels to increase alkalinity in the water

***Monkey Hollow**

-Close 15 subsidences to limit infiltration of water into underground mine

*Currently in design/construction

The following tables show potential projects WNF is proposing within the watershed. Many of the potential projects are similar to the projects previously constructed in the watershed as described above.

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FY05 New Straitsville East	FY06 Valley Junk Subsidence Snow Fork/Goose Run Subsidence Sand Run Subsidence Monkey Hollow Subsidence
FY07+ Lost Run AMD Restoration (Phase II) Long Hollow Subsidence Long Hollow AMD Restoration Brush Fork Subsidence Bessimer Hollow Subsidence and AMD	

Ohio Department of Natural Resources, Mines and Minerals

ODNR is partnering with Wayne National Forest on projects within the forest. The following projects have been completed in the watershed by ODNR.

Goose Run	-Subsidence elimination project restored 506 acres of surface water runoff back into Snow Fork. Captured water was presumed to have discharged at Truetown in Sunday Creek.
Snow Fork Subsidence	-240 acres same as above.
Majestic Mine	-Subsidence elimination of 120 acre surface capture in Lower Monday Creek. Subject of a pre-reclamation thesis (Piggati) and post reclamation thesis (Graham, pending).
Happy Hollow	-Cooperative project with USFS and Corps to divert AMD away from a pond and add alkalinity with a limestone leach bed (LLB).
Job's Hollow Doser*	-Environmental Doser Inc. machine will be installed in Jobs Hollow (Perry County) in 2004 to add alkalinity to Monday Creek headwaters.
Big 4 Hollow	-Cooperative project with USFS and MCRP to treat AMD seeps from deep mines in this direct, mid-basin Monday Creek tributary. Restoration alternative will be mostly Open Limestone Channels (OLC) and LLB units. Designed in 2003 and planned to be built in 2005 for partial remediation of AMD in Big 4 Hollow
Snake Hollow Reclamation Project^	-Similar to Big 4 Hollow project but located in lower Monday Creek just above Snow Fork confluence. A slag leach bed (SLB) will also be used here. Numerous subsidence holes and cracks will be eliminated
Big Bailey Gob	-Cooperative project with USFS to reclaim a 2 acre gob pile causing a sedimentation problem in Big Bailey Run
Jobs Hollow Gob Pile^	-Cooperative project underway with USFS and Hocking College to reclaim a 2 acre gob pile in Job's Hollow (Perry County)
Rock Run Gob Pile*	-14 acre coal refuse reclamation and AMD abatement project on Rock Run in Perry County. Employed Fluid Gas Desulphurization (FGD) capping, Open Limestone Channels and a SAPS
Rock Run 24*	-OLC installed upstream of described project
Lost Run	-Pending #319 application to OEPA for restoration alternative of AMD in Lost Run, using OLC, SLB and LLBs. Some elimination of blocked drainages and subsidence not being addressed by USFS in their project
Grimmett	-Gob pile reclamation and AMD abatement project under contract in upper Jobs Hollow (Perry County). Employs LKD "J" trenches, pile capping and OLCs
Murray City Subsidence	-Closure of three small stream capturing subsidence to deprive the Murray City Seeps of some recharge. To be built in 2004

* located in the WNF; ^Projects completed.

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Ohio University

Ohio University (OU) located in Athens, Ohio has been active in studying the effects of AMD in the watershed. The Monday Creek Watershed has been the topic of several Master's Theses from the Department of Geological and Biological Sciences. In addition, the faculty at OU is very active in obtaining grants and research monies to study the watershed. Work completed by OU includes:

"Monday Creek Restoration Project, Phase II," sponsored by USEPA, Ohio's Non-Point Source Program (319) FY 1997, and Ohio Department of Natural Resources Division of Mines and Reclamation. Principal Investigator: Dr. Mary W. Stoertz.

Matthew Allen - *Monday Creek Watershed Database Design*. Geology Undergraduate, 1997.

Heather Burling – *Assessment of fish population isolation due to acid mine drainage in the Monday Creek Watershed*. Environmental Studies Graduate, 1996.

Kenneth Carroll – *The transport and fate of acid mine drainage along the Snow Fork flowpath in the Monday Creek Watershed, southeastern Ohio*. Geology Graduate (Dr. Dina Lopez), completed August 1999.

Silvino daLuz, Jr. *Off-road vehicle impacts on soil properties of trails in Wayne National Forest, Southeastern Ohio*. MSES Graduate (Dorothy Sack), defended September 13, 1999.

Jennifer Last – *Relative Contribution of AMD chemicals and sedimentation to macroinvertebrate communities in the Raccoon Creek and Monday Creek*. Environmental Studies Graduate (Kelly Johnson)

Dina L. López, *Hydrogeochemical Characterization of the Carbondale Wetland, Athens County, Ohio: Evaluation of Remediation Alternatives*, Ohio Department of Natural Resources, Division of Mine Reclamation, 1999.

Dina L. López, *Transport and fate of contaminants under high flow conditions at Monday Creek Watershed, Ohio*. Ohio Department of Natural Resources, Division of Mine Reclamation, 2000.

Bryan Overly. *The Chemical and Microbiological Variability of Acid Mine Drainage Affecting the Snow Fork Drainage Basin, Ohio: The Essex Underground Mine*, Environmental Studies Graduate, 1997.

Eric Pigati – *Hydrogeochemistry of Majestic Mine Drainage, Monday Creek*. Geology Graduate, 1997.

Dave Simon – *Integration of geographic information system and a model to estimate sedimentation in a watershed [Brush Fork of Monday Creek]*. Environmental Geography, 1996.

Pam Stachler – *Chemical and hydrologic variability of acid mine drainage from abandoned Esco #40 underground coal mine, Ohio*. Geology Graduate, 1997.

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Steve Worsley – *Flooding, stream competence, and bedload transport in Snow Fork of Monday Creek, Athens and Hocking Counties, Ohio*. Geology Graduate 1996.

A Comprehensive Management Plan for the Monday Creek Watershed. – Management Plan – USEPA, Green Mountain Institute, ILGARD and Rural Action, Inc. 1999.

2+4 = *Service on Common Ground – 2 Environmental Service Projects on History and Environmental Restoration in Monday Creek*. – Campus Compact National Center of Community Colleges, Hocking College, Sunday Creek Associates, Rural Action, Inc.

Environmental Justice and the Monday Creek Watershed. – *Environmental Justice Case Study* – US EPA, Rural Action, Inc.

3.0 EXISTING CONDITIONS

This chapter describes the existing, without project, conditions in the Monday Creek Watershed. Due to the severity and extent of degradation caused by AMD, it is assumed that these conditions would continue to persist in the future without restoration efforts. The Monday Creek Watershed is the boundary of the study area, or region of influence.

3.1 Land Use

3.1.1 Existing Land Use

Primary land cover categories consist of forest (87 percent), mining (in the form of current sand/gravel mines) (5 percent), crop land (3 percent), pasture (1 percent), wetlands (2 percent), grazing (1 percent), and urban (1 percent).

Forty percent of the watershed is owned and managed by the Wayne National Forest (WNF). The WNF was established in 1934 as a result of the United States Forest Service (USFS) policy to purchase and improve abandoned farm tracts and other heavily degraded lands. Currently, no logging is taking place in the Wayne National Forest. The Sunday Creek Coal Company is the region's second largest landowner. Currently Sunday Creek Coal owns and manages 8.5 percent of the watershed. Combined, the Forest Service and the Sunday Creek Coal Company manage almost half (48 percent) of the Monday Creek Watershed. Although logging does not take place on the property owned by the Wayne National Forest, some logging may be taking place in parts of the watershed owned by the Sunday Creek Coal Company. While exact figures are unavailable, timber logging may be taking place in parts of Salem Hollow, Sycamore Hollow, Spencer Hollow, Brush Fork, Sand Run and Snow Fork. There are no current surface mining operations in the watershed on Sunday Creek Coal properties.

3.1.2 Historical Land Use

Underground mining for coal began in the study area in the mid 1800s with small pick and shovel operations and progressed to large scale drift mining operations as technology advanced. Most underground mines in Ohio were drift mines until extensive surface mining became the predominant form of coal mining in the early 1900's (Ohio Geological Survey, 1974).

Most deep mines in the Monday Creek Watershed were closed by 1922 after a post-World War I economic slowdown in coal production. Underground mining operations ceased in 1972 in the Athens and Hocking County portions of the watershed and ceased in 1991 in the Perry County portions (ILGARD 1999).

Surface mining emerged again as a result of the post-World War II economic boom of the 1940s. This method of mining continued to support the area until a production peak in 1970. Coal production declined again sharply in 1972 in response to regulatory environmental pressures as the country sought out the cleaner burning, lower sulfur coal of the western United States. There are no current surface coal mining operations in the Monday Creek Watershed.

Besides coal, other resource extraction industries in the region found temporary success. The production of iron grew sizably during the Civil War as southeast Ohio provided much of the iron needed for the war. As clear-cutting around smelting furnaces made timber scarce, the companies relied increasingly on coal to stoke iron furnaces. However, the coal mined in the Monday Creek Watershed contained many impurities and lacked sufficient carbon content to cure

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iron into steel, and thus produced only a marginal grade of iron. Nevertheless, by the early 1880s there were over a dozen coal-fired furnaces in the watershed (Bogsavitz and Levine 1996).

Timber was essential to many other watershed industries, especially coal and iron production. Charcoal was used in ore production, while timber was used as support beams in underground mining, as well as for houses and tipples (a structure where coal was sorted before being transported). Demand for timber prompted the first wholesale clear-cut of the region. One estimate claims that by 1885, after approximately 30 years of clear-cutting, 89 percent of the forested land was cleared. Revegetation did not start until the creation of the Wayne National Forest in 1934.

Extraction of oil and natural gas in the Monday Creek Watershed began in 1909 near New Straitsville, Ohio. That year alone, prospectors drilled more than 100 wells (ILGARD 1999). There are still many active oil and gas wells the watershed.

Salt mining was the main industry in southeastern Ohio in the early 1800s. Salt was mined by pumping the salt brine from the earth, boiling off the liquid, and then removing the impurities to allow the salt to crystallize. Many of the salt factories were short-lived. Although there are currently no active salt mines in the watershed, the effects of an abandoned salt brine well on Route 78 are still apparent as it continues to spill brine that eventually feeds into the Snow Fork sub-basin.

Drawing on the vast clay and coal deposits in the Monday Creek Watershed, clay extraction and clay production peaked in the early twentieth century. Three brick factories were located in the watershed: Greendale Brick, Ohio Mining and Manufacturing (later Claycraft), and Straitsville Impervious Brick (later Straitsville Brick and Columbus Clay).

Since clay was found near coal seams, the brick factories also mined for clay. Coal-fired kilns were used until natural gas replaced them in the second half of the twentieth century. Brick production outlasted coal mining and remained one of the watershed's most profitable industries until the 1960s. Greendale Brick closed permanently in 1930, but Claycraft and Straitsville Brick both reopened after World War II, and then finally closed in the 1970s.

The 13-acre Rock Run / Seven Chimneys coal refuse pile was a stark remnant of the Straitsville Impervious Brick Company and was located near New Straitsville. The 13-acre site consisted of an abandoned valley-fill coal washing facility with a 60-foot coal-waste dam on Forest Service property. The Monday Creek partners chose the exposed dam materials and coal slurry as their first major reclamation project in 1996. The project capped the site with an impervious layer containing a mixture of coal-combustion by-product materials and local soils. The engineering design utilized innovative wetland restoration alternative systems and the implementation of positive drainage to reduce erosion and acidification of fresh water. The project was completed in the spring of 1999. Recent measurements at this site indicate surface water with a neutral pH and low concentrations of metals and acid.



*Rock Run /Seven
Chimneys coal refuse pile
prior to reclamation*



*Rock Run after
reclamation in 1999*

Figure 3-1 Before and After Photographs of Reclamation Activities

3.2 Geology and Topography

The Monday Creek Watershed lies in the unglaciated portion of the Appalachian Plateau physiographic province. The bedrock is Pennsylvanian in age and consists primarily of sandstones, shale, coal, and limestone. The Allegheny and Conemaugh formations comprise the primary stratigraphic section found in the watershed. Coal has been mined from the Middle Kittanning coal and the Upper Freeport coal seams.

Monday Creek headwaters begin in the northeast section of the watershed in the Upper Freeport sandstone and shale at elevation of 990 ft above Mean Sea Level (msl). The creek flows south over Pleistocene lake and stream sediments to join the Hocking River on glacial outwash which was deposited on an erosional surface at the top of the Pottsville formation. Little Monday Creek, which drains the northwest corner of the watershed, has its headwaters in the Upper Freeport sandstone at elevation 1000 ft above msl. Snow Fork, which drains the eastern portion of the watershed, originates in the Brush Creek limestone at elevation 1000 ft above msl.

Underground mining in the Monday Creek Watershed has produced weaknesses in the subsurface due to the removal of coal seams. These weaknesses occur in strata both above and below the coal seam that was removed. The weight of the overlying strata will typically cause collapse due to excessive weight and mine floors will “heave” due to pressure from the overburden on pillars.

One method for underground mining in the coal fields was room and pillar mining. Room and pillar mining consists of mining in a linear fashion, but leaving coal “pillars” for support of the

mine roof. Modern technology has allowed the support “pillars” to become smaller due to advances in roof bolting, timbers and other methods of support. A common practice in earlier history was to shave the support pillars during abandonment of the mine to maximize recovery of the coal. Typically, once an area was mined, it was more economical to mine virgin reserves rather than go into former mined areas.

If the area of mining was near the surface (typically <100 feet), fractures will migrate upwards from the coal seam and result in surface subsidence. These fractures capture water during rainfall events or, if located near a stream, the surface stream itself. Subsidence within Monday Creek Watershed are extensive, especially on the west side of Brush Fork.

3.3 Soils and Farmland

The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Soil Surveys for Perry, Hocking, and Athens counties were reviewed. Soils in the uplands are classified as Westmoreland-Guernsey and/or Dekalb/Zanesville associations. Soils in the valley bottoms are classified as Chagrin and/or Orrville-Otwell/Nolin associations, except in Perry County where the valley bottoms are classified as Westmoreland-Bethesda-Guernsey associations.

There is no prime farmland within the vicinity of the AMD impacted areas.

3.4 Air Quality

The United States Environmental Protection Agency (USEPA), under the 1970 Clean Air Act (CAA), has established primary and secondary National Ambient Air Quality Standards (NAAQS) for various pollutants. The NAAQS were based on attainment and maintenance of air quality required to protect the public health. Subsequently, the Federal Clean Air Act Amendments of 1992 were enacted. It requires states to take additional steps to control ground-level ozone pollution, reduce sulfur dioxide and nitrogen oxide emissions which lead to formation of acid rain, and restrict emissions of air toxins. The Monday Creek Watershed is in attainment for all NAAQS.

3.5 Noise

Ambient noise levels in the project area are those typically found in a semi-rural urbanized setting. Within the project area, noise levels are related to road noises and commercial areas located adjacent to the sites. The current uses and associated activities in the project area do not generally create noise levels above 55 decibals, which is considered the threshold nuisance level.

3.6 Vegetation

The project is part of the mixed mesophytic forest region. Mesophytic forests are woody plant communities that exist on deep, well drained soils that are rich in nutrients and are characterized by a diverse dominant and codominant canopy and subcanopy. The project area is comprised of mature or maturing second-growth forest with areas of upland brush, emergent and scrub-shrub wetlands, roads, trails, exposed coal refuse piles, and water resources.

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The most common tree species include yellow poplar (*Liriodendron tulipifera*), Virginia pine (*Pinus virginiana*), white pine (*Pinus strobus*), white oak (*Quercus alba*), and sweetgum (*Liquidambar styraciflua*). Other common tree species include red oak (*Q. rubra*), black oak (*Q. velutina*), chestnut oak (*Q. prinus*), sugar maple (*Acer saccharum*), red maple (*A. rubrum*), American beech (*Fagus grandifolia*), shagbark hickory (*Carya ovata*), mockernut hickory (*C. tomentosa*), bitternut hickory (*C. cordiformis*), sycamore (*Platanus occidentalis*), and white ash (*Fraxinus americana*).

Common understory tree and shrub species found in the watershed include young maples and beech, black cherry (*Prunus serotina*), dogwood (*Cornus florida*), ironwood (*Carpinus caroliniana*), hornbeam (*Ostrya virginiana*), hackberry (*Celtis occidentalis*), spicebush (*Lindera benzoin*), and blueberry (*Vaccinium* spp.). Edge type habitats are occupied by redbud (*Ceris canadensis*), greenbrier (*Smilax* spp.), and blackberry (*Rubus* spp.).

Common herbaceous species include trout lily (*Erythronium americanum*), Christmas fern (*Polystichum acrostichoides*), and various species of violets (*Viola* spp.) and mints (*Dicerandra* spp.). Roadsides and more open canopy habitats include panic grass (*Panicum* spp.), common milkweed (*Asclepias syriaca*), clover (*Trifolium* spp.), aster (*Aster* spp.), and goldenrod (*Solidago* spp.).

The exotic species documented by the WNF in the Monday Creek Watershed is multiflora rose (*Rosa multiflora*) and autumn olive (*Elaeagnus umbellata* Thunberg).

3.7 Water Resources and Water Quality

Surface Water.

The Monday Creek Watershed is located entirely within the Hocking River basin. The project is located in parts of the 100-year flood plain as designated by the Federal Emergency Management Agency Flood Insurance Rate Maps.

In areas where mining occurred close to the surface, cracks and crevices form and convey stream flow into underground workings. Many headwater areas and small tributaries no longer have flow due to these subsidences. Much of the surface water in the watershed is generated from portal and mine openings.

Water Quality

Due to extensive mining in the watershed, AMD formation and pollution is prevalent in surface water on the central to eastern sections of the watershed along the mainstem and its tributaries and along Snow Fork. AMD is produced from deep mine portals, seeps from rock outcrops and gob piles of waste material from mining.

pH, an Indicator of Habitat Health

Measurements of pH within the watershed indicated that the 8 subwatersheds in the study were shown to be severely impacted by pH levels below 4.5 at the confluences of the subwatersheds with Monday Creek. This impact has decreased the water quality and aquatic habitat along the mainstem of Monday Creek.

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Under constant AMD conditions, the macroinvertebrates in a body of water are eliminated or reduced to a small fraction of that present above the entrance of the AMD. Low pH causes a disturbance of the balance of sodium and chloride ions in the blood of aquatic animals. At low pH, hydrogen ions may be taken into cells and sodium ion expelled (Morris et al., 1989), thus causing death. Most organisms have a well defined range of pH tolerance. If the pH falls below the tolerance range, death will typically occur due to respiratory or osmoregulatory failure (Kimmel, 1983). Increased metal concentrations can increase the toxicity of mine drainage and act as metabolic poisons. Iron, manganese and aluminum are the most common heavy metals found in association with AMD. In addition, acidity is a significant factor causing the loss of sodium ions from the blood and loss of oxygen in the tissues (Brown and Sadler, 1989). Acidity that is not directly lethal may adversely affect fish growth rates and reproduction (Kimmel, 1983).

Acidic waters typically have fewer species and lower abundance and biomass of macroinvertebrates than near-neutral pH waters. Low pH tends to eliminate species that feed on algae and also inhibits growth of bacteria which helps break down leaves to make them more easily digestible.

Table 3-1
Recovery Potential for Aquatic Organisms

pH	Effect
<4.5	No Fish
4.5-5.5	Limited Recovery for some trout, dace and chub
5.6-6.0	Moderate Recovery
>6.0	Further Recovery with rock bass, small mouth bass and darters

*Taken from Coal Mine Drainage Prediction and Pollution Prevention in Pennsylvania 1998

Aluminum Toxicity

Aluminum measurements indicated that average aluminum concentrations were significantly greater than the USEPA water quality requirements of 0.7 mg/L. Many areas in the Monday Creek watershed concentrations range from 10 to 100 time greater than allowed by current permit limitations.

Aluminum has the most severe adverse effects on stream aquatic life by decreasing sodium uptake and increasing sodium loss in blood and tissues. Research by Earle et al (1997), indicated that a combination of pH less than 5.5 and dissolved aluminum concentration greater than 0.5 mg/L will generally eliminate all fish and many macroinvertebrates. Baker and Schofield (1982) found aluminum is most toxic to fish at pH between 5.2 and 5.4 standard units (s.u.).

Streams with precipitated aluminum usually have lower numbers and diversity of invertebrates than streams with low pH and high dissolved aluminum. Rosemond et al. (1992) stated that deposition of aluminum hydroxide particles on invertebrates block surfaces important for respiratory or osmoregulatory exchange. Precipitated aluminum can also acculmulate on fish gills and interfere with their breathing (Brown and Sadler, 1989).

Iron Toxicity

Iron concentrations varied within the subwatersheds and ranged from 3.7 mg/l to 171 mg/L. Some concentrations could cause toxicity in aquatic organisms.

Precipitation (sedimentation) of ferric hydroxide may result in a complete blanketing of the stream bottom, adversely affecting both macroinvertebrates and fish (Hoehn and Sizemore, 1977). However, the effects of precipitated iron are less severe in alkaline conditions. Many fish and macroinvertebrates are tolerant of iron precipitate in alkaline water; however, total numbers and diversity are usually lower than in unaffected streams.

The underground mining also forms pathways that allow surface water to enter the groundwater system. Subsidence of the mines causes fractures in the strata above and below the mines also allowing ground water to infiltrate the mines, causing, in some areas, karst-like behavior or fracture flow of groundwater.

3.8 Wetlands

A routine delineation of waters of the United States, including wetlands, was conducted by the North Regulatory Section of the Huntington District for the Monday Creek Feasibility Study. Potential wetlands located on non-agricultural lands were identified using the 1987 Wetland Delineation Manual (Environmental Laboratory, 1987) for confirmation by the U.S. Army Corps of Engineers (COE).

TABLE 3-2
Extent of Jurisdictional Wetlands

Location	Acres
Snow Fork - Brush Fork Area A	0.2
Snow Fork - Brush Fork Area B	0.2
Snow Fork - Brush Fork Area C	0.2
Snow Fork - Brush Fork Area D	0.5
Snow Fork – Spencer Hollow	3.6
Lost Run	0.3
Dixie Hollow	0.2
Monkey Hollow	0.2
Snow Fork - Orbiston	4.0

Wetland Descriptions

The dominant vegetation within the wetland areas, hydric soil and wetland hydrologic indicators found within the areas are described below based on data forms completed during the field investigations. Corresponding upland sample points are also located on data forms. Data forms and photographs of the wetlands are included in Appendix A.

Snow Fork - Brush Fork - Area A

Area A consisted of an herbaceous wetland dominated by *Salix nigra* (black willow) and *Populus deltoides* (cottonwood) in the tree layer. The herbaceous layer was dominated by *Scirpus cyperinus* (wool-grass), *Typha latifolia* (broad-leaf cattail) and *Juncus effusus* (soft rush). Soils were identified as hydric, poorly drained Melvin silt loam. Inundation, saturated soils and oxidized root channels were observed as the primary and secondary indicators of wetland hydrologic conditions.

The upland area surrounding Area A consisted of a scrub-shrub community dominated by *Rubus allegheniensis* (Allegheny blackberry) and *Rosa multiflora* (multiflora rose) in the shrub layer and an *Aster* species in the herbaceous layer. Upland soils were identified as non-hydric, well drained Chargin silt loam. No indicators of wetland hydrologic conditions were observed.

Snow Fork - Brush Fork Area B

Area B consisted of a forested wetland dominated by *Acer negundo* (box elder), *Ulmus rubra* (slippery elm) and *Populus deltoides* (cottonwood) in the tree layer. The herbaceous layer was dominated by *Onoclea sensibilis* (sensitive fern), *Rhus radicans* (poison ivy), *Juncus effusus* and *Aselapias incarnata* (swamp milkweed). Soils were identified as hydric, poorly drained Melvin silt loam. Inundation, saturated soils and oxidized root channels were observed as the primary and secondary indicators of wetland hydrologic conditions.

The upland area surrounding Area B consisted of a scrub-shrub community dominated by *Rosa multiflora* shrub layer *Rhus radicans* and *Panicum cladestum* (deer tongue). Soils were identified as non-hydric, well drained Chargin silt loam. No indicators of wetland hydrologic conditions were observed.

Snow Fork - Brush Fork Area C

Area C consisted of a scrub-shrub wetland dominated by *Acer saccharum* (sugar maple) in the tree layer and *Impatiens* species (jewel weed) in the herbaceous layer. Soils were identified as hydric, poorly drained Melvin silt loam. Inundation and saturated soils were observed as the primary indicators of wetland hydrologic conditions.

The upland area surrounding Area C consisted of a forested/scrub-shrub community dominated by *Liriodendron tulipifera* (tulip poplar) and *Aesculus glabra* (Ohio buckeye) in the tree layer and *Rosa multiflora* and *Lindera benzoin* in the shrub layer. Soils were identified as hydric, poorly drained Melvin silt loam. No indicators of wetland hydrologic conditions were observed.

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Snow Fork - Brush Fork Area D

Area D consisted of an herbaceous wetland dominated by *Acer rubrum* (red maple) in the tree layer and *Onoclea sensibilis* (sensitive fern), *Juncus effusus* and *Typha angustifolia* (narrow-leaf cattail) in the herbaceous layer. Soils were identified as hydric, poorly drained Melvin silt loam. Inundation, saturated soils and oxidized root channels were observed as the primary and secondary indicators of wetland hydrologic conditions.

The upland area surrounding Area D consisted of a scrub-shrub community dominated by *Rosa multiflora* in the shrub layer and *Crysanthemum leucanthemum* (oxeye daisy) in the herbaceous layer. Upland soils were identified as non-hydric, well drained Chargin silt loam. No indicators of wetland hydrologic conditions were observed.

Snow Fork (Spencer Hollow)

The wetland at Spencer Hollow consisted of forested and herbaceous communities. The forested community was dominated by *Salix nigra* in the tree layer and *Spiraea alba* (white meadowsweet) in the shrub layer. The herbaceous community was dominated by *Scirpus cyperinus*, *Carex lupulina* (fox sedge), *Alisma sp.* (water plantain), *Aselapias incarnata* (swamp milkweed), *Typha latifolia*, *Ludwigia alternifolia* (bushy seedbox), *Iris* species, *Phalaris arundinacea* (reed canary grass), *Onoclea sensibilis*, *Juncus effusus* and *Scirpus validus* (soft-stem bulrush). Soils were identified as hydric, poorly drained Melvin silt loam. Inundation, saturated soils, sediment deposits, drainage patterns and oxidized root channels were observed as the primary and secondary indicators of wetland hydrologic conditions.

The upland area surrounding Spencer Hollow was bound by steep spoil from abandoned mining activities. No indicators of wetland hydrologic conditions were observed.

Lost Run

The wetland at Lost Hollow consisted of a forested wetland dominated by *Quercus bicolor* (swamp white oak) and *Carpinus caroliniana* (American hornbeam) in the tree layer and *Lindera benzoin* in the shrub layer. The herbaceous layer was dominated by *Onoclea sensibilis* and *Leersia oryzoides*. Soils were identified as hydric, poorly drained Melvin silt loam. Inundation and saturated soils were observed as the primary indicators of wetland hydrologic conditions.

The upland area surrounding the wetland consisted of a forested community dominated by *Liriodendron tulipifera*, *Fagus grandifolia* (beech) and *Carpinus caroliniana* in the tree layer. The herbaceous layer was dominated by *Parthenocissus quinquefolia* (Virginia creeper), *Rhus radicans* (poison ivy) and *Sphagnum* species. Upland soils were identified as non-hydric, well drained Chargin silt loam. No indicators of wetland hydrologic conditions were observed.

Dixie Hollow

The wetland at Dixie Hollow consisted of a forested wetland dominated by *Salix nigra* and *Platanus occidentalis* (American sycamore) in the tree layer and *Scirpus cyperinus* and *Juncus effusus* in the herbaceous layer. Soils were identified as hydric, poorly drained Melvin silt loam. Inundation and saturated soils were observed as the primary indicators of wetland hydrologic conditions.

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The upland area surrounding the wetland consisted of mowed lawn. Upland soils were identified as non-hydric, well drained Chargrin silt loam. No indicators of wetland hydrologic conditions were observed.

Monkey Hollow

The wetland at Monkey Hollow consisted of an herbaceous area dominated by *Glyceria* species (manna grass). Soils were identified as hydric, poorly drained Melvin silt loam. Saturated soils were observed as the primary indicator of wetland hydrologic conditions.

The upland area surrounding the wetland consisted of a forested community dominated by *Fagus grandifolia* and *Carpinus caroliniana* in the tree layer. Upland soils were identified as non-hydric, well drained Chargrin silt loam. No indicators of wetland hydrologic conditions were observed.

Snow Fork - Orbiston

The wetland at Snow Fork (Orbiston) consisted of an herbaceous wetland dominated by *Spiraea tomentosa* (steeple bush) in the shrub layer. The herbaceous layer was dominated by *Onoclea sensibilis*, *Juncus effusus*, *Microstigium* species, *Carex lupulina*, *Typha latifolia* and *Scirpus cyperinus*. Soils were identified as hydric, poorly drained Melvin silt loam. Inundation, saturated soils and oxidized root channels were observed as the primary and secondary indicators of wetland hydrologic conditions.

The upland area surrounding the wetland consisted of a forested community dominated by *Prunus* species in the tree layer and *Rosa multiflora* and *Rubus allegheniensis* in the shrub layer. The herbaceous layer was dominated by *Panicum cladestum*. Upland soils were identified as non-hydric, well drained Chargrin silt loam. No indicators of wetland hydrologic conditions were observed.

3.9 Aquatic Life and Wildlife

3.9.1 Aquatic Life

Biological assessments are used to monitor ecosystem conditions by using fish and stream macroinvertebrates as indicators of stream conditions. The composition of benthic and fish communities is then used to judge the conditions of the stream. Pollution tolerant species are found in a wide range of conditions, while moderately tolerant species will be found in fair to high quality environments. Pollution sensitive species are found only in high quality water. During sampling, the presence and quantity of these species can be used as indicators of the stream health.

The headwaters of Little Monday Creek are designated as Warm Water Habitat which is defined as streams which have the ability to achieve the biological criteria requirements that include diverse fish and macroinvertebrate populations.

During the Total Maximum Daily Load (TMDL) field investigations performed by OEPA in 2001, fish and macroinvertebrate sampling was conducted at various sites in the watershed. Figure 3-3 displays the total number of fish caught for the Monday Creek Basin, Snow Fork, Mainstem Monday Creek and Little Monday Creek.

Figure 3-3 Total Number Fish Caught During TMDL Field Activities

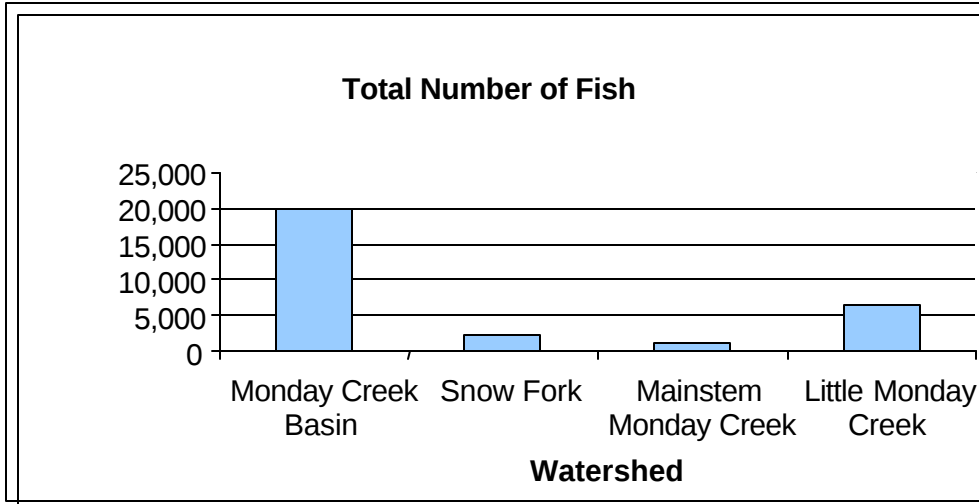


Figure 3-4 shows the species diversity including hybrids found in Monday Creek Basin, Snow Fork, Mainstem Monday Creek and Little Monday Creek.

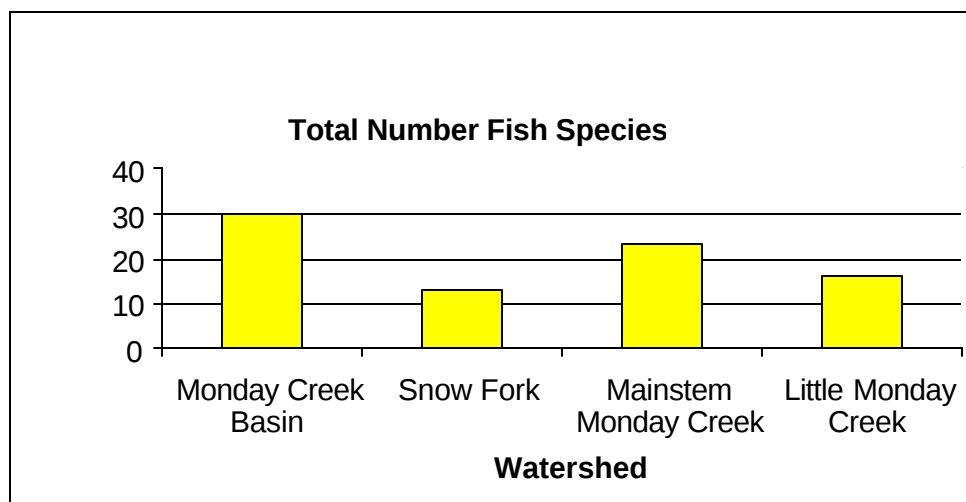


Figure 3-4 Total Number Fish Species Caught During TMDL Field Activities

As shown in Figure 3-5 in mainstem Monday Creek pollution tolerant species consisted of approximately 70 percent of the fish caught during the sampling period. Figure 3-4 indicates the pollution tolerant species found in the main stem of Monday Creek. These include yellow bullhead (*Ameriurus natalis*) (T), bluegill sunfish (*Lepomis macrochirus*) (M), green sunfish (*Lepomis cyanellus*) (T), and creek chubs (*Semotilus atromacculatus*) (T).

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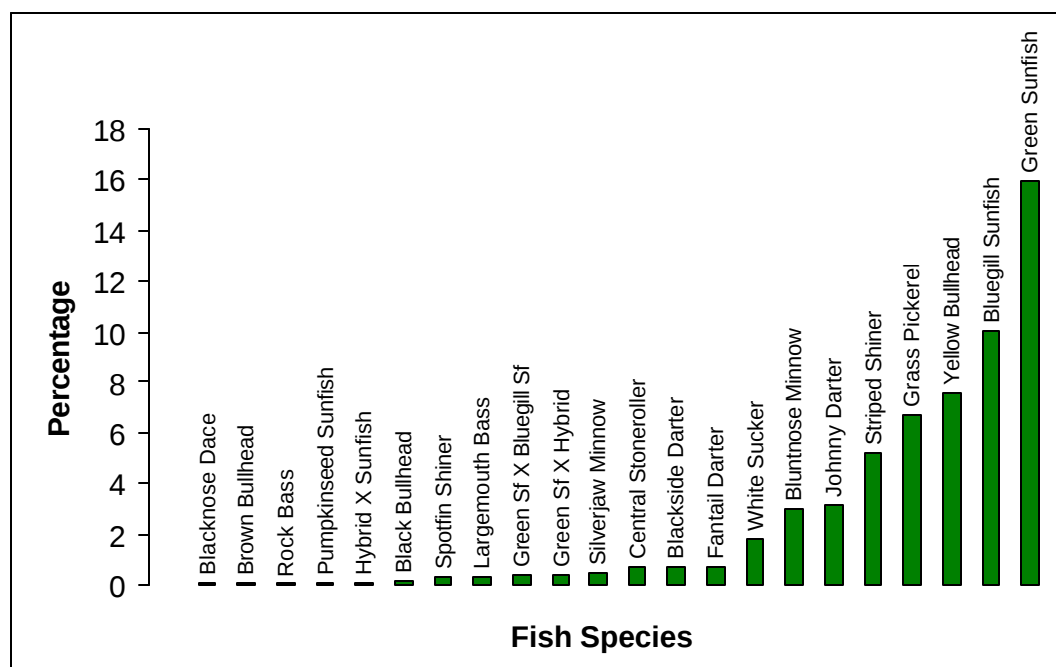


Figure 3-5 Main Stem Monday Creek Fish Populations by Percentage

Figure 3-6 shows pollution tolerant species found in Snow Fork made up approximately 89 percent of the fish caught during the sampling period. Pollution tolerant species found in Snow Fork included green sunfish, bluntnose minnow (*Pimephales notatus*) (T), blacknose dace (*Rhinichthys atratulus*) (T) and creek chubs.

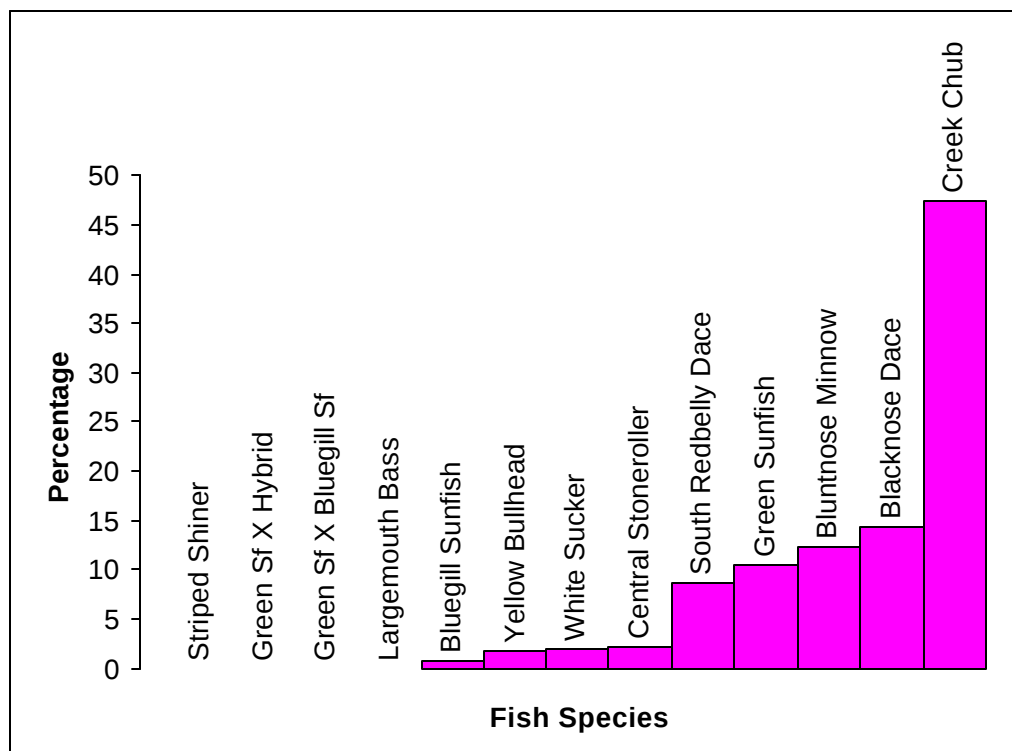


Figure 3-6 Snow Fork Fish Populations by Percentage

Figure 3-7 displays pollution tolerant species made up 52 percent of the fish caught in Little Monday Creek during the sampling period. Pollution tolerant species found in Little Monday Creek included blacknose dace, central stoneroller (*Campostone anomalum*) (M), southern redbelly dace (*Phoxinus erythrogaster*) (M) and creek.

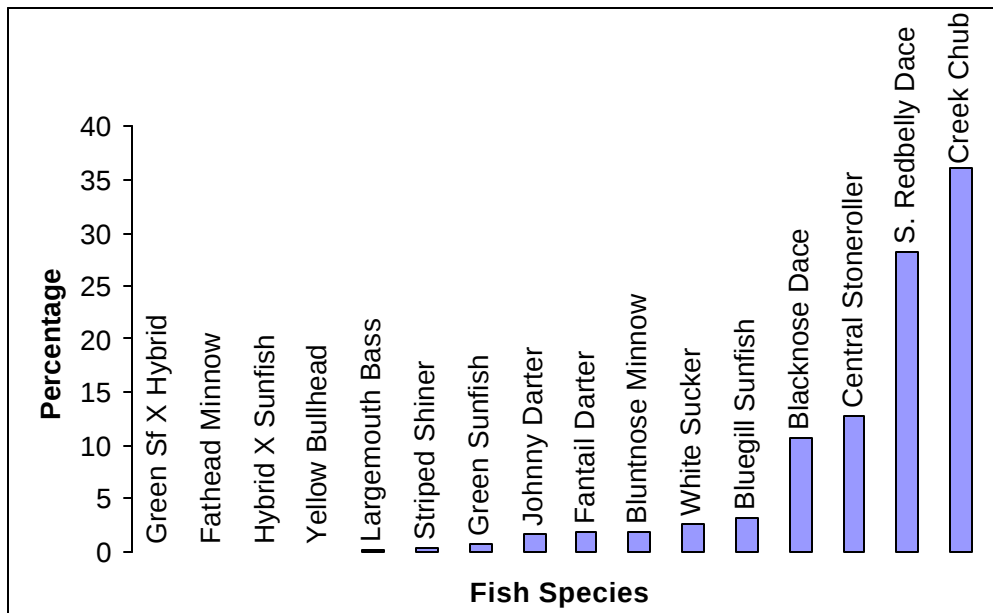


Figure 3-7 Little Monday Creek Fish Populations by Percentage

From the headwaters of mainstem Monday Creek and the majority of Snow Fork, aquatic habitat is degraded primarily due to intolerable pH levels that result in the lack of aquatic organism or decreased diversity within the ecosystem. Furthermore, Monday Creek and its tributaries are listed on Ohio's 303(d) list for AMD pollutants, specifically pH and metals.

Few data exist on the tolerance of mollusks, crustaceans, amphibians and turtles to low pH levels. Most research indicates that the pH levels are much too low to be conducive to support healthy populations of any of these groups. In turn, the lack of basic food chain elements (i.e., amphibians, fish) provided by these aquatic species would undoubtedly have negative effects on terrestrial species. Species of waterfowl, wading birds, and small mammals that feed upon fish and amphibians may no longer use, or use in a much reduced capacity, the existing aquatic ecosystem as food sources.

3.9.2 Wildlife

The Monday Creek Watershed supports common game wildlife species such as the white-tailed deer (*Odocoileus virginianus*), wild turkey (*Meleagris gallopavo*), ruffed grouse (*Bonasa umbellus*), eastern cottontail (*Sylvilagus floridanus*), and gray squirrel (*Sciurus carolinensis*). Raccoon (*Procyon lotor*), opossum (*Didelphis virginiana*), coyote (*Canis latrans*), gray fox (*Urocyon cinereoargenteus*), and the white-footed mouse (*Peromyscus leucopus*) are common transient or resident mammal species. The beaver (*Castor canadensis*) has been very active within the watershed. Mine portals in the watershed may provide entranceways to suitable hibernacula for several bat species including the big brown bat (*Eptesicus fuscus*). Species of reptiles such as the ringneck snake (*Diadophis punctatus*) and copperhead (*Agkistrodon contortrix*) may be found utilizing the forested habitats of the watershed.

Nesting and foraging habitat exist for bird species such as the northern cardinal (*Cardinalis cardinalis*), pileated woodpecker (*Dryocopus pileatus*), blue jay (*Cyanocitta cristata*), American crow

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(*Corvus brachyrhynchos*), eastern phoebe (*Sayornis phoebe*), white-breasted nuthatch (*Sitta carolinensis*), black-capped chickadee (*Parus atricapillus*), brown creeper (*Certhia familiaris*), and various flycatchers and warblers.

Waterfowl such as the wood duck (*Aix sponsa*) and wading birds such as the great blue heron (*Ardea herodias*) typically use area wetlands and ponds for resting and breeding.

3.10 Threatened and Endangered Species

The US Fish and Wildlife Service (USFWS) provided a list of federally listed endangered and threatened species pursuant to the Endangered Species Act (ESA) that have part of their range within or near the WNF. The species list included indiana bat (*Myotis sodalis*), American burying beetle (*Nicrophorus americanus*), and the bald eagle (*Haliaeetus leucocephalus*). Endangered or threatened Federally listed plants that may be found within Monday Creek watershed include northern monkshood (*Aconitum noveboracense*) and small whorled pogonia (*Isotria medeoloides*). Their range and status are listed below.

Indiana Bat (*Myotis sodalis*)

The proposed project lies within the range of the Indiana bat (*Myotis sodalis*), a Federally listed endangered species. Summer habitat requirements for the species are not well defined; however, the U. S. Fish and Wildlife Service (Service) provided the following observations that are potentially critical habitat:

1. Dead or live trees that have snags with peeling or exfoliating bark, split tree trunk and/or branches, or cavities, which may be used as maternity roost areas.
2. Live trees (such as shagbark hickory) which have exfoliating bark.
3. Stream corridors, riparian areas, and upland woodlots which provide forage sites.
4. and should the proposed sites contain trees or associated habitats exhibiting any of the characteristics listed above, the habitat and surrounding trees be saved wherever possible. If the trees must be cut, further coordination with the USFWS will occur. Suitable bat roost trees should not be cut between April 15 and September 15.
5. If desirable trees are present and must be cut, mist net or other surveys may be warranted to determine if bats are present. Any survey will be designed and conducted in coordination with the Endangered Species Coordinator of the Reynoldsville Field Office. The survey should be conducted in June or July, since the bats would only be expected in the project area from approximately April 15 to September 15.

American Burying Beetle (*Nicrophorus americanus*)

The downstream portion of Monday Creek lies within the range of the American burying beetle (*Nicrophorus americanus*), a Federally listed endangered species. This insect is a "generalist" as far as habitat preference is concerned, with a slight preference for grasslands, open woodlands and brushlands.

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Bald Eagle (*Haliaeetus leucocephalus*) - Hocking County only

The project area lies within the range of the bald eagle (*Haliaeetus leucocephalus*), a Federally-listed threatened species. The Service recommends that the Corps contact Mr. Mark Shieldcastle, with the Ohio Department of Natural Resources, Division of Wildlife, (419) 898-0960, for the location(s) of the eagle nest(s) in the county. The requested coordination will occur in April 2005.

Federally Listed Plant Species

Northern Monkshood (*Aconitum noveboracense*) - Hocking County only

This project lies within the range of the Federally listed threatened northern monkshood (*Aconitum noveboracense*). The plant is found on cool, moist, talus slopes or shaded cliff faces in wooded ravines.

Small Whorled Pogonia (*Isotria medeoloides*) - Hocking County only

The project lies within the range of the small whorled pogonia (*Isotria medeoloides*), a Federally listed threatened species. *Isotria medeoloides* occurs both in fairly young forests and in maturing stands of mixed-deciduous or mixed-deciduous/coniferous forests. The majority of small whorled pogonia sites share several common characteristics. These may include sparse to moderate ground cover in the microhabitat (except when among ferns), a relatively open understory canopy, and proximity to old logging roads, streams, or other features that create long-persisting breaks in the forest canopy. The soil in which the shallow-rooted small whorled pogonia grows is usually covered with leaf litter and decaying material. The spectrum of habitats includes dry, rocky, wooded slopes to moist slopes or slope bases crisscrossed by vernal streams.

Species With a Conservation Plan

Timber Rattlesnake (*Crotalus horridus horridus*)

The projects in Athens and Hocking Counties lie within the range of the timber rattlesnake (*Crotalus horridus horridus*), a large shy rattlesnake that is declining throughout its national range. No Federal listing status has been assigned to this species. Instead, the U.S. Fish and Wildlife Service has initiated a pre-listing Conservation Action Plan to support state and local conservation efforts. The timber rattlesnake is protected throughout much of its range and is listed as endangered by the State of Ohio. Due to its rarity and reclusive nature, the USFWS encourages early project coordination to avoid potential impacts to the timber rattlesnake and its habitat.

In Ohio, the timber rattlesnake is restricted to the un-glaciated Allegheny Plateau and utilizes the specific habitat types depending upon the season. Winters are spent in dens usually associated with high, dry ridges. These dens may face any direction, but southeast to southwest are most common. Such dens usually consist of narrow crevices in the bedrock. Rocks may or may not be present on the surface. From these dens, timber rattlesnakes radiate throughout the surrounding hills and move distances as great as 4.5 miles. In the fall, timber rattlesnakes return to the same den. Intensive efforts to transplant timber rattlesnakes have not been successful.

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Regional Forester's Sensitive Species

Regional Forester's Sensitive (RFS) species are those species that occur within the proclamation boundaries of the Wayne NF and are either candidates for Federal listing under the ESA, species delisted under the ESA in the last five years, globally or nationally ranked 1-3 by The Nature Conservancy and Association for Biodiversity Information or considered Sensitive on the Wayne NF based on Risk Evaluations. Thirty-three plant and animal RFS species are currently identified for the Wayne NF. This list includes eleven plant, four mollusk, four insect, three fish, one reptile, two amphibian, two bird and six mammal species. These species are listed in Table 3-3.

TABLE 3-3
Regional Forester's Sensitive Species Listed for Wayne National Forest

Species	Common Name	State Status*
Plants		
<i>Carex juniperorum</i>	Juniper sedge	T
<i>Dicanthelium bicknellii</i> (<i>Panicum bicknellii</i>)	Bicknell's panicgrass	T
<i>Gentiana alba</i>	Yellow gentian	T
<i>Gentiana villosa</i>	Striped gentian	E
<i>Juglans cinerea</i>	Butternut	P
<i>Magnolia tripetala</i>	Umbrella magnolia	P
<i>Panicum philadelphicum</i>	Philadelphia panicgrass	T
<i>Phacelia ranunculacea</i>	Blue scorpionweed	E
<i>Platanthera ciliaris</i>	Yellow fringed orchid	T
<i>Scutellaria saxatilis</i>	Rock skullcap	P
<i>Vitis cinerea</i>	Pigeon grape	P
Mollusks		
<i>Obovaria subrotunda</i>	Round hickorynut	No Status
<i>Simponaias ambigua</i>	Salamander mussel	SI
<i>Toxolasma parvus</i>	Liliput	No Status
<i>Villosa lienosa</i>	Little spectaclecase	E
Insects		
<i>Euchloe oympia</i>	Olympa marble	SI
<i>Macromia wabashensis</i>	Wabash river cruiser	No Status
<i>Pyrgus Wyandot</i>	Southern grizzled skipper	SI
<i>Speyeria idalia</i>	Regal fritillary	M
Fish		
<i>Ammocrypta pellucida</i>	Eastern sand darter	No Status
<i>Erimyzon sucetta</i>	Lake chubsucker	No Status
<i>Ichthyomyzon bdellium</i>	Ohio lamprey	E
Reptiles		
<i>Crotalus horridus</i>	Timber rattlesnake	E

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Amphibians		
<i>Cryptobranchus allegheniensis</i>	Eastern hellbender	E,M
<i>Aneides aeneus</i>	Green salamander	E
Birds		
<i>Ammodramus henslowii</i>	Henslow's sparrow	SI,M
<i>Dendroica cerulea</i>	Cerulean warbler	SI,M

Mammals		
<i>Corynorhinus (=Plecotus)</i>	Rafinesque big-eared bat	SI,M
<i>Felis rufus</i>	Bobcat	E
<i>Lutra canadensis</i>	River otter	E
<i>Nycticeius humeralis</i>	Evening bat	No Status
<i>Neotoma magister</i>	Allegheny woodrat	E,M
<i>Ursus americanus</i>	Black bear	E

* E=Endangered, T=Threatened, SI=Special Interest, M=Monitored, P=Potential Threatened

3.11 Historic and Archaeological Resources

The Corps of Engineers is responsible for cultural resources compliance in areas affected by construction activities under its sponsorship. The National Historic Preservation Act, as amended and its implementing regulations at 36 CFR Part 800 requires the Corps to take into consideration the effects of its actions on historic properties. This begins with identification of all cultural resources listed in or potentially eligible for listing in the National Register of Historic Places and an assessment of potential effects. Historic properties may include archaeological sites, structures, districts, or objects. Appropriate state and federal agencies are consulted in the process and federally recognized Indian Tribes also may be consulted under certain circumstances.

Corps cultural resource specialists inspected private lands and the WNF has inspected Forest Service lands. Project locations have been altered by coal mining activities or bulldozed clearing of home sites. In many locations, compacted mining waste material--gob dumps--covers the narrow valley bottoms to depths of one to two meters. At other locations houses have been removed and the foundations bulldozed into small rubble piles. Most of these houses were constructed on mining waste. On one private property, a log structure appears to be of only marginal historic interest due to loss of integrity from weathering. However, it will not be directly affected by the proposed treatments but two limestone leach beds and two open limestone channels will be constructed in the vicinity; the nearest will be some 30 meters from the site. The Corps proposes to document this feature and have a professional archeologist monitor excavations during construction activities.

3.12 Hazardous, Toxic and Radiological Wastes

A Phase I Environmental Site Assessment (ESA) was conducted for the project areas in 2002 and 2003. The study indicated that a total of 70 potential Hazardous, Toxic and Radiological

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Waste (HTRW) conditions and 14- non-HTRW conditions were identified on the project properties during field reconnaissance. The potential HTRW conditions consisted of crude oil production systems (wells, pipelines, aboveground storage tanks (ASTs), etc.); drum and other AST sites, and underground storage tanks/leaking underground storage tanks (UST/LUST) sites. The non-HTRW conditions consisted of miscellaneous debris and rubbish; junk vehicles and equipment; vehicle parts and old tires; occasional drums and containers for household or farm usage; and old appliances and furniture. Refer to Appendix B for a copy of the Phase I ESA.

The Phase I report identified two sites in Long Hollow. These sites are crude oil tanks and oil wells. These facilities, as well as feeder lines, will be avoided during construction operations.

The Phase I report indicated that there were no sites identified in Snake Hollow.

The Phase I report identified three sites in Monkey Hollow. Two of these sites are crude oil tanks and oil wells. These facilities as well as the feeder lines will be avoided during construction operations. The other site was noted as 20 yards of miscellaneous debris, old cars, refrigerator, tires and a drum. This area is not located in a construction site.

The Phase I report identified three sites in Lost Run. Two of these sites are crude oil tanks and oil wells. These facilities as well as the feeder lines will be avoided during construction operations. This area is not located in a construction site.

3.13 Socio-Economics

Although evidence of European settlement in southeastern Ohio dates back to 1774, communities did not take root until adequate transportation routes were established. The Hocking Canal, which was opened in 1843, allowed for greater commercial activity, facilitating the transport of large quantities of wool, coal, packed meat, salt, tobacco, and lumber between Athens and Columbus (ILGARD 1999).

Clearly the most significant population expansion in the Monday Creek Watershed came in response to the extension of the railroad in the 1870s. There were only 36 miles of railroad in Ohio in 1841, but by 1885 7,124 miles of track were in place (ILGARD 1999). With the introduction of this effective and economical means of transportation came a subsequent increase in industrialization. Population analyses show that thousands of Irish, Welsh, Italian, Dutch, Hungarian, Polish and German immigrants flocked to the area during times of economic prosperity. These immigrants settled in "company towns" with colorful names such as Buchtel, Jobs, and New Pittsburg (Zanski 1997), which were exclusively owned by mining companies and provided housing, food, and work for the people who lived there. When "coal was king" in the 1880s, some of the villages in the Monday Creek Watershed were actually small cities, that boasted populations of between 3,000 and 4,000 (Graham 1883).

Between 1910 and 1950, the population of the watershed has declined by more than half. A post-World War II population decline resulted from increased mechanization and decreased demand for coal coupled with better paying jobs in steel factories, oil fields, and airplane factories in northern Ohio and Michigan (Zanski 1997) resulted in the loss of another one-third of the population (Davison 1996).

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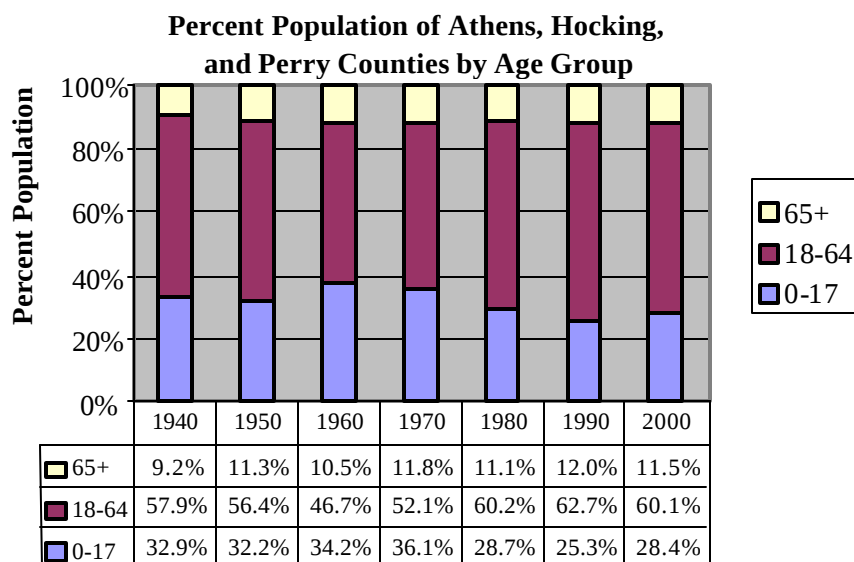
Table 3-4
Watershed Population by Village, 1900-2000

	1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000
Buchtel		1,180	1,178	799	755	569	499	592	585	640	574
Murray City	1,118	1,386	1,493	1,048	1,009	752	717	562	579	499	452
New Straitsville	2,302	2,242	2,208	1,718	1,473	1,122	1,019	947	937	865	774
Shawnee	2,966	2,280	1,918	1,457	1,475	1,145	1,000	914	924	742	608
TOTAL	6,386	7,088	6,797	5,022	4,712	3,588	3,235	3,015	3,025	2,746	2,408

Source: U.S. Bureau of Census, 1900-2000.

Though not apparent in the above statistics, some growth occurred in the unincorporated areas during the 1980s. However, most of the watershed villages have continued to experience a gradual population decline.

The gradual out-migration of young people from Athens, Hocking, and Perry Counties has left these areas with a slightly larger percentage of elderly in comparison to 1940 statistics.



Source: U.S. Bureau of Census, 1940-2000.

Figure 3-8 **Percent Population of Athens, Hocking, and Perry Counties by Age Group**

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In terms of racial demographics, the Monday Creek Watershed is made up largely of Caucasians, with small minority populations located in specific pocket areas. The comparatively large population of minority groups in York Township can be attributed to the presence of Hocking College in Nelsonville, Ohio, which maintains a sizeable population of minority and foreign students.

Table 3-5
Demographic Population of Townships by Race

	Total Population	White	Black	American Indian	Asian	Pacific Islander	Other	Hispanic
York	7,740	7,446	131	36	25	0	102	76
Ward	1,937	1,746	166	2	1	0	22	5
Coal	1,106	1,085	4	0	0	0	17	18
Monday Creek	671	659	2	4	2	0	4	9
Salt Lick	1,200	1,184	0	0	5	0	11	6
Falls Gore	11,409	11,192	55	35	10	0	117	69

Source: U.S. Bureau of Census, 2000.

POVERTY STATISTICS

Reflective of the Monday Creek Watershed's locality in Ohio's Appalachian region, almost 18 percent of the watershed's residents live below the poverty level. Athens County has a 27 percent poverty rate, Hocking County 13 percent, and Perry County 12 percent. These rates were 1 to 17 points higher than the state average of 10 percent (U.S. Bureau of Census 2000). The 1998 Ohio Department of Development (ODOD) trends (based on 1990 Census) estimated poverty rates of 18 percent for Athens, 13 percent for Hocking, and 14 percent for Perry. These figures represent a poverty rate 2 to 7 points higher than the state average of 11 percent.

The per capita income of watershed residents is around \$5,500 per year less than the average in the state of Ohio (U.S. Bureau of Census 2000)

Table 3-6
Percent of Individuals Below Poverty by County, 1970-1999

	1970	1980	1990	1995	1999
Athens	16.4%	21.6%	28.7%	32.5%	27.4%
Hocking	18.1%	12.4%	15.7%	14.5%	13.5%
Perry	16.8%	12.5%	19.1%	21.0%	11.8%
State of Ohio	9.78%	11.1%	13.6%	14.9%	10.6%
United States	13.7%	12.4%	13.1%	13.8%	12.4%

Source: US Bureau of Census, 1969, 1979, 1989, 1995, and 2000.

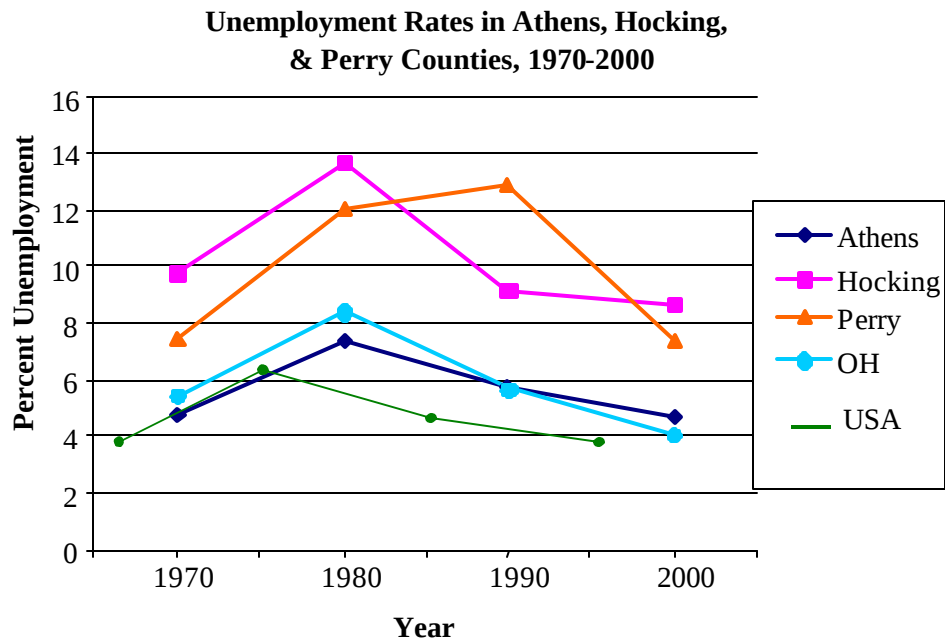
Table 3-7
Per Capita Income by County, 1969-1999

	1969	1979	1989	1999
Athens	\$7,213	\$8,531	\$9,170	\$14,171
Hocking	\$7,342	\$9, 493	\$10,265	\$16,095
Perry	\$6,575	\$9,109	\$9,247	\$15,674
State of Ohio	\$10,068	\$12,207	\$13,461	\$21,003
United States	\$9,816	\$12,229	\$14,420	\$21,587

Source: U.S. Department of Commerce, 1969, 1979, 1989, and 2000.

EMPLOYMENT STATISTICS

The coal mining industry, which historically served as the region's primary source of employment, suffered a drastic decline in the 1970s and a dramatic loss of jobs in the watershed. Today, only 1.9 percent of the population remains involved in coal mining in the Ohio Appalachian region (U.S. Census 1990). The 1990 Census indicates that only 11 percent of the employed residents (in the four largest villages) in the Monday Creek Watershed worked locally. In contrast, 29 percent of Ohio workers and 17 percent of Ohio Appalachian workers were employed close to home. Most residents were forced to commute to Logan, Nelsonville, and Columbus for employment or choose to leave the area altogether in order to find work.



Source: U.S. Bureau of Labor Statistics, 1970, 1980, 1990, and 2000.

Figure 3-9 Unemployment Rates in Athens, Hocking and Perry Counties 1970-2000

The Monday Creek Watershed experienced a dramatic increase in unemployment in the 1980s. The unemployment rate in Athens County was at 7.3 percent, Hocking County was at 13.7, and Perry County was at 12.1 percent unemployment (Labor Market Information 2002). This trend was taking place statewide as unemployment in Ohio rose 3.0 points from 1970 levels to 8.4 percent in 1980 (*ibid*). The 1990 Census showed marked decreases in unemployment, while the 2000 Census indicates the lowest unemployment rates since 1970. The 2000 Census listed 4.7 percent unemployment in Athens County, 7.4 percent in Perry County and 8.7 percent in Hocking County. In relation to the state of Ohio's unemployment rate of 4.0 percent, the Ohio Department of Development ranked Athens County thirty-ninth, Perry County twelfth, and Hocking County seventh highest in unemployment among Ohio's 88 counties. As of December 2002, the unemployment rate in Ohio was 5.3% as compared to 6.0% in the U.S (Ohio Department of Development 2002).

EDUCATIONAL ATTAINMENT

Residents of the watershed tend to have lower educational attainment than the State average. In 2000, between 45 and 62 percent of the watershed's population held a high school diploma as the highest level of educational attainment, while 36 percent of Ohio residents held a similar level of educational attainment. Compared with the state of Ohio's rate of 7.5 percent, only 0.6 to 1.8 percent of the watershed residents have obtained a post-secondary degree, (U.S. Bureau of Census 2000).

Table 3-8
Educational Attainment For Persons 25 Years and Over

	Buchtel	Murray City	New Straitsville	Shawnee	Ohio Appalachia*	State of Ohio	United States
Less than 9th grade	8%	7.9%	6.5%	4.7%	6.2%	4.5%	7.5%
9-12th grade, no diploma	15.2%	23.3%	21.1%	11.7%	14.9%	12.6%	12.1%
High school graduate	45.6%	49%	52.8%	62%	43.7%	36.1%	28.6%
Some college, no degree	15.7%	10.3%	12.3%	14.8%	16.6%	19.9%	21%
Associate's degree	9%	5.5%	3.2%	5%	5.6%	5.9%	6.3%
Bachelor's degree	4.6%	3.4%	2.6%	1.1%	7.9%	13.7%	15.5%
Graduate or professional	1.8%	0.7%	1.6%	0.6%	4.4%	7.4%	8.9%

Source: U.S. Bureau of Census, 2000.

*Source: Ilgard Data Services – Census 2000 Reports

For K-12 education, the Monday Creek Watershed is serviced by the Nelsonville-York City School District, the Logan-Hocking School District, and the Southern Local School District. It is significant to note that it was the Southern Local School District that filed a petition in 1991 with the Perry County Common Pleas Court, which ultimately led to the monumental Supreme Court case, *DeRolph versus the State of Ohio*. This case was subsequently joined by numerous other Ohio school districts, questioning the constitutionality of the state's heavy reliance on local property taxes for the funding of public schools, thus disadvantaging poverty-stricken areas such as Monday Creek Watershed. As a result of this litigation, the state has appropriated billions of dollars to school infrastructure improvements and is currently evaluating the manner in which local school districts are funded.

The watershed contains no colleges or universities. However, Ohio University and Hocking College, both located in Athens County, are within close proximity to the watershed boundaries.

3.14 Recreation

The primary recreational uses in the watershed are Off Road Vehicle (ORV) trail use and hunting. Other uses include hiking, biking, camping and firewood, mushroom and ginseng collecting. A small portion of the Monday Creek ORV area traverses the watershed. Hiking and biking are also allowed on Monday Creek ORV trails. Use of the ORV trails is often heavy, peaking around the holidays and weekends. However use by ORV and bike riders is not allowed between

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December 14 and April 16. There is one designated camping area in the watershed and primitive camping is allowed in the Wayne National Forest.

Of the 65.0 miles of ORV trails, 5.0 miles are within the boundaries of the watershed. ORV trails will average 6.4 miles per square mile when all trails are built (Forest Plan, 1998).

Game species, primarily deer, wild turkey, ruffed grouse and squirrel are hunted seasonally. Deer, ruffed grouse, and squirrel hunting occur during the fall months, whereas wild turkey hunting occurs in the fall and spring. Spring turkey season usually begins around the last week of April and continues to the end of the third week in May.

3.15 Future Without Project Condition (FWOPC) or No-Action

Aquatic conditions in the watershed would be only slightly improved since other partners (ODNR and WNF) have plans to treat the AMD and subsidence issues. However, recovery of the impacted aquatic ecosystem would not be realized. Property and funding constraints limit the amount of work that can be completed in the watershed. The future restoration of the watershed would be piecemealed and the current habitat disconnectivity of the ecosystem would still occur throughout the entire watershed. In addition, aquatic diversity and population increases would not be realized.

4.0 Plan Formulation and Alternative Evaluation

4.1 Formulation Process

The study team used the study goals and objectives to identify, develop, and ultimately select potential projects, following the philosophy and policy included in the Engineering Circular (EC 1105-2-210), Ecosystem Restoration Planning in the Civil Works program (ER-1105-2-100), as well as other applicable policies and guidance. This document, in addition to the model development by WVU, data and knowledge of the watershed provided by MCRP, ODNR, OEPA, Ohio University, WNF, USFWS, and DOE-NETL were invaluable in the development of the recommended plan presented in this report. Implementing the recommended plan from this study would improve the quality and quantity of aquatic, riparian and terrestrial habitat in the Monday Creek Watershed. In addition the Environmental Operating Principles outlined below were integrated into the formulation process.

Environmental Operating Principles (EOP)

In 2002, The USACE reaffirmed its long-standing commitment to the environment by formalizing a set of EOPs applicable to all of its decision-making and programs. The principles are consistent with NEPA; the Department of the Army's Environmental Strategy with its four pillars of prevention, compliance, restoration and conservation; and other environmental statutes and Water Resources Development Acts (WRDAs) that govern USACE activities. The EOPs have guided the plan formulation process and are integrated into all proposed program and project management processes. The EOPs are:

1. Strive to achieve environmental sustainability, and recognize that an environment maintained in a healthy, diverse and sustainable condition is necessary to support life.
2. Recognize the interdependence of life and the physical environment, and proactively consider environmental consequences of USACE programs and act accordingly in all appropriate circumstances.
3. Seek balance and synergy among human development activities and natural systems by designing economic and environmental solutions that support and reinforce one another.
4. Continue to accept corporate responsibility and accountability under the law for activities and decisions under our control that impact human health and welfare and the continued viability of natural systems.
5. Seek ways and means to assess and mitigate cumulative impacts to the environment; bring systems approaches to the full life cycle of our processes and work.
6. Build and share an integrated scientific, economic, and social knowledge base that supports a greater understanding of the environment and impacts our work.
7. Respect the views of individuals and groups interested in Corps activities, listen to them actively, and learn from their perspective in the search to find innovative win-win solutions to the nation's problems that also protect and enhance the environment.

4.2 Aquatic Ecosystem Approach

Some tributaries in the headwaters of Monday Creek and Little Monday Creek have healthy headwater areas but then flow into the degraded mainstem. This situation has created a fragmented watershed with isolated populations of healthy aquatic communities. Thus, reconnecting these aquatic communities was an objective. Attaining the water quality thresholds at the mouth of Monday Creek to meet aquatic resource habitat requirements was one of the primary objectives for this study and the formulation of restoration projects.

Although much of the stream structure and physical attributes are considered good, in some areas the streambeds have been covered by metal precipitates. This causes a film to coat the rocks and stream bed and prohibits colonization by plants and macroinvertebrates. In addition, these precipitants cause excessive turbidity and sedimentation on the streambed decreasing habitat for macroinvertebrates and other organisms. Increased turbidity leads to a decrease in light penetration, slowing primary production activities. Loss of macroinvertebrates within the stream causes a significant loss of food sources for higher food chain organisms such as fish, other invertebrate communities and terrestrial organisms.

Toxicity of AMD is dependent on discharge volume, pH, total acidity, and concentrations of dissolved metals (Earle et al, 1998). To achieve a sustainable warm water habitat ecosystem, the pH, iron, and aluminum endpoints required would need to provide the chemical water quality necessary for related benthic, aquatic, and vegetative species to survive and reproduce, as shown in Table 4-1. Improving pH levels in the mainstem of Monday Creek would also connect upstream native fish populations to the Hocking River. Restoration and creation of wetlands would also increase habitat diversity and biodiversity.

**Table 4-1. Remediation Thresholds and Margins of Safety
for the Remediation Simulation Models.**

Water Quality Constituent	Remediation Threshold	Margin of Safety	Remediation Threshold plus Margin of Safety
pH	6.82 standard units	+0.25 standard units	7.07 standard units
Aluminum	1.12 mg/L	-0.4 mg/L	0.72 mg/L
Iron	1.49 mg/L	-0.4 mg/L	1.09 mg/L

The ecosystem approach to restoration was specifically applied to the Monday Creek Watershed by:

- Addressing AMD pollution in the source-headwater region versus continually treating a downstream result of AMD.
- Understanding that the exposure of fish to metals via metal-contaminated diets differs from water-borne exposure due to the processing of metals through the stream food web. Chronic metal exposure occurring via both water and diet may result in impacts at sites where water is not acutely toxic.
- Connecting upstream and tributary fish populations by restoring the mainstem of Monday Creek.

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- Determining the largest limiting factor to aquatic habitat and the survival of fish as being pH, then metals.
- Targeting the worst acid contributors (8 subwatersheds) and not necessarily all seep locations.
- Return flow regimes to pre-mining levels where possible.

In addition, the abandoned underground mines in the Monday Creek Watershed have caused subsidence features which are affecting the amount of water flow entering the hydrologic system. Subsidence generally occurs where overburden is thin (<100 feet) (Hobba, 1993). Collapse of the overburden will cause surface cracking. When this occurs within the valley floors, the subsidence areas will capture surface water and precipitation runoff. Thus, these waters are subsequently directed into the underground mine complexes where they add to the generation of AMD in the watershed.

4.3 Quantifying Environmental Benefits as Species Diversity

Headwater and tributary reaches of mined watersheds that are not severely polluted by AMD support relatively complex communities of macroinvertebrates and fish. Literature reviews cited research that indicates aquatic species diversity is strongly correlated with increasing pH values to approximately a pH=6.0 as shown in Table 4-2.

Table 4-2 Aquatic Organisms Response to AMD Constituent Levels														
pH (s.u)	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Acidity	TOXIC too acidic				Limited	<10					TOXIC too alkaline			
Iron	TOXIC in suspension				Limited	<1 mg/l				TOXIC				
Aluminum	TOXIC in suspension				<0.5 mg/L				TOXIC in suspension					
Flow	At low flow, metal concentrations and acidity levels increase. At higher flow, dilution of constituents occurs.													
Macros	NO LIFE		No EPT		Limited				Limited	9	NO LIFE			
Fish	NO LIFE				Limited				Limited	9	NO LIFE			
Overall Recovery Status	NO LIFE			Very Limited	Limited if no AI					NO LIFE				

Legend	
Toxic - No Life	
Very Limited Life	
Limited Life if no AI	
Supports Life	

Benthic macroinvertebrates are usually abundant in streams, and the variety of species represents a range of food web levels and pollution tolerances. For example, changes in pollution, such as increased sediment loading, modified habitats, and degraded water quality, can be observed in the population densities of macroinvertebrates. Some species are pollution and stress tolerant so community composition can be used to help identify stream reaches with impaired waters or habitat and can be used to assist in the location of point and non-point sources.

Macroinvertebrate communities inhabit the waters for most of their life cycle and are a reflection of the past chemical, physical, and biological history of the waters (OEPA, 1987). With a

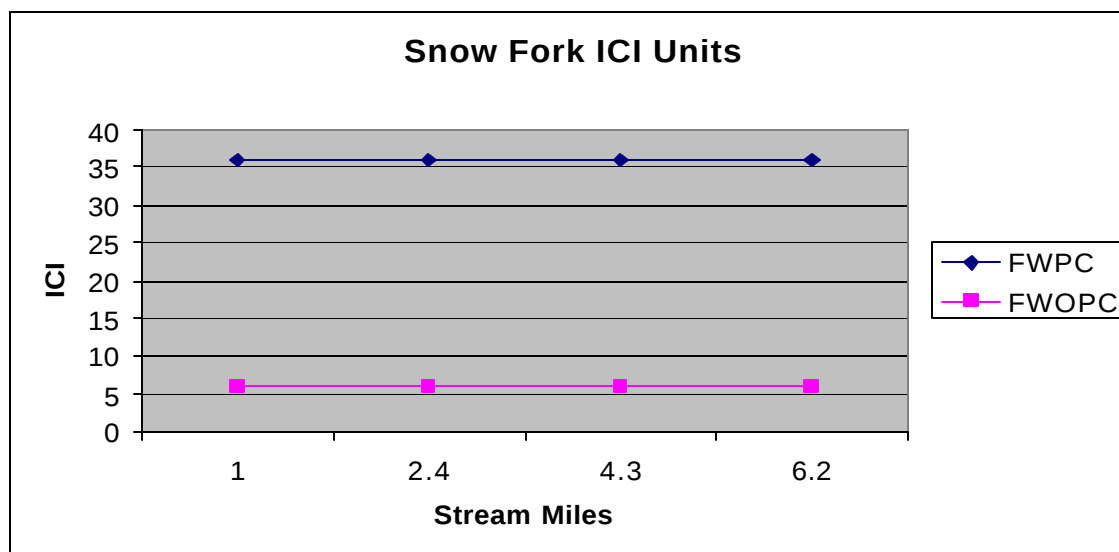
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limited migration pattern and complex, short lifespans, benthic data is a good indicator of localized short term effects (EPA, 2002). With a longer life span, fish are a good indicator of large, long term effects.

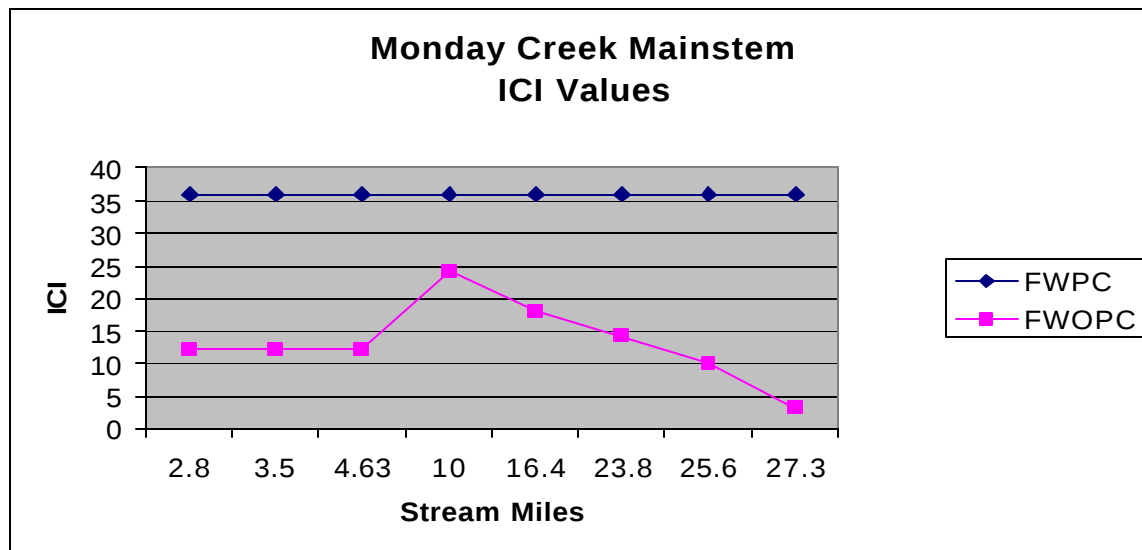
To assess the biological health of a stream, the EPA's Rapid Bioassessment Procedures use sampling to identify the type of individuals and their quantity. The Invertebrate Community Index (ICI) uses artificial substrate samplers which are then populated by existing macroinvertebrates. Measurements on the total taxa which include percentages of mayflies, caddisflies, dipterans and non-insects, Ephemeroptera (Mayflies), Plecoptera (Stoneflies), and Trichoptera (Caddisflies) or EPT taxa and tolerant species are utilized in the assessment. The ICI metrics will indicate Exceptional Warm Water Habitat with a score >46; Warm Water Habitat would score >36 but <46; Modified Warm Water Habitat would score >22 but <36; and Limited Resource Waters would score >8 but <22.

The ICI was utilized in this study as a tool to determine existing conditions and to measure the habitat response as a result of implementation of restoration alternatives. As can be seen in Figure 4-1 and 4-2, the goal of the project is to sustain an aquatic ecosystem within the Warm Water Habitat (>36). Both the mainstem of Monday Creek and Snow Fork ICI scores indicate macroinvertebrates cannot sustain and reproduce in significant populations indicating there is not suitable habitat. Therefore, the team chose to utilize the ICI metric to assist in the determination of Future Without Project Conditions (FWOPC) or No Action and Future With Project Conditions (FWPC).

Graph 4-1 Snow Fork ICI Existing Conditions Scores



Graph 4-2 Mainstem Monday Creek ICI Existing Conditions Scores



4.4 Initial Screening Technologies for Abating AMD

Recent studies have indicated that certain types of alkaline amendments can successfully control AMD (Brady, et al., 1990; Burnett, et al., 1995; Perry and Brady, 1995; Rich and Hutchinson, 1990; Rose et al., 1995; Wiram and Naumann, 1995). Alkaline additions can be implemented in several manners, including (1) blended with potentially acid-producing material to either neutralize the acid or to retard and, in some cases, prevent the oxidation of pyrite; (2) incorporated as stratified layers at specific intervals within the backfill or spoil; (3) applied as trenches or funnels to create alkaline groundwater conduits through the reclaimed mine; and (4) applied on or near the surface to enhance plant growth and create an alkaline wetting front that will migrate downward through the overburden.

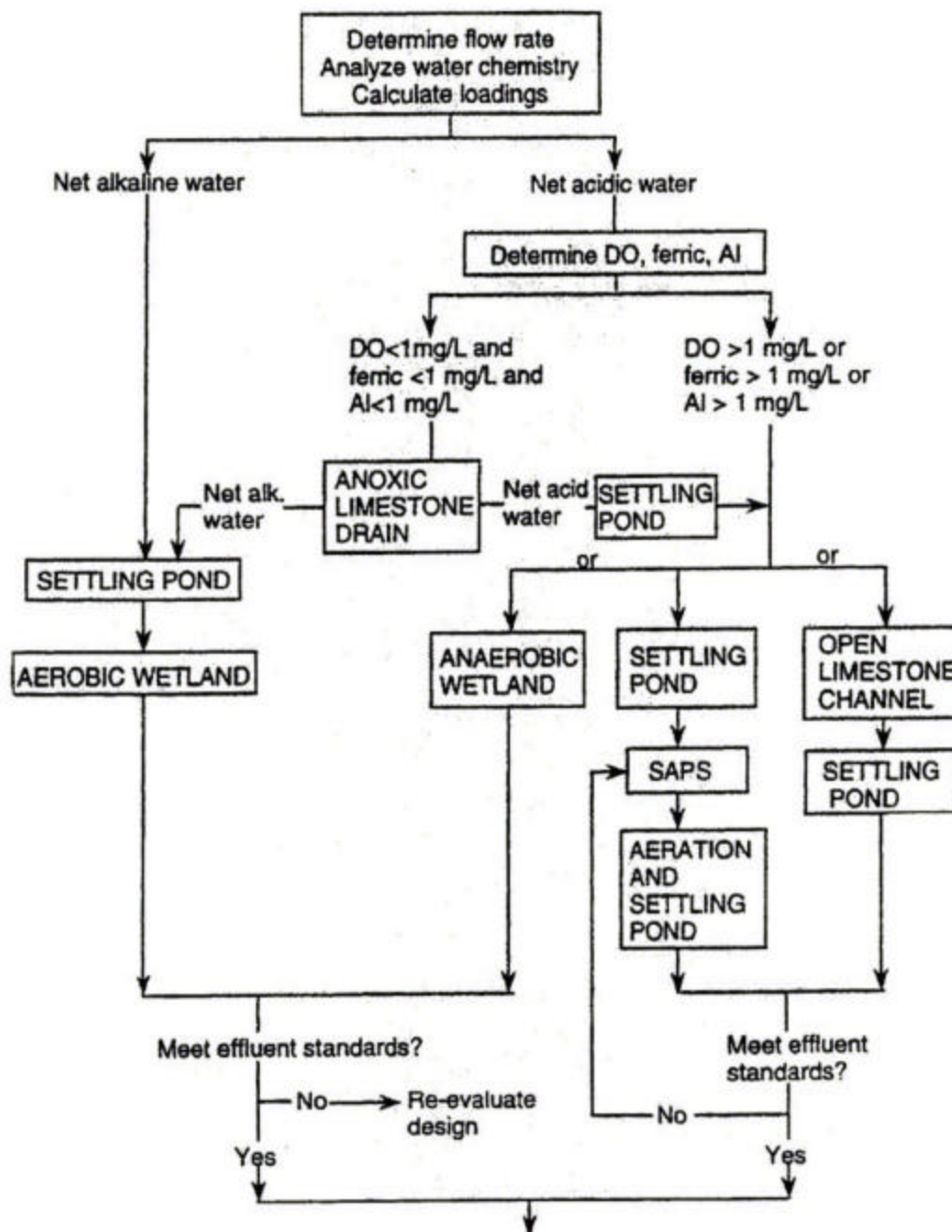
The chemical interactions between iron, pH, acidity, aluminum, stream flow, and dissolved oxygen are quite complex and concentrations vary from site to site. As shown in Figure 4.3, these aforementioned constituents are the limiting factors in choosing a suitable restoration method at a site. The technical feasibility of active long-term remediation technologies is controlled primarily by AMD properties and, for passive restoration alternative systems, site constraints (amount of land available for construction). Parameters that may limit these technologies from being feasible include:

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Table 4-3 Parameters that limit type of technologies used in AMD remediation

AMD Properties	Site Constraints
Flow Rate	Insufficient area to construct project
Total iron (Fe) concentration	Gradient too steep
Ferric (Fe+3) concentration	Gradient too gentle
Dissolved oxygen (DO)	
Alkalinity	
pH	
Acidity (H+)	
Aluminum (Al) concentration	
Manganese (Mn) concentration	
Sulfate (SO ₄) concentration	

Figure 4.3 Flow Chart for Selecting Passive Treatment Systems for AMD Projects



(Modified from Hedin, et al. 1994)

Passive and Active Treatment Alternative Descriptions

Two types of treatment technologies were evaluated as possible alternatives for this project. The two types of technologies include active and passive systems. Active restoration alternative technologies address pH problems however they traditionally do not address metal precipitants. In addition, active restoration alternatives usually require routine operation and maintenance at minimum to restock the neutralizing agent. Passive restoration alternative techniques on the other hand are designed to be more self-sufficient and are typically designed for a 20-30 year project life. Unlike active restoration alternatives, passive restoration alternatives require minimal operation and maintenance and are designed to eliminate precipitating metals in addition to raising pH. General descriptions of remediation technologies considered for the Monday Creek Watershed are described below.

- Limestone Dosing (Active): A process where limestone product is introduced into a stream in regular increments. The limestone particles may be in a large hopper or from a plant-type operation. The doser can be electric or water driven. Maintenance, weather, regular access, vandalism, and the lack of variability in dosing are concerns. While dosing can be effective restoration alternative for low pH, dosing does not address metal precipitants.
- Limestone Dumping (Active): Similar to limestone dosing where limestone fines are added directly into a stream. Unlike dosing where the limestone is released incrementally, an entire truck's worth of limestone is literally dumped into the stream. Additional limestone is dumped after the previous dump has dissolved.
- Anoxic Limestone Drain (ALD) (Passive): An ALD is a buried channel containing limestone that is designed to limit oxygen contact with the mine discharge. An ALD requires relatively low metal concentration (dissolved Al <1 mg/L and >75% ferric iron) and low dissolved oxygen (<1 mg/L). Typically, an ALD is used in conjunction with aeration and a wetland system of settling ponds to allow for metal precipitation reactions.
- Compost or Anaerobic Wetland (Passive): The wetlands consist of wetland vegetation, permeable organic mixtures of compost, straw/manure etc., and underlain or mixed with limestone. A compost wetland generates alkalinity through a combination of bacterial activity and limestone dissolution. In some cases, an aerobic settling pond may be needed for metal precipitation reactions before the compost wetland.
- Aerobic Wetland (Passive): The wetlands consist of wetland vegetation planted in shallow, relatively impermeable sediments comprised of soil, clay or mine spoil. It typically requires another restoration alternative such as an ALD to raise the pH above 4. Aerobic wetlands are typically designed to promote precipitation of iron hydroxide and thus often require periodic dredging.
- Open Limestone Channels (OLC) (Passive): An adequately sized open channel containing large limestone that carries and treats the mine discharge. The OLC must be on a fairly steep slope (greater than 10 percent) to ensure sufficient amount of oxygen necessary to precipitate metals and to transport the metal precipitates down the channel otherwise the metals will precipitate onto the limestone affecting the efficiency of the system. An OLC is suited for AMD with high dissolved oxygen and metal concentrations and low pH.

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- Successive Alkalinity Producing Systems (APS or SAPS) (Passive): combine the use of an ALD and an anaerobic wetland. Oxygen concentrations are often a design limitation for ALDs. They are generally ineffective where Dissolved Oxygen (DO) concentrations are greater than 1 or 2 mg/l. In situations where the DO concentrations are above 1 or 2 mg/l, the water can be introduced into a pond. In APS and SAPS, a drainage system is installed in the bottom of the pond. The drainage pipes are overlain by limestone which is then overlain by organic material. Four to 8 feet of water are ponded on top of the organic layer. The principle is to introduce the semi-aerated water into the pond and cause the water to move down through the organic matter to filter out ferric iron or reduce it by microbial iron reduction to ferrous iron. The reduced water then continues downward into the limestone, picking up additional alkalinity by limestone dissolution. The water then discharges through the drainage system in the bottom of the pond, having a pH of 6.0 and a much higher level of alkalinity in the water. The treated water is then aerated and the metals precipitate in a sedimentation pond, aerobic wetland, or anaerobic wetland.
- Limestone Ponds (LSPs) (Passive): LSPs are a new passive restoration alternative idea in which a pond is constructed at the upwelling of an AMD seep or underground water discharge point. Limestone is placed in the bottom of the pond and the water flows through the limestone.
- Limestone Leach Bed (LLB) (Passive): LLBs are buried cells or trenches of limestone which the water flows through. The limestone dissolves in the water and adds alkalinity. The purpose of these leach beds is to provide alkalinity to fresh water streams upstream of any AMD sources.
- Slag Leach Beds (SLB) (Passive): Steel slag, a by-product of steel making, is produced during the separation of the molten steel from impurities in steel-making furnaces. Steel slags are often locally available in large quantities at low cost. When fresh, they have NPs ranging from 45 to 90 percent. Studies indicate that columns of steel slag maintain constant hydraulic conductivity over time and produce highly alkaline leachate (>1,000 mg/l as CaCO_3). Steel slag can be used as an alkaline amendment as well as a medium for alkaline recharge trenches. Slags are produced by a number of processes so care is needed to ensure that candidate slags are not prone to leaching metal ions such as Chromium (Cr), Manganese (Mn), Nickel (Ni), or Lead (Pb).
- Diversion (Passive): Diverting surface water upstream of AMD sites to decrease the amount of water entering the mined area is highly recommended in acid-producing areas. Channeling surface waters or mine waters to control volume, direction, and contact time can be used to minimize the effects of AMD on receiving streams. The diversion of water from mining areas and from acid-producing materials is an abatement technique used in both surface and underground mines. Surface diversion of runoff involves the construction of drainage ditches to move surface water quickly off the site before infiltration occurs, or to limit its movement into the backfill. The diversion is accomplished either by ditching on the uphill side of surface mines or by providing impervious channels for existing surface streams to convey water across the disturbed area. Diversion methods would decrease sedimentation and metal concentrations downstream.
- Inundation (Saturation) (Passive): The physical restriction of waters by constructing impoundments within an isolated area of a surface mine has been used to minimize or

eliminate AMD. Inundation of acid-producing materials may be a less expensive reclamation technique on some areas than traditional reclamation by backfilling and planting, although the latter are typically required by law. Improvements in the quality of impounded waters flowing from acid areas have not always been the result. While pH has not always shown marked improvement, there has been some reduction in total acid and iron (Fe). The creation of an impoundment in the final cut of a surface mine not only lowers the cost of reclamation, but also has several other advantages. It forms recreation areas, aids in recharging the water table in the local area, and can eliminate or greatly reduce the amount of pollution from AMD and silt. By carefully designing the impoundment size and depth so the body of water formed will cover all acid-producing and carbonaceous materials, and also completely flood any intercepted deep mine workings or auger mining holes, the pyrite oxidation process will be stopped and thus the formation of acid will cease. Field studies have confirmed this action, and have also shown that the resulting impoundment quickly flushes the oxidized acid salts from the contacted area and produces a body of water of near neutral to alkaline quality.

- Underground Mine Sealing (Passive): Deep mine sealing is defined as closure of mine entries, drifts, slopes, shafts, boreholes, barriers, outcrops, subsidence holes, fractures, and other openings into underground mine complexes. Deep mine seals are constructed to achieve one or more functional design goals including (1) eliminate potential access to the abandoned mine works following closure, (2) minimize AMD production by limiting infiltration of air and water into the deep mine, (3) minimize AMD production by maximizing inundation of the mine works, (4) minimize AMD exfiltration through periphery barriers to surface water systems, and (5) develop staged internal mine pools to regulate maximum hydraulic head and pressure. Mine sealing would increase surface flows within the subwatershed, while decreasing the generation of metal precipitants thus causing sedimentation elsewhere in the surrounding watershed.
- Low Head Dams (Passive): The purpose of these low head dams is to aerate the stream and ensure that most, if not all, of the iron in the stream is in the ferric oxidation state. The limestone, or any other non-acid producing rock, used to build these dams should have a diameter no less than 20% of the total stream width.

Initial screening to determine the best alternatives to utilize in the watershed was performed by the study team using the criteria described in Table 4-3. Results of the initial screening indicated that the limestone dumping and inundation alternatives were infeasible and all other alternative restoration methods were retained. Limestone dumping was eliminated from further consideration because even though limestone dumping method adds much needed alkalinity to the waters, this method concentrate the increase in alkalinity effectively as other methods, and would still cause a disconnection with upstream stream habitat. Inundation was deemed infeasible since the team could not design a project which would inundate 15,000 acres of underground workings that are generating the AMD. Please refer to Table 4-5 for a summary of the initial screening results.

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TABLE 4-5 INITIAL SCREENING OF ALTERNATIVES

Restoration Techniques Considered	Addition of Alkalinity	Addresses Metals	Preventative Alternative	AMD Constraint	Retained or Not Feasible
Limestone (LS) Doser	X			Active Technique - Costly OM&RR, measured addition	Retained
Limestone Dumping	X			Active Technique - Does not address source of AMD	Not Feasible
Anoxic LS Drain	X			Passive Technique - Needs low metal concentrations	Retained
Anaerobic Wetland		X		Passive Technique - Needs low metal concentrations	Retained
Aerobic Wetland		X		Passive Technique - Availability of land	Retained
Open LS Channel	X	X		Passive Technique - Needs slopes for oxygen addition	Retained
LS Leach Bed	X	X		Passive Technique - Needs low metal concentrations	Retained
Slag Leach Bed	X	X		Passive Technique - Needs low metal concentration	Retained
Diversion			X	Eliminates AMD generation through prevention	Retained
Inundation		X	X	Impoundments or lakes; eliminates oxygen	Not Feasible
Mine Sealing			X	Eliminates AMD generation through prevention	Retained
Low Head Dams		X		Needs Low Dissolved Oxygen	Retained

4.5 Intermediate Screening of Alternatives

Intensive field reconnaissance was performed by the study team within eight subwatersheds previously identified by ODNR as contributors to AMD and subsidence features. Field activities determined the sources of AMD, and characterized each source by levels of metals, acidity and pH in addition to identification of subsidence features.

Subsidence feature reconnaissance identified numerous subsidence features such as stream captures, stream blocks and dissipating streams in Brush Fork of Snow Fork, Lost Run, Monkey Hollow and Coe Hollow. These areas are known as losing significant quantities of surface water into the underground mines. Table 4-6 identifies the capture areas and total drainage area of surface water captured.

Table 4-6 Drainage Areas Captured in Subsidence Features

Subwatershed	Total Drainage Area Captured (Sq. Miles)
Brush Fork of Snow Fork	4.77
Lost Run	5.14
Monkey Hollow	3.00
Coe Hollow	0.19

Subsidence alternatives were developed by the study team for the four areas identified in the field reconnaissance. The subsidence alternative selection was based on the physical characteristics of the subsided area. By minimizing the volume of water entering the underground mine workings, there will be less generation of AMD elsewhere in the watershed.

Stream subsidence closures restore drainage to the stream and reduce AMD generation by preventing contact between stream water and pyritic minerals located within the underground mine workings. Restoring positive drainage to the affected streams would improve the long-term performance of other AMD restoration systems and should reduce human and animal hazards. There are subsidence closures planned for this project located within Snow Fork (Long Hollow and Brush Fork), Lost Hollow, Monkey Hollow, and Coe Hollow. Each subsidence that was selected is currently capturing a stream flow.

The method of closure would depend on the location, size and extent of the subsidence. Generally, the subsidence may be filled with graded limestone or recycled concrete (if available) in conjunction with a geotextile and spoiled soil. In some cases the entrances may be blocked and sealed by stacking bags of cement. Once the subsidence is filled and sealed the previously captured stream would be re-routed, when possible, to avoid the filled subsidence. The stream would be lined with a geosynthetic clay liner (GCL) to inhibit downcutting action of the stream and another encounter with the subsidence. The stream would be re-routed to existing channel at the nearest downstream location.

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Spoil blocks are locations where spoil from previous mining operations is blocking the natural stream course and would be either completely removed or partially removed by breaching. The method and extent of removal would depend upon the size of the spoil block. When feasible, the block would be entirely removed to provide positive drainage to a stream. In other cases, when the size of the spoil block does not make removal feasible, the block would be breached to allow stream flow to resume. In most cases, the stream would need to be rerouted to reconnect to the existing channel downstream. Stream reconstruction would entail lining the channel with a geosynthetic clay liner and limestone.

A dissipating stream is one that is captured by jointed rock, scarps or fractures associated with mining subsidences but visible surface cracking and opening are not present. The proposed fix for dissipating streams is to re-route the channel upstream to avoid the capturing feature and line it using a geosynthetic clay liner (GCL) to prevent contact with the underground mine workings. In some cases the capturing feature may need to be filled with a high fly ash content grout mixture. In other cases the capturing feature may be filled with spoil material and covered with a GCL.

Development of the Monday Creek Total Acid Mine Drainage Loading (TAMD) model was a cooperative effort between the U.S. Army Corps of Engineers, Huntington District and West Virginia University (WVU). The Monday Creek TAMD model simulated the transport and reaction of those water quality constituents related to AMD. This model was used to simulate the required load reductions of metals and acidity from each of the Monday Creek and Snow Fork subwatersheds in order to satisfy the fish and macroinvertebrates species survival requirements as specified in Table 4-2. Design of alternative restoration plans for each subwatershed were developed and simulated in the TAMD model. The plans were then adjusted until the pH, aluminum and iron remediation thresholds were met. For a more detailed discussion of the TAMD model please refer to Appendix C.

The TAMD model indicated that the AMD constituents required for Anoxic Limestone Drains and Anaerobic Wetlands were not present in any of the locations in the watershed. These alternatives were eliminated from further consideration because the parameters required for the specific alternatives were not found in the watershed. Therefore, Anoxic Limestone Drain and Anaerobic Wetland plans were not considered in the final plans. All other restoration alternatives were retained and analyzed in the final array.

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TABLE 4-7 INTERMEDIATE SCREENING OF ALTERNATIVES

	Jobs Hollow	Dixie Hollow	Rock Run	Lost Run	Monkey Hollow	Snake Hollow	Coe Hollow	Snow Fork	Retained or Not Feasible
Alternative									
Limestone Active Doser	X			X	X	X		X	Retained
Anoxic Limestone Drain									Not Feasible
Anaerobic Wetland									Not Feasible
Aerobic Wetland	X				X	X	X	X	Retained
Open Limestone Channel	X	X		X	X	X	X	X	Retained
Limestone Ponds		X		X	X	X	X	X	Retained
Limestone Leach Bed		X	X	X	X	X	X	X	Retained
Slag Leach Bed		X		X	X		X	X	Retained
Diversion				X	X		X	X	Retained
Mine Sealing (includes subsidence, spoil blocks and dissipating streams)				X	X		X	X	Retained
Low Head Dams			X						Retained

4.6 Alternatives Considered in Detail

During intermediate screening, 202 sites were developed in 8 subwatersheds for the restoration of the aquatic habitat of the Monday Creek Watershed. The eight subwatersheds included Jobs Hollow, Dixie Hollow, Rock Run, Lost Run, Monkey Hollow, Snake Hollow, Snow Fork and Coe Hollow.

Corps policy requires that all feasible and reasonable alternatives be evaluated. During the formulation process, the team recognized that four subwatersheds had numerous treatment sites (greater than 20). Dosers were considered feasible alternatives, and the team added this feature into the final array of alternative plans at the mouths of Lost Run, Monkey Hollow, Snake Hollow and a tributary of Snow Fork (Brush Fork) to be analyzed during the Cost Effectiveness/Incremental Cost Analysis (CE/ICA) process thus potentially eliminating many construction sites. These four alternatives brought number of the alternative plans from eight to twelve.

Final alternative analysis consisted of developing 12 plans plus the Future Without Project Conditions (FWOPC) or No-Action Plan. The team used the IWR-Plan Decision Support Software (IWR-Plan) developed by the Institute for Water Resources (IWR) as another tool to assess subwatershed combinations and to look at incremental cost analysis and cost effectiveness of alternative plans. The Plan works by combining solutions to project plans and calculating the additive effects of each combination. It also conducts cost effectiveness and incremental cost analyses, identifying plans which are the best financial investments. The alternative plans features are described in Table 4-8

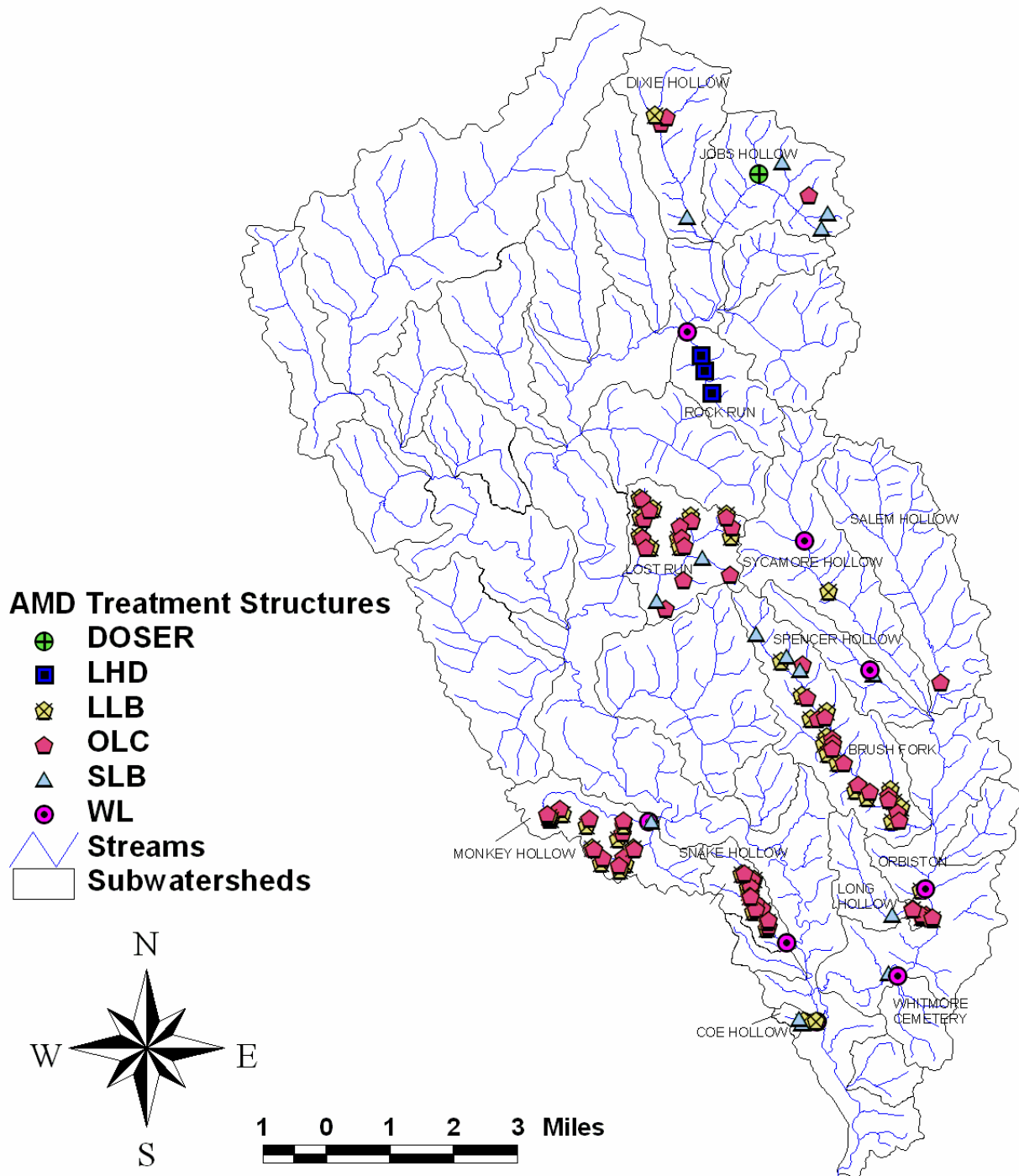
Table 4-8
Description of Alternative Plans Analyzed

Plan	Location	Description
A	Jobs Hollow	1 doser, 3 SLB* and 1 OLC*
B	Dixie Run	1 SLB, 2 OLC and 1 LLB*
C	Rock Run	3 LHD* and 1 wetland
D	Lost Run	30 + 16 spoil blocks and 12 subsidences
E	Lost Run w/ Doser	1 doser + 16 spoil blocks and 12 subsidences
F	Monkey Hollow	25 + 9 spoil blocks and 6 subsidences
G	Monkey Hollow w/ Doser	1 doser and 9 spoil blocks and 6 subsidences
H	Snake Hollow	1 SLB, 4 OLC and 4 LLB
I	Snake Hollow w/ Doser	1 doser
J	Snow Fork	6 SLB, 19 OLC, 20 LLB, 8 dissipating streams, 9 spoil blocks, 7 subsidences, and 2 wetlands
K	Snow Fork w/ Doser	1 doser, 3 SLB, 5 OLC, 6 LLB, 8 dissipating streams, 9 spoil blocks, 7 subsidences and 2 wetlands.
L	Coe Hollow	2 SLB, 1 OLC, 4 LLB, 3 dissipating streams and 1 Subsidence
M	FWOPC	No Action, Future Without Project Conditions

*SLB – slag leach bed; LLB – limestone leach bed; OLC open limestone channel; LHD – low head dam

Figure 4-5

Monday Creek AMD Treatment



4.6.1 Environmental Outputs

For ecosystem restoration projects, the Corps evaluates environmental outputs versus costs to determine benefits. For this project, sustainability metrics were developed by determining the acreage of stream habitat (quantity) improved by the plans multiplied by the minimum ICI score to meet the minimum threshold (quality) and then multiplied by the Importance Ranking. Each plan was evaluated between the existing conditions and the Future With Project Condition (FWPC) over the life of the project. The generated scores are used only to provide an understanding of the magnitude of the improvement and to provide an equal basis for comparing the efficiency and effectiveness of various alternative plans. Scores for FWPC and FWOPC are displayed in Table 4-8.

$$\text{Sustainability} = \text{Quantity} \times \text{Quality} \times \text{Importance} = \text{Score (units)}$$

Importance ranking was developed to take into account the hydraulic connectivity of the headwaters of each subwatershed and the downstream waters. The importance ranking is a percentage of the acreage of the aquatic system impacted by the projects divided by the total possible acreage connected to the headwaters. The numbers were then normalized by 100 to reflect importance with respect to each subwatershed project with the overall watershed.

For example: Total acreage in Jobs Hollow improved by the project = 10.38 acres
Total acreage in Monday Creek (including headwaters) = 279 acres

$$(10.38 \text{ acres} / 279 \text{ acres}) \times 100 = 3.86$$

Since the study effort looked at a top down approach to restoration of the watershed, the Plan allows for additive units or dependency within the combinations. For example, in the headwaters of Monday Creek, Dixie Hollow is located near the upper part of the mainstem. The Plan allows you to look at the cumulative impacts of adding Dixie Hollow benefits (2,733 units) plus Rock Run (860 units), in addition to the downstream benefits of Monday Creek mainstem (27,048 units). These downstream impacts were measured and accounted for the mainstem until the next significant contributing subwatershed was reached. As part of the IWR-Plan, the combined dependencies were also analyzed.

For example:

$$\begin{array}{r} 2,733 \text{ units (Plan B Dixie Hollow)} \\ 860 \text{ units (Plan C Rock Run)} \\ + \quad 27,048 \text{ units (Monday Creek Mainstem)} \\ \hline 30,641 \text{ total units} \end{array}$$

Calculations for the FWPC and FWOPC may be found in Appendix E.

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Table 4-8.
Future With Project and Without Project Output

FWPC Plan	Impact Area	Quantity (acres)	Minimum Quality (ICI Score)	Importance	FWP Score (Units)	FWOP Score (Units)
A - Jobs Hollow Plan	Jobs and MC	10.38	36	3.9	1444	93
B- Dixie Hollow Plan	Dixie and MC	14.16	36	5.4	2733	127
C - Rock Run Plan	Totals	46.31			27908	46
	Rock Run	1.43	36	16.7	860	13
	Monday Creek	44.88	36	16.7	27048	1346
D - Lost Run Plan	Totals	46.07			43372	1688
	Lost Run	7.47	36	26.2	7046	67
	Monday Creek	38.6	36	26.2	36326	1621
E - Lost Run w/ Doser only Plan	Totals	38.72			19343	1622
	Lost Run (D)	0.12	36	13.9	60	1
	Monday Creek	38.6	36	13.9	14283	1621
F - Monkey Hollow Plan	Totals	37.52			18501	1812
	Monkey Hollow	4.75	36	13.7	2343	43
	Monday Creek	32.77	36	13.7	16158	1770
G - Monkey Hollow w/ Doser only Plan	Totals	32.89			13957	1771
	Monkey Hollow (D)	0.12	36	11.8	51	1
	Monday Creek	32.77	36	11.8	13906	1770
H - Snake Hollow Plan	Totals	11.3			1735	688
	Snake Hollow	1.99	36	4.3	308	18
	Monday Creek	9.31	36	4.3	1427	670
I - Snake Hollow w/ Doser only Plan	Totals	9.43			1147	671
	Snake Hollow (D)	0.12	36	3.4	15	1
	Monday Creek	9.31	36	3.4	1132	670
J - Snow Fork Plan	Totals	51.44			43630	946
	Snow Fork	49.76	36	23.6	42203	896
	Monday Creek	1.68	36	23.6	1427	50
K - Snow Fork w/ Doser only Plan	Totals	45.24			34402	573
	Snow Fork (D)	43.56	36	21.1	33125	523
	Monday Creek	1.68	36	21.1	1276	50
L - Coe Hollow Plan	Totals	17.65			4042	841
	Coe Hollow	0.54	36	6.4	124	19
	Monday Creek	17.11	36	6.4	3918	821
M - FWOPC	Existing Conditions	234.83	^	^	6243	6243

^The values for the FWOPC = existing ICI scores x acreage x 1

4.6.2 Costs

The next step in the CE/ICA process was to develop annualized costs for each of the 13 plans to be used in the IWR-Plan. Total average annual costs of the Monday Creek restoration plans are presented in Table 4-9. These costs are based on average annual implementation costs and annual operation, maintenance, repair, replacement and rehabilitation (OMRR&R) costs. Average annual implementation costs include capital costs, real estate costs, and interest during construction and utilized an interest rate of 5.375%. The project life was determined to be 20 years.

Table 4-9
Alternative Plans Cost

Plan		Project Cost*	O&M	Interest During Construction	Total Average Annual Cost
A	Jobs	\$1,005,276	\$1,147,940	\$92,835	\$148,336
B	Dixie	\$268,135	\$78,240	\$25,139	\$28,199
C	Rock Run	\$559,214	\$282,640	\$51,465	\$64,705
D	Lost	\$5,304,532	\$372,920	\$490,491	\$498,553
E	Lost w/ Doser	\$382,729	\$705,640	\$35,752	\$69,938
F	Monkey	\$3,157,005	\$2,697,860	\$292,814	\$420,585
G	Monkey w/ Doser	\$1,020,007	\$705,640	\$98,597	\$127,918
H	Snake	\$514,533	\$117,780	\$46,501	\$52,390
I	Snake w/ Doser	\$367,245	\$705,640	\$33,530	\$68,471
J	Snow Fork	\$6,890,536	\$3,644,108	\$635,373	\$805,453
K	Snow Fork w/ Doser	\$4,688,091	\$3,193,305	\$430,720	\$583,573
L	Coe	\$610,957	\$87,250	\$58,143	\$61,787
M	FWOPC	\$0	\$0	\$0	\$0

* Includes: construction costs; planning engineering and design costs; real estate costs; and contingency

4.6.3 IWR-Plan Results

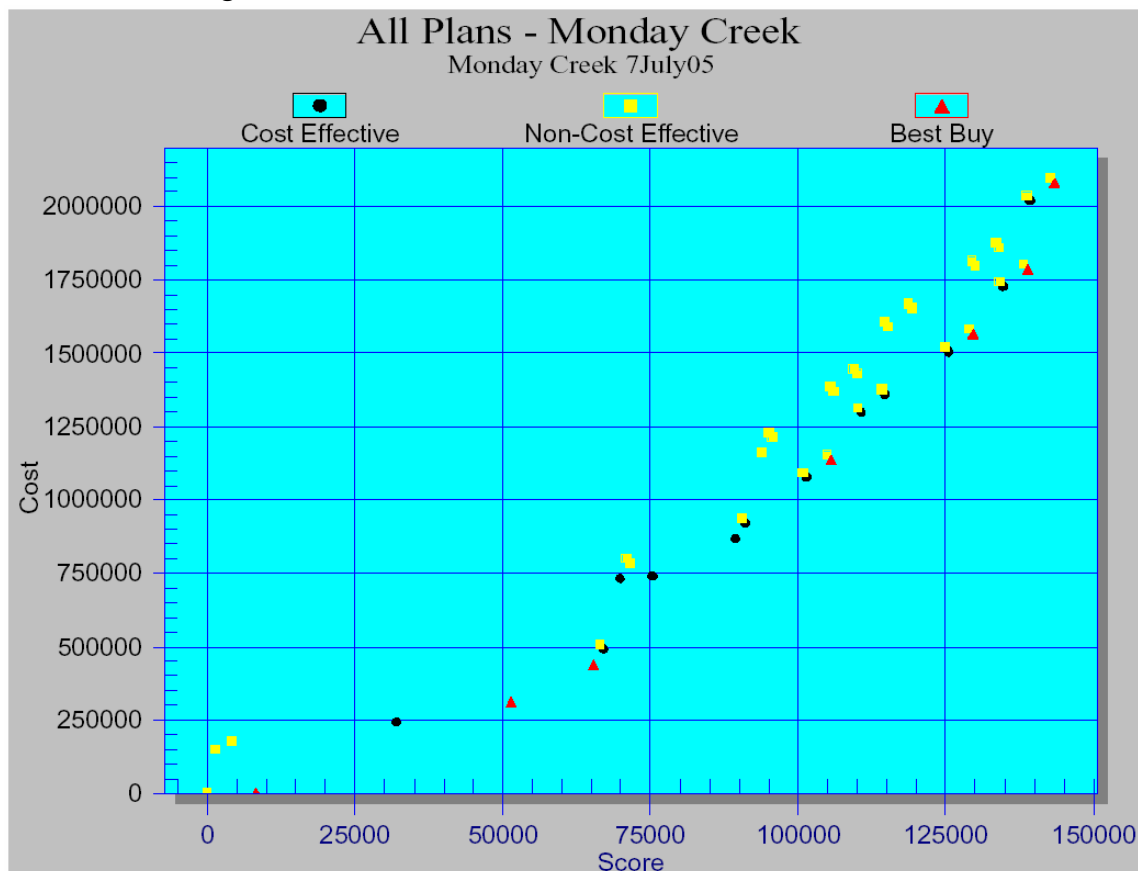
In addition to dependencies, the IWR-Plan also allows for constraints. An example of a constraint is that Plan D Lost Run would not be analyzed with Plan E Lost Run Doser since a doser can achieve the same results downstream as the construction of a series of restoration alternatives. However, a sponsor may perceive dosers as operation and maintenance prohibitive. Dosers would not be considered in combination with TAMDL recommended restoration alternatives within the same subwatershed. Table 4-10 shows a listing of plans that would not be combined with other plans.

Table 4-10

Non-Combinability Constraints	
Primary Plan	Alternative Plan
Plan D – Lost Run Plan (58 sites)	Plan E – Lost Run with Doser (29 sites)
Plan F – Monkey Hollow Plan (40 sites)	Plan G – Monkey Hollow with Doser (16 sites)
Plan H – Snake Hollow Plan (9 sites)	Plan I – Snake Hollow with Doser (1 sites)
Plan J – Snow Fork Plan (71 sites)	Plan K – Snow Fork with Doser (40 sites)

After the dependencies (from environmental output section) and non-combinability features were developed, this information, in addition to the annualized costs for each plan, was input into the IWR-Plan for analysis. IWR-Plan analyzed the cost effectiveness of each plan and full range of combination of plans. The full range of plans included 8,192 possible combinations. However, in the comparison of the costs and outputs of the combination of plans, IWR-Plan identified 51 plan combinations that are possible within the constraints, combinability, and dependency limitations. Cost effective plans are plans where no other plan provides the same output level for less cost, or no other plan provides a higher output level for the same or less cost. Only 19 plans were identified as cost effective plans and are shown in Figure 4-6 as black and red points.

Figure 4-6 Plan Combinations and Cost Effective Plans



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Of the 19 cost effective plans, 7 plans were found to be Best Buy Plan Combinations. The Best Buy Plans are plans that are a subset of the cost effective plans and are the most efficient in output production. The Best Buy Plans also have the greatest increases in the sustainability units for the least increase in costs and have the lowest incremental costs per sustainability unit output. The seven plan combinations shown to be the Best Buy Plans are described in Table 4-11.

Table 4-11
Best Buy Plan Descriptions

Plan Combination	Plan Combinations
1	M (No Action or FWOPC)
2	A (Jobs) + B (Dixie) + C (Rock) + E (Lost w/ Doser)
3	A (Jobs) + B (Dixie) + C (Rock) + E (Lost w/ Doser) + G (Monkey w/ Doser)
4	A (Jobs) + B (Dixie) + C (Rock) + E (Lost w/ Doser) + G (Monkey w/ Doser) + H (Snake) + K (Snow Fork w/ Doser) + L (Coe)
5	A (Jobs) + B (Dixie) + C (Rock) + D (Lost) + G (Monkey w/ Doser) + H (Snake) + K (Snow Fork w/ Doser) + L (Coe)
6	A (Jobs) + B (Dixie) + C (Rock) + D (Lost) + G (Monkey w/ Doser) + H (Snake) + J (Snow Fork) + L (Coe)
7	A (Jobs) + B (Dixie) + C (Rock) + D (Lost) + F (Monkey) + H (Snake) + J (Snow Fork) + L (Coe)

The results of ICA for Monday Creek are presented in Table 4-12. The table includes the incremental cost and incremental output of six plan combinations which were identified by the CE/ICA as Best Buy plans. The average costs per unit presented in Table 6 indicates that Plan Combination 2, which includes Alternatives A (Jobs) + B (Dixie) + C (Rock) + E (Lost w/ Doser) + G (Monkey w/ Doser), is the most efficient plan, producing out at the lowest incremental cost per unit. Plan Combination 6, which includes alternatives A (Jobs) + B (Dixie) + C (Rock) + D (Lost) + G (Monkey w/ Doser) + H (Snake) + J (Snow Fork) + L (Coe) is the plan that maximizes the cost per incremental output.

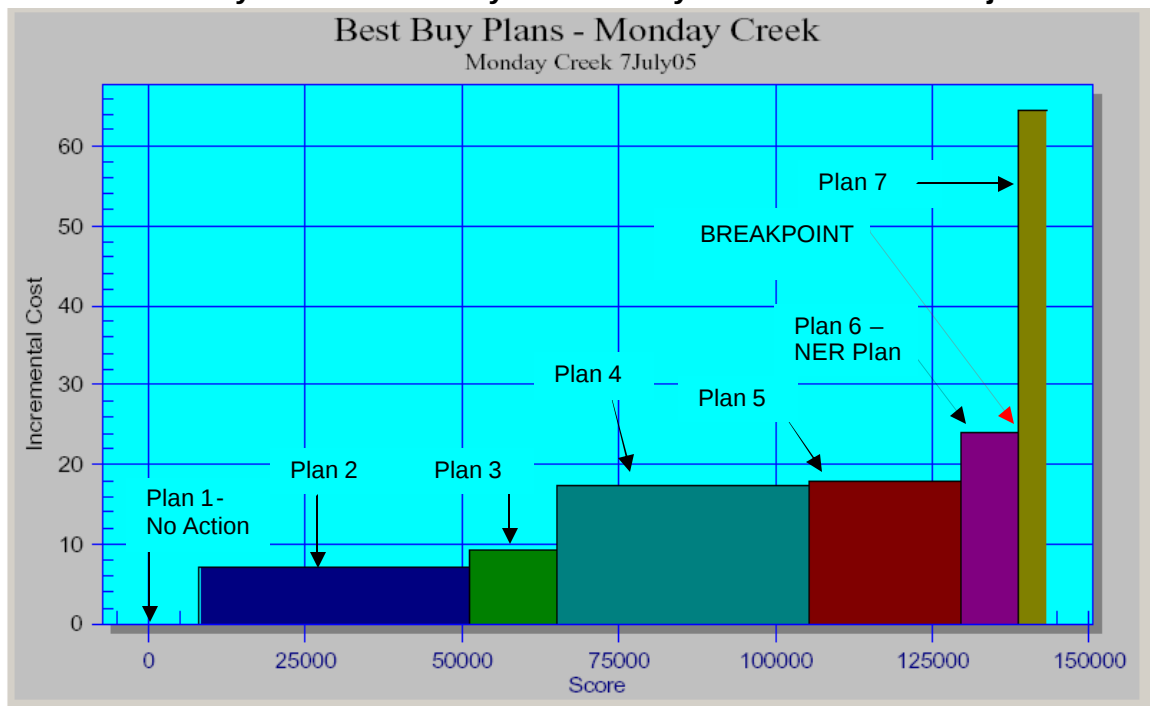
The average costs of the Monday Creek Best Buy Plan Combinations in dollars per restoration output (unit) are also presented in Table 4-12. Average costs per sustainability unit ranged from \$0.00 for the Plan Combination 1 - FWOPC to \$64.40 for Plan Combination 6.

Table 4-12
Average Costs and Incremental Cost Analysis
Of Best Buy Restoration Plans

Plan Combination	Score (Units)	Costs (\$)	Average Cost (\$ per unit)	Incremental Costs (\$)	Incremental Output (unit)	Incremental Cost per Output (\$ per unit)
1	8,269	\$0.00	\$0.00	\$0.00	8,269	0.00
2	51,428	\$311,178	\$6.05	\$311,178	43,159	\$7.21
3	65,385	\$439,096	\$6.71	\$127,918	13,957	\$9.16
4	105,564	\$1,136,846	\$10.76	\$697,750	40,179	\$17.36
5	129,593	\$1,565,461	\$12.07	\$428,615	24,029	\$17.83
6	138,821	\$1,787,341	\$12.87	\$221,880	9,228	\$24.04
7	143,365	\$2,080,008	\$14.50	\$292,667	4,544	\$64.40

Figure 4-7 graphically displays the incremental costs and the breakpoint which indicates which plan has the most the incremental output versus costs and which plan is considered the best investment. Plan Combination 1 (existing conditions) is the most efficient plan since benefits appear to be occurring with no costs.

Figure 4-7
Best Buy Plans for Monday Creek Ecosystem Restoration Project



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Plan Combination 6 has the greatest increase in output for least increase in cost and is considered the National Ecosystem Restoration Plan (NER) Plan. Plan Combination 7 is also a Best Buy Plan but costs more per sustainability unit at \$64.40/unit, respectively for gains of 4,544 sustainability units. Incrementally, Plan Combination 7 indicates that there is little gain in sustainability units versus the investment costs.

4.7 Final Array

Of the six plan combinations that were Best Buy Plans, only Plan Combinations 1 and 6 were retained for further consideration. Plan Combination (PC) 1 is the Future Without Project Conditions (FWOPC) or existing conditions and will be evaluated during the NEPA analysis. PC 6 was the Best Buy Plan that had the greatest increase in output for least increase in cost. PCs 2, 3, 4, 5, and 7 were not the most efficient in production for the least increases in costs as compared to Plan Combination 6 and were eliminated from further consideration.

Table 4-13. Final Plan Comparisons

Plan Combination	Score (Units)	Incremental Cost per Output (\$ per unit)	Acres Restored	Stream Miles Restored	Efficiency	Effectiveness	Completeness	Acceptability	Retained
1 No Action	8,269	0.00	0	0	Economically efficient.	Not effective. Does not improve any habitat.	Plan is not complete. Does not make any improvement of ecosystem.	Plan is not acceptable to state and local authorities.	Yes because it is the No Action Plan under NEPA.
2	51,428	\$7.21	109.57	21.34	Economically efficient plan.	Only slightly effective. Improves some habitat but does not address fish passage from Hocking River.	Plan is not complete. Only partially restores upper reach of watershed.	Not acceptable to local sponsor. Does not achieve project goals.	No
3	65,385	\$9.16	142.46	26.84	Economically efficient plan	Only slightly effective. Improves some habitat but does not address fish passage from Hocking River	Plan is not complete. Only partially restores upper reach of watershed.	Not acceptable to local sponsor. Does not achieve project goals.	No
4	105,564	\$17.36	216.65	46.33	Economically efficient plan.	Moderately effective. Restores mainstem connectivity with Hocking River.	Not complete. Does not restore 15.29 miles of subwatershed stream habitat.	Somewhat acceptable. Important headwater habitat is still disconnected from downstream fauna.	No
5	129,593	\$17.83	223.9	53.49	Economically efficient plan.	Moderately effective. Restores mainstem connectivity with Hocking River.	Somewhat complete. Does not restore 8.13 miles of subwatershed stream habitat.	Somewhat acceptable. Important headwater habitat is still disconnected from downstream fauna.	No
6	138,821	\$24.04	230.20	58.55	Economically efficient plan. NER Plan	Moderately to highly effective plan. Restores mainstem connectivity with Hocking River.	Mostly complete. Does not restore 3.07 miles of subwatershed stream habitat.	Acceptable. Minimized amount of headwater habitat still disconnected from downstream fauna.	Yes
7	143,365	\$64.40	234.83	61.62	Economically efficient plan.	Effective plan.	Complete plan. Restores subwatershed headwater habitat connectivity with	Not economically acceptable	No

4.7.1 Comparison of Efficiency

Efficiency is the extent to which an alternative plan is cost effective in alleviating identified problems. Efficiency generally is associated with the plan having the greatest net benefits, but it extends beyond NER criteria. The most efficient plan is the least costly means of achieving planning objectives when all outlays are considered, both monetary and non-monetary.

Through the cost effectiveness and incremental cost analysis, all seven plans were considered to be “best buy” plans or to provide the greatest increase in the sustainability units for the least increase of cost, and therefore, efficient. PC 7 is considered efficient but the incremental increase of cost per sustainability units gained does not justify the cost of the plan. The “breakpoint” of increment can be seen in Figure 4-7. PCs 1 through 6 all fall within the NER guidelines for efficiency.

4.7.2 Comparison of Effectiveness

Effectiveness is the extent an alternative plan alleviates identified problems and achieves the planning goals. It generally describes the physical attributes of the alternative plans. An effective plan is one that is responsive to the wants and needs of the citizens, and makes significant contributions to the planning objective.

The goal of this project is to sufficiently restore both the structural and functional components of the ecosystem to a less degraded state downstream of the AMD discharges. The restoration objective is to restore the degraded Monday Creek ecosystem to self sustaining conditions generally consistent with the functioning ecosystem designated as Warm Water Habitat by the Ohio Environmental Protection Agency.

PCs 1 through 3 are not effective or only slight effective in regards to the planning goals of the study. PC 1 is the No Action or Future Without Project Condition plan; therefore, there would be no improvement of the aquatic ecosystem. PC 2 and 3 are plans that show improvements in the upper reaches of the Monday Creek watershed, but do not address biologic disconnectivity with the Hocking River ecosystem nor any fauna downstream of Lost Run. The aquatic species would continue to remain be isolated, thus decreasing species diversity and abundance.

PCs 4, 5 and 6 are moderately effective with respect to connectivity with the aquatic species in Hocking River and other reaches of the watershed. Increased species diversity and abundance would be realized with these plans. However, headwater habitat in three subwatersheds (or 18.18 acres) would remain isolated from the rest of the ecosystem with PC 4. Headwater habitat in two subwatersheds (or 10.93 acres) would remain isolated in PC 5. In PC 6 only the Headwater habitat in Monkey Hollow (or 4.63 acres) would remain isolated and is the most effect of these three plan combinations.

PC 7 is the most effective plan in that it restores mainstem of Monday Creek and reconnects the headwaters of the impacted subwatershed with downstream flora and

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fauna but there is a significant increase in the incremental costs per output to achieve this level of effectiveness. PC 6 is effective for over 98% of the Monday Creek watershed.

4.7.3 Comparison of Completeness

Completeness is the extent to which a given plan provides and accounts for all necessary investments to ensure the realization of the planned ecosystem restoration outputs. This may include looking at investments made by others and sponsorship considerations.

As stated in Section 2.6, the Wayne National Forest has designated some projects to address some of the water resource problems and needs. However, their projects would not replace any of the plans in Final Array. Their projects they have proposed would only enhance any of the alternative plan combination being considered in this analysis.

PC 1 is not a complete plan as it does not restore any structural or functional components of the ecosystem. As stated in 4.7.2, PC 1 is the No Action Plan. PCs 2 and 3 only restore the upper reaches of the Monday Creek watershed. Terrestrial flora and fauna dependent upon the aquatic system will continue to function with lesser productivity and biological diversity. Fish species within most of the watershed would remain predominantly pollution tolerant species and would not necessarily increase the species diversity or population numbers.

PC 4 restores the aquatic habitat of mainstem Monday Creek and allows connectivity to the Hocking River ecosystem; however, within the subwatersheds of Lost Run, Monkey Hollow and Snow Fork (Brush Fork) there would remain approximately 15.29 miles of streams that would continue to be impacted by AMD. Limited aquatic resources would persist and the structural and functional components of those subwatersheds would remain degraded.

PC 5 also restores the aquatic habitat of mainstem Monday Creek and allows connectivity to the Hocking River ecosystem; however, within the subwatersheds of Monkey Hollow and Snow Fork (Brush Fork) there would remain approximately 8.13 miles of streams that would continue to be impacted by AMD. Limited aquatic resources would persist and the structural and functional components of those subwatersheds would remain degraded.

PC 6 restores the aquatic habitat of mainstem Monday Creek and allows connectivity to the Hocking River ecosystem; in addition, seven of eight subwatersheds would be restored from their degraded condition. Within the subwatershed of Monkey Hollow, there would only remain 3.07 miles of streams that would continue to be impacted by AMD. Limited aquatic resources would persist and the structural and functional components of Monkey Hollow would remain degraded.

PC 7 completely restores the degraded structural and functional components of the aquatic ecosystem in the Monday Creek watershed. All eight subwatersheds and

the mainstem are addressed in this plan. It is not however, considered an NER plan for efficiency. PC 6 is the most complete plan that also is considered efficient.

4.7.4 Comparison of Acceptability

Acceptability is the viability of the alternative plan with respect to acceptance by state and local entities, project sponsors, and the public, and compatibility with existing laws, regulations, and public policies. There are two primary aspects to acceptability. One is the ability to implement the project, meaning it is feasible in the technical, environmental, and economic sense. To be acceptable to state and local entities as well as the public, the plan has to be achievable. There are many factors that can make a plan infeasible, such as technical (engineering or natural), economic, environmental, social, political, legal, and institutional. If a plan cannot be developed for any legitimate reason it is not feasible. The other aspect to acceptability is the satisfaction it brings to people – the sponsor as well as the public at large. However, the fact that a particular plan has opposition or is not the favored plan of the non-Federal sponsor does not make it unacceptable. Opposition may make a plan unpopular or difficult to develop, but not necessarily unacceptable.

PC 1 or No Action is not acceptable to state and local authorities. PC 1 is not acceptable since there will be no improvement to the Monday Creek aquatic ecosystem. The existing ecosystem will continue to persist, as is, and aquatic species will continue to remain isolated, causing limited species diversity and abundance. However, this plan will be carried forward in accordance with Corps guidance and NEPA requirements.

PCs 2 and 3 are not considered acceptable since they only restore the upper reaches of the Monday Creek watershed and do not make significant contribution toward the goals and objectives of the planning study. Disconnectivity of aquatic species from will continue. Restoration of the lower reaches of the watershed would not be realized.

PCs 4 and 5 are somewhat acceptable. PCs 4 and 5 restore connectivity of the mainstem with the Hocking River ecosystem and also restore 46.33 and 53.49 miles of stream within the watershed. However, in both plans, important headwater habitat will remain disconnected both structurally and functionally from the rest of the ecosystem. Both plans are technically feasible as well as economically and environmentally feasible.

PC 6 is acceptable in that the plan addresses AMD impacts in seven of the eight subwatersheds have been addressed. Approximately 58.55 miles of the 61.62 miles of AMD impacted streams within the watershed would be restored. Only 4.63 acres of headwater habitat will remain disconnected from mainstem Monday Creek. PC 6 is technically feasible as well as economically and environmentally feasible. PC 6 has been identified as the NER plan in accordance with Corps guidance on Cost Effectiveness and Incremental Cost Analysis.

PC 7 is not an acceptable plan since it was shown during the incremental cost analysis; the plan is not the best investment at \$64.40/ sustainability unit (Figure 4-7). However, PC 7 is technically feasible as well as environmentally feasible. PC 7 does address all the planning goals for the study.

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Based on the decision criteria discussed in Section 4.7, PC 2 and 3 are considered efficient plans were eliminated from further consideration due to the lack of effectiveness, completeness and acceptability. Plans 4 and 5 were efficient, but lack effectiveness, completeness and acceptability. Therefore, they were eliminated from further consideration. PC 6 is efficient, effective, and acceptable. PC 6 is a complete plan, restoring 98% of the Monday Creek watershed and fulfils nearly all of the planning goals and objectives. Therefore, PC 6 is the NER and recommended plan.

PC 7 is an effective and complete plan, restoring 100% of the Monday Creek watershed from a less degraded state; however, it is not economically efficient as PC 6. Restoring the reaming 2% of the Monday Creek Watershed, as proposed in PC7, would increase total project costs from \$1,787,341 to \$2,080,008, or approximately \$292,667. The incremental costs per unit of output would increase approximately 267%, from \$24.04/unit to 64.40/unit. Therefore, PC 7 will be eliminated from further consideration.

5.0 Recommended Plan

The Cost Effectiveness and Incremental Cost Analysis described in Chapter 4 discussed seven Plan Combinations that were determined to be considered the “Best Buy Plans.” Plan Combination 6 was identified as the National Ecosystem Restoration Plan (NER). The Recommended Plan is Plan Combination 6, the NER Plan, and addresses AMD impacts in seven of the major subwatersheds within Monday Creek and includes connectivity of the aquatic resources with the headwaters. The Recommended Plan successfully reduces the toxic concentrations of iron, aluminum, acidity, and increases pH which meet the water quality thresholds in the mainstem of Monday Creek. The minimum resource requirements considered necessary to support the aquatic ecosystem will exist in 98% of the watershed except for Monkey Hollow. Descriptions of the major project features associated with construction of the project, real estate requirements, and operation and maintenance requirements are included.

5.1 Plan Description

Plan Combination 6 would have construction of project features in each of the eight subwatersheds affected by the AMD in Monday Creek. Features such as dissipating streams, stream blockages, and subsidences would be constructed to prevent surface water from flowing into underground mine workings and thus preventing the generation of AMD within the Monday Creek watershed and in adjacent watersheds. The AMD restoration sites would best contribute to the ecological restoration objective to restore Monday Creek ecosystem by keeping the surface water from entering the mines and producing AMD. These restoration sites would reduce the production of AMD and help dilute other sources of AMD. This would allow the existing pockets of diverse fish and macroinvertebrate populations to repopulate areas currently impacted by AMD and thus restore both the structural and functional components of the ecosystem to a less degraded state. The Recommended Plan is expected to result in significant benefits to the aquatic ecosystem from headwaters to Monday Creek’s confluence with the Hocking River.

The plan includes the following features:

Table 5-1. Plan Combination 6.

Plan	Location	Description
A	Jobs Hollow	1 doser, 3 SLB* and 1 OLC*
B	Dixie Run	1 SLB, 2 OLC and 1 LLB*
C	Rock Run	3 LHD* and 1 wetland
D	Lost Run	30 sites + 16 spoil blocks and 12 subsidences features
F	Monkey Hollow	1 doser + 9 spoil blocks and 6 subsidences features
H	Snake Hollow	1 SLB, 4 OLC and 4 LLB
J	Snow Fork	6 SLB, 19 OLC, 20 LLB, 8 dissipating streams, 9 spoil blocks, 7 subsidences, and 2 wetlands
	Coe Hollow	2 SLB, 1 OLC, 4 LLB, 3 dissipating streams and 1
L		Subsidence feature

*SLB – slag leach bed; LLB – limestone leach bed; OLC open limestone channel;
LHD – low head dam

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Currently, the project consists of 178 total restoration structures located within the following eight subwatersheds locations: Jobs Hollow, Dixie Hollow, Rock Run, Monkey Hollow, Lost Run, Snake Hollow, Coe Hollow, and Snow Fork (which is comprised of Salem Hollow, Sycamore Hollow, Spencer Hollow, Brush Fork, Long Hollow, Whitmore Cemetery and Orbiston). The locations of these subwatersheds may be found on Map 4-5 in Section 4 of this report.

Proposed structures include open limestone channels, low head dams, limestone leach beds, slag leach beds, aerobic wetlands and dosers. Other forms of construction activities involve the closure of stream-capturing subsidences, re-routing dissipating streams, and either breaching or removal of spoil blocks.

The construction of the passive treatment structures would require over 370,000 cubic yards of excavation, presumed to be about two-thirds soil and one-third rock. Soil spoil locations have been identified on US Forest Service property in Rock Run, Sycamore Hollow, Long Hollow and Coe Hollow. All the proposed spoil sites are abandoned strip mining operations. Placement of the excess material will reclaim part of those sites. Over 41,500 tons of limestone would be required for various treatment structures. An estimated 60,000 cubic yards of excavation will be entailed in the removal of spoil blocks: 10,000 cubic yards for nine spoil blocks in Snow Fork (Brush Fork area) and 55,000 cubic yards for seventeen spoil blocks in Lost Run. The closure of stream capturing subsidences will require approximately 3,000 tons of stone: 1,000 tons for six subsidences in Snow Fork (Brush Fork), 100 tons for one subsidence in Coe Hollow, 350 tons for one subsidence in Snow Fork (Long Hollow), 1,000 tons for twelve subsidence in Lost Run and 300 tons for five subsidences in Monkey Hollow.

Stone dimensions for channel lining are estimated for this Engineering Analysis. For the Feasibility Phase of this project a terrain model, River Analysis System (RAS), was used to analyze flow velocities and possible flooding on the mainstems of Monday Creek and Snow Fork. This mainstem model indicated that minor increases in flood elevations may occur downstream. Hydraulic modeling will continue through the next phase of the project.

5.1.1 Open Limestone Channel

There are forty-five proposed open limestone channels included in the project. An open limestone channel would require the use of coarse aggregate limestone (generally 18-inch top-size or ODOT Type C Rock Channel Protection) as a means to increase the pH of the water within the stream. The channel would also aid in the precipitation of dissolved metals in the stream. Stream widths average 6 feet and depths average 2 feet. Excavation quantities for the channels range from 12 to over 4,000 cubic yards. The estimated amount of limestone required for these structures is over 25,000 tons.

Armoring by ferric iron or aluminum hydroxides is a concern using open limestone channel to increase the pH of a stream. Studies have shown that fully armored limestone is one-fifth as soluble as unarmored limestone. This factor was taken into consideration during the modeling of the open limestone channels in regards to length of the channel and the tonnage of limestone required to remedy the AMD. The

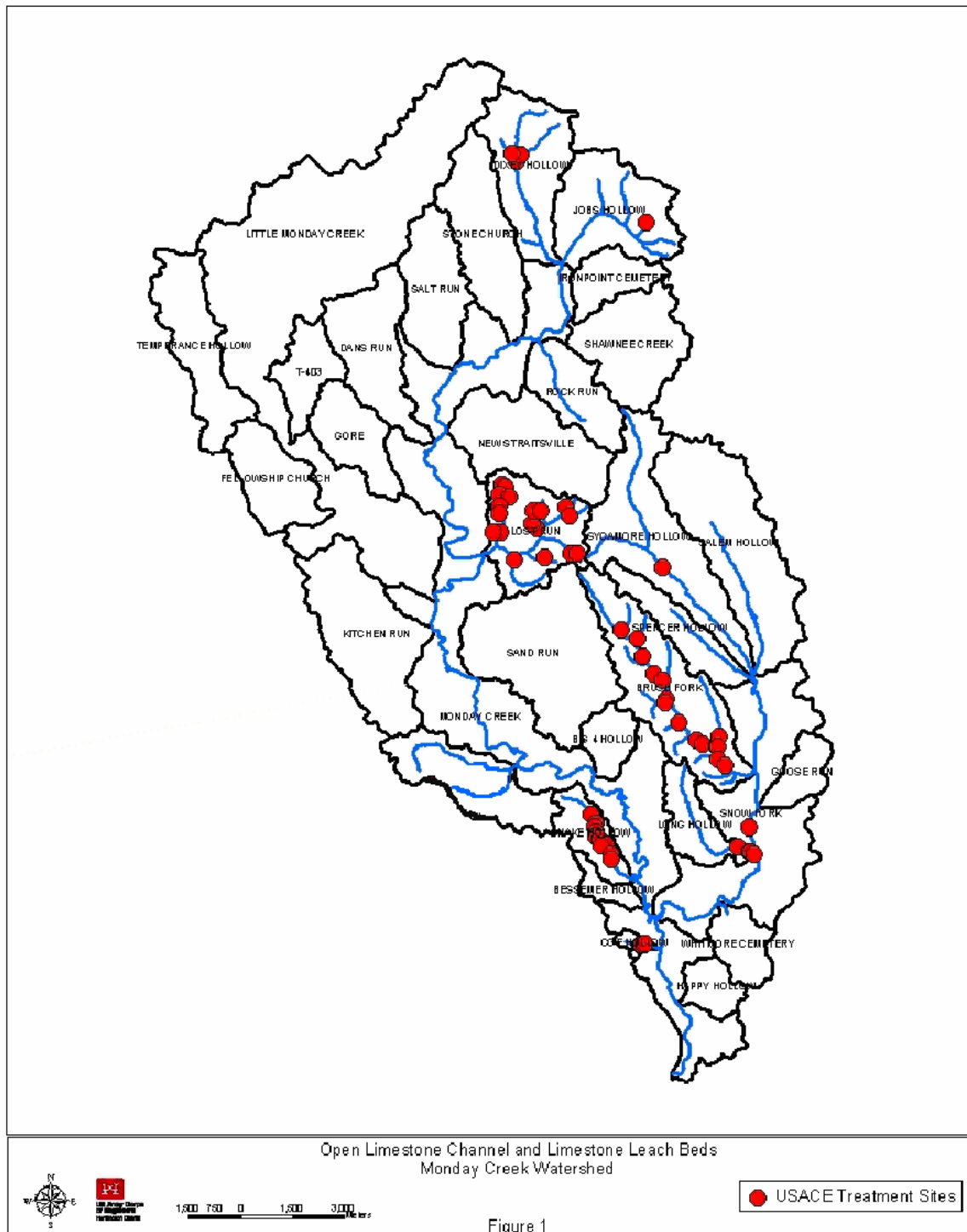
service lives of the open limestone channels proposed for this project range from two to nine years. Proposed Open Limestone Channel Locations are shown of Figure 5-1.

5.1.2 Limestone Leach Bed

Limestone leach beds will be designed to provide alkalinity to freshwater streams located upstream of an AMD source. The added alkalinity will provide additional buffering capacity for the stream to remove the acidity of the AMD. The top-size of the limestone must be large enough to withstand high precipitation events. Currently the proposed project consists of thirty-nine limestone leach beds located in Lost Run, Dixie Hollow, Coe Hollow, Brush Fork, Snake Hollow , and Snow Fork (with locations Sycamore Hollow, Orbiston, and Long Hollow.) Excavation quantities for these leach beds ranges from 2 to 3,500 cubic yards. The amount of limestone required for these leach beds is estimated to be 16,500 tons. A spoil location for the excavated material should be determined prior to any excavation. The proposed service lives for the limestone leach beds range from three to ten years but may be increased during detailed design. The locations for limestone leach beds are shown in Figure 5-1.

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Figure 5-1—Open Limestone Channel and Limestone Leach Beds

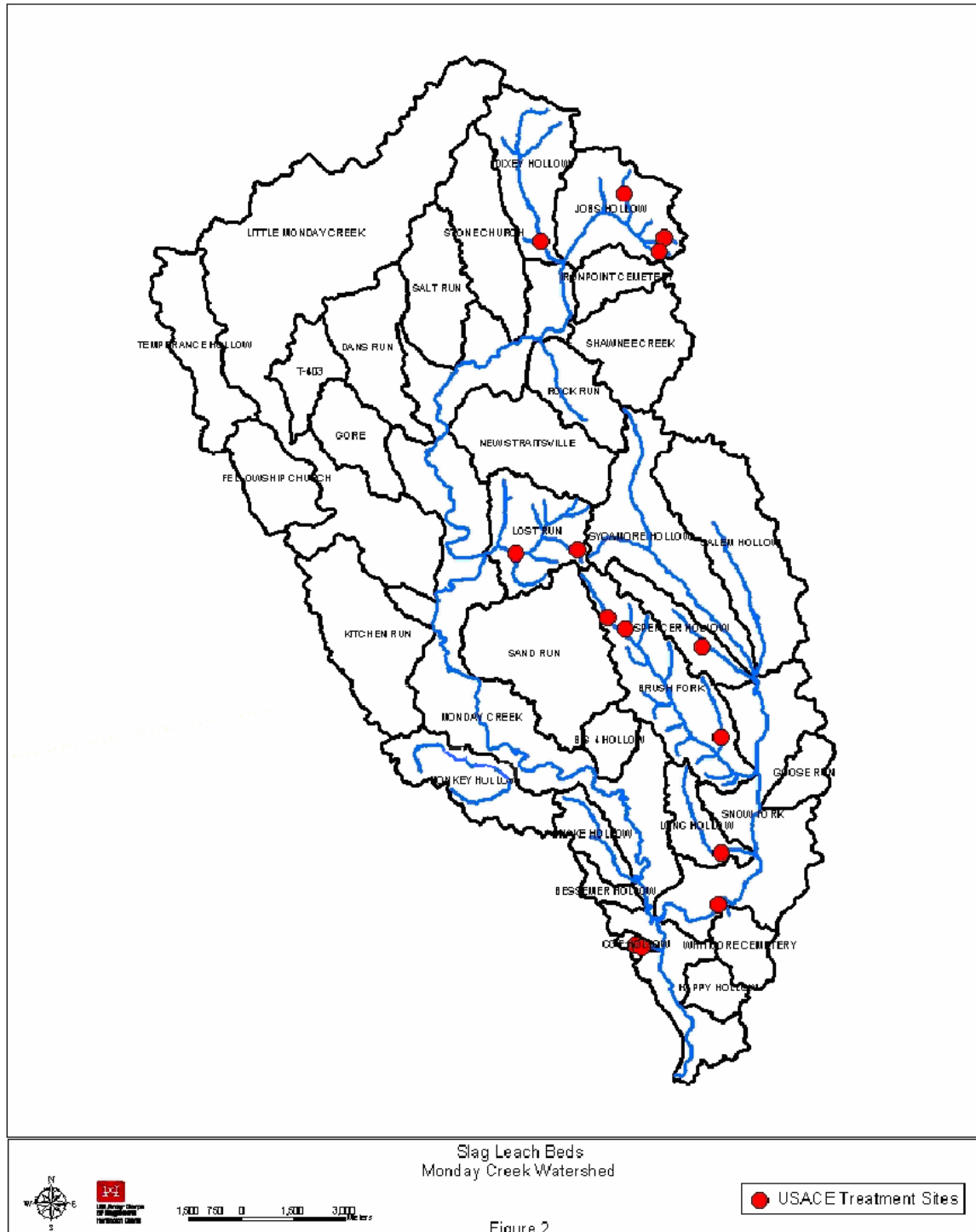


5.1.3 Steel Slag Leach Bed

A steel slag leach bed would be utilized to boost alkaline concentrations contained within the stream water. The slag leach beds will be positioned upstream of an AMD source to boost alkalinity. The effluent from the leach bed will be a high pH of about 10 when it encounters the AMD to compensate for the low pH of the AMD and neutralize the stream. Currently, the Monday Creek Watershed project includes seventeen slag leach beds to be constructed in Whitmore Cemetery, Spencer Hollow, Lost Run, Coe Hollow, Brush Fork, Dixie Hollow, Long Hollow and Jobs Hollow. The amount of soil excavation for these structures ranges from 100 to over 7700 cubic yards with a total excavation of approximately 30,000 cubic yards. A spoil location for excavated materials should be determined prior to any excavation. The amount of slag required for all of these leach beds is estimated at 55,000 tons. Each of the leach beds will be 4 feet deep with varying lengths and widths. The design of a steel slag leach beds averages a 6.2 year service life but may be increased during detailed design. Proposed steel slag leach bed locations are shown on Figure 5-2.

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Figure 5-2—Slag Leach Beds

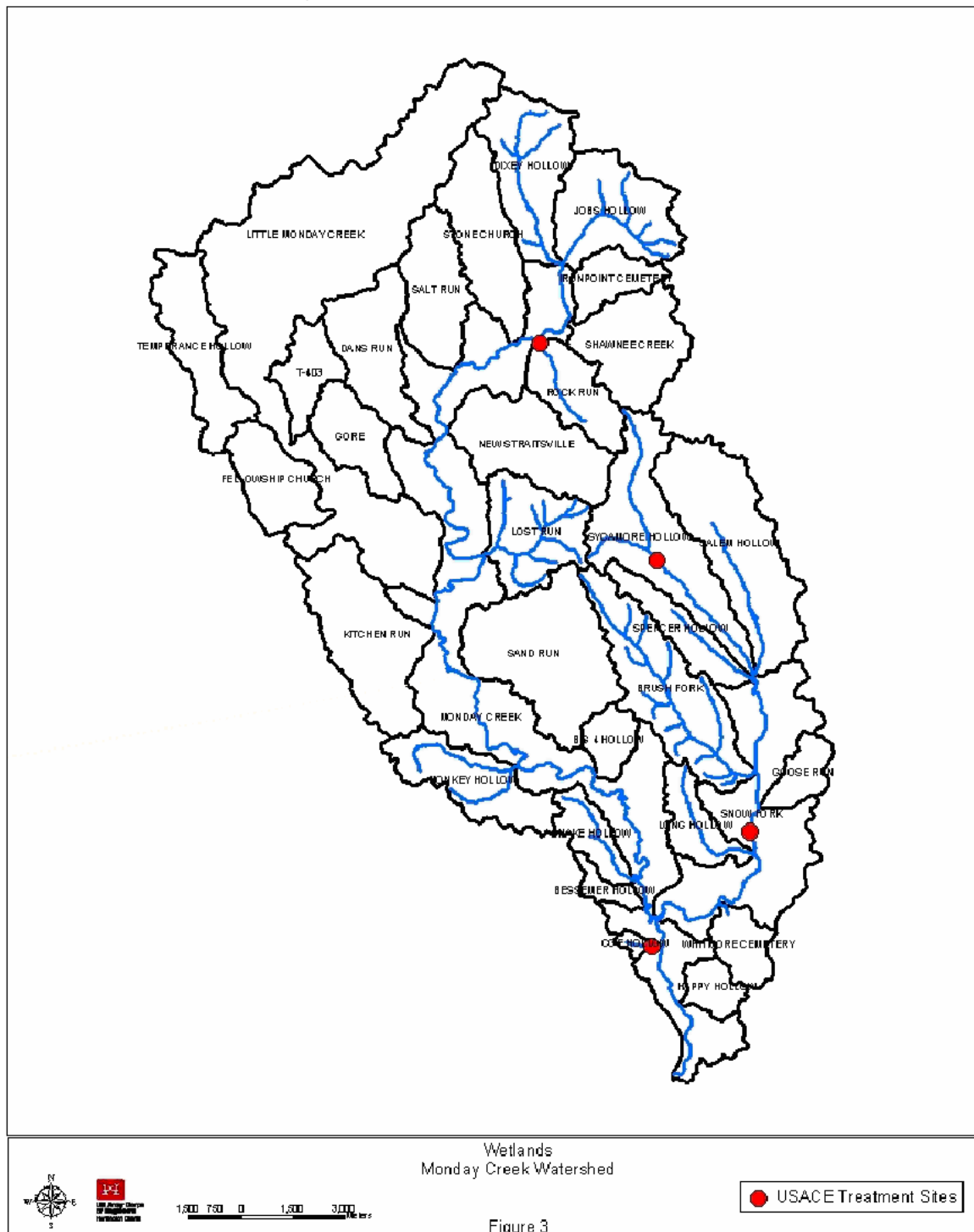


5.1.4 Aerobic Wetlands

An aerobic wetland would provide a large area of stream with a small depth of flow to facilitate the precipitation and sedimentation of metal hydroxides downstream of passive AMD restoration structures. A hydraulic analysis, using the RAS model, would be required to ensure the long-term stability of all the aerobic wetlands during high flow events. Aerobic wetlands are planned for Rock Run, Snow Fork, and Coe Hollow. The wetland in Coe Hollow would require 150 tons of limestone. Design of wetlands entails excavation of soil in accordance with the stream flow. The amount of excavation can range from 150 to 130,000 cubic yards of soil. Spoil sites, for deposition of the excavated material, will need to be determined prior to any excavation. The wetlands would range in depth from one to four feet with varying lengths and widths. The proposed locations of aerobic wetlands are shown in Figure 5-3.

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Figure 5-3—Wetland Locations



5.1.5 Low Head Dam

A low head dam would require the use of large riprap to armor-sized limestone as a means to lower the metals content of the water and increase the pH by increasing the retention time, allowing for increased kinetic and biological activities. The low head dam would be constructed to aerate the stream and consequently convert most, if not all, of the iron into the ferric oxidation state. Limestone used to build these dams should have a diameter of no less than 2% of the total stream width. Design of the low head dam entails excavation of the channel and placement of filter fabric and large stone of the same volume (ODOT Type C Dumped Rock Fill). Currently there are three low head dams proposed for Rock Run. The proposed geometries of Rock Run low head dams would consist of a 5-foot deep by 10-foot wide and 6.2-foot long structure across the width of the stream. Each of the three dams will require approximately 7 cubic yards of excavation and 8 tons of limestone. These structures would be designed with an expected life of fifteen years. Proposed low head dam locations are shown on Figure 5-4.

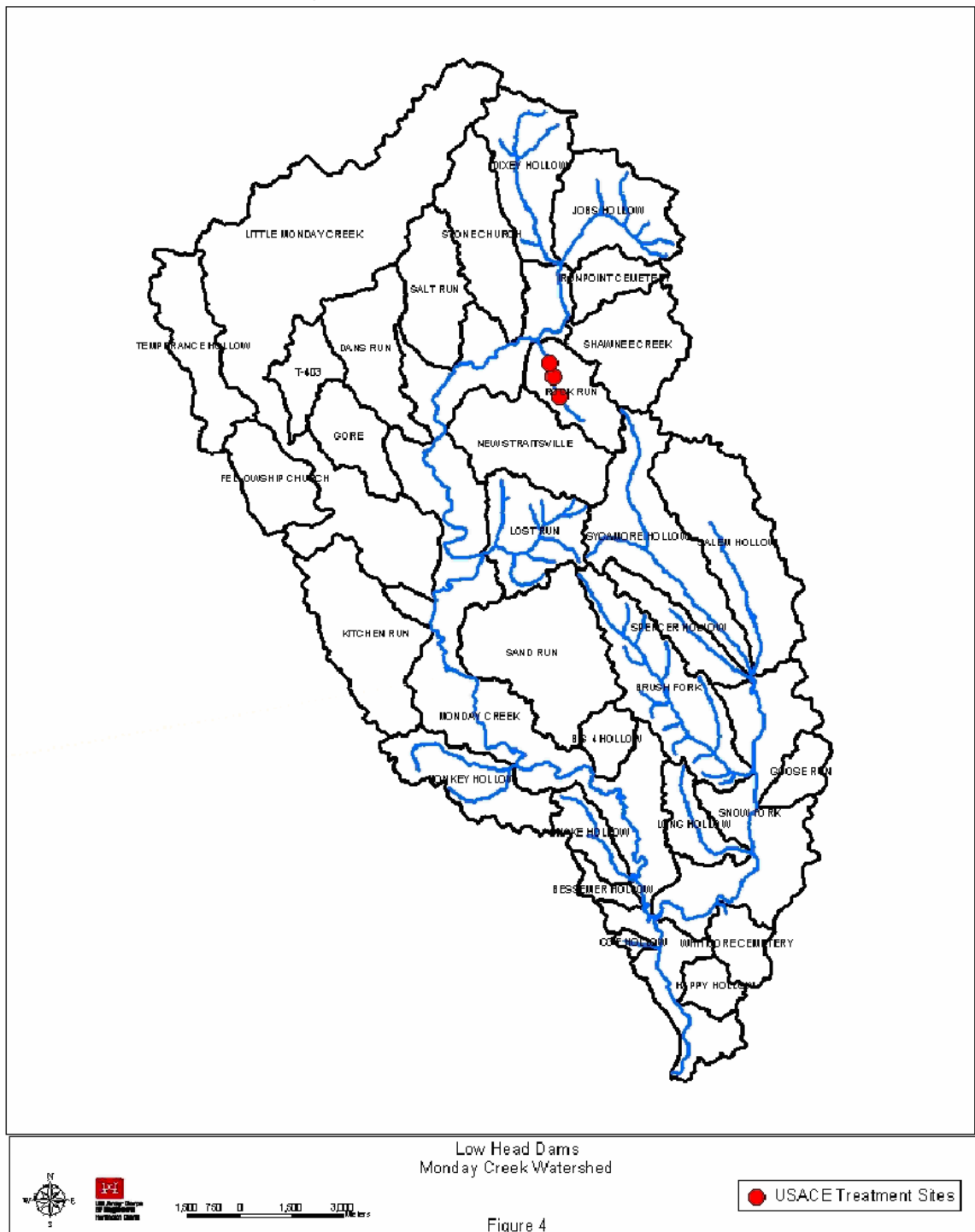
5.1.6 Lime Doser

A lime doser would release controlled amounts of lime products into the flowing stream as a means to increase pH and reduce acidity of the water. The chemical reaction between the limestone products and the acidic water would result in precipitation of metals (primarily iron) from the water. The metals would settle onto the streambed as a precipitate. This restoration method was chosen for this site, in lieu of a passive treatment, due to the topography of the associated tributaries.

Use of a doser would require either a concrete pad or sound bedrock for placement. A doser is planned to be placed in Jobs Hollow and Monkey Hollow. The doser would be located 1500 to 3000 feet upstream from the confluence with Monday Creek. Water would be fed to the doser through a two-inch diameter pipe. The intake would be located about 550 feet upstream from the doser. The inlet would collect water near the bottom of the stream and would be protected by a concrete anchor. A limestone berm would be constructed just downstream from the intake. The treated discharge from the doser would be returned to the stream by pipe. Access to the doser would require minimal improvements to an existing road, which would need to be maintained for periodic refilling. The doser can hold up to 75 tons of lime products. Service life of a doser is estimated at 20 years. The proposed locations of the lime dosers in Jobs Hollow and Monkey Hollow are provided in Figure 5-5.

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Figure 5-4—Low Head Dams



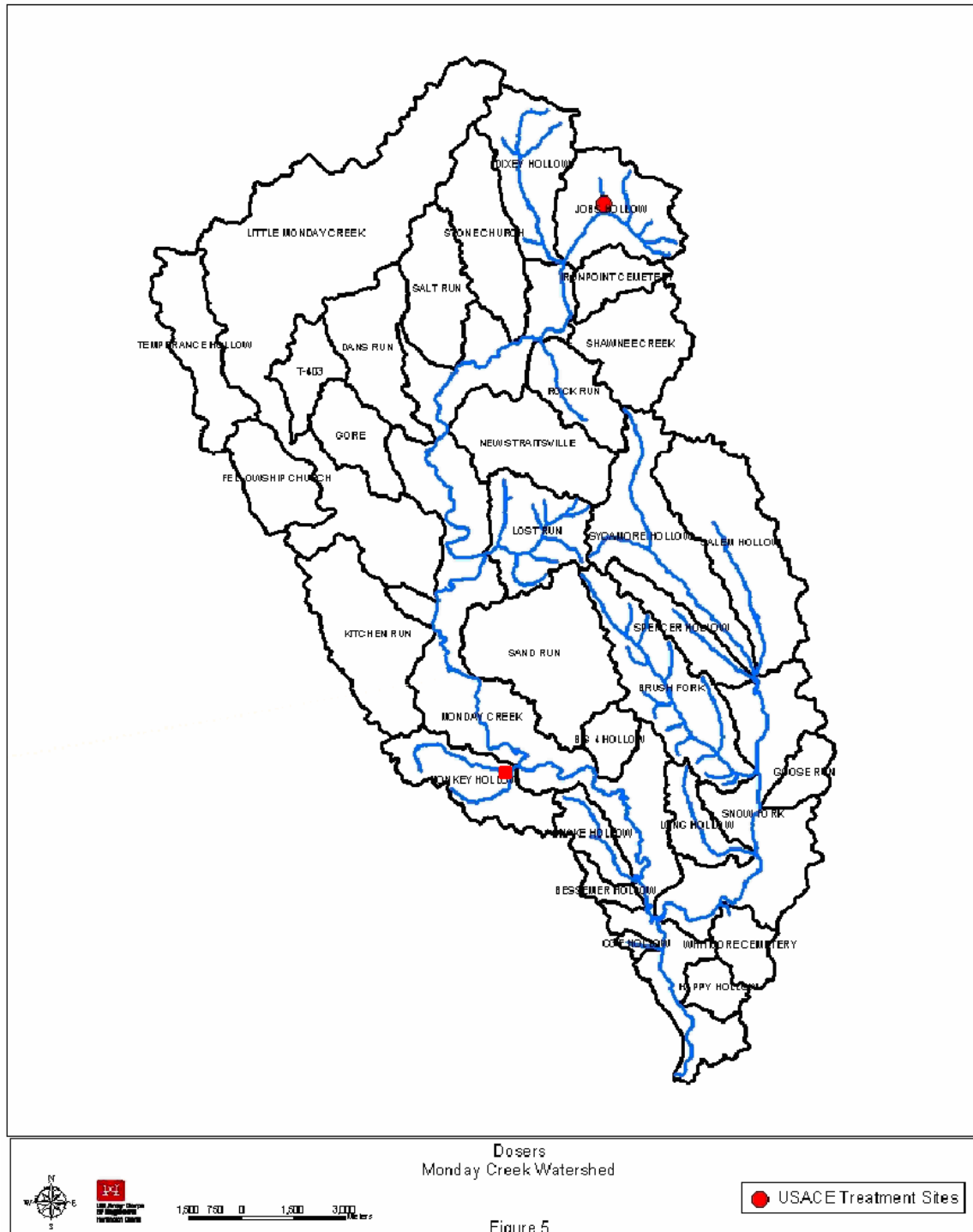
5.1.7 Stream- Capturing Subsidence Closures

The goal of stream subsidence closures is to restore positive drainage to the stream and reduce AMD generation by preventing contact between stream water and pyritic minerals located within the underground mines. Restoring positive drainage to the affected streams would improve the long-term performance of other AMD restoration systems and should reduce human and animal hazards. There are 25 subsidence closures planned for this project located within Long Hollow, Lost Hollow, Monkey Hollow, Brush Fork and Coe Hollow. Each subsidence that was selected to be included is currently capturing a stream.

The method of closure would depend on the location, size and extent of the subsidence. Generally, the subsidence may be filled with graded limestone or recycled concrete (if available) in conjunction with a geotextile and spoiled soil. Once the subsidence is filled and sealed the previously captured stream would be re-routed, when possible, to avoid the filled subsidence. The stream would be lined with a geosynthetic clay liner (GCL) or geomembranes to inhibit downcutting action of the stream and another encounter with the subsidence. The stream would be re-routed to existing natural flow at the nearest downstream location. Prior to closure, some subsidences would be drilled to determine the amount of coal that was extracted, the extent of the subsidence and to locate the top of sound bedrock. Geophysical investigations may also be performed to assist in determining the extent of the void.

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Figure 5-5—Lime Doser Location



5.1.8 Spoil Block Removal

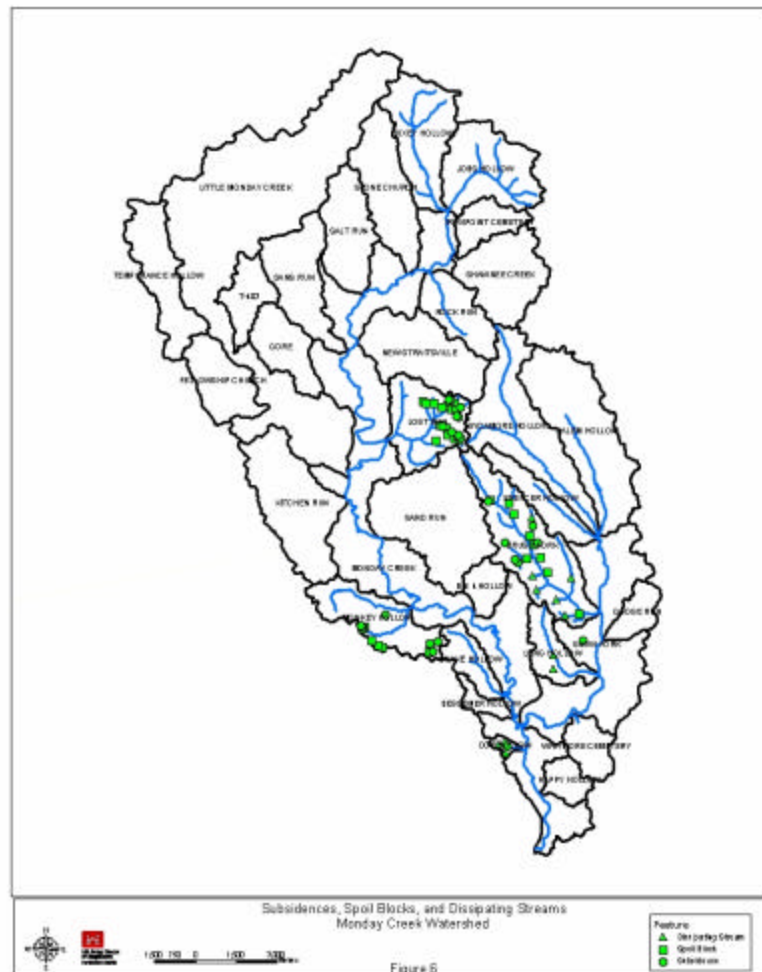
There are currently 35 spoil blocks planned to be either completely removed or partially removed by breaching. The method and extent of removal would depend upon the size of the spoil block. When feasible, the block would be entirely removed to provide positive drainage to a stream. In other cases, when the size of the spoil block does not make removal feasible, the block would be breached to allow stream flow to resume. In most cases, the stream would need to be rerouted to reconnect to the existing channel downstream. Stream reconstruction would entail lining the channel with a GCL or geomembrane and limestone and employ natural channel techniques where appropriate.

The estimated volume of excavation for the spoil block removal or breaching is 79,500 cubic yards of material to achieve positive drainage. This total is comprised of approximately 55,000 cubic yards of spoil in Lost Run, 16,000 cubic yards in Monkey Hollow and an estimated 8,400 cubic yards in Brush Fork. A disposal sites should be determined prior to any excavation.

5.1.9 Re-routing Dissipating Streams

Within the scope of this project are eleven dissipating streams. A dissipating stream is one that is captured by jointed rock, scarps or fractures associated with mining subsidences. The proposed fix for dissipating streams is to re-route the channel upstream to avoid the capturing feature and line it using a GCL or geomembrane to prevent contact with the capturing feature. In some cases the capturing feature may need to be filled with a high fly ash content grout mixture. In other cases the capturing feature may be filled with spoil material and covered with a GCL. Rerouting of channels will incorporate natural channel design where appropriate. Proposed stream capturing subsidence closures, spoil block removals and dissipating streams are shown in Figure 5-6.

Figure 5-6—Subsidence, Spoil Blocks, and Dissipating Streams



5.2 Plan Benefits

The Recommended Plan (RP) – Plan Combination 6 will improve 230.20 acres of aquatic stream habitat (stream bottom) by allowing improved water quality to flow through areas that were once uninhabitable due to severe acidity loadings and toxic metal concentrations. Baseline conditions indicated some structural and functional components of the aquatic system exist. The missing attribute is the chemistry of the water. The project will reduce the elevated iron and aluminum that currently exist in concentrations that are acutely toxic to the aquatic biological community. Acidity levels that are toxic to the aquatic organisms will also be reduced. The proposed water quality measures will restore the natural water chemistry of the area, improve the productivity of the benthos, and allow the stream to be re-colonized by fish and benthic species located downstream of the project site. Species diversity and abundance will increase both laterally and longitudinally over time. In addition, once the benthos populations have

increased, higher order aquatic and terrestrial organisms will return, enabling the cycling of organic material between the terrestrial and aquatic ecological components to become reestablished.

5.3 Monitoring and Adaptive Management

The long-term monitoring plan will consist of chemical and biologic monitoring along the mainstem of Monday Creek and Snow Fork at existing monitoring sites and also the establishment of new sites on tributaries where restoration sites are located. The baseline dataset is robust with historic data dating back to 1997. In addition, the EPA's Total Maximum Daily Load (TMDL) monitoring sites are tied to these locations. The EPA data includes chemistry, sediment, biology (fish and macroinvertebrates) and flow. Long-term monitoring is proposed for the mainstem to:

- Assess the impact of reclamation in the tributaries on Monday Creek
- Provide an assessment of water chemistry and biologic trends over time

Monitoring of water chemistry will also be conducted in tributaries proposed for reclamation projects. This effort will be confined temporally to pre- and post-construction projects. The following information generally discusses the monitoring that will be required during and after construction for a period of five years. For a more detail discussion of these monitoring sites and protocols please refer to Appendix F.

Water Quality Parameters

The following water quality parameters will be collected;

Specific conductance	Field and lab	Us/cm
pH and Temp	Field and lab	SU and C
Total Dissolved Solids	Laboratory	mg/L
Acidity (total hot)	Laboratory	mg/L
Alkalinity (total)	Laboratory	mg/L
Sulfate (total)	Laboratory	mg/L
Aluminum (total and dissolved)	Laboratory	mg/L
Manganese (total and dissolved)	Laboratory	mg/L
Iron (total and dissolved)	Laboratory	mg/L

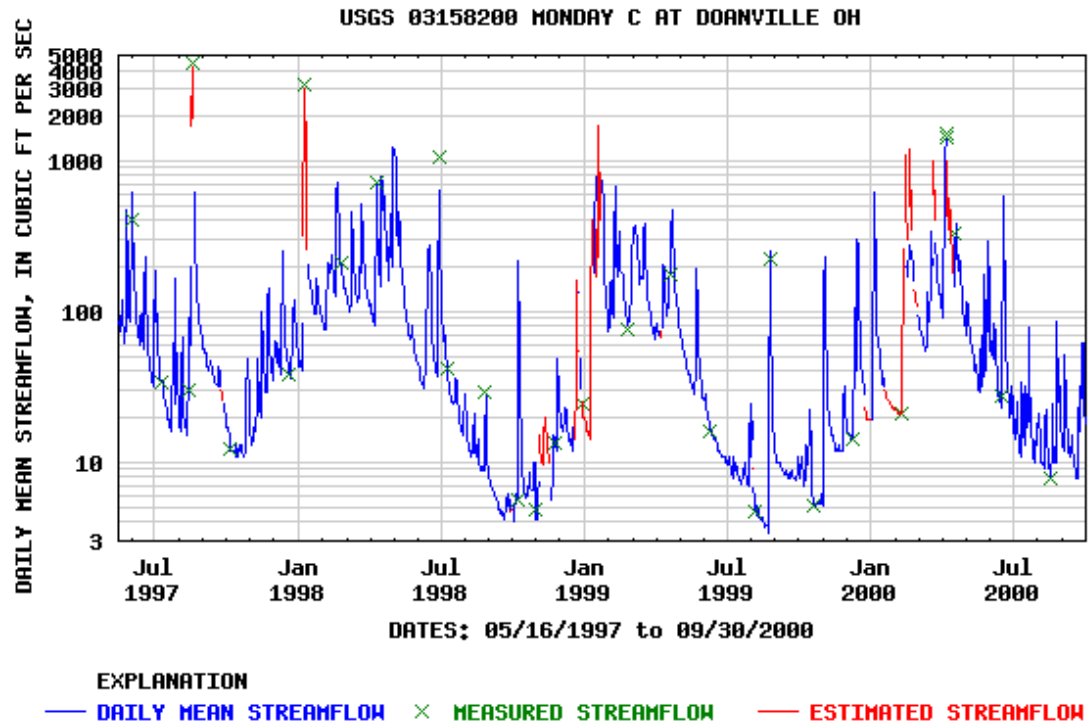
Total net acidity will also be calculated.

Flow Data

Flow data will be compared against the USGS Doanville station flow measurements so that relative conditions can be established for flow during sampling events and in order to calculate loading rates. The graph below shows flow conditions for three years. This type of information provides a benchmark for yearly fluctuations.

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Figure 5-7 Flow Conditions – Past Conditions

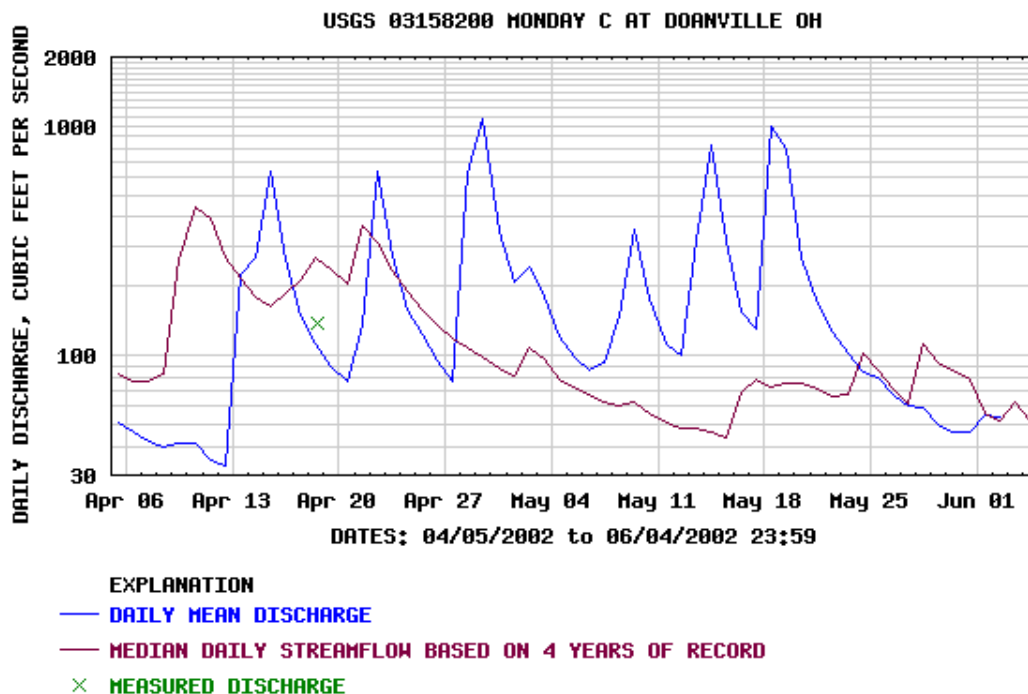


The following USGS graph from the Doanville gage station shows daily mean discharge and median daily stream flow for four years of record for flow conditions several weeks prior to sampling. When collecting flow in the field, extreme high flows that occur after a precipitation event will not be measured but will be measured during the baseline (as represented on the hydrograph, not baseflow) conditions.

Daily mean flow statistics for 6/4 based on 5 years of record in ft ³ /sec						
Current Flow	Minimum	Mean	Maximum	80 percent exceedence	50 percent exceedence	20 percent exceedence
	26	105	232	28.0	52.0	221
Percent exceedence means that 80, 50, or 20 percent of all daily mean flows for 6/4 have been greater than the value shown.						

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Figure 5-8 Daily Mean Discharge and Median Daily Stream Flow



Sampling locations

The following sites are located in Monday Creek mainstem from downstream to upstream. All the historic monitoring sites are located just downstream of the proposed reclamation projects with the exception of Oreville (103) and Carbon Hill (153). Oreville should still be included as it provides a transition point between Lost Run and Rock Run, a distance of seven miles. Carbon Hill (153) should be relocated below the input from the Monkey Hollow tributary. The new station would be renamed Carbon Hill (154), approximately 1.1 miles downstream at RM 10.4. Unfortunately, there would not be historic baseline data for this site. The sampling locations may be seen in Figure 5-9.

Below is a listing of the long term monitoring sites and a general description of their locations.

- | | | |
|----|--------------------------------------|--|
| 1 | Doanville at USGS gage station (108) | TR 1042 dst Coe Hollow (RM 1.7) |
| 2 | Below Snake Hollow | 151 Loop Rd dst McKnight Seep (RM 4.3) |
| 3* | Below Carbon Hill | 153 SR 278 (RM 10.4) |
| 3 | Carbon Hill Below Monkey | 154 dst of Monkey Hollow (RM 9.29-Establish) |
| 4 | Below Lost Run | 131 Adj. SR 595 (RM 16.0) |
| 5 | Above Oreville | 103 @ Monday Cr. Junction (RM 19.7) |
| 6 | Below Rock Run | 127 (RM 23.4) |
| 7 | Below Jobs Hollow/Above Dixie Hollow | 148 Portie Flamingo Rd (RM 26.5) |

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Snow Fork enters Monday Creek at RM 3.5. Sites along Snow Fork mainstem from downstream to upstream:

8	Snow Fork at Buchtel gage station	109	SR 685 dst Orbisten Seep (RM 2.4)
9	Snow Fork above Goose Run	107	Dst Snow Fk Mainstem Seep (RM 4.3)
10	Murray City Bridge	106	Dst Murray City Seeps 1&2 (RM 6.2)

A new site will be located downstream of Little Monday Creek. This location has the best water chemistry and will offer information on biologic refugia that could repopulate Monday Creek.

Frequency of collection

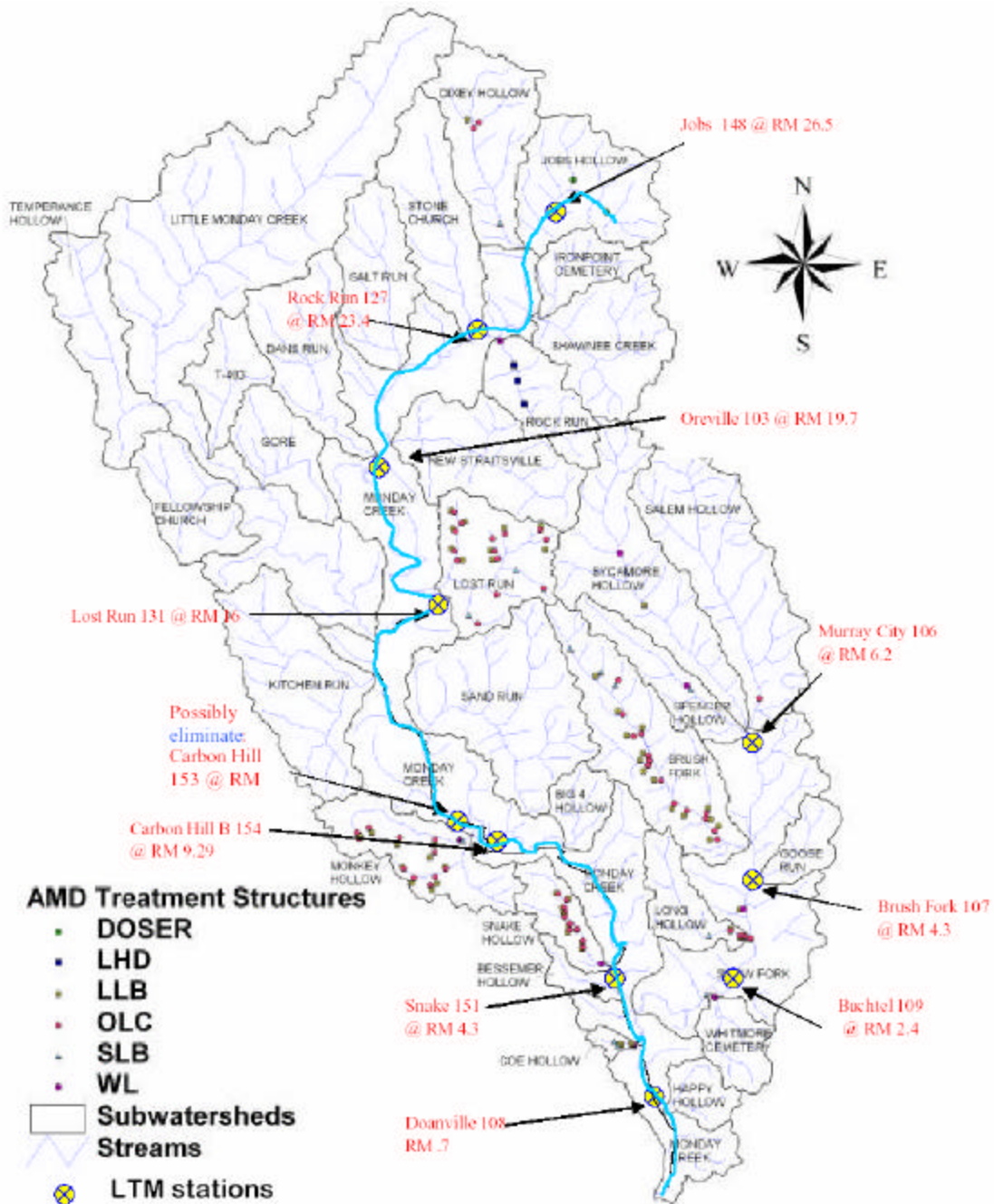
For the long-term monitoring, the chemistry and hydrologic data will be collected twice a year at low flow and high flow prior to initiation of restoration work, during construction, and for at least five years after restoration work is complete.

Tributary monitoring for pre- and post-construction

Both Ohio EPA (in 2001 TMDL survey) and Monday Creek group conducted sampling in the tributaries to Monday Creek and Snow Fork. Therefore, tributary level monitoring for reclamation projects should be located at the site of previous monitoring where some historic data exists. Construction monitoring will begin one year prior to reclamation construction and for one year after completion. Monitoring frequency will be every other month so that six sampling events are conducted for each year.

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Figure 5-9 Long Term Monitoring Site Locations



Sediment Monitoring

A new baseline will be established by Ohio EPA. These sediment-sampling sites will be located at the established (and new) long-term monitoring locations. Sampling will occur with the 10-year return of the TMDL update.

Biological Monitoring

Fish and macroinvertebrate baseline data were collected by Ohio EPA in the 2001 TMDL survey. To document improvements to the watershed, fish and/or macroinvertebrate data will be collected following the same methodologies used by Ohio EPA. The Macroinvertebrate Aggregate Index for Streams (MAIS) method will also be used for a rapid assessment of macroinvertebrates. Baseline data should be collected using this methodology so that trends can be documented.

Sampling locations

The biological sampling locations will be conducted at chemical sampling locations (ODNR's long-term monitoring stations). As restoration projects are completed on the tributaries, biological monitoring stations should be added downstream from those projects to document improvements if a long-term monitoring station does not exist at that location.

Frequency of biologic monitoring

All methodologies need sufficient baseline monitoring prior to reclamation. As individual restoration projects are completed in the tributaries, some monitoring should be conducted downstream from the project or at the mouth of the tributary. Frequency of each type of biological monitoring is listed below:

- EPA full biological assessment: Every 10 years; to be sampled next in year 2011. MAIS family-level aggregate multimetric index
- Fish assemblage to be sampled by EPA SEDO; every five years to be sampled next 2006 and also on an as-needed basis.

5.4 Operations, Maintenance, Repair, Rehabilitation & Replacement Considerations (OMRR&R)

Plan Combination 6 is designed to a 20-year horizon with minimal operation and maintenance during that time frame. Only the recommended passive treatments and the active dosers will require OMRR&R. Dissipating streams projects, spoil blocks and subsidences will not require OMRR&R after construction. Routine inspections should be conducted on the projects on a regular basis (quarterly) to make certain that the systems continue to function properly.

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To continue accruing ecosystem benefits, the passive treatment systems will need to be maintained on a regular cycle. Operation requirements should be minimal and are expected to consist of performance monitoring and routine inspections. The monitoring program should attempt to document seasonal patterns in the treatment system's performance so that gradual degradation in the system's chemical efficiency can be recognized and corrective actions taken before an ecosystem-threatening discharge event occurs. The monitoring program, while including standard measurements of pH and metal concentrations, should emphasize measurements of alkalinity and acidity because these parameters are currently considered the best descriptors of current and long-term water treatment performance by passive systems. The local sponsor will conduct the performance monitoring for the remainder of the five years as part of their routine inspection program.

Routine inspections of the passive treatment system should be conducted on a monthly basis throughout the operational life of the facility so that any problems that develop can be corrected before they impact the performance of the system. Routine inspections and maintenance of the passive treatment system will be the responsibility of the local sponsor.

Flushing of the underdrain pipes should be conducted twice a year. This can be accomplished by opening and closing valves (as necessary) in the transfer system to increase discharge velocities in the underdrain pipes, which should clean out most of the accumulated sludges in the pipes. It is anticipated that this work would be conducted by local sponsor employees.

Cleaning of the underdrain pipes should be conducted once every five years. This work would most likely be accomplished using high pressure jets. It is anticipated that this work would be contracted out by the local sponsor.

Miscellaneous drainage repairs would most likely be conducted once every ten years. Although it is not possible to predict what drainage repairs would be needed, it is anticipated that the repairs would require a level of effort similar to replacing one run of underdrain pipe in the passive treatment system. It is anticipated that miscellaneous drainage repairs would be contracted out by the local sponsor.

Miscellaneous facility repairs would most likely be conducted once every two years. Although it is not possible to predict what facility repairs would be needed, it is anticipated that they would be the result of weather related damages (site erosion, etc.). It is anticipated that miscellaneous facility repairs would be contracted out by the local sponsor.

The estimated average annual OMRR&R cost (2005) to the local sponsor is \$0.26 M. This cost is included in the MCACES Cost Estimate in Volume 2, Appendix D. The OMRR&R cost estimate for the local sponsor to operate the passive treatment system for 20 years is presented in Table 5-3.

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Table 5-2. Recommended Alternative – Plan Combination 6 Features

Sub-Watershed	Wetland *	Slag Leach Bed*	Open Limestone Channel*	Limestone Leach Bed*	Low Head Dam*	Subsidence	Spoil Block	Dissipating Stream	Doser	Total Restoration Alternative
Jobs		3	1						1	5
Dixie		1	2	1						4
Rock Run	1				3					4
Lost		2	18	10		12	16			58
Monkey						6	9		1	16
Snake			4	4						8
Coe	1	2	1	4		1		3		12
Snow Fork	2	6	19	20		7	9	8		71
TOTAL	4	14	45	39	3	26	35	11	2	178

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Table 5-3 Summary Comparison of Final Alternative Plans		
	No Action	Plan Combination 6
1. Plan Description	Without project condition / no improvement in the aquatic ecosystem	NER Plan
2. Economic Analysis		
A. Project cost	\$0	\$17.7 M
Federal	NA	\$11.5 M
Non Federal	NA	\$6.2 M
B. Real Estate	NA	\$99 K
C. Annual Cost	NA	\$1.6 M
D. Annual O&M	NA	\$0.26 M
E. Benefits	8,269 units	138,821 units
F. BCR	NA	NA
3. Environmental Impacts		
A. Land Use	Existing conditions will continue.	No Impact
B. Geology and Topography	Existing conditions will continue.	No Impact
C. Farmland	No Impact	No Impact
D. Surface Water	Existing degraded quality will continue.	Improvement will be seen in 7 subwatersheds and mainstem Monday Creek.
E. Groundwater	Existing conditions will continue.	Subsidence features will minimize surface water entering the groundwater system.
F. Aquatic Resources	Existing degraded quality will continue.	Improvement will be seen in 230.20 acres if aquatic habitat in 7 subwatersheds in addition to the mainstem. Improvement will also be seen in the Hocking River system.
G. Terrestrial Resources	Existing quality will continue.	Existing quality will improve.
H. Cultural and Archeological Resources	No impacts.	No impacts due to construction activities.
I. Aesthetics	No impacts.	No impacts.
J. Wetlands	No impacts.	No impacts. Project sites have been moved to avoid wetland impacts.
4. Social Effects		
A. Air Quality	No impacts.	No significant impacts due to

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		construction activities.
B. Noise	No impacts.	No significant impacts due to construction activities.
C. Socio-economics	No impacts.	Temporary increase in commerce during construction activities.
D. Recreation	No impacts.	No impacts.
5. Evaluation Criteria		
A. Acceptability	No improvement to the aquatic ecosystem	Acceptable. Meets planning constraints and goals. Sponsor preferred plan.
B. Completeness	No improvement to the aquatic ecosystem	138,821 sustainability units Project will reconnect headwaters with downstream fauna except Monkey Hollow. Connectivity of downstream populations of diverse fish species would repopulate the watershed.
C. Efficiency	No improvement to the aquatic ecosystem	Most efficient plan that satisfies the objectives of the study
D. Effectiveness	No improvement to the aquatic ecosystem	An effective plan by reconnecting headwaters with downstream flora and fauna.

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Table 5-3 Summary Comparison of Final Alternative Plans	
	Plan Combination 6
1. Plan Description	NER Plan
2. Evaluation Criteria	
A. Acceptability	Plan is acceptable by the cost share partner and other agencies involved in the project.
B. Completeness	138,821 sustainability units One large headwater area would remain disconnected from the mainstem and downstream fauna.
C. Efficiency	Most Efficient Plan
D. Effectiveness	Effective plan however it does not address connectivity of headwater habitat in Monkey Hollow. 31.13 acres of aquatic stream habitat would not be restored. Restores 230 acres of aquatic habitat

Analysis of the evaluation criteria for PC 6 indicated that PC 6 does not meet all of the planning constraints and goals for completeness and effectiveness. It does meet the criteria for acceptability and efficiency criteria. Plan 6 is the NER plan and is the recommended plan.

6.0 Watershed Impacts of Recommended Alternative

This chapter summarizes the environmental impacts determined in accordance with the required procedures to comply with the National Environmental Policy Act, as well as other regulatory requirements. The Recommended Plan is Plan Combination 6 and includes 178 sites. Please refer to Section 5.1 for a detail plan description.

6.1 Land Use

6.1.1 Future Without Project Conditions (FWOPC No Action)

Land use designation in the Wayne National Forest (WNF) and private land owners will not change. The WNF will continue to function within the designation land uses determined by the Wayne Forest Plan. Other land use designations within the watershed will also remain the same.

6.1.2 Future With Project Conditions (FWPC) Alternative Plan Combination 6

The FWPC would have no change or impact on land use. Land use in the Wayne National Forest and private land owners will not change. The land use designation will not change. The construction of the recommended plan on the land of eight private property owners will be held in a 20 year easement.

6.2 Geography and Topography

6.2.1 FWOPC (No Action)

The FWOPC alternative would result in no impact to geography and soils as conditions would remain the same. The past mining practices have significantly changed the geology and hydrogeology in the watershed and are irreversible.

6.2.2 FWPC Alternative Plan Combination 6

The geology at the proposed restoration alternative sites will primarily remain unchanged from the before project conditions. The past mining practices have significantly changed the geology and hydrogeology in the watershed and are irreversible. The topography will also remain relatively unchanged except in areas in the immediate vicinity of the restoration alternative sites where excess spoil would be regraded within at the designated spoil locations which are located on abandoned strip mining areas.

6.3 Soils and Farmland

6.3.1 FWOPC (No Action)

Although there are a few abandoned small farms within the watershed, there are no prime or unique farmlands in the project area. Conditions would remain the same.

6.3.2 FWPC Alternative Plan Combination 6

Conditions would be the same as FWOPC (No Action) Alternative.

6.4. Air Quality

6.4.1 FWOPC (No Action)

The Monday Creek Watershed is in attainment for all National Ambient Air Quality Standards (NAAQS). The NAAQS were based on attainment and maintenance of air quality required to protect the public health. Subsequently, the Federal Clean Air Act Amendments of 1992 were enacted. The Clean Air Act, as amended, requires states to take additional steps to control ground-level ozone pollution, reduce sulfur dioxide and nitrogen oxide emissions which lead to formation of acid rain, and restrict emissions of air toxins. FWOPC would not affect this designation.

6.4.2 FWPC Alternative Plan Combination 6

Minor and temporary emissions from equipment would be released during construction activities. Likewise, dust and particulates would slightly increase above ambient levels during construction. No long-term, adverse, or significant impacts are anticipated.

6.5 Noise

6.5.1 FWOPC (No Action)

Ambient noise levels in the project area are those typically found in a semi-rural urbanized setting and is not expected to change with FWOPC.

6.5.2 FWPC Alternative Plan Combination 6

Construction and placement activities will occur at each of the 178 locations in the watershed; therefore minor impacts from equipment noise and traffic to the local residents will occur but will be temporary in duration. Truck traffic and associated noise will occur during normal daytime working hours. The disturbances to community residents should not be significant.

6.6 Vegetation

6.6.1 FWOPC (No Action)

Vegetation impacts from the future without project condition would occur due to the continued impact of AMD on the ecosystem. Impacts would continue to be impacted since the stream water is acidic. Seeps and springs would continue to flow into the aquatic system affecting both terrestrial and aquatic vegetation.

6.6.2 FWPC Alternative Plan Combination 6

Minor impacts would occur during construction activities due to clearing and grubbing activities required for site access. All disturbances would be revegetated with native species of grasses and shrubs. Future with project conditions for vegetation and wildlife habitat would be improved since the aquatic system would have increased populations of macroinvertebrates and fish populations and the water quality would be improved overall.

6.7 Water Resources and Quality

6.7.1 FWOPC (No Action)

Water resources and quality would remain the same as existing conditions with only slight improvement from the construction of projects by other agencies in the watershed. However, these improvements would be localized in nature and full watershed restoration and a connection of the aquatic resources would not be realized.

6.7.2 FWPC Alternative Plan Combination 6

Surface and Ground Water

No adverse impacts are anticipated to affect groundwater as a result of the proposed project. It is, however, anticipated that long-term groundwater infiltrations will be decreased at the proposed reclamation subsidence sites. Also, the surface topography is irregular and creates impoundments or spoil blocks, which increase surface water infiltration. The restoration alternative will lower the mine pools, ideally decreasing AMD flow and the number seeps emanating from other locations in the watershed. Overall, surface water discharges would be slightly higher, however; because of the construction of wetlands overall peak discharges would remain unchanged from current conditions.

Water Quality.

Water quality will be significantly improved immediately and for the life of the project. Acidity loading would be significantly decreased and metals would no longer occur at toxic concentrations. Dissolved metal concentrations would decrease and pH would increase. Siltation and sedimentation caused by precipitation of metals will decrease. Surface water currently being captured and conveyed into the underground workings would be kept in the stream channel, also improving overall stream quality of the mainstem. Overall, water quality would improve throughout the watershed.

During construction, Best Management Practices will be used to control erosion of sediment from the disturbed areas near streams. A Nationwide or Individual 401 Water Quality permit may be required for this project. The Corps regulatory staff will assist in the determination of the type of permit required. All other permits will be coordinated through the staff of the Ohio EPA.

6.8 Wetlands

6.8.1 FWOPC (No Action)

As discussed in Section 3.8, wetland complexes exist throughout the watershed. However, the FWOPC would not affect the wetlands within the watershed.

6.8.2 FWPC Alternative Plan Combination 6

During field investigations, jurisdictional wetlands were found within the following project areas of Brush Fork, Snow Fork, Lost Run, Dixie Hollow, and Monkey Hollow. All proposed wetland areas would be avoided for the FWPC. The wetlands identified in Table 6-1 were flagged for avoidance purposes. The Snow Fork (Spencer & Orbiston) wetlands were very high quality wetlands. Treatment is proposed for the water entering and exiting the Snow Fork (Spencer) wetland. The Snow Fork (Orbiston) wetland is to be enhanced through sediment removal and an additional 7 acres of wetland is proposed to be created through excavation.

Table 6-1 Extent of Jurisdictional Wetlands

Sub-Watershed	Project ID Number	Approximate Wetland Area (acres)
Snow Fork-Brush Fork Area A	SLB2	0.2
Snow Fork-Brush Fork Area B	LLB1	0.2
Snow Fork-Brush Fork Area C	OLC3/LLB3	0.2
Snow Fork-Brush Fork Area D	OLC5/LLB5	0.5
Snow Fork (Spencer)	SLB	3.6
Lost Run	OLCMS1/LLB4E1	0.3
Dixie Hollow	LLB	0.2
Monkey Hollow	OLC10 /LLB10	0.2
Snow Fork (Orbiston)	Snow Fork	4.0

Wetland Avoidance Areas

The wetland areas identified in the areas listed below were found to be of exceptional quality. Due to the high quality, the team adjusted the project construction area to avoid those areas.

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Coe Hollow	LLBA	Emergent Wetland located to the south-Should be monitored to determine if soils develop after construction of recommended alternative.
Lost Run	LLB1W1	Wetland located to the north
Snake Hollow	LLB7	Wetland located to the north

Wetland areas would be constructed in Rock Run, Coe Hollow and along Snow Fork. Thirty three acres of wetland would be created are listed below in Table 6-2.

Table 6-2 Wetlands Created

Rock Run	26.3 acres
Coe Hollow	0.02 acres
Snow Fork	7 acres
Total Wetland Acres Created	33.32 acres

6.9 Aquatic Life and Wildlife

6.9.1 Aquatic Life

6.9.1.1 FWOPC (No Action)

Conditions would remain the same as existing conditions with only slight improvement due to activities by other state and local agencies in the watershed. The watershed would continue to have limited species diversity and population quantity. Pollution tolerant aquatic species of fish and macroinvertebrate populations would remain dominant in the ecosystem. Pockets of relatively diverse species would remain and would be disconnected from the rest of the ecosystem and specifically the Hocking River.

6.9.1.1 FWPC Alternative Combination Plan 6

The proposed action will have long-term, direct and beneficial impacts to aquatic life and their habitat by reducing approximately 90 percent of the acidity entering surface waters. Significant reductions in sedimentation will also occur. Seeps will be captured, treated, and returned to the stream channel. Fish and other aquatic life diversity, abundance, and mobility will be substantially improved to restore the watershed.

Fish and macroinvertebrate species in the watershed would shift from pollution tolerant species to more sensitive species. Diversity and species numbers would significantly improve for both fish and macroinvertebrate populations. Macroinvertebrate colonization would occur with one to two seasons in areas where populations are currently limited. Fish and other aquatic organisms would return quickly.

6.9.2 Wildlife

6.9.2.1 FWOPC (No Action)

Wildlife resources would remain the same with little improvement to those species that require food sources from the aquatic system since that system would remain unchanged from existing conditions.

6.9.2.2 FWPC Alternative Combination Plan 6

Wildlife resource populations would improve for those species which are dependent on aquatic resources as food sources. Construction activities would not have any impact on wildlife resources.

6.10 Threatened and Endangered Species

6.10.1 FWOPC (No Action)

The USFWS provided a list of potential species which are federally listed as endangered and threatened pursuant to the Endangered Species Act (ESA) and that have part of their range within or near the Monday Creek Watershed and the Athens Unit of the WNF. The species and their status are listed in Section 3.10.

Wildlife habitat is of good quality in most areas of the watershed except where impacted by mining operations, residential areas, and roads. Activities outlined in the WNF 5-Year Forest Plan would occur, however, any impacts to endangered species would be addressed by the WNF. Otherwise, conditions would not be expected to change.

6.10.2 FWPC Alternative Plan Combination 6

The FWPC would not affect the endangered species found in the WNF. The following measures were included as “Reasonable and Prudent Measures” in the Biological Opinion for the Wayne National Forest in 2001. Some of these measures may be applicable for management of adjacent areas to favor several species of bats, including the Indiana bat, as well as other species of wildlife. On portions of the Monday Creek Watershed managed by the U.S. Forest Service, these measures will be followed. Measures for the “Terms and Conditions” which the Wayne National Forest must follow to be exempt from the prohibitions of Section 9 of the Endangered Species Act, as amended, will also be incorporated. This information, in addition to continued consultation with the U. S. Fish and Wildlife Service, would be incorporated to the project when providing access during construction and operation of treatment measures, and during restoration of the impacted and surrounding areas.

FEDERALLY LISTED VERTEBRATE/INVERTEBRATE SPECIES

Three vertebrate and invertebrate species were identified as having a range near or within the Monday Creek Watershed. These species include Indiana Bat (*Myotis sodalis*), American Burying Beetle (*Nicrophorus americanus*), and Bald Eagle

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(*Haliaeetus leucocephalus*). Reasonable and prudent measures along with terms and conditions for each species are discussed below.

INDIANA BAT (*Myotis sodalis*)

Reasonable and Prudent Measures

The USFWS believes the following reasonable and prudent measures are necessary and appropriate to minimize impacts upon Indiana bats. The terms and conditions listed are specific actions on how the reasonable and prudent measures must be met.

1. Maintain adequate canopy cover in hardwood stands (depending on the size of the stands) to provide Indiana bat foraging habitat.
2. Provide roosting habitat by preserving shagbark hickory (*Carya ovata*) and shellbark hickory (*Carya laciniosa*) trees.
3. No snag removal (snags with a diameter breast height of 8 inches), except where they pose an imminent threat to human safety.
4. Maintain a component of large, over-mature trees, in hardwood stands, when possible. These trees will ensure a continuous supply of large roost trees for the bat.
5. Tree removal activity will be closely monitored and reported on a project-by-project basis to ensure that impacts of incidental take associated with future proposed projects are appropriately minimized.
6. Protect all known Indiana bat hibernacula on the WNF.

Terms and Conditions

In order to be exempt from the prohibitions of Section 9 of the ESA, the WNF must comply with the following terms and conditions, which implement the reasonable and prudent measures, described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

1. When conducting hardwood timber harvests and completing timber stand improvements (TSI) within hardwood stands, maintain at least 60 percent canopy cover whenever possible.
2. Shagbark hickory or shellbark hickory trees shall not be cut during TSI activities, unless the density of trees of these 2 species, combined, exceeds 16 trees/acre. If present, at least 16 live shagbark and shellbark hickory (combined) greater than 11 inches diameter breast height (dbh) must be maintained per acre.

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3. Snags that are potential Indiana bat habitat shall not be removed for TSI purposes. Firewood cutting permits should clearly state that standing dead trees may not be taken.

4. To maintain a component of large, over-mature trees, at least 3 live trees per acre > 20 inches dbh should be maintained in the stand. The 3 trees should be any of the preferred species listed below or a combination of the species listed below. (A tree with < 10 percent live canopy should be considered a snag and would not count towards the 3 trees to be left). These must be among the largest trees of these species remaining in the stand. An additional 6 live trees per acre > 11 inches dbh (of the species listed below) must also be maintained. (The "per acre" requirement can be expressed as the average per acre on a stand-wide basis, depending on the definition of a stand).

shagbark hickory (*Carya ovata*)
shellbark hickory (*Carya laciniosa*)
bitternut hickory (*Carya cordiformis*)
silver maple (*Acer saccharinum*)
green ash (*Fraxinus pennsylvanica*)
white ash (*Fraxinus americana*)
eastern cottonwood (*Populus deltoides*)
northern red oak (*Quercus rubra*)
post oak (*Quercus stallata*)
white oak (*Quercus alba*)
slippery elm (*Ulmus rubra*)
American elm (*Ulmus americana*)
black locust (*Robinia pseudoacacia*)

(This list is based on review of literature and data on Indiana bat roosting requirements. The possibility exists of adding other species as identified)

If there are no trees > 20 inches dbh to leave standing, 16 live trees per acre must be left, and these must include the largest specimens of the preferred species remaining in the stand.

5. During non-hibernation season, WNF will retain all shagbark and shellbark hickory trees over 6 inches dbh and all live trees, of any species, over 6 inches dbh that are hollow, have major splits, or have broken tops, unless they are a safety hazard. Additionally, the WNF will retain a minimum of 12 live trees per acre over 6 inches dbh, of any species, with large areas of loose bark, unless they are a safety hazard. Harvesting of shagbark and shellbark hickory is allowed on the forest during the Indiana bat hibernating season (after September 15 and before April 15) except as might be restricted by the preceding terms and conditions (#2 and #4).

The following conservation recommendations for the Indiana bat are also taken from the USFWS 2001 Biological Opinion on the Wayne National Forest's Biological Assessment of its activities on Federally listed species. Some of these recommendations may be appropriate, however, consultation with the USFWS will continue throughout design and construction.

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Conservation Recommendations

Section 7(a) (1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

AMERICAN BURYING BEETLE (*Nicrophorus americanus*)

The USFWS has determined that no incidental take for this species is anticipated, therefore, no reasonable and prudent measures or terms and conditions are necessary and appropriate to minimize incidental take of American burying beetles on the WNF. However, the Corps will contact Ms. Carolyn Caldwell of ODNR, Division of Wildlife at (614) 265-6329 for information concerning known locations of the American burying beetle.

BALD EAGLE (*Haliaeetus leucocephalus*) - Hocking County only

If any nests are located within ½ mile of the project site, further coordination with this office is necessary. If the nest is active, the USFWS recommends that work at the site be restricted from mid-January through July to allow pre-nesting activities, incubation, and raising of the young.

TIMBER RATTLESNAKE (*Crotalus horridus horridus*)

The projects in Athens and Hocking Counties lie within the range of the timber rattlesnake (*Crotalus horridus horridus*). No Federal listing status has been assigned to this species.

In Ohio, the timber rattlesnake is restricted to the un-glaciated Allegheny Plateau and utilizes the specific habitat types depending upon the season. Thus, protection of the winter dens is critical to the survival of this species. Some project management ideas include the following:

- 1) At a minimum, project evaluations should contain delineations of timber rattlesnake habitat within project boundaries. Descriptions should indicate the quality and quantity of timber rattlesnake habitat (den sites, basking sites, foraging areas, etc.) that may be affected by the project.
- 2) In cases where timber rattlesnakes are known to occur or where potential habitat is rated moderate to high, timber rattlesnake surveys may be necessary. If surveys are conducted, it may be helpful to inquire with local resource agency personnel who may know of timber rattlesnake sightings or from reliable local residents. In addition, local herpetologists may have knowledge of historical populations, as well as precise knowledge of the habits and especially the specific, local types of habitats that may contain timber rattlesnakes. Surveys

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should be performed during the periods of spring emergence from dens (usually a narrow window in April or May) and throughout the active season until October. The species is often easiest to locate during the summer months when pregnant females seek out open areas in early morning, especially after cool evenings.

3) In portions of projects where timber rattlesnakes will be affected, clearing and construction activities should occur at distances greater than 100 feet from known dens. Most importantly, tops of ridges and areas of exposed rock should be avoided.

4) In areas where timber rattlesnake dens are known, or likely to exist, maintenance activities (mowing, cutting, burning, etc.) should be conducted from November 1 to March 1, when timber rattlesnakes are hibernating.

In addition, if a Timber rattlesnake is encountered during construction, work will immediately stop and the Ohio Division of Wildlife will be contacted at the following number (614) 265-6344.

FEDERALLY LISTED PLANT SPECIES

NORTHERN MONKSHOOD (*Aconitum noveboracense*) - Hocking County only

This project lies within the range of the Federally listed threatened northern monkshood (*Aconitum noveboracense*). The USFWS recommends that the project location be examined to determine if suitable habitat for the monkshood is present. If suitable habitat is found, surveys may be necessary to determine if the plant is present.

SMALL WHORLED POGONIA (*Isotria medeoloides*) - Hocking County only

The project lies within the range of the small whorled pogonia (*Isotria medeoloides*), a Federally listed threatened species. The USFWS recommends that the project area be examined for the small whorled pogonia to determine if suitable habitat for this plant species is present. If suitable habitat is found, surveys may be necessary to determine if the plant is present.

6.11 Historic and Archaeological Resources

6.11.1 FWOPC (No Action)

No impacts are anticipated on historical and archaeological resources under the FWOPC.

6.11.2 FWPC Alternative Plan Combination 6

Implementation of the FWPC would not have an effect on historical and archaeological resources. Based on literature reviews and field investigations, it is

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expected that the proposed project will not impact any archeological or historic resources.

6.12 Hazardous, Toxic and Radiological Wastes

6.12.1 FWOPC (No Action)

Under FWOPC conditions would remain the same as identified in existing conditions and no impact is anticipated.

6.12.2 FWPC Alternative Plan Combination 6

There would not be any impact to HTRW resources in the project areas. The only potential sites that are located near the project areas include crude oil tanks, feeder lines, wells and other associated facilities. These facilities will be avoided by the construction activities.

6.13 Socio-Economics

6.13.1 FWOPC (No Action)

The FWOPC would not change the economic conditions throughout the project area.

6.13.2 FWPC Alternative Plan Combination 6

The project will not directly or indirectly affect population trends and no impacts are anticipated. Also, the proposed project is not expected to alter employment or economic development at the project area. The proposed actions may produce minor and temporary increases in employment during construction and perhaps a slight increase in use of temporary lodging and general services. If equipment operators do not live locally they will likely spend money in the area on food and lodging near the project sites.

6.14 Recreation

6.14.1 FWOPC (No Action)

Recreation within the WNF and other areas of the watershed would not negatively or positively impacted by the FWOPC.

6.14.2 FWPC Alternative Plan Combination 6

The FWPC would not significantly increase recreational use of the WNF and surrounding areas; however, the quality of recreational experience may be improved.

6.15 Cumulative Effects

Evidence is increasing that the most significant environmental effects may not result from the direct effects of a particular action, but from the combination of individually minor effects of multiple actions over time (CEQ 1997). The Council on Environmental Quality (CEQ) regulations implementing the procedural provisions of the National Environmental Policy Act (NEPA) define cumulative effects as “the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such actions” (40 CFR 1508.7). The regulations further explain “cumulative effects can result from individually minor but collectively significant actions taking place over a period of time.”

6.15.1 Past, Present, and Future

To incorporate the principles of cumulative effect analysis into an environmental impact assessment of an action, the team addressed the following:

- Past, present, and future actions, as well as
- Federal, non-Federal, and private actions, that could foreseeably create impacts that could in some way add to, interact, magnify, or reduce, the impacts on the specific action under consideration

Methodology

The primary resources that are likely to have cumulative effects from other reasonably foreseeable future projects are water and ecological resources within the watershed. The cumulative effects to water resources occur primarily during rain events, when hydrologic conditions are altered by activities within the watershed. The water resource effects are based on an increase of disturbances within the watershed and floodplain of the Monday Creek and its tributaries. The cumulative effects to ecological resources occur both during normal flow and high water events, and are primarily impacts to aquatic habitats. The following reasonably foreseeable actions are considered in the Monday Creek cumulative impacts analysis.

Cumulative environmental effects for the proposed alternatives were assessed in accordance with guidance provided by the President's Council on Environmental Quality (USEPA, EPA 315-R-99-002, May 1999). This guidance provides an eleven-step process for identifying and evaluating cumulative effects in NEPA analyses. These eleven steps are grouped into three general phases: scoping; describing the affected environment; and determining the environmental consequences.

6.15.2 Scoping

In this phase, the cumulative effects issues and assessment goals are established, the spatial and temporal boundaries are determined, and reasonably foreseeable future actions are identified. In the current assessment, the cumulative effects issue is to determine if the sustainability of any of the resources is adversely affected, and the goal is to determine the incremental impact to key resources that would occur should Plan Combination 6 be built.

Looking at the needs of a cumulative impact assessment of this nature requires a determination of the level of data needed to assess the impacts. In most cases, future actions, even those five to ten years in the future, cannot be described in much, if any, detail. Potential actions further in the future, approximately 20 or 30 years from now, can be identified to a less precise degree. Therefore, the study team determined that overall trends would be a far more reasonable approach to the subject.

Geographic Location

The first phase of the determination of past, present and future actions included establishments of geographic bounds. The spatial boundary for the assessment has already been broadened to consider effects beyond the Contractor Work Limits (CWL) of either alternatives in the final array. The Monday Creek Watershed and its bordering watersheds were chosen as the geographic location of this project. As we stated in Chapter 4, AMD impacts cross watershed boundaries by water moving through the abandoned mine workings and actually discharging in other watersheds. Actions which affect surface water flow could impact these other areas.

Temporal Bounds

Given the geographic bounds of the area of study, the temporal bounds, or the timeframe of the actions to be included in the study were determined. Mining activities have occurred in the watershed since the mid 1800s, however, technological advances for AMD restoration does not allow for a project life to extend past 20 to 30 years. Therefore, the future temporal extent of the study was set beyond that time to the year 2025. These bounds were somewhat flexible by necessity, to account for resource-by-resource differences in cumulative impact mechanisms, and also to accommodate the different availabilities of reliable data in different resource areas.

The temporal boundaries considered are:

- Past – mid 1900s because this is the approximate time of significant resource development established in southeast Ohio.
- Present – 2005 when the decision on a specific aquatic ecosystem and AMD restoration techniques was made
- Future – 2030, the year used for demonstrating the life expectancy of the project of approximately 20 years, after construction is complete (calendar year 2010).

6.15.3 Reasonable Foreseeable Actions

Projecting the reasonably foreseeable future action is difficult. Clearly, the proposed action is reasonably foreseeable. However, the actions by others that may affect the same resources are not as clear. Resources that may be affected by either of the two alternatives include encroachment on the riparian corridor, the 100-year floodplain, and Monday Creek; development pressures on terrestrial and aquatic environments, and potential archeological impacts. Projections of those actions must rely on judgments as to what is reasonable based on existing trends and, where available, projections from qualified sources. Reasonably foreseeable does not include unfounded or speculative projections. In this case, reasonably foreseeable future actions include:

- Logging on property within the watershed and adjacent properties
- Possible surface mining
- Continued National Forest Service purchase of property
- Other AMD restoration activities by other parties
- Increases in recreational activities that include hiking, biking, off road vehicles, horseback riding, hunting, etc.
- Natural gas/oil production
- Prescribed burning activities

Table 6-2 displays the both positive and negative effects of reasonably foreseeable future actions within the watershed.

6.15.4 Cumulative Effects Analysis

Future actions that may occur within the watershed and surrounding areas have both negative and positive effects on the resources. Analysis of the effects indicates that activities caused by man and includes mineral resource extraction, such as coal and natural gas have negative effects on the resources. Logging also has a negative effect. These impacts, when analyzed individually would not appear to affect the resources. However, over the life of the project (20 years), these activities would cause additional pressure on the already degraded aquatic ecosystem. Positive future actions include the WNF purchase of property to add to the existing property. AMD restoration activities have overall positive effects to the resources. Table 6-2 does not appear to indicate that these activities will contribute to significant negative cumulative effects on the resources in the Monday Creek Watershed.

Figure 6-2 Affected Resources and Foreseeable Future Actions
Direct/Indirect Effects Key: (+) Positive; (-) Negative; (Blank) No effect/Neutral

Foreseeable Future Actions	Land Use	Geography/ Topography	Soils and Farmland	Air Quality	Noise	Vegetation	Water Resources and Quality	Wetlands	Aquatic Life	Wildlife	T & E Species	Historical and Archaeologica I Resources	HTRW	Socio- Economics	Recreation
Logging	-		-			+ -	-	-	-	+ -	-	-		+	
Prescribed Burning			+ -	-		+ -		+ -		+ -	+ -	-			
Property Purchase by WNF	+					+	+	+	+	+	+	+			+
Natural Gas Exploration	-	-	-			-	-	-	-	-	-	-		-	
Future Mining Activities	-	-	-	-	-	-	-	-	-	-	-	-		+	
Recreation	+		-											+	
Urban Development	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-
AMD Restoration by others	+		+ -			+ -	+	+	+	+	+	-			
Plan Combination 6	+		+ -			+ -	+	+	+	+	+	-			

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Table 6-3
Relationship of Selected Alternatives to Environmental Requirements and
Protection Statutes

Federal Statutes	No-Action	Proposed Action
Archeological and Historic Preservation Act As amended, 16 U.S.C. 469, et seq.	FC	FC
Clean Air Act As amended, 42 U.S.C. 7401, et seq.	FC	FC
Clean Water (Federal Water Pollution Control Act) As amended, 336 U.S.C. 1251, et seq.	FC	FC
Endangered Species Act As amended, 16 U.S.C. 1531, et seq.	FC	PC
Federal Water Project Recreation Act As amended, 16 U.S.C. 406-1 (12), et seq.	FC	FC
Fish and Wildlife Coordination Act As amended, 16 U.S.C.661, et seq.	FC	FC
Land and Water Conservation Fund Act As amended, 16 U.S.C. 4601-4601-11, et seq.	FC	FC
National Environmental Policy Act as amended, 42 U.S.C. 4321, et seq.	FC	FC
National Historic Preservation Act As amended, 16 U.S.C. 470a, et seq.	FC	FC
Rivers and Harbors Act, 33 U.S.C. 401, et seq.	FC	FC
Rivers and Harbors Act, 91 U.S.C. 122, et seq.	FC	FC
Watershed Protection and Flood Prevention Act, 16 U.S.C. 1001, et seq.	FC	FC
Wild and Scenic Rivers Act As amended, 16 U.S.C. 1271, et seq.	NA	NA
Comprehensive Environmental Response, Compensation And Liability Act, 42 U.S.C. 9601, et seq.	FC	FC
Executive Orders, Memoranda, Etc.		
Floodplain Management (E.O. 119888)	FC	FC
Protection of Wetlands (E.O. 11990)	FC	FC
Protection of Children (E.O. 13045)	FC	FC
Environmental Justice (E.O. 12898)	FC	FC
Farmland Protection Policy Act, PL 97-98, 7CFR 658	FC	NA
State, Local & Corps Policies		
Hazardous, Toxic and Radioactive Waste (HTRW) Guidance, ER 1165-2-132	FC	FC

NOTE: FC – Full Compliance
PC – Partial Compliance
NA – Not Applicable

7.0 FINANCIAL ANALYSIS

The Ohio Department of Natural Resources is willing and financially capable to share in the construction, and operation and maintenance of the project according to the terms of the draft Project Cooperation Agreement. A letter of intent from the non-Federal sponsor is included after the "Recommendations" section of this report.

7.1 Local Cooperation and Cost Sharing

In accordance with the Water Resources Development Act of 1996 (WRDA 1996), Construction General ecosystem restoration projects are cost shared 65 percent Federal and 35 percent non-Federal. Included in the 35 percent non-Federal cost is all lands, easements, rights of way, relocations, and dredged material disposal areas (LERRD's). No minimum cash requirement from the non-Federal cost sharing partner is required. However, if the LERRD's do not equal 35 percent of the total project costs, the non-Federal cost sharing partner is required to pay an amount in cash that will bring the non-Federal contributions to 35 percent of the total project costs. Upon completion of construction, the non-Federal cost sharing partner assumes 100 percent of the costs associated with operation and maintenance, repair, replacement, and rehabilitation (OMRR&R) of the project.

Cultural resources mitigation costs are a 100 percent Federal cost up to an amount equal to one percent of the total project cost. If cultural resources mitigation costs are estimated to exceed one percent of the total project cost, that amount above one percent of total project costs must be approved by Congress and is cost shared with the non-Federal cost sharing partner at the rate of the remainder of the project (35 percent non-Federal).

The non-Federal local cooperation requirements are further outlined as follows:

(1) Provide 35 percent of the separable project costs allocated to environmental restoration as further specified below:

(a) Enter into an agreement which provides, prior to execution of a project cooperation agreement, 25 percent of project design costs;

(b) Provide, during construction, any additional funds needed to cover the non-federal share of project design costs;

(c) Provide all lands, easements, and rights-of-way, including suitable borrow and dredged or excavated material disposal areas, and perform or assure the performance of all relocations determined by the Government to be necessary for the construction, operation, and maintenance of the project;

(d) Provide or pay to the Government the cost of providing all retaining dikes, wasteweirs, bulkheads, and embankments, including all monitoring features and stilling basins, that may be required at any dredged or

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excavated material disposal areas required for the construction, operation, and maintenance of the project; and

(e) Provide, during construction, any additional funds as necessary to make its total contribution equal to 35 percent of the separable project costs allocated to environmental restoration.

(2) For so long as the project remains authorized, operate, maintain, repair, replace, and rehabilitate the completed project, or functional portion of the project, at no cost to the Government, in accordance with applicable Federal and State laws and any specific directions prescribed by the Government.

(3) Give the Government a right to enter, at reasonable times and in a reasonable manner, upon land which the local sponsor owns or controls for access to the project for the purpose of inspection, and, if necessary, for the purpose of completing, operating, maintaining, repairing, replacing, or rehabilitating the project.

(4) Assume responsibility for operating, maintaining, replacing, repairing, and rehabilitating (OMRR&R) the project or completed functional portions of the project, including mitigation features without cost to the Government, in a manner compatible with the project's authorized purpose and in accordance with applicable Federal and State laws and specific directions prescribed by the Government in the OMRR&R manual and any subsequent amendments thereto.

(5) Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended, and Section 103 of the Water Resources Development Act of 1986, Public Law 99-662, as amended, which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until the non-Federal sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element.

(6) Hold and save the Government free from all damages arising from the construction or operation and maintenance of the Project and any Project-related betterments, except for damages due to the fault or negligence of the Government or the Government's contractors. The phrase "operations and maintenance" includes repair, replacement and rehabilitation.

(7) Keep and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project to the extent and in such detail as will properly reflect total project costs.

(8) Perform, or cause to be performed, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. 9601-9675, that may exist in, on, or under lands, easements or rights-of-way necessary for the construction, operation, and maintenance of the project; except that the non-Federal sponsor shall not perform such investigations on lands, easements,

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or rights-of-way that the Government determines to be subject to the navigation servitude without prior specific written direction by the Government.

(9) Assume complete financial responsibility for all necessary cleanup and response costs of any CERCLA regulated materials located in, on, or under lands, easements, or rights-of-way that the Government determines necessary for the construction, operation, or maintenance of the project.

(10) To the maximum extent practicable, operate, maintain, repair, replace, and rehabilitate the project in a manner that will not cause liability to arise under CERCLA.

(11) Prevent future encroachments on project lands, easements, and rights-of-way which might interfere with the proper functioning of the project.

(12) Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public law 91-646, as amended by title IV of the Surface Transportation and Uniform Relocation Assistance Act of 1987 (Public Law 100-17), and the Uniform Regulations contained in 49 CFR part 24, in acquiring lands, easements, and rights-of-way, and performing relocations for construction, operation, and maintenance of the project, and inform all affected persons of applicable benefits, policies, and procedures in connection with said act.

(13) Comply with all applicable Federal and State laws and regulations, including Section 601 of the Civil Rights Act of 1964, Public Law 88-352, and Department of Defense Directive 5500.11 issued pursuant thereto, as well as Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army".

(14) Provide 50 percent of that portion of total cultural resource preservation mitigation and data recovery costs attributable to environmental restoration that are in excess of one percent of the total amount authorized to be appropriated for environmental restoration.

(15) Do not use Federal funds to meet the non-Federal sponsor's share of total project costs unless the Federal granting agency verifies in writing that the expenditure of such funds is authorized.

Nothing herein shall constitute, or be deemed to constitute, an obligation of future appropriations by the General Assembly of the State of Ohio when such obligation would be inconsistent with the State's constitutional or statutory limitations.

7.2 Cost Apportionment

A summary of fully funded non-Federal and Federal costs, by year, is presented in Table 7-1. This table presents the cost summary for full implementation of the recommended plan based on fully funding requirements assuming construction to occur over a four (4) period from 2007 through 2010. Non-Federal costs are estimated to be \$6,753,811, including prior studies, planning, engineering and design (PED), engineering during construction, and for lands, easements, rights of way, relocations, and dredged material disposal areas (LERRDDs). Federal costs are estimated to be \$11,983,461 which is for prior studies, PED and construction costs. The non-Federal cost sharing partner (ODNR) will be required to assume the total annual operation, maintenance, repair, replacement, and rehabilitation costs (estimated at \$ 320,000) for all features.

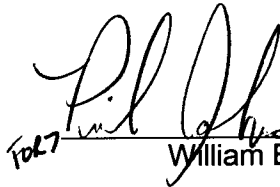
Implementation of this project is currently estimated to be completed in three phases, phase one in FY 2008, phase two in FY 2009, and phase three in FY 2010. Tables 7-1 shows the associated cost sharing taking into account the phased implementation. The first phase consists of the clearing and grubbing of phase one construction sites so as to avoid cutting trees during the roosting season of the Federally endangered *Myotis sodalists* (Indiana Bat).

Table 7-1. Fully Funded Cost Share Summary

		Cost Share 50/50	Cost Share 65/35, Federal/Non-Federal											Fully Funded Total
		Prior Expenditures	FY06	FY07	FY08	FY09	FY10	FY11	FY12	FY13	FY14	FY15		
Phase I (North)														
Total		\$435,033	\$665,589	\$731,674	\$7,799,467	\$59,712	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$9,691,475
Federal		\$217,517	\$432,633	\$475,588	\$5,069,654	\$38,813	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$6,234,205
Non-Federal		\$217,517	\$232,956	\$256,086	\$2,729,813	\$20,899	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$3,457,271
Phase II (East)														
Total		\$435,033	\$64,821	\$21,014	\$512,253	\$4,885,877	\$35,739	\$0	\$0	\$0	\$0	\$0	\$0	\$5,954,737
Federal		\$217,517	\$42,134	\$13,659	\$332,964	\$3,175,820	\$23,230	\$0	\$0	\$0	\$0	\$0	\$0	\$3,805,324
Non-Federal		\$217,517	\$22,687	\$7,355	\$179,289	\$1,710,057	\$12,509	\$0	\$0	\$0	\$0	\$0	\$0	\$2,149,414
Phase III (South)														
Total		\$435,033	\$27,074	\$20,807	\$0	\$211,971	\$2,088,985	\$15,295	\$0	\$0	\$0	\$0	\$0	\$2,799,165
Federal		\$217,517	\$17,598	\$13,525	\$0	\$137,781	\$1,357,840	\$9,942	\$0	\$0	\$0	\$0	\$0	\$1,754,203
Non-Federal		\$217,517	\$9,476	\$7,282	\$0	\$74,190	\$731,145	\$5,353	\$0	\$0	\$0	\$0	\$0	\$1,044,963
Stream Monitorin														
Total		\$0	\$0	\$12,903	\$66,099	\$13,537	\$27,731	\$39,779	\$40,734	\$41,723	\$27,480	\$0	\$0	\$269,986
Federal		\$0	\$0	\$8,387	\$42,964	\$8,799	\$18,025	\$25,856	\$26,477	\$27,120	\$17,862	\$0	\$0	\$175,490
Non-Federal		\$0	\$0	\$4,516	\$23,135	\$4,738	\$9,706	\$13,923	\$14,257	\$14,603	\$9,618	\$0	\$0	\$94,496
RE Office Buildin														
Total		\$0	\$0	\$0	\$5,315	\$5,422	\$5,528	\$5,641	\$0	\$0	\$0	\$0	\$0	\$21,906
Federal		\$0	\$0	\$0	\$3,455	\$3,524	\$3,593	\$3,667	\$0	\$0	\$0	\$0	\$0	\$14,239
Non-Federal		\$0	\$0	\$0	\$1,860	\$1,898	\$1,935	\$1,974	\$0	\$0	\$0	\$0	\$0	\$7,667
Fully Funded Summary														
YEAR TOTAL		\$1,305,099	\$757,484	\$786,398	\$8,383,134	\$5,176,519	\$2,157,983	\$60,715	\$40,734	\$41,723	\$27,480	\$0	\$0	\$0
Federal Yearly		\$652,551	\$492,365	\$511,159	\$5,449,037	\$3,364,737	\$1,402,688	\$39,465	\$26,477	\$27,120	\$17,862	\$0	\$0	\$0
Non-Federal Yearly		\$652,551	\$265,119	\$275,239	\$2,934,097	\$1,811,782	\$755,295	\$21,250	\$14,257	\$14,603	\$9,618	\$0	\$0	\$0
CUMULATIVE TOTAL		\$1,305,099	\$2,062,583	\$2,848,981	\$11,232,115	\$16,408,634	\$18,566,617	\$18,627,332	\$18,668,066	\$18,709,789	\$18,737,269	\$18,737,269	\$18,737,269	\$18,737,269
Federal Cumulative		\$652,551	\$1,144,916	\$1,656,075	\$7,105,112	\$10,469,849	\$11,872,537	\$11,912,002	\$11,938,479	\$11,965,599	\$11,983,461	\$11,983,461	\$11,983,461	\$11,983,461
Non-Federal Cumulative		\$652,551	\$917,670	\$1,192,909	\$4,127,006	\$5,938,788	\$6,694,083	\$6,715,333	\$6,729,590	\$6,744,193	\$6,753,811	\$6,753,811	\$6,753,811	\$6,753,811
												TOTAL PROJECT COST	\$18,737,000	
												PRIOR EXPENDITURES	-\$1,305,000	
												FY05 THRU FY15 TOTAL COST TO COMPLETE	\$17,432,000	
*OMB Factors are for Base Year FY05 (PL Oct-2004)														
**Prior Expenditures are not included in the Total Cost to Complete.														
21.- Reconnaissance Study - \$135,000 22.- Feasibility Study - \$1,170,100														

8.0 Conclusions

This Feasibility Report is a summary of the results of the study performed by the Huntington District, U.S. Army Corps of Engineers for the Monday Creek Watershed Restoration Project. The documentation in the report includes data, analyses, and engineering designs produced by the multi-disciplinary study team to address the problems and opportunities identified in the Monday Creek study area. The studies and evaluations were performed in coordination with the sponsor and other State and Federal agencies in accord with current guidance for environmental restoration projects.


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BIBLIOGRAPHY

- Barbour, M.T., J. Gerritsen, B.D. Snyder, J.B. Stribling. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish. Second Edition. EPA 841-B-99-002.
- Boyer, A.L. Biological Opinion on the Land and Resource Management Plan Wayne National Forest, Ohio. Reynoldsburg, Ohio: U.S. Fish and Wildlife Service, 2001.
- Brown, D.J.A. and K. Sadler, 1989. Fish survival in acid waters. In: Acid Toxicity and Aquatic Animals. Society for Experimental Biology Seminar Series: 34, (Morris, R. et al., eds.), Cambridge University Press, pp. 31-44.
- Digest of Water Resources Policies and Authorities. Washington D.C.: Department of the Army, U.S. Army Corps of Engineers. 1999.
- Ecosystem Restoration – Supporting Policy Information. Washington D.C.: Department of the Army, U.S. Army Corps of Engineers. 1999.
- Environmental Assessment Big Four Hollow Restoration. Nelsonville, Ohio: USDA Forest Service Wayne National Forest, 2003.
- Environmental Assessment Forest Plan Amendment for Threatened and Endangered Species. Nelsonville, OH: USDA Forest Service Wayne National Forest, 2003.
- Hoehn, R.C. and D.R. Sizemore, 1977. Acid mine drainage (AMD) and its impact on a small Virginia stream. Water Res. Bull. V. 13, pp. 153-160.
- Kimmel, W.G., 1983. The impact of acid mine drainage on the stream ecosystem. In: Pennsylvania Coal: Resources, Technology and Utilization, (S. K. Majumdar and W. W. Miller, eds.), The Pa. Acad. Sci. Publ., pp. 424-437.
- Morris, R., E.W. Taylor, D.J.A. Brown and J.A. Brown, 1989. Acid toxicity and aquatic animals. Society for Experimental Biology Seminar Series, v. 34, Cambridge University Press, 282 p.
- Planning Guidance Notebook. Washington D.C.: Department of the Army, U.S. Army Corps of Engineers. 2000.
- Rosemond, A.D., S.R. Reice, J.W. Elwood and P.J. Mulholland, 1992. The effects of stream acidity on benthic invertebrate communities in the south-eastern United States. Freshwater Ecol., v. 27, pp. 193-209.
- Wayne National Forest Snake Hollow Watershed Restoration Project Environmental Assessment. Fredonia, New York: Northern Ecological Associates, Inc., 2003.

APPENDIX A

WETLAND INFORMATION

INTRODUCTION

A routine delineation of waters of the United States, including wetlands has been conducted and a report prepared by the North Regulatory Section for the Monday Creek Restoration Project which encompasses approximately 116 square miles (74,240 acres) throughout portions of Athens County, Hocking County and Perry County, Ohio.

The Monday Creek Restoration Project will involve construction of 178 projects throughout 14 sub-watersheds within the Monday Creek Watershed. The sub-watersheds where projects are proposed are Jobs Hollow, Dixie Hollow, Rock Run, Lost Run, Monkey Hollow, Snake Hollow, Coe Hollow, Salem Hollow, Sycamore Hollow, Spencer Hollow, Brush Fork, Long Hollow, Whitmore Cemetery and Snow Fork near Orbiston. Environmental restoration projects planned for these areas include filling mining subsidences, plugging stream captures, creating wetlands, constructing low head dams, installing a lime kiln doser and constructing limestone leach beds, slag leach beds and open limestone channels.

Potential wetlands located on non-agricultural lands are identified using the 1987 Wetland Delineation Manual (Environmental Laboratory, 1987) for confirmation by the U.S. Army Corps of Engineers (COE). Impacts to waters of the United States are regulated by the COE and the United States Environmental Protection Agency (USEPA) through Section 404 of the Clean Water Act (33 U.S.C. 1344). In addition, prior to federal authorization for impacts to waters of the United States, certification must first be obtained from the State as defined in Section 401 of the Clean Water Act (33 U.S.C. 1341).

A review of public information and a field investigation were conducted for the property. The results of the review and location and extent of potential jurisdictional waters are summarized in the following report.

SITE DESCRIPTION

As shown on Figure 1, the subject property is located in the unglaciated portion of the Allegheny Plateau region of Athens, Hocking and Perry Counties in southeastern Ohio.

INVESTIGATIVE METHODOLOGY

According to the Federal Register (1980;1982), wetlands are defined as *Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances of support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.* Under normal site conditions, all three indicators of jurisdictional wetlands including the presence of hydrophytic macrophytes, hydric soils and certain hydrologic indicators must be identified to meet the criteria for a jurisdictional wetland (Environmental Laboratory, 1987).

Field investigations were conducted June 2004 to determine the location and extent of waters of the United States. Areas identified as potential waters and areas that exhibited all three indicators of potential jurisdictional wetlands were noted. Identification of potential jurisdictional wetlands required characterization of plant community types and identification of hydric soils and hydrologic indicators for each community type.

For all potential wetland areas, dominant species in the tree, sapling, shrub, woody vine and herbaceous layers were determined for all jurisdictional areas in accordance with the 1987 Wetland Delineation Manual. Recorded vegetative data consisted of herbs with the greatest percentage of aerial cover within 5' of the plot center. Within a 30' radius of the plot center, saplings and shrubs with the greatest height, trees with the largest relative basal area and woody vines with the greatest number of stems were recorded. Species within each of these layers were listed on data forms in order of dominance.

Dominance was determined for each stratum individually and dominant species included those that consisted of 50 percent of the total dominance measure for a stratum, plus any additional species comprising 20 percent or more of the total dominance measure of a stratum. Hydrophytic vegetation was determined to be present when more than 50 percent of the dominants in a sample area were listed as facultative (FAC), facultative wetland (FACW) or obligate wetland (OBL) plants according to Reed (1988).

Soil data were collected using a 1" diameter soil sampling probe to a depth of 30" (where possible) to determine the soil series or phase. Soil matrix and mottle colors were identified using a Munsell Soil Color Chart (Macbeth, Revised 1992). Evidence of any other hydric soil characteristics and evidence of the presence of wetland hydrology were also recorded.

The boundaries of areas in which all three wetland criteria were met were identified and measured in the field. Points at which dominant vegetation species changed from wetland to upland, where soils changed from hydric to non-hydric, or where indicators of wetland hydrology were no longer observed were noted. The characteristics of each community type were recorded on dataforms and sample points were chosen to represent both an identified potential wetland and its surrounding upland community.

DELINEATION INVESTIGATION RESULTS

The location and extent of jurisdictional wetlands identified during the field investigation are shown on Figure . The locations of sample points are also shown on Figure . Table 1 shows the extent of jurisdictional waters.

TABLE 1
Extent of Jurisdictional Wetlands

Sub-Watershed	Treatment Number	Approximate Wetland Area (acres)
Brush Fork Area A	SLB2	0.2
Brush Fork Area B	LLB1	0.2
Brush Fork Area C	OLC3/LLB3	0.2
Brush Fork Area D	OLC5/LLB5	0.5
Spencer	SLB	3.6
Lost	OLCMS1/LLB4E1	0.3
Dixie	LLB	0.2
Snake	LLB6/LLB10	0.2
Orbiston	Snow Fork	4.0

WETLAND DESCRIPTIONS

The dominant vegetation within the wetland areas and hydric soil and wetland hydrologic indicators found within the areas are described below based on data forms located in Appendix . Corresponding upland sample points are also located on data forms in Appendix . Photographs of the wetlands are included in the Exhibits.

Brush Fork - Area A

Area A consisted of an herbaceous wetland (Exhibit 1) dominated by *Salix nigra* (black willow) and *Populus deltoides* (cottonwood) in the tree layer. The herbaceous layer was dominated by *Scirpus cyperinus* (wool-grass), *Typha latifolia* (broad-leaf cattail) and *Juncus effusus* (soft rush). Soils were identified as hydric, poorly drained Melvin silt loam. Inundation, saturated soils and oxidized root channels were observed as the primary and secondary indicators of wetland hydrologic conditions.

The upland area surrounding Area A consisted of a scrub-shrub community dominated by *Rubus allegheniensis* (Allegheny blackberry) and *Rosa multiflora* (multiflora rose) in the shrub layer and an *Aster* species in the herbaceous layer. Upland soils were identified as non-hydric, well drained Chargrin silt loam. No indicators of wetland hydrologic conditions were observed.

Brush Fork Area B

Area B consisted of a forested wetland (Exhibit 2) dominated by *Acer negundo* (box elder), *Ulmus rubra* (slippery elm) and *Populus deltoides* (cottonwood) in the tree layer. The herbaceous layer was dominated by *Onoclea sensibilis* (sensitive fern), *Rhus radicans* (poison ivy), *Juncus effusus* and *Aselapias incarnata* (swamp milkweed). Soils were identified as hydric, poorly drained Melvin silt loam. Inundation, saturated soils and oxidized root channels were observed as the primary and secondary indicators of wetland hydrologic conditions.

The upland area surrounding Area B consisted of a scrub-shrub community dominated by *Rosa multiflora* shrub layer *Rhus radicans* and *Panicum cladestum* (deer tongue). Soils were identified as non-hydric, well drained Chargin silt loam. No indicators of wetland hydrologic conditions were observed.

Brush Fork Area C

Area C consisted of a scrub-shrub wetland (Exhibit 3) dominated by *Acer saccharum* (sugar maple) in the tree layer and *Impatiens* species (jewel weed) in the herbaceous layer. Soils were identified as hydric, poorly drained Melvin silt loam. Inundation and saturated soils were observed as the primary indicators of wetland hydrologic conditions.

The upland area surrounding Area C consisted of a forested/scrub-shrub community dominated by *Liriodendron tulipifera* (tulip poplar) and *Aesculus glabra* (Ohio buckeye) in the tree layer and *Rosa multiflora* and *Lindera benzoin* in the shrub layer. Soils were identified as hydric, poorly drained Melvin silt loam. No indicators of wetland hydrologic conditions were observed.

Brush Fork Area D

Area D consisted of an herbaceous wetland dominated by *Acer rubrum* (red maple) in the tree layer and *Onoclea sensibilis* (sensitive fern), *Juncus effusus* and *Typha angustifolia* (narrow-leaf cattail) in the herbaceous layer. Soils were identified as hydric, poorly drained Melvin silt loam. Inundation, saturated soils and oxidized root channels were observed as the primary and secondary indicators of wetland hydrologic conditions.

The upland area surrounding Area D consisted of a scrub-shrub community dominated by *Rosa multiflora* in the shrub layer and *Crysanthemum leucanthemum* (oxeye daisy) in the herbaceous layer. Upland soils were identified as non-hydric, well drained Chargin silt loam. No indicators of wetland hydrologic conditions were observed.

Spencer Hollow

The wetland at Spencer Hollow consisted of forested and herbaceous communities. The forested community (Exhibit 4) was dominated by *Salix nigra* in the tree layer and *Spiraea alba* (white meadowsweet) in the shrub layer. The herbaceous community (Exhibits 5-9) was dominated by *Scirpus cyperinus*, *Carex lupulina* (fox sedge), *Alisma sp.* (water plantain), *Aselapias incarnata* (swamp milkweed), *Typha latifolia*, *Ludwigia alternifolia* (bushy seedbox), *Iris* species, *Phalaris*

arundinacea (reed canary grass), *Onoclea sensibilis*, *Juncus effusus* and *Scirpus validus* (soft-stem bulrush). Soils were identified as hydric, poorly drained Melvin silt loam. Inundation, saturated soils, sediment deposits, drainage patterns and oxidized root channels were observed as the primary and secondary indicators of wetland hydrologic conditions.

The upland area surrounding Spencer Hollow was bound by steep spoil from abandoned mining activities. No indicators of wetland hydrologic conditions were observed.

Lost Hollow

The wetland at Lost Hollow consisted of a forested wetland (Exhibit 10) dominated by *Quercus bicolor* (swamp white oak) and *Carpinus caroliniana* (American hornbeam) in the tree layer and *Lindera benzoin* in the shrub layer. The herbaceous layer was dominated by *Onoclea sensibilis* and *Leersia oryzoides*. Soils were identified as hydric, poorly drained Melvin silt loam. Inundation and saturated soils were observed as the primary indicators of wetland hydrologic conditions.

The upland area surrounding the wetland consisted of a forested community dominated by *Liriodendron tulipifera*, *Fagus grandifolia* (beech) and *Carpinus caroliniana* in the tree layer. The herbaceous layer was dominated by *Parthenocissus quinquefolia* (Virginia creeper), *Rhus radicans* (poison ivy) and *Sphagnum* species. Upland soils were identified as non-hydric, well drained Chargin silt loam. No indicators of wetland hydrologic conditions were observed.

Dixie Hollow

The wetland at Dixie Hollow consisted of a forested wetland (Exhibit 11) dominated by *Salix nigra* and *Platanus occidentalis* (American sycamore) in the tree layer and *Scirpus cyperinus* and *Juncus effusus* in the herbaceous layer. Soils were identified as hydric, poorly drained Melvin silt loam. Inundation and saturated soils were observed as the primary indicators of wetland hydrologic conditions.

The upland area surrounding the wetland consisted of mowed lawn. Upland soils were identified as non-hydric, well drained Chargin silt loam. No indicators of wetland hydrologic conditions were observed.

Snake Hollow

The wetland at Snake Hollow consisted of an herbaceous area (Exhibit 12) dominated by *Glyceria* species (manna grass). Soils were identified as hydric, poorly drained Melvin silt loam. Saturated soils were observed as the primary indicator of wetland hydrologic conditions.

The upland area surrounding the wetland consisted of a forested community dominated by *Fagus grandifolia* and *Carpinus caroliniana* in the tree layer. Upland soils were identified as non-hydric, well drained Chargin silt loam. No indicators of wetland hydrologic conditions were observed.

Orbiston - Snow Fork

The wetland at Snow Fork consisted of an herbaceous wetland (Exhibits 13 & 14) dominated by *Spiraea tomentosa* (steep bush) in the shrub layer. The herbaceous layer was dominated by *Onoclea sensibilis*, *Juncus effusus*, *Microstigium* species, *Carex lupulina*, *Typha latifolia* and *Scirpus cyperinus*. Soils were identified as hydric, poorly drained Melvin silt loam. Inundation, saturated soils and oxidized root channels were observed as the primary and secondary indicators of wetland hydrologic conditions.

The upland area surrounding the wetland consisted of a forested community dominated by *Prunus* species in the tree layer and *Rosa multiflora* and *Rubus allegheniensis* in the shrub layer. The herbaceous layer was dominated by *Panicum cladeustum*. Upland soils were identified as non-hydric, well drained Chargin silt loam. No indicators of wetland hydrologic conditions were observed.

AVOIDANCE AREAS

Areas to avoid during construction that were noted but not flagged:

Coe Hollow	LLBA	Emergent Wetland located south-Should be monitored to see if soils develop after stream restoration See Data Forms & Exhibits (15 & 16)
Lost Hollow	LLB1W1	Wetland located to the north
Snake Hollow	LLB7	Wetland located to the north

All wetland areas are proposed to be avoided. The wetlands identified in Table 1 were flagged for avoidance purposes.

The Spencer & Orbiston wetlands were very high quality wetlands. Treatment is proposed for the water entering and exiting the Spencer wetland. This wetland area should be monitored after restoration. The Orbiston wetland is to be enhanced through sediment removal (Exhibit 17) and an additional 7 acres of wetland is proposed to be created through excavation.

WETLAND HABITAT ASSESSMENT

A wetland rapid assessment method has been developed by the State of Ohio for use in determining wetland quality and the following assessment is based upon that method. The Ohio Rapid Assessment Method (ORAM) seeks to determine whether wetlands are rated as Category 1, 2 or 3 based on the State of Ohio Wetland Water Quality Standards adopted in 1998. Category 1 represents the lowest quality wetland. Category 2 is a moderate quality and Category 3 is the highest quality wetland. The ORAM asks a series of questions regarding wetland functions and characteristics and scores wetlands based on the answers provided. Table 2 represents a scoring breakdown for the wetlands based on the ORAM Version 5.0.

(ORAM scores can not be calculated until the wetlands are surveyed)

CONCLUSIONS

A routine delineation of waters of the United States has been conducted by the North Regulatory Branch for the Monday Creek Restoration Project. Nine wetlands consisting of approximately 9.4 acres were observed on the site.



Exhibit 1



Exhibit 2



Exhibit 3



Exhibit 5



Exhibit 6



Exhibit 7



Exhibit 8



Exhibit 9



Exhibit 10



Exhibit 11



Exhibit 4



Exhibit 12



Exhibit 13



Exhibit 17



Exhibit 14



Exhibit 15



Exhibit 16

APPENDIX B

HTRW SUMMARY

Monday Creek Restoration Project
Hocking River Basin, Ohio
Report of Phase I
Hazardous, Toxic, and Radioactive Waste Investigation
Contract No. DACW69-00-D-0026 Work Order No. 18

EXECUTIVE SUMMARY

The Monday Creek watershed is situated in Athens, Hocking, and Perry counties in Ohio, and is a tributary of the Hocking River, which flows into the Ohio River. The Monday Creek ecosystem has been subjected to acid mine drainage (AMD) for over a century and a half of deep mining and strip mining operations. As a result of AMD, large portions of Monday Creek and its tributaries are dead, with fish and macrovertebrate populations being destroyed in much of the 270 stream miles within the watershed.

The Monday Creek Restoration Project was created in 1994 to address the affects of AMD in the Monday Creek watershed. Since that time an effort has been made to assess the entire watershed and to further identify projects that warrant reclamation. The project is a collaborative partnership of officials and residents of the Monday Creek Watershed, along with more than 20 organizations and state and federal agencies. The goal of the Monday Creek Restoration Project is to sufficiently treat specific discharges to aid in the restoration of both the structural and functional components of the ecosystem of Monday Creek downstream of the discharges. The restoration objective is to restore a portion of Monday Creek to conditions generally consistent with the functioning ecosystem upstream in its headwaters.

The USACE Huntington District is working in partnership with the other organizations in the assessment of the Monday Creek watershed and is currently investigating six (6) study areas (Monday Creek sub-watersheds) under the feasibility study process. These areas include Monkey Hollow, Snake Hollow, Coe Hollow, Jobs Hollow, Lost Run, and Snow Fork sub-watersheds. The Snow Fork sub-watershed includes the areas of Snow Fork, Brush Fork, Long Hollow, and Sycamore Hollow.

It was determined that, prior to completion of the design phase and in accordance with U.S. Army Corps of Engineers Regulation, ER 1165-1-132, 26 June 1992, Water Resources Policies and Authorities, Hazardous, Toxic, Radioactive Waste (HTRW) Guidance for Civil Works Projects, a Phase I HTRW Investigation of the six (6) current study areas is necessary. The purpose of this Phase I HTRW Investigation is to determine the potential for the presence of hazardous and toxic waste materials within the six study areas.

During the current investigation consideration was given to the generally accepted standard practice provided in the ASTM Designation E-1527-00 and ASTM E-1528-00. Also, the policies set forth in the *USACE Huntington District Section 202 HTRW Policy for Nonstructural Programs* were considered. The current investigation, however, deviates from the standard practices for Phase I HTRW Investigations in several ways. These deviations include the method of field reconnaissance, which was performed by means of windshield surveys rather than physically walking the project areas. As a result, the majority of the project areas were not

physically inspected, and many of the potential site conditions investigated in a standard Phase I HTRW Investigation may not have been identified. Additionally, there were no 60 year chain of title searches performed on any of the properties within the project areas.

During the windshield surveys all highways and secondary roads within the project and surrounding areas, including gravel and dirt roads where access was possible, were traveled and surveyed for environmental conditions. In most instances the properties were examined from an automobile, but some properties were surveyed on foot when access was not possible or when potential environmental conditions could not be fully identified from the automobile. In the case of Snake Hollow, access could not be gained to the interior of the property, and therefore only part of the perimeter of the project area and the surrounding areas were physically surveyed.

Federal and state environmental database searches were performed by Environmental Data Resources (EDR) on the project areas. Within the search areas there were a total of 7 mapped sites that were actually located within the project areas. Six of these seven sites are MINES sites, all of which are either abandoned or temporarily closed coal mines. The other site is a leaking underground storage tank (LUST) site, which has received a letter of No Further Action (NFA) from the State of Ohio. All of the other mapped sites that were identified in the searches are located in the surrounding areas of the project properties and are not considered to be a potential concern to the project areas themselves. Additionally, none of the unplotable orphan sites that were identified in the searches are located within the actual project properties, and none of these are considered to be a concern to the project areas.

Freedom of Information Act (FOIA) requests were made to federal and state environmental agencies to obtain public information on environmental conditions within the project areas and surrounding properties. None of the sites identified by these agencies are expected to have an impact on the project properties. Additionally, interviews were conducted with federal, state, and local agencies, as well as with local private businesses, property owners, and residents. Most of the persons interviewed were familiar with the Monday Creek restoration project or familiar with the past and/or current uses of the project properties. Several potential HTRW conditions were identified during these interviews, which included underground storage tank (UST), LUST, dump sites, and various non-HTRW conditions.

Summary of the Findings from this Phase I HTRW Investigation

A total of 70 potential HTRW conditions and 14 non-HTRW conditions (conditions that may interfere with construction/restoration activities but did not exhibit HTRW characteristics) were identified on the project properties during field reconnaissance. The potential HTRW conditions consisted of crude oil production systems (wells, pipelines, aboveground storage tanks (ASTs), etc.); drum storage and other AST sites; and UST/LUST sites. The non-HTRW conditions consisted of miscellaneous debris and rubbish; junk vehicles and equipment; vehicle parts and old tires; occasional drums and containers for household or farm usage; and old appliances and furniture. All site conditions identified during this investigation are shown in Tables 1-7 at the end of this Executive Summary.

There were other potential HTRW and non-HTRW conditions identified by other sources that were not identified during field reconnaissance. These other potential HTRW conditions include

numerous structures identified by the USACE, which consist mostly of crude oil structures. There was also a LUST site identified by the environmental database searches that was not identified during field reconnaissance. The other non-HTRW conditions include numerous structures and rubbish deposits identified by the USACE, a miscellaneous debris and rubbish dump site, and various sewage related problems throughout the project areas.

In addition to the above, other potential HTRW conditions and non-HTRW conditions are likely to exist in the project areas that were not positively identified during field reconnaissance or by other information sources. This is due primarily to the limited nature of the windshield survey method of field reconnaissance. Large portions of the project areas were not physically surveyed because there were no access roads into these areas. Additionally, interview contacts in some instances were aware of potential conditions, but they could not positively identify the locations of these conditions. These potential conditions include the numerous crude oil and natural gas pipelines that exist throughout the project areas, and also a suspected dump site in Jobs Hollow. There is also the potential for other environmental conditions to exist within the old coal mine properties, such as buried tanks and drums, and potential soil and groundwater contamination other than AMD.

Database searches, FOIA requests, and telephone interviews revealed several potential HTRW conditions on properties surrounding the project areas, but none of these are expected to have an affect on the project properties.

Recommendations for Project Areas with Potential HTRW Concerns

It is recommended that areas with known potential HTRW conditions be avoided during restoration/construction activities. If it is determined, however, that these activities are required in areas of potential HTRW conditions, then a standard Phase I HTRW Investigation is recommended in each of these areas. If the information produced during the standard Phase I Investigation shows that contamination is likely to exist that could impact construction activities or workers health and safety, then a Phase II HTRW Investigation may be required.

Where restoration/construction work is to be performed within old coal mine properties, care should be taken by workers to watch for buried tanks and other containers of potential hazardous or petroleum wastes, and also for evidence of soil and groundwater contamination. Additionally, if restoration/construction work is performed in areas where crude oil or natural gas pipelines are likely to exist, the appropriate owners of these lines should be contacted to mark their locations.

Finally, if any potential HTRW conditions are encountered during restoration/construction activities, then work should be stopped and a Phase II HTRW Investigation should be performed to determine the nature and extent of the contamination before work proceeds. If determined necessary by Phase II HTRW Investigations, appropriate remediation procedures should be conducted to mitigate the environmental conditions before proceeding with restoration/construction activities.

APPENDIX C

TOTAL ACID MINE DRAINAGE LOADING MODEL

**Cost Effective Ecosystem Restoration of the
Monday Creek, Ohio Watershed**

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September 15, 2003

Prepared For:

U.S. Army Corps of Engineers, Huntington District

Project Number: WV195

Introduction

The basic goal of this research project was to design a cost effective Acid Mine Drainage (AMD) treatment strategy for the Monday Creek, Ohio watershed. This treatment strategy was designed by first developing a Total Acid Mine Drainage Loading (*TAMD*L) model of the watershed. The computer program *TAMD*L was designed to simulate the evolution of stream water quality in watersheds affected by AMD and its treatment. The watershed's *TAMD*L model and the remediation endpoints for the mainstem were used to calculate the level of treatment required in each Monday Creek subwatershed affected by AMD. The level of required AMD treatment was employed to design passive and active AMD treatment structures for each affected subwatershed. The feasibility of the designed structures was tested by incorporating them into the Monday Creek model and comparing the simulated stream pH, aluminum, and iron concentrations against the corresponding remediation endpoints. Because the original design did not result in the satisfaction of the pH, aluminum, and iron remediation endpoints, the design was adjusted until the remediation endpoints were satisfied.

Methodology

Computer Program TAMDL

Governing Equation

The following partial differential equation is the governing equation for the one-dimensional transport of a water quality constituent in a stream and is solved by *TAMDL* for each of the simulated constituents, except for proton activity.

$$\frac{\partial C_i}{\partial t} = m \frac{\partial^2 C_i}{\partial x^2} - V \frac{\partial C_i}{\partial x} + L_i + S_i \quad (1)$$

Where:

C_i	=	Simulated concentrations of the constituents.
L_i	=	Model node loading terms for each of the constituents.
S_i	=	Net chemical and physical reaction source (sink) terms.
μ	=	Hydrodynamic dispersion.
V	=	Mean stream velocity.

Because the hydrodynamic dispersion and mean stream velocity must remain uniform throughout the computational domain, the watershed must be divided into small sub-watersheds before using the computer program. The spatial coordinate, x , proceeds from the head of the sub-watershed and follows the stream channel to the mouth.

The governing equation is solved using net acidity rather than pH. Net acidity is defined as the total acidity minus the total alkalinity. Total acidity consists of the acidity caused by metal ion hydrolysis and the acidity caused by proton activity. In typical mine drainage, metal ions, rather than protons, constitute the major component of acidity. Therefore, *TAMDL* estimates pH through its relationship with net acidity by subtracting the effect of the metal ions.

If the stream chemistry was simulated with proton activity instead of net acidity, then it would be necessary to also simulate dissolved carbon dioxide, bicarbonate ion, carbonic acid, and total sulfate in addition to the other constituents. While this would be more pleasing theoretically, each of the additional parameters would require the estimation of boundary and initial conditions, which would degrade overall simulation precision. When the transport of acidity by the stream is simulated with net acidity instead of proton activity, then a constitutive relationship is required to calculate the pH from the net acidity.

Net Acidity – pH Constitutive Relationship

The parameter pH must be calculated by the model because water quality standards invariably use pH instead of net acidity and the kinetic rates of ferrous iron, aluminum and manganese oxidation and/or precipitation depend heavily upon pH. Because

defining the nature of the net acidity – pH constitutive relationship is a part of the modeling process, the computer program *TAMDL* allows the user to specify the relationship with paired series of net acidity and pH data.

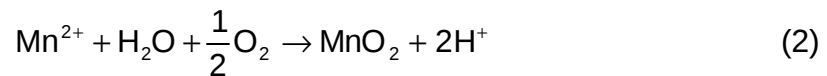
Ferric Iron Sedimentation

TAMDL assumes that all ferric iron above the pH-dependent ferric iron solubility limit has combined with dissolved oxygen to form ferric hydroxide. The computer program also assumes all of the ferric hydroxide in the stream clings to sediment particles, which leave the computational domain by flowing through the downstream boundary or by sedimentation. The rate at which ferric iron leaves the model domain via sedimentation is assumed to follow Stokes Law. This assumption is valid when the particle Reynolds number is less than unity (Roberson and Crowe 1980). Given the size of sediment particles most likely to carry ferric hydroxide, this assumption is realistic.

Because this process is not dependent upon the precise concentration of suspended solids, the simulation of the erosion, transport, and deposition of sediment was not required. Since *TAMDL* is often employed to simulate watersheds, like Monday Creek, where very little information on stream hydraulics is available, sediment transport is not simulated and the re-suspension of ferric iron-containing sediment particles must be neglected. Because the computer program can be easily modified to use the results of a sophisticated hydraulics model, the incorporation of a suspended sediment constituent and ferric iron re-suspension into the model would not be difficult.

Manganese Oxidation and Precipitation

The formulation used by *TAMDL* to calculate the kinetic rate of manganese oxidation and precipitation was obtained from Stumm and Morgan (1981). When the stream's dissolved oxygen concentration is less than 0.01 mg/L, manganese oxidation and reduction are neglected.



The kinetic rate for the progress of manganese oxidation and precipitation is calculated by the program using the following formula.

$$S'_{\text{Mn}} = \frac{-a_{\text{Mn}} C_{\text{Mn}} C_{\text{DO}} C_{\text{Fe}^{3+}}}{[\text{H}^+]^2} \exp\left(\frac{-E_{\text{Mn}}}{RT}\right) \quad (3)$$

Where:

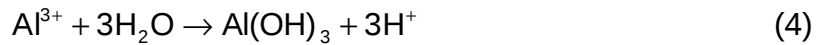
S'_{Mn}	=	Manganese kinetic rate, mg/L/day.
E_{Mn}	=	Empirical rate constant, kJ/mole.
	=	107.987 kJ/mole.
a_{Mn}	=	Empirical rate multiplier specified by user, L ⁴ /(mg ⁴ -day).
R	=	Universal gas constant, kJ/mole/K.
	=	8.314 x 10 ⁻³ kJ/mole/K.

T	=	Stream water temperature, K.
C_{Mn}	=	Manganese concentration, mg/L.
C_{DO}	=	Dissolved oxygen concentration, mg/L.
C_{Fe3+}	=	Ferric iron concentration, mg/L.

The array containing the net rate of production (consumption) for each of the constituents, S_i is calculated by taking the algebraic sum of the kinetic rates for each chemical and physical reaction being modeled. Because manganese oxidation consumes oxygen, equation (2) is used to calculate the corresponding decline in dissolved oxygen concentration. The effect of this reaction's proton production on the pH and net acidity is calculated with equation (2) and the net acidity – pH constitutive relationship.

Aluminum Precipitation

The chemical reaction for aluminum precipitation is similar to the equation for manganese oxidation and precipitation except for the absence of oxidation because aluminum has only a single oxidation state.



$$S'_{Al} = \frac{-a_{Al}C_{Al}A_{Al}}{[H^+]^3} \exp\left(\frac{-E_{Al}}{RT}\right) \quad (5)$$

Where:	S'_{Al}	=	Aluminum precipitation kinetic rate, mg/L/day.
	a_{Al}	=	Empirical rate constant specified by the user, dimensionless.
	C_{Al}	=	Aluminum concentration, mg/L.
	A_{Al}	=	Empirical rate multiplier, mole ³ /L ³ /day.
		=	3160 mole ³ /L ³ /day.
	E_{Al}	=	Empirical rate constant, kJ/mole.
		=	58.2 kJ/mole.

Like for manganese precipitation and oxidation, the effect of this reaction's production of protons on the pH and the net acidity is calculated with the chemical equation (4) and the net acidity – pH constitutive relationship.

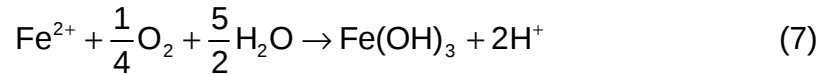
If the user specifies a negative value for the dimensionless empirical rate constant, the program does not evaluate equation (5), but does not allow the aluminum concentration to be greater than the solubility limit under equilibrium conditions, which is calculated with equation (6).

$$C_{Al-equ} = \exp(35.071 - 6.9078pH) \quad (6)$$

Where:	C_{Al-equ}	=	Solubility limit for aluminum, mg/L.
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Ferrous Iron Oxidation

Ferrous iron oxidation can be simulated by *TAMDL* with the following chemical reaction, when the stream's dissolved oxygen concentration is greater than 0.01 mg/L.



The rate of ferrous iron oxidation is calculated by the program with the formulation presented by Kirby, Thomas, Southam, and Donald (1998). This formulation has a biotic term as well as an abiotic term to account for the oxidation of ferrous iron by *T. ferrooxidans* bacteria.

$$S'_{\text{Fe}^{2+}} = -\frac{U_{\text{DO}} A_a C_{\text{Fe}^{2+}} C_{\text{DO}}}{[\text{H}^+]^2} \exp\left(\frac{-E_a}{RT}\right) - U_{\text{DO}} A_b C_{\text{Fe}^{2+}} C_{\text{DO}} C_{\text{TF}} [\text{H}^+] \exp\left(\frac{-E_b}{RT}\right) \quad (8)$$

Where:

$S'_{\text{Fe}^{2+}}$	=	Ferrous iron oxidation kinetic rate, mg/L/day.
U_{DO}	=	Unit conversion constant, g-moles O_2 / mg O_2 .
	=	$3.125117192 \times 10^{-5}$ g-moles O_2 / mg O_2 .
A_a	=	Empirical abiotic oxidation rate multiplier, mole/L/day.
	=	3.456×10^{10} mole/L/day.
E_a	=	Empirical abiotic rate constant, kJ/mole.
	=	96 kJ/mole.
$C_{\text{Fe}^{2+}}$	=	Ferrous iron concentration, mg/L.
C_{TF}	=	Dry biomass concentration of <i>T. ferrooxidans</i> bacteria, mg/L.
A_b	=	Empirical biotic rate constant, mole/L/day.
	=	8.8128×10^{13} mole/L/day.
E_b	=	Empirical biotic rate constant, kJ/mole.
	=	58.77 kJ/mole.

All of the empirical rate constants in equation (8) were determined from the analysis of field data (Kirby, Thomas, Southam and Donald, 1998). Because the results of Kirby, Thomas, Southam, and Donald (1998) suggest that the dry biomass concentration of *T. ferrooxidans* bacteria is difficult to measure accurately, it can be used as a model calibration parameter. Simulating ferrous oxidation requires that the user have information about the speciation of iron in the stream. Because this data was not available for streams in the Monday Creek watershed, the Monday Creek *TAMDL* model assumed that all of the iron was in the ferric oxidation state.

Other Reactions

Because the kinetic rates of manganese oxidation and precipitation, aluminum precipitation and ferrous iron oxidation depend upon the stream temperature and the dissolved oxygen concentration, it is necessary that *TAMDL* simulate these water quality constituents as well. With dissolved oxygen, the user has the option of directing the program to assume that saturated conditions are always present or calculate the

dissolved oxygen concentration from stream reaeration and organic material decay. A zeroth order sediment oxygen demand formulation from the lake model *CE-QUAL-W2* (Cole and Buchak, 1995) was adapted for use in *TAMDL*. Stream reaeration is calculated with the O'Conner and Dobbins (1958) formulation. Because stream temperature is not absolutely crucial to the modeling of streams affected by acid mine drainage, the simplified formulation used by the program assumes that the amount of heat transferred between the stream and the atmosphere is directly proportional to the difference in temperature and wind speed and inversely proportional to the depth of the stream.

Boundary and Initial Conditions

Upstream of the computational domain for each simulation, the user specifies the boundary temperature and concentrations. The specified upstream boundary temperature and concentrations may vary with simulation time. Normally, the upstream boundary condition is calculated from the results of the model for the upstream sub-watershed. If there is no upstream sub-watershed, the upstream boundary condition must be implied from the results of water quality sampling.

At the downstream end of each computational domain, *TAMDL* assumes that the spatial gradient of the temperature and concentration is zero. Downstream boundary conditions are required because of the dispersion (second derivative) term in governing equations. If there is no flow through the computational domain, *TAMDL* automatically applies the downstream boundary condition to the upstream boundary, and the concentrations specified for the upstream boundary are ignored.

The program also requires that the initial temperature and concentration be specified for each node. Initial conditions are not very important when one desires a steady state solution. When one is simulating a transient problem, the precise selection of initial conditions may have an important effect on the results calculated in the early portion of the simulation. Realistic initial conditions can be generated by simulating water quality conditions for a period prior to the desired simulation period.

Numerical Algorithm

In order to make efficient use of computational resources, the selection of an appropriate numerical algorithm is very important. In the planning stages of *TAMDL*, it was decided that the selected algorithm should be both explicit and at least second order accurate in both time and space. One well-tested algorithm that satisfies this requirement is the explicit MacCormack predictor – corrector method described by Anderson, Tannehill, and Pletcher (1984). Because this finite difference algorithm is normally applied to the solution of the advection – dispersion equation, the loading and chemical reaction terms in the governing equation must be solved analytically or with a numerical technique for first order ordinary differential equations.

Since the equations describing the kinetic rates of the aforementioned reactions are both complex and non-linear, it was decided that both the loading and reaction terms should be solved numerically. First order ordinary differential equations are commonly solved with one of the Runge-Kutta methods (Boyce and DiPrima, 1977). In order to simplify the program's source code, it was decided that intermediate time steps to solve the chemical reaction terms would not be employed. Therefore, to achieve the desirable accuracy, it was decided to use the fourth order Runge-Kutta method to solve the contributions of these terms.

Source Loads

The source loads applied to finite difference model nodes are represented in *TAMD*L's governing partial differential equation, equation (1), by the array L_i . The program allows one to specify thermal, alkaline, acid, ferrous iron, ferric iron, manganese, aluminum and dissolved oxygen loads with this array. The operation of passive acid mine drainage treatment systems can also be simulated for specified model nodes. Because the production of alkalinity by passive acid mine drainage treatment systems depends upon the stream's acidity, the source load terms can be non-linear and the fourth order Runge-Kutta method is also used to calculate the contribution of these terms.

Hydrology

Because the advection term in the governing partial differential equation, equation (1), contains the mean flow velocity of the stream, V , the mean velocity must be known for all portions of the computational domain throughout the simulation period. The current formulation of the explicit MacCormack predictor – corrector method requires that the stream velocity and the hydrodynamic dispersion be uniform throughout the computational domain. Therefore, to account for changes in the stream hydraulics, the watershed must be divided into many small sub-watersheds.

*Strengths and Weaknesses of TAMD*L

The basic strength of the *TAMD*L computer program is that it solves the differential equation governing the transport, loading and reaction of AMD-related water quality constituents, equation (1). This equation requires that the user specify the stream's discharge flow rate, Q , throughout the simulation period and rating tables for the depth, h , flow area, A , wetted perimeter, P , and top width, T . Ideally, one would use a hydrologic simulation program to determine these parameters before executing the *TAMD*L computer program.

Unfortunately, those streams affected by AMD tend to be small and the information required to run a sophisticated hydrologic simulation program is not available. In those situations, the user is required to estimate the discharge flow rate for a particular stream segment from the drainage area of the stream segment and discharge flow rate data collected at a nearby stream gage. The rating tables for the stream segment are then estimated from measurements of the stream channel geometry and educated guesses

about the Manning's n value for the stream. This was the approach used for Monday Creek.

Model Development

The development of the Monday Creek *TAMDL* was a cooperative effort between the U.S. Army Corps of Engineers, Huntington District and West Virginia University (WVU). WVU submitted to the Huntington District a series of locations along Monday Creek and its tributaries. The Huntington District contracted a surveyor to measure the cross section of the stream at those locations and calculated the drainage area and rating tables for the stream cross sectional area, top width and wetted perimeter at those sites. This information was used by the computer program to calculate the stream hydraulics during the simulation period.

With the hydrologic model results provided by the Huntington District, WVU determined that the mainstem of Monday Creek needed to be divided into seventeen sections and that Snow Fork needed to be divided into three sections. The other Monday Creek subwatersheds needed no further division. When this was completed, the computational domain for the Monday Creek *TAMDL* model was devised and is shown in Figure 1.

Because the computer program *TAMDL* calculates stream pH from net acidity, an empirical constitutive relationship between the two variables was required. The empirical relationship derived for the Monday Creek watershed is shown in Figures 2 and 3. Figure 2 is a plot of the constitutive relationship with observed pH and net acidity data. Figure 3 is a plot of the observed pH versus the pH calculated by the empirical net acidity – pH constitutive relationship and the observed net acidity arranged in box-plot format to facilitate the evaluation of the empirical relationship.

Because *TAMDL* calculates in-stream pH and metals concentrations by simulating the stream transport process, the net acidity and metals concentrations or loading rates in the water entering the computation domain from the upstream ends must be specified in some manner. Since these concentrations or loading rates must be specified continuously throughout the simulation, regression equations were derived for these locations. It was empirically observed that regression equations of the following form best replicated observed concentrations.

$$C \cong C_{\text{model}} = aQ^b \quad (9)$$

Where:

C	=	Observed constituent concentrations, mg/L.
C_{model}	=	Estimated constituent concentrations, mg/L.
Q	=	Stream discharge flow rate, m ³ /s.
a, b	=	Empirical regression coefficients.

The discharge flow rate, Q , in equation (9) is the same as what was used by the Monday Creek *TAMDL* model for that stream segment. This data was calculated by

adjusting the discharge flow rate measured at the USGS gage at Doanville, OH by the drainage area of the stream segment. Stream or seep loading rates can be specified with a formula virtually identical to equation (9).

$$L \cong L_{\text{model}} = 86.4 (a) Q^{b+1} \quad (10)$$

Where: L = Observed constituent loading rates, kg/day.
 L_{model} = Estimated constituent loading rates, kg/day.

The empirical coefficients in equations (9) and (10) were calculated for the net acidity, iron, manganese, and aluminum entering the Monday Creek TAMDL model's computational domain. The empirical coefficients for the manganese and aluminum entering the model's computational domain via stream JS-8 in the Jobs Hollow subwatershed are shown in Figures 4 and 5. Figures 4 and 5 also contain plots that compare the results of the regression equations with the observed concentrations.

Figures 4 and 5 show the observed manganese and aluminum concentrations at various levels of stream discharge flow rate. All but one of these samples were collected when the stream discharge flow rate was more than 0.1 m³/s. Since the 75th percentile of the stream discharge flow rate data is less than 0.1 m³/s, the collected stream samples appear to reflect the normal variation in stream flow at the site. The plots show the change in estimated concentration at stream discharge flow rates as high as 0.5 m³/s.

Model Calibration

Model calibration was accomplished by comparing the model results at water quality sample collection sites against the observed data. The quality of the calibration was judged by calculating the correlation coefficients (R^2) between the observed data and the model's results. These correlation coefficients for the calibration model are listed in Table 1. All of the correlations are greater than 62%. Given the complexity of AMD chemistry, simplifying assumptions made by the *TAMDL* computer program, and sampling error, these correlations are fairly good.

In order to verify the calibration of the model, a verification model run was executed and the results compared against observed data collected after the end of the calibration model run. The correlation coefficients (R^2) for the verification model run are also listed in Table 1. Since these coefficients were not less than the coefficients for the calibration model run, we concluded that the quality of the model calibration is accurately reflected in the correlation coefficients for the calibration model run.

The observed data used to calculate the correlation coefficients listed in Table 1 and the observed data shown in the time series plots in this report were filtered by comparing the titrated and estimated total acidity values. The estimated total acidity values were calculated by summing the proton and metal acidities. Those samples with a difference

between the estimated total acidity and the titrated total acidity greater than 50% were removed from the analysis.

Figures 6, 7, and 8 are time series plots of the aluminum concentrations calculated by the calibration model at station JS-107-MC on Snow Fork and stations JS-153-MC and JS-151-MC on the Monday Creek mainstem, respectively. Most of the observed concentrations are replicated rather closely by the model, but there are a few low concentrations not replicated at station JS-107-MC, shown in Figure 6. The low concentrations not replicated at station JS-107-MC may be a consequence of errors in the stream hydrology of Snow Fork. Snow Fork and its tributaries are above abandoned mines which are probably modifying the Snow Fork stream hydrograph in ways that cannot be replicated by any existing hydrologic model.

Because of the error associated with the Monday Creek *TAMD*L model, margins of safety will have to be specified for the remediation endpoints before the model is employed in the design of AMD treatment strategies. Since no water quality model is free of error, this outcome is expected. Table 2 lists the remediation endpoints and the margins of safety for pH, iron, and aluminum. The margin of safety for pH was 0.25 standard units, which is approximately 25% of the range in the 5th percentile of mainstem stream pH in the treatment model. The margins of safety for iron and aluminum were greater than 25% of the remediation endpoint.

While the quality of the calibration of the model is less than desirable, we believe that the Monday Creek *TAMD*L model should be employed in the development of AMD treatment strategies, with the aforementioned margins of safety, because of sampling error. Additional collected data would have allowed more complete quality assurance and quality control of the calibration data. Error in stream pH measurements can be introduced by debris plugging the probe's reference junction, improper probe calibration, or carelessness in measurement. Error in total metal concentration measurements can be introduced by the collection of bottom sediment in the stream water or procedural errors made by the laboratory.

Development of AMD Treatment Strategies

The first step in designing an AMD treatment strategy for the Monday Creek watershed is deciding the final goal of the remediation process. This goal was expressed by the Huntington District in terms of remediation endpoints, which are listed in Table 2. Because all models have some error associated with their results, margins of safety for each of the parameters are included in Table 2. The endpoints listed in Table 2 express the minimum allowable 5th percentile for stream pH and the maximum allowable 95th percentile for aluminum and iron concentration and were enforced for the entire length of the Monday Creek mainstem.

Figures 9, 10 and 11 show the simulated 5th percentile of stream pH, the 95th percentile of aluminum concentration and the 95th percentile of iron concentration, respectively, before, and after AMD load reductions in various subwatersheds. The load reductions

in each of the Monday Creek subwatershed required to achieve the improvements shown in Figures 9, 10 and 11 are shown in Table 3.

Originally, the remediation endpoint margin of safety for the 5th percentile of the mainstem stream pH was 0.2 standard units; this was increased to 0.25 standard units as the result of a flow parametric study that was conducted to determine the variability of the calculated results with changes in the stream discharge flow rate. With the margin of safety for the pH remediation endpoint increased to 0.25, the minimum 5th percentile for mainstem stream pH remained above the remediation endpoint for changes in the discharge flow rate as large as 30%.

Because the stream discharge hydrographs employed in the Monday Creek *TAMD*L model had an accuracy of approximately 30%, this result, shown in Figure 12, was deemed acceptable. Figures 13 and 14 show the results of the flow parametric study for aluminum and iron, respectively, and indicate that the discharge flow rate would have to change by approximately 50% in order for the 95th percentile of the aluminum and iron concentrations to be greater than the remediation endpoints.

Design of AMD Treatment Structures

Traditional techniques for the design of active and passive AMD treatment structures were used to develop treatment systems for all of the subwatersheds listed in Table 3 with required reductions in AMD load. The unit cost assumptions made in the cost estimates for these structures are listed in Table 4. With the exception of the stream subsidence closures, the designed treatment structures are summarized in Table 5 and displayed schematically in Figure 15. AMD treatment designs for the Monday Creek watershed include: a lime kiln dust doser, low head dams, limestone leach beds, open limestone channels, slag leach beds, aerobic wetlands, and stream subsidence closures. The details of these designs are shown in Tables 6 through 12.

The treatment efficiency in Tables 6, 8, 9, 10 and 12 is the average cost of the acid removed from the stream over the course of the treatment structure's service life and was calculated with the following formula.

$$E_T = \frac{C}{\Delta L(T)} \quad (11)$$

Where:

E_T	=	Treatment efficiency of the treatment structure, \$/ton.
C	=	Estimated cost of the treatment structure, \$.
ΔL	=	Acid load removed by the treatment structure, tons/yr.
T	=	Service life of treatment structure, yrs.

The mean treatment efficiency in Table 5 is the average treatment efficiency for the treatment structures in that subwatershed. No mean treatment efficiency is given for the Rock Run subwatershed because the structures in that subwatershed are not treating acidity.

Feasibility Testing of Designed AMD Treatment Strategies

In order to test the feasibility of the designed AMD treatment structures, the action of the treatment structures was directly simulated by the Monday Creek *TAMD*L model. With the structures designed for Jobs Hollow, none of the designs required later modification. In order to satisfy the remediation endpoints for the upper portion of the Monday Creek mainstem, the mean alkalinity load from the OLC and SLB in Jobs Hollow had to be increased from 247 tons per year to 547 tons per year. Table 8 reflects this change in the design.

Results

Lime Kiln Dust Dosers

Table 6 lists the design parameters for the lime kiln dust doser designed for the Jobs Hollow subwatershed. Generic drawings of the layout, flow control and pad design for the doser are shown in Figures 19, 20 and 21, respectively. Figures 19, 20 and 21 were obtained from Environmental Dosers International, LLC of Clarksburg, WV, <http://www.limedoser.com/>. Dan Dunkle, the president of Environmental Dosers International, recommended that a retaining wall (not included in the drawings) be built around the doser pad to prevent erosion from interfering with the operation of the doser.

A lime kiln dust doser was selected for Jobs Hollow because the topography of tributaries near the proposed doser site does not permit the placement of passive AMD treatment structures.

Low Head Dams

Table 7 lists the basic design parameters for the three low head dams designed for the Rock Run subwatershed. Generic plan and profile views for these dams are shown in Figure 22. The purpose of these low head dams is to aerate the Rock Run and ensure that most, if not all, of the iron in the stream is in the ferric oxidation state. The design parameters listed in Table 7 are approximate because specific topological information was not available for these sites.

The limestone, or any other non-acid producing rock, used to build these dams should have a diameter no less than 20% of the total stream width. Because a flood safety analysis was beyond the scope of this project, a hydraulic analysis should be performed to ensure the stability of all of the low head dams during high flow events. Since these low head dams will be placed in the upper portion of the watershed, upstream sedimentation should not pose a problem. Because sedimentation modeling is outside the scope of the TAMDL model, the potential for erosion and sedimentation near the low head dams should be determined with a hydraulic analysis.

Limestone Leach Beds

Table 8 lists the basic design parameters for the limestone leach beds designed throughout the Monday Creek watershed. Generic plan and profile views for these limestone leach beds are shown in Figure 23. The purpose of these leach beds is to provide alkalinity to fresh water streams upstream of any AMD sources. Because a flood safety analysis was beyond the scope of this project, a hydraulic analysis should be performed to ensure the stability of all of the limestone leach beds during high precipitation events.

Open Limestone Channels

Table 9 lists the basic design parameters for the open limestone channels designed throughout the Monday Creek watershed. Generic cross section view for these open limestone channels are shown in Figure 24. The purpose of these channels is to provide alkalinity to streams affected by AMD. The channels also assist in the precipitation of dissolved metals in the stream and ensure positive drainage of the stream. Because a flood safety analysis was beyond the scope of this project, a hydraulic analysis should be performed to ensure the stability of all of the open limestone channels during high flow events.

Slag Leach Beds

Table 10 lists the basic design parameters for the slag leach beds designed throughout the Monday Creek watershed. Generic plan and profile views for these slag leach beds are shown in Figure 25. The purpose of these leach beds is to provide a large amount of alkalinity to fresh water streams upstream of any AMD sources. Because a flood safety analysis was beyond the scope of this project, a hydraulic analysis should be performed to ensure the stability of all of the slag leach beds during high precipitation events.

Aerobic Wetlands

Table 11 lists the basic design parameters for the aerobic wetlands designed throughout the Monday Creek watershed. Generic plan and profile views for a typical aerobic wetland are shown in Figure 26. The generic cross section view is shown in Figure 27. In general, the purpose of these wetlands is to provide a large area of stream with a small depth of flow to facilitate the precipitation and sedimentation of metal hydroxides downstream of passive AMD treatment structures.

Because a flood safety analysis was beyond the scope of this project, a hydraulic analysis should be performed during the detailed design process to ensure the long-term stability of all of the aerobic wetlands during high flow events. Plant life selected for the meandering channel sides should be chosen to retain deposited sediments during relatively high flow ($T = 10$ years) events. Figure 26 indicates that boundary of the wetland should correspond to the 10 year flood elevation; this should be taken as a design suggestion and not as a requirement.

Stream Subsidence Closures

Table 12 lists the basic design parameters for the stream subsidence closures. Because the requirements for stream subsidence closure depend upon the degree of mine subsidence, generic plan and profile views of stream restoration are not available. The goal of stream subsidence closure is to restore positive drainage to the stream and reduce AMD generation by preventing contact between stream water and pyritic minerals. Restoring positive drainage to the affected streams will improve the long-term

performance of the other AMD treatment systems and should reduce human and animal hazards.

Table 5 does not summarize the amount of excavation and limestone required for the stream subsidence closures because these quantities will vary according to the degree of mine subsidence and local geotechnical conditions. However, experience with other Monday Creek stream restoration projects has indicated that the mean cost of stream restoration is approximately \$43.78 per foot of stream (Farley, 2002). Because the costs of the stream subsidence closures were calculated in a different manner than the costs of the other AMD treatment systems, the treatment efficiencies shown in Table 12 probably should not be compared to the efficiencies for the other treatment systems.

Conclusion

This project developed the Monday Creek *TAMD*L model for simulating the transport and reaction of those water quality constituents related to AMD within the Monday Creek watershed. This model was used to calculate the required load reductions from each of the Monday Creek and Snow Fork subwatersheds in order to satisfy the remediation endpoints specified by the Huntington District. No water quality model is free from error, and the Monday Creek *TAMD*L model is no exception. To ameliorate the effect of this error on the calculation of the required amount of AMD treatment, margins of safety were adopted for the remediation endpoints. These margins of safety were designed to force the model to over-estimate the amount of AMD treatment needed to satisfy the remediation endpoints to ensure that modeling errors do not result in substandard water quality conditions after the proposed treatment structures have been constructed.

These required reductions in AMD load were used to develop an AMD treatment strategy that will bring the mainstem of Monday Creek back into compliance with the remediation endpoints specified by the Huntington District. This strategy consists of a lime kiln dust doser, low head dams, limestone leach beds, open limestone channels, slag leach beds, aerobic wetlands, and stream subsidence closures. The ultimate feasibility of this treatment strategy was tested by directly simulating the actions of the designed structures in the Monday Creek *TAMD*L model. The results of these simulations led to an increase in the designed capacity of the treatment structures to be placed within Jobs Hollow.

Overall, the strategy provided by this project appears to provide a near optimal set of designs for treating AMD. In the strategy's current form, it will treat approximately 54,100 tons of acid at an estimated cost of \$6,020,000. This total includes \$1,570,000 for stream subsidence closures and \$4,450,000 for conventional passive and active AMD treatment.

References

- Anderson, D.A. and J.C. Tannehill, R.H. Pletcher, 1984. Computational Fluid Mechanics and Heat Transfer, Hemisphere Publishing Company, New York, NY.
- Boyce, W.E. and R.C. DiPrima, 1977. Elementary Differential Equations and Boundary Value Problems, Third Edition, John Wiley & Sons, Inc., New York, NY.
- Cole, T.M. and E.M. Buchak, 1995. CE-QUAL-W2: A two-dimensional, laterally averaged, Hydrodynamic and Water Quality Model, Version 2.0, Draft Instruction Report, US Army Engineer Waterways Experiment Station, Vicksburg, MS.
- Farley, M., 2002. Personal Communication.
- Kirby, C.S., H.M. Thomas, G. Southam, and R. Donald, 1998. Relative Contributions of Abiotic and Biological Factors in Fe(II) Oxidation in Mine Drainage, Applied Geochemistry, preprint.
- O'Conner D.J. and W.E. Dobbins, 1958. Mechanism of Reaeration in Natural Streams, Transactions ASCE 123(655).
- Roberson, J.A. and C.T. Crowe, 1980. Engineering Fluid Mechanics, Second Edition, Houghton Mifflin Company, Boston, MA.
- Stumm, W. and J.J. Morgan, 1981. Aquatic Chemistry: An Introduction Emphasizing Chemical Equilibria in Natural Waters, Second Edition, John Wiley and Sons, Inc., New York, NY.

Tables

Table 1. List of correlation coefficients of the water quality constituents calculated during model runs versus observations.

Water Quality Constituent	Calibration Model Run Correlation Coefficient, R^2	Verification Model Run Correlation Coefficient, R^2
Stream Discharge Flow Rate	73%	86%
Stream pH	65%	70%
Total Iron Concentration	77%	81%
Total Aluminum Concentration	63%	70%

Table 2. Remediation Endpoints and Margins of Safety for the Remediation Simulation Models.

Water Quality Constituent	Remediation Endpoint	Margin of Safety	Remediation Endpoint plus Margin of Safety
pH	6.82 standard units	+0.25 standard units	7.07 standard units
Aluminum	1.12 mg/L	-0.4 mg/L	0.72 mg/L
Iron	1.49 mg/L	-0.4 mg/L	1.09 mg/L

Table 3. Minimum Required Load Reductions in each Monday Creek Subwatershed.

Subwatershed	Mean Net Acidity Load Reduction	Mean Fe Load Reduction	Mean Al Load Reduction
Jobs Hollow	123%	90%	99%
Dixey Hollow	178%	0%	97%
Shawnee Creek	0%	0%	0%
Ironpoint Cemetery	0%	0%	0%
Rock Run	0%	50%	0%
Stone Church	0%	0%	0%
Salt Run	0%	0%	0%
Dans Run	0%	0%	0%
New Straitsville	0%	0%	0%
Lost Run	90%	96%	90%
Little Monday Creek	0%	0%	0%
Kitchen Run	0%	0%	0%
Sand Run	0%	0%	0%
Monkey Hollow	28%	0%	90%
Big-4 Hollow	0%	0%	0%
Snake Hollow	90%	90%	90%
Bessemer Hollow	0%	0%	0%
Snow Fork	98%	53%	88%
Coe Hollow	54%	51%	50%
Happy Hollow	0%	0%	0%
Salem Hollow (of Snow Fork)	331%	50%	90%
Sycamore Hollow (of Snow Fork)	90%	78%	90%
Spencer Hollow (of Snow Fork)	91%	8%	99%
Brush Fork (of Snow Fork)	90%	52%	90%
Long Hollow (of Snow Fork)	90%	51%	90%
Whitmore Cemetery (of Snow Fork)	296%	50%	0%
Orbiston (of Snow Fork)	0%	50%	50%

Table 4. Unit Cost Assumptions for AMD Treatment Designs.

Item	Unit Cost	Units
Limestone (installed)	\$25.00	Per Ton
Steel Slag (installed)	\$25.00	Per Ton
Excavation	\$3.00	Per Cubic Yard
Lime Kiln Dust	\$25.50	Per Ton
Lime Kiln Dust Doser	\$60,000.00	Per Unit
Stream Channel Restoration	\$43.78	Per Foot

Table 5. Summary of Monday Creek AMD Treatment Designs, excluding Stream Subsidence Closures.

Subwatershed	Excavation, yd ³	Limestone, tons	Steel Slag, tons	Estimated Cost	Acid Load Removed, tpy	Mean Treatment Efficiency, \$/ton
Jobs Hollow	9,122	1,851	13,626	\$527,647	681	\$44.62
Dixie Hollow	2,208	2,881	636	\$94,571	82	\$47.15
Rock Run	42,554	24	0	\$128,262	0	Not Applicable
Lost Run	24,718	40,277	5,863	\$1,227,659	610	\$58.24
Monkey Hollow	10,446	3,378	10,472	\$377,599	183	\$180.33
Snake Hollow	43,263	3,825	0	\$225,423	162	\$80.83
Coe Hollow	561	387	301	\$18,886	91	\$50.29
Salem Hollow	1,959	2,673	0	\$72,703	67	\$49.12
Sycamore Hollow	132,413	3,454	0	\$483,578	106	\$138.41
Spencer Hollow	5,358	0	5,236	\$146,978	55	\$402.01
Brush Fork	10,519	5,397	9,080	\$393,480	580	\$86.98
Long Hollow	5,047	3,206	3,129	\$173,520	245	\$57.52
Whitmore Cemetery	14,272	0	12,567	\$356,987	132	\$435.50
Orbiston	70,196	394	0	\$220,428	42	\$587.86
Total	372,636	67,747	60,910	\$4,447,720	3,036	\$81.91

Table 6. Monday Creek Lime Kiln Dust Doser Designs (DOSER).

Subwatershed	Site	Treatment Unit	Q, gpm	Total Acidity, mg/L	Acid Load, tpy	Estimated Cost	Acid Load Removed, tpy	Service Life, years	Treatment Efficiency, \$/ton
Jobs Hollow	DOSER SITE #1	DOSER #1	2237.45	34.87	104.64	\$113,366	104.64	20.00	\$54.17

Table 7. Monday Creek Low Head Dam Designs (LHD).

Subwatershed	Site	Treatment Unit	Q, gpm	Total Acidity, mg/L	Acid Load, tpy	L, ft	W, ft	H, ft	Excavation, yd ³	Limestone, tons	Estimated Cost	Service Life, years
Rock Run	RR-1	LHD-1	815.00	2.71	48.54	6.2	10.0	5.0	7.04	7.99	\$221	15.00
Rock Run	RR-2	LHD-2	815.00	2.71	48.54	6.2	10.0	5.0	7.04	7.99	\$221	15.00
Rock Run	RR-3	LHD-3	815.00	2.71	48.54	6.2	10.0	5.0	7.04	7.99	\$221	15.00

Table 8. Monday Creek Limestone Leach Bed Designs (LLB).

Subwatershed	Site	Treatment Unit	Q, gpm	Total Acidity, mg/L	Acid Load, tpy	L, ft	W, ft	H, ft	Excavation, yd ³	Limestone, tons	Estimated Cost	Acid Load Removed, tpy	Treatment Efficiency, \$/ton
Sycamore	RM-2.5	LLB	782.4	65.0	111.6	181.6	75.0	6.0	3532.0	3453.6	\$96,935	105.9	\$27.74
Orbiston	302+304	LLB 1	96.3	395.9	41.8	116.4	20.0	4.0	431.2	393.5	\$11,132	41.7	\$29.69
Dixie	DIX-16	LLB 1	50.0	-75.0	-8.3	75.0	40.0	5.0	666.7	672.2	\$18,806	8.3	\$27.99
Lost Run	LR-1W	LLB 1W1	1065.1	72.6	170.1	112.7	25.0	4.0	521.7	505.0	\$14,190	23.5	\$30.13
Lost Run	LR-1W	LLB 1W2	1065.1	72.6	170.1	112.7	25.0	4.0	521.7	505.0	\$14,190	23.5	\$30.13
Lost Run	LR-1W	LLB 1W3	1065.1	72.6	170.1	112.7	25.0	4.0	521.7	505.0	\$14,190	23.5	\$30.13
Lost Run	LR-1W	LLB 1W4	1065.1	72.6	170.1	112.7	25.0	4.0	521.7	505.0	\$14,190	23.5	\$30.13
Lost Run	LR-1W	LLB 1W5	1065.1	72.6	170.1	112.7	25.0	4.0	521.7	505.0	\$14,190	23.5	\$30.13
Lost Run	LR-2W	LLB 2W1	86.0	237.6	45.0	56.3	50.0	4.0	521.7	505.0	\$14,190	8.4	\$29.67
Lost Run	LR-2W	LLB 2W2	86.0	237.6	45.0	56.3	50.0	4.0	521.7	505.0	\$14,190	7.1	\$29.99
Lost Run	LR-3W	LLB 3W1	94.3	390.2	80.9	22.5	25.0	4.0	104.3	101.0	\$2,838	3.3	\$30.33
Lost Run	LR-MS	LLB 4E1	13.3	183.3	5.4	22.5	25.0	4.0	104.3	101.0	\$2,838	1.8	\$30.03
Lost Run	LR-4W	LLB 4W1	128.9	390.2	110.6	112.7	50.0	4.0	1043.4	1010.0	\$28,380	55.0	\$30.38
Coe	A SEEP	LLB-A	58.2	230.0	29.5	23.5	20.0	3.0	69.6	63.1	\$1,787	14.6	\$30.51
Coe	B SEEP	LLB-B	66.0	285.0	41.4	26.6	20.0	3.0	78.9	71.6	\$2,026	20.6	\$32.83
Coe	D TRIB	LLB-D	84.3	302.0	56.0	25.5	20.0	4.0	94.3	91.3	\$2,566	27.8	\$30.76
Brush Fork	MSBS	LLB1	167.3	465.3	171.2	89.9	30.0	3.0	399.5	362.6	\$10,263	85.1	\$30.17
Monkey	FRT-3	LLB1	0.9	340.0	0.7	2.9	5.0	3.0	2.1	1.9	\$55	0.3	\$33.03
Snake	ATC-03	LLB1	2.1	151.0	0.7	6.9	5.0	3.0	5.1	4.6	\$131	0.4	\$37.18
Long	LON-93	LLB1	268.0	178.0	104.9	216.0	30.0	4.0	1200.1	1161.7	\$32,643	52.1	\$62.62
Brush Fork	32A	LLB10	163.0	384.0	137.7	262.8	20.0	3.0	778.8	706.7	\$20,005	68.4	\$29.24
Monkey	FRT-5	LLB10	29.4	181.0	11.7	26.4	18.0	3.0	70.3	63.8	\$1,806	5.8	\$31.01
Snake	SNA-61	LLB10	163.0	384.0	137.7	39.1	18.0	3.0	104.3	94.7	\$2,680	8.8	\$30.35
Brush Fork	MS7C	LLB11	288.1	90.1	57.1	116.2	20.0	3.0	344.2	312.3	\$8,840	28.4	\$31.16
Monkey	FRT-1	LLB11	35.9	78.5	6.2	32.2	18.0	3.0	85.8	77.8	\$2,203	3.1	\$29.80
Brush Fork	MS7	LLB12	172.8	83.5	31.7	69.7	20.0	3.0	206.4	187.3	\$5,301	15.8	\$30.57
Brush Fork	21	LLB13	8.5	164.0	3.1	6.9	20.0	3.0	20.4	18.5	\$523	1.5	\$31.12
Brush Fork	20	LLB14	98.7	251.0	54.5	79.6	20.0	3.0	235.9	214.0	\$6,059	27.1	\$31.96
Brush Fork	MSSP1	LLB2	62.4	85.4	11.7	25.1	20.0	3.0	74.5	67.6	\$1,914	5.8	\$29.88
Monkey	FRT-4	LLB2	1.3	455.0	1.3	8.4	5.0	3.0	6.2	5.6	\$160	0.7	\$59.56
Snake	ATC-02	LLB2	62.4	85.4	11.7	8.4	6.0	3.0	7.5	6.8	\$192	0.6	\$29.65
Long	LON-94	LLB2	114.9	142.0	35.9	46.3	30.0	4.0	257.3	249.1	\$6,999	17.8	\$30.19
Brush Fork	MSSP2	LLB3	118.9	140.5	36.7	95.9	20.0	3.0	284.1	257.8	\$7,297	18.3	\$30.75
Monkey	MNK-7A	LLB3	2.6	609.0	3.5	8.4	5.0	3.0	6.2	5.6	\$160	1.7	\$30.73
Snake	SNA-64	LLB3	118.9	140.5	36.7	20.3	6.0	3.0	18.0	16.3	\$463	1.5	\$31.90
Long	LON-95	LLB3	242.4	52.0	27.7	97.7	30.0	4.0	542.8	525.4	\$14,763	13.8	\$29.77
Brush Fork	5E50	LLB4	7.1	141.0	2.2	5.8	20.0	3.0	17.0	15.5	\$438	1.1	\$30.63
Monkey	FRT-2	LLB4	2.2	274.0	1.4	3.6	5.0	3.0	2.7	2.4	\$69	0.7	\$14.64
Snake	ATC-04	LLB4	7.1	141.0	2.2	12.5	10.0	3.0	18.5	16.8	\$476	1.1	\$44.84
Long	S-27	LLB4	695.7	52.0	79.6	210.3	20.0	4.0	779.0	754.0	\$21,188	39.5	\$29.77
Brush Fork	MSSP3	LLB5	358.5	210.4	165.9	289.0	20.0	3.0	856.2	777.0	\$21,995	82.4	\$29.65
Monkey	MNK-8	LLB5	6.0	465.3	6.1	8.0	12.0	3.0	14.3	13.0	\$367	3.0	\$30.17
Snake	SNA-62	LLB5	358.5	210.4	165.9	28.6	10.0	3.0	42.4	38.5	\$1,090	5.4	\$20.25
Brush Fork	6WB	LLB6	39.9	148.0	13.0	32.2	20.0	3.0	95.4	86.6	\$2,451	6.5	\$29.18
Monkey	FRT-5A	LLB6	7.6	200.0	3.4	12.3	20.0	3.0	36.5	33.1	\$936	1.7	\$29.55

Subwatershed	Site	Treatment Unit	Q, gpm	Total Acidity, mg/L	Acid Load, tpy	L, ft	W, ft	H, ft	Excavation, yd ³	Limestone, tons	Estimated Cost	Acid Load Removed, tpy	Treatment Efficiency, \$/ton
Snake	ATC-01	LLB6	39.9	148.0	13.0	44.3	20.0	3.0	131.2	119.0	\$3,370	13.7	\$12.33
Brush Fork	6WC	LLB7	35.9	132.0	10.4	28.9	20.0	3.0	85.8	77.8	\$2,203	5.2	\$30.38
Monkey	MNK-1	LLB7	9.8	337.9	7.3	10.6	15.0	3.0	23.5	21.3	\$604	3.6	\$27.69
Snake	SNA-63	LLB7	35.9	132.0	10.4	34.9	15.0	3.0	77.6	70.4	\$1,994	8.2	\$24.30
Brush Fork	MSSP5	LLB8	150.9	206.9	68.7	121.7	20.0	3.0	360.5	327.2	\$9,262	34.1	\$30.16
Monkey	MNK-11	LLB8	18.9	493.0	20.5	30.5	20.0	3.0	90.5	82.1	\$2,324	10.2	\$28.47
Snake	SNA-60	LLB8	150.9	206.9	68.7	58.6	20.0	3.0	173.7	157.6	\$4,461	34.2	\$6.52
Brush Fork	4W	LLB9	9.8	228.0	4.9	7.9	20.0	3.0	23.5	21.3	\$603	2.4	\$30.78
Monkey	MNK-13	LLB9	21.1	256.2	11.9	22.6	15.0	3.0	50.3	45.6	\$1,292	5.9	\$31.31
Snake	ATC-07	LLB9	9.8	228.0	4.9	40.2	15.0	3.0	89.3	81.1	\$2,294	8.0	\$28.80

Table 9. Monday Creek Open Limestone Channel Designs (OLC).

Subwatershed	Site	Treatment Unit	Q, gpm	Total Acidity, mg/L	Acid Load, tpy	L, ft	W, ft	H, ft	A, deg	F, Ft	Limestone, tons	Excavation, yd ³	Estimated Cost	Acid Load Removed, tpy	Treatment Efficiency, \$/ton
Lost Run	LR-1E	OLC 1E1	530.4	17.5	20.4	3838.0	6.0	2.0	153	2.0	5868.1	2558.7	\$154,378	21.4	\$30.31
Lost Run	LR-1W	OLC 1W1	1065.1	72.6	170.1	1023.0	6.0	2.0	153	2.0	1564.1	682.0	\$41,147	15.0	\$78.38
Lost Run	LR-1W	OLC 1W2	1065.1	72.6	170.1	1023.0	6.0	2.0	153	2.0	1564.1	682.0	\$41,147	15.0	\$78.38
Lost Run	LR-1W	OLC 1W3	1065.1	72.6	170.1	1023.0	6.0	2.0	153	2.0	1564.1	682.0	\$41,147	15.0	\$78.38
Lost Run	LR-1W	OLC 1W4	1065.1	72.6	170.1	1023.0	6.0	2.0	153	2.0	1564.1	682.0	\$41,147	15.0	\$78.38
Lost Run	LR-1W	OLC 1W5	1065.1	72.6	170.1	1023.0	6.0	2.0	153	2.0	1564.1	682.0	\$41,147	15.0	\$78.38
Lost Run	LR-2E	OLC 2E1	160.2	22.6	8.0	1140.0	8.0	2.0	153	2.0	1947.4	1013.3	\$51,724	7.8	\$67.38
Lost Run	LR-2W	OLC 2W1	86.0	237.6	45.0	712.5	5.0	1.5	153	1.5	636.7	329.9	\$16,907	8.4	\$74.64
Lost Run	LR-2W	OLC 2W2	86.0	237.6	45.0	944.1	5.0	1.5	153	1.5	843.7	437.1	\$22,404	7.0	\$75.76
Lost Run	LR-2W	OLC 2W3	86.0	237.6	45.0	1397.9	6.0	2.0	153	2.0	2137.3	932.0	\$56,230	10.2	\$79.64
Lost Run	LR-3E	OLC 3E1	227.6	160.7	80.5	4025.6	8.0	2.5	153	2.5	9842.4	4174.7	\$258,585	79.7	\$75.43
Lost Run	LR-3W	OLC 3W1	94.3	390.2	80.9	2431.7	8.0	2.0	153	2.0	4153.9	2161.5	\$110,331	77.3	\$67.92
Lost Run	LR-4W	OLC 4W1	128.9	390.2	110.6	1277.4	8.0	2.0	153	2.0	2182.1	1135.5	\$57,958	49.5	\$68.90
Lost Run	LR-MS	OLC MS1	13.3	183.3	5.4	57.5	8.0	2.0	153	2.0	98.2	51.1	\$2,609	3.4	\$64.54
Brush Fork	MSSP7E	OLC1	8.5	81.6	1.5	653.4	4.0	0.5	153	1.0	144.6	145.2	\$4,051	1.5	\$72.64
Monkey	FRT-3	OLC1	0.9	170.0	0.3	40.1	4.0	1.0	153	1.0	17.1	11.9	\$464	0.3	\$69.75
Salem Hollow	87+89	OLC1	86.2	357.0	67.7	1102.2	16.0	2.0	153	2.0	2673.0	1959.4	\$72,703	67.3	\$49.12
Snake Hollow	ATC-03	OLC1	2.1	75.5	0.4	101.2	4.0	0.5	153	1.0	22.4	22.5	\$627	0.3	\$72.88
Dixie Hollow	DIX-14	OLC1	50.0	220.0	24.2	586.8	8.0	2.0	153	2.0	1002.4	521.6	\$26,624	24.0	\$65.22
Long Hollow	LON-93	OLC1	268.0	89.0	52.5	214.5	4.0	0.5	153	1.0	47.5	47.7	\$1,330	2.4	\$70.72
Brush Fork	BR-32A	OLC10	163.0	384.0	137.7	155.6	6.0	1.5	153	1.5	149.6	86.5	\$3,998	15.0	\$66.59
Monkey	FRT-5	OLC10	29.4	90.5	5.9	384.7	8.0	1.5	153	1.5	421.4	285.0	\$11,389	5.8	\$57.98
Snake Hollow	SNA-61	OLC10	163.0	92.5	33.2	492.9	6.0	1.5	153	1.5	473.6	273.8	\$12,662	8.4	\$68.68
Brush Fork	MS7C	OLC11	288.1	90.1	57.1	132.5	6.0	1.5	153	1.5	127.3	73.6	\$3,403	3.2	\$66.68
Monkey	FRT-1	OLC11	35.9	39.3	3.1	382.3	8.0	1.5	153	1.5	418.7	283.2	\$11,318	3.0	\$58.72
Brush Fork	BR-MS7	OLC12	172.8	83.5	31.7	141.2	5.0	1.5	153	1.5	126.2	65.4	\$3,352	2.6	\$72.92
Brush Fork	BR-21	OLC13	8.5	164.0	3.1	110.7	5.0	1.5	153	1.5	99.0	51.3	\$2,628	1.4	\$76.04
Brush Fork	BR-20	OLC14	98.7	251.0	54.5	152.4	5.0	1.5	153	1.5	136.2	70.5	\$3,616	7.7	\$78.41
Brush Fork	MSSP1	OLC2	62.4	85.4	11.7	103.0	8.0	2.0	153	2.0	175.9	91.5	\$4,671	3.1	\$68.38
Monkey	FRT-4	OLC2	1.3	227.5	0.7	63.6	4.0	1.0	153	1.0	27.2	18.8	\$736	0.7	\$68.74
Snake Hollow	ATC-02	OLC2	62.4	94.7	13.0	42.7	5.0	1.5	153	1.5	38.2	19.8	\$1,014	0.6	\$74.89

Subwatershed	Site	Treatment Unit	Q, gpm	Total Acidity, mg/L	Acid Load, tpy	L, ft	W, ft	H, ft	A, deg	F, Ft	Limestone, tons	Excavation, yd ³	Estimated Cost	Acid Load Removed, tpy	Treatment Efficiency, \$/ton
Dixie Hollow	DIX-98	OLC2	61.0	205.0	27.5	706.5	8.0	2.0	153	2.0	1206.9	628.0	\$32,056	27.3	\$41.95
Long Hollow	LON-94	OLC2	114.9	71.0	17.9	22.1	8.0	2.0	153	2.0	37.7	19.6	\$1,002	1.5	\$66.25
Brush Fork	MSSP2	OLC3	118.9	140.5	36.7	162.8	8.0	2.0	153	2.0	278.0	144.7	\$7,385	45.7	\$80.84
Monkey	MNK-7A	OLC3	2.6	304.5	1.7	129.4	4.0	1.0	153	1.0	55.3	38.3	\$1,496	1.7	\$66.53
Snake Hollow	SNA-64	OLC3	118.9	88.0	23.0	100.4	5.0	1.5	153	1.5	89.7	46.5	\$2,382	1.4	\$75.46
Long Hollow	LON-95	OLC3	242.4	26.0	13.9	290.1	8.0	1.5	153	1.5	317.7	214.9	\$8,588	5.8	\$43.20
Brush Fork	BR-5E50	OLC4	7.1	141.0	2.2	141.0	5.0	1.5	153	1.5	126.0	65.3	\$3,345	1.1	\$75.02
Monkey	FRT-2	OLC4	2.2	137.0	0.7	76.9	5.0	1.0	153	1.0	36.3	28.5	\$992	0.7	\$61.78
Snake Hollow	ATC-04	OLC4	7.1	62.6	1.0	91.0	5.0	1.5	153	1.5	81.3	42.1	\$2,159	1.0	\$76.00
Long Hollow	S-27	OLC4	695.7	26.0	39.8	126.7	5.0	1.5	153	1.5	113.2	58.6	\$3,006	1.5	\$75.77
Brush Fork	MSSP3	OLC5	358.5	210.4	165.9	162.1	6.0	1.5	153	1.5	155.8	90.1	\$4,164	11.9	\$49.85
Monkey	MNK-8	OLC5	6.0	232.6	3.1	188.9	6.0	1.0	153	1.0	97.6	84.0	\$2,692	3.0	\$55.44
Snake Hollow	SNA-62	OLC5	358.5	115.5	91.1	258.9	6.0	1.5	153	1.5	248.8	143.9	\$6,652	5.2	\$67.77
Brush Fork	BR-6WB	OLC6	39.9	148.0	13.0	167.4	5.0	1.5	153	1.5	149.6	77.5	\$3,973	3.9	\$73.63
Monkey	FRT-5A	OLC6	7.6	100.0	1.7	203.9	6.0	1.0	153	1.0	105.3	90.6	\$2,905	1.7	\$56.58
Snake Hollow	ATC-01	OLC6	39.9	227.7	20.0	405.6	6.0	1.5	153	1.5	389.7	225.3	\$10,419	13.4	\$64.75
Brush Fork	BR-6WC	OLC7	35.9	132.0	10.4	131.4	5.0	1.5	153	1.5	117.4	60.8	\$3,118	2.8	\$73.35
Monkey	MNK-1	OLC7	9.8	169.0	3.7	195.3	6.0	1.5	153	1.5	187.6	108.5	\$5,016	3.6	\$69.19
Snake Hollow	SNA-63	OLC7	35.9	115.5	9.1	394.7	6.0	1.5	153	1.5	379.2	219.3	\$10,139	7.9	\$67.77
Brush Fork	MSSP5	OLC8	150.9	206.9	68.7	150.0	6.0	1.5	153	1.5	144.1	83.3	\$3,853	1.6	\$345.13
Monkey	MNK-11	OLC8	18.9	246.5	10.3	806.9	6.0	1.5	153	1.5	775.3	448.3	\$20,728	10.2	\$67.77
Snake Hollow	SNA-60	OLC8	150.9	430.5	143.0	852.9	12.0	1.5	153	1.5	1163.6	947.7	\$31,932	34.2	\$49.08
Brush Fork	BR-4W	OLC9	9.8	228.0	4.9	143.4	5.0	0.5	153	1.0	34.9	39.8	\$993	1.6	\$69.17
Monkey	MNK-13	OLC9	21.1	128.1	5.9	806.9	8.0	1.5	153	1.5	883.8	597.7	\$23,888	5.9	\$156.54
Snake Hollow	ATC-07	OLC9	9.8	97.5	2.1	644.4	6.0	1.0	153	1.0	333.0	286.4	\$9,183	7.6	\$55.05
Jobs Hollow	JOB-7	OLC7	27.3	35.3	2.1	1200.0	4.0	3.0	153	1.0	1851.1	711.1	\$48,411	2.1	\$79.50

Table 10. Monday Creek Slag Leach Bed Designs (SLB).

Subwatershed	Site	Treatment Unit	Q, gpm	Total Acidity, mg/L	Acid Load, tpy	L, ft	W, ft	H, ft	Excavation, yd ³	Steel Slag, tons	Estimated Cost	Acid Load Removed, tpy	Treatment Efficiency, \$/ton
Whitmore C.	WC	SLB	120.0	0.0	0.0	204.4	204.4	4.0	7738.2	12566.9	\$337,387	132.0	\$411.59
Spencer H.	SPN	SLB	50.0	42.0	4.6	132.0	132.0	4.0	3224.3	5236.2	\$130,905	55.0	\$383.27
Lost Run	LR-1E	SLB-1E1	530.4	17.5	20.4	118.0	118.0	4.0	2578.5	4187.5	\$112,423	55.0	\$157.24
Lost Run	LR-3E	SLB-3E1	227.6	160.7	80.5	74.6	74.6	4.0	1031.8	1675.6	\$44,985	22.0	\$157.29
Coe Hollow	SOUTH-TRIB	SLB-1	4.3	0.0	0.0	25.0	20.0	4.0	92.6	150.4	\$4,037	4.8	\$136.27
Coe Hollow	UP-MAIN	SLB-2	20.8	0.0	0.0	25.0	20.0	4.0	92.6	150.4	\$4,037	22.9	\$28.39
Brush Fork	BR-TOP	SLB1	47.1	8.9	0.9	128.1	128.1	4.0	3039.0	4935.3	\$132,500	51.8	\$411.59
Monkey Hollow	FRT-6	SLB1	100.0	27.3	6.0	186.6	186.6	4.0	6448.5	10472.4	\$281,156	110.0	\$411.59
Dixie Hollow	DIX-4	SLB1	20.0	0.0	0.0	46.0	46.0	4.0	391.9	636.4	\$15,909	22.0	\$116.45
Long Hollow	LON-4	SLB1	100.0	-500.0	-110.0	102.0	102.0	4.0	1926.7	3128.9	\$78,223	110.0	\$114.51
Brush Fork	SM-E-MSBS	SLB2	31.1	0.0	0.0	104.0	104.0	4.0	2002.3	3251.7	\$87,299	34.2	\$411.59
Brush Fork	BR-MSSP7E	SLB3	8.5	81.6	1.5	54.5	54.5	4.0	549.9	893.1	\$23,976	9.4	\$411.59
Jobs Hollow	JOB-US	SLBUS	27.3	4.6	0.3	97.5	97.5	4.0	1759.7	2850.8	\$76,548	120.1	\$40.10
Jobs Hollow	JOB-10	SLB10	75.9	12.8	2.1	162.5	162.5	4.0	4891.4	7924.0	\$212,774	333.8	\$40.10
Jobs Hollow	JOB-5	SLB5	27.3	5.8	0.4	97.5	97.5	4.0	1759.7	2850.8	\$76,548	120.1	\$40.10

Table 11. Monday Creek Aerobic Wetland Designs (WL).

Subwatershed	Site	Treatment Unit	Q, gpm	L, ft	W, ft	H, ft	Excavation, yd ³	Limestone, tons	Estimated Cost
Whitmore C.	WC	WL	120.0	210.0	210.0	4.0	6533.3	0.0	\$19,600
Spencer H.	SPN	WL	50.0	120.0	120.0	4.0	2133.3	0.0	\$6,400
Rock Run	MOUTH	WL	815.0	1740.0	660.0	1.0	42533.3	0.0	\$127,600
Sycamore H.	RM-3.4	WL	782.4	1077.0	1077.0	3.0	128881.0	0.0	\$386,643
Orbiston	302+304	WL 1	96.3	792.4	792.4	3.0	69765.1	0.0	\$209,295
Coe Hollow	MAINSTEM	WL COE	99.9	60.0	15.0	4.0	133.3	161.3	\$4,433
Monkey Hollow	FRT-6	WL1	100.0	104.4	104.4	3.0	1614.7	0.0	\$4,844
Snake Hollow	US SNA-65	WL1	494.0	522.0	522.0	3.0	40368.0	0.0	\$121,104

Table 12. Monday Creek Subsidence Closure Designs.

Subwatershed	Acid Load Removed, tpy	Capture Area, acres	Restored Stream Length, feet	Estimated Cost	Estimated Service Life, years	Treatment Efficiency, \$/ton
Brush Fork	130.73	1,275.29	14,268	\$624,653	30	\$159.28
Coe Hollow	26.03	75.11	2,847	\$124,642	30	\$159.64
Lost Run	106.09	578.32	14,134	\$618,787	30	\$194.43
Monkey Hollow	35.87	319.70	4,551	\$199,243	30	\$185.16
Total	298.72	2,248.42	35,800	\$1,567,325	30	\$174.89

Figures

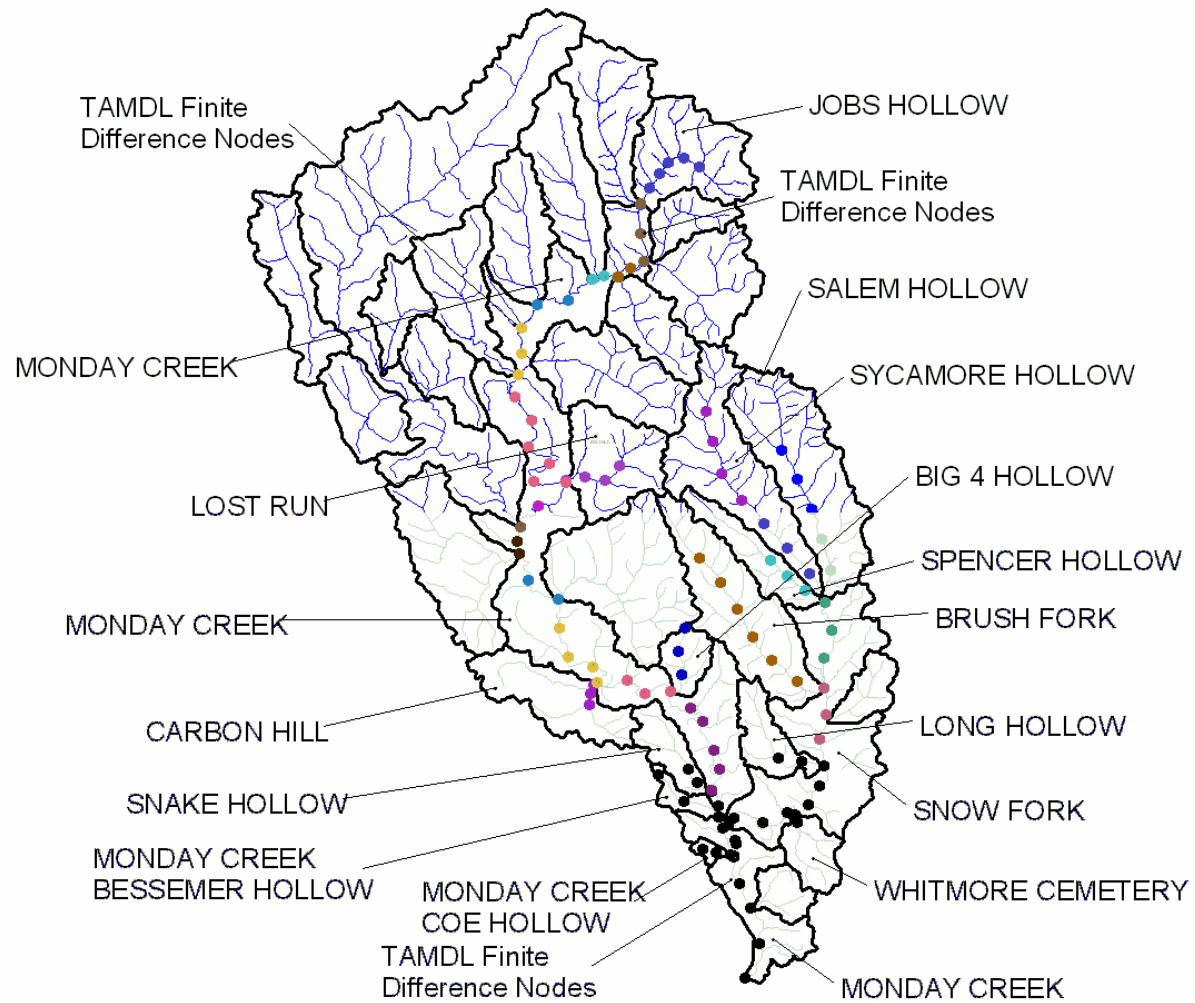


Figure 1. Computational Domain of the Monday Creek *TAMDL* model.

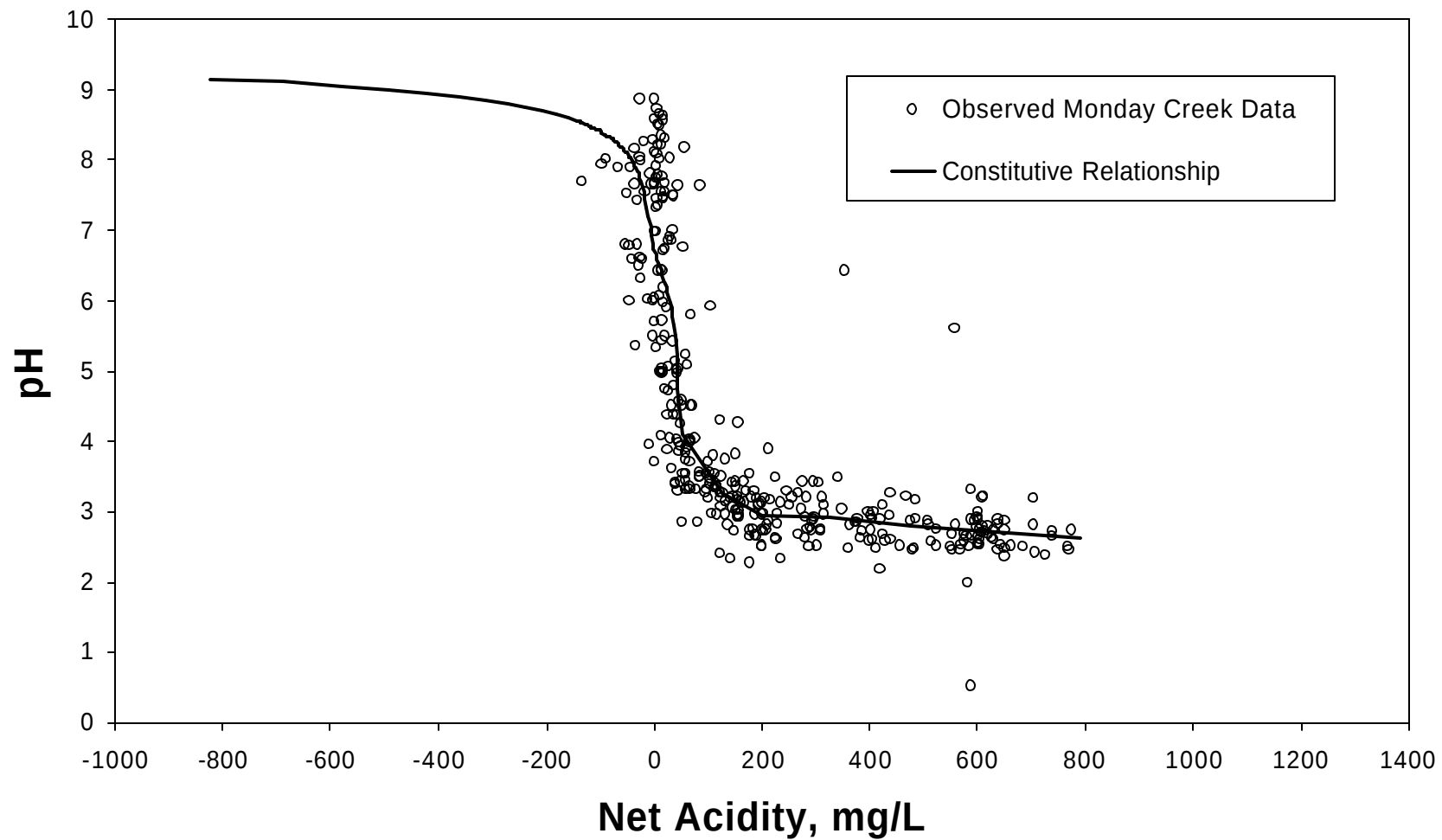


Figure 2. Comparison of Empirical Net Acidity – pH Constitutive Relationship with Observed Data.

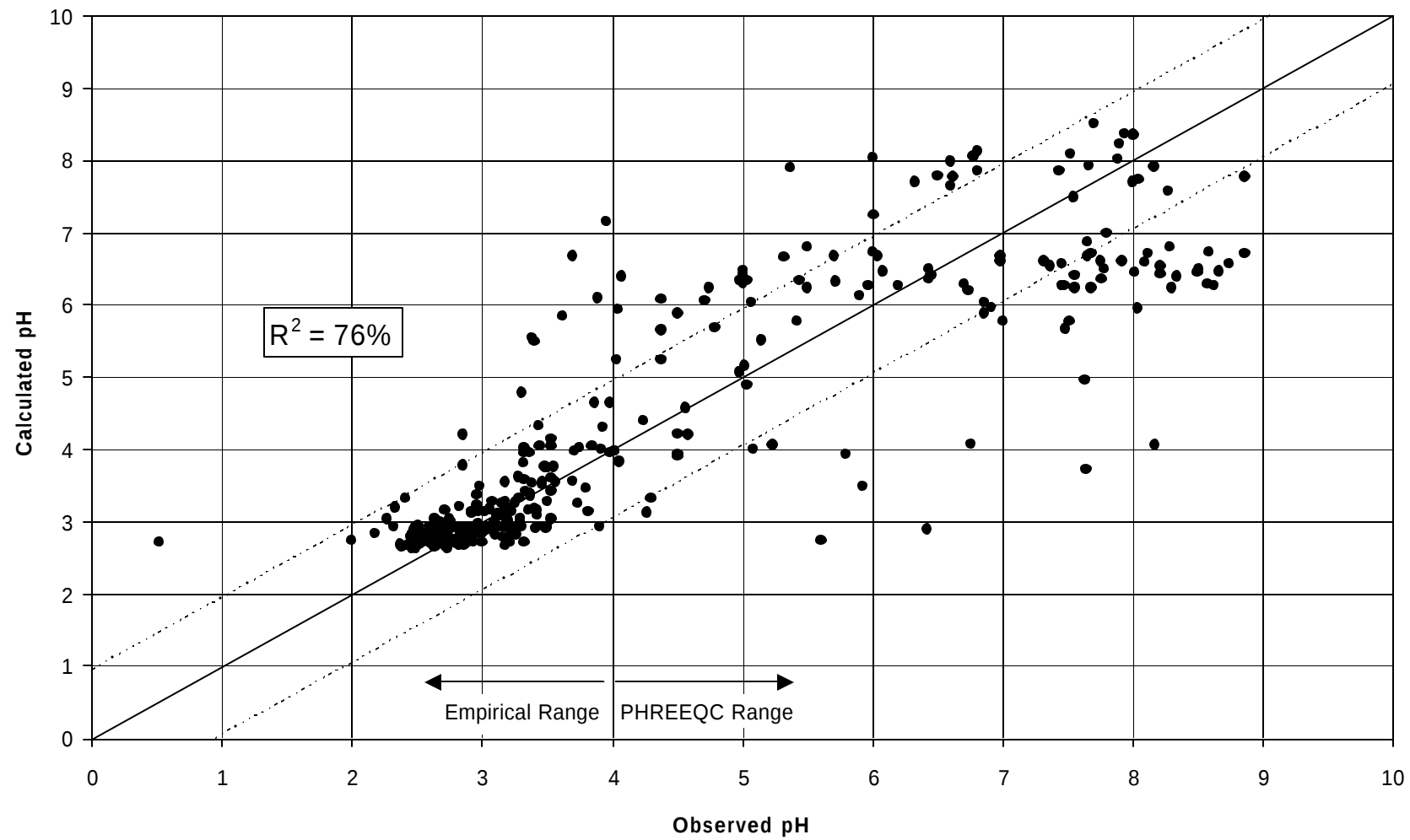


Figure 3. Box-plot comparison of Empirical Net Acidity – pH Constitutive Relationship with Observed Data.

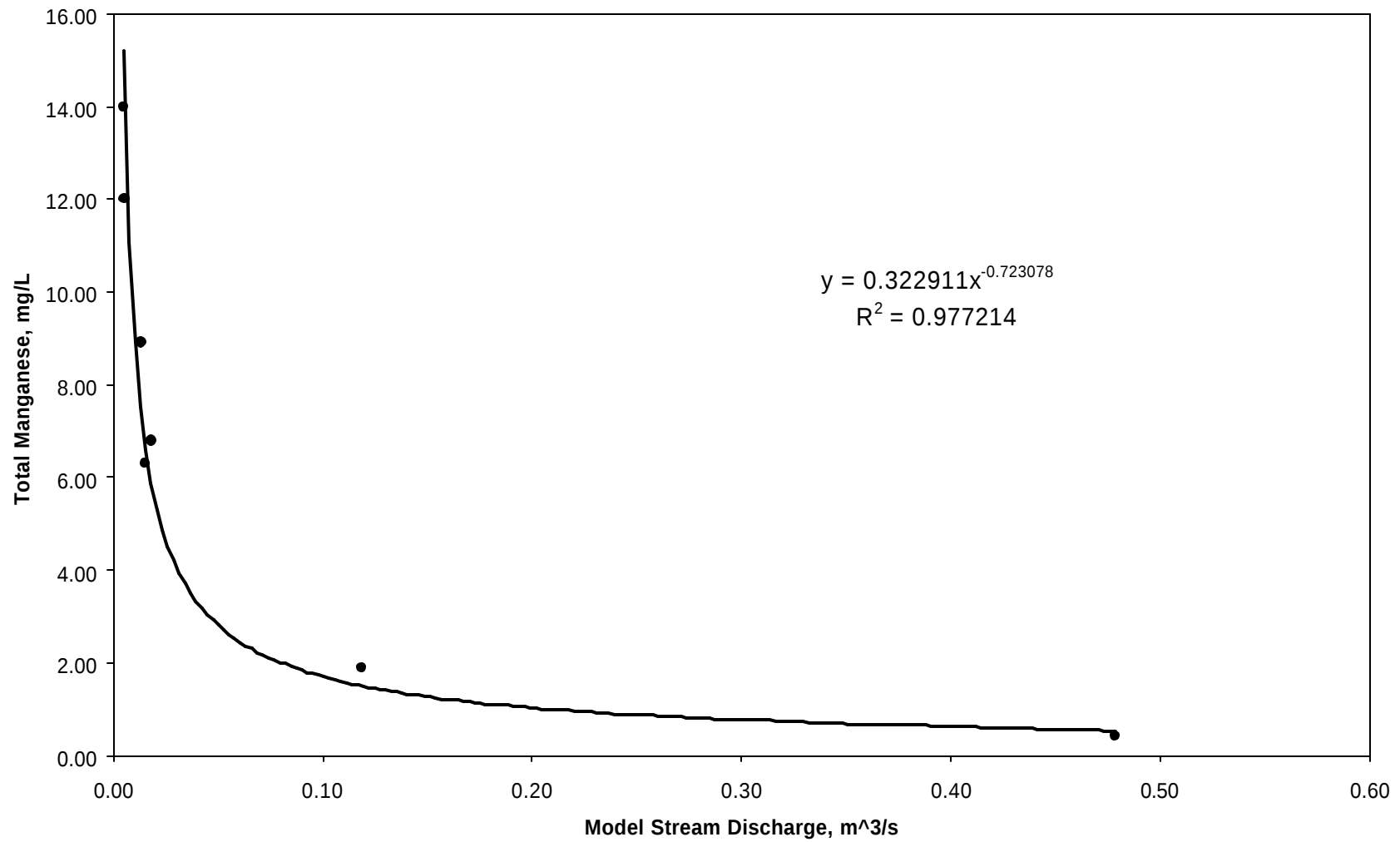


Figure 4. Regression Formula for Manganese at Stream Station JS-8 in the Jobs Hollow Subwatershed.

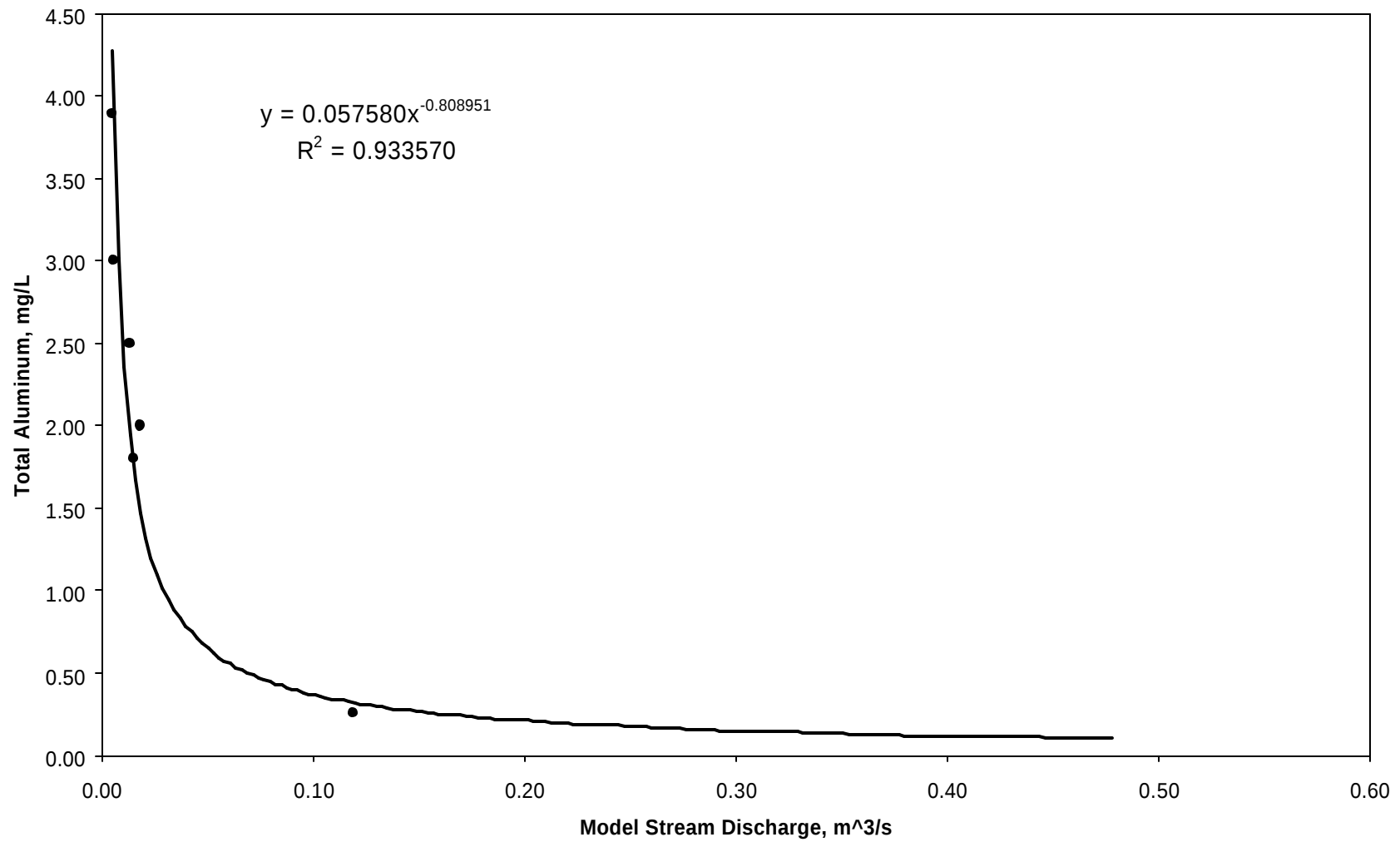


Figure 5. Regression Formula for Aluminum at Stream Station JS-8 in the Jobs Hollow Subwatershed.

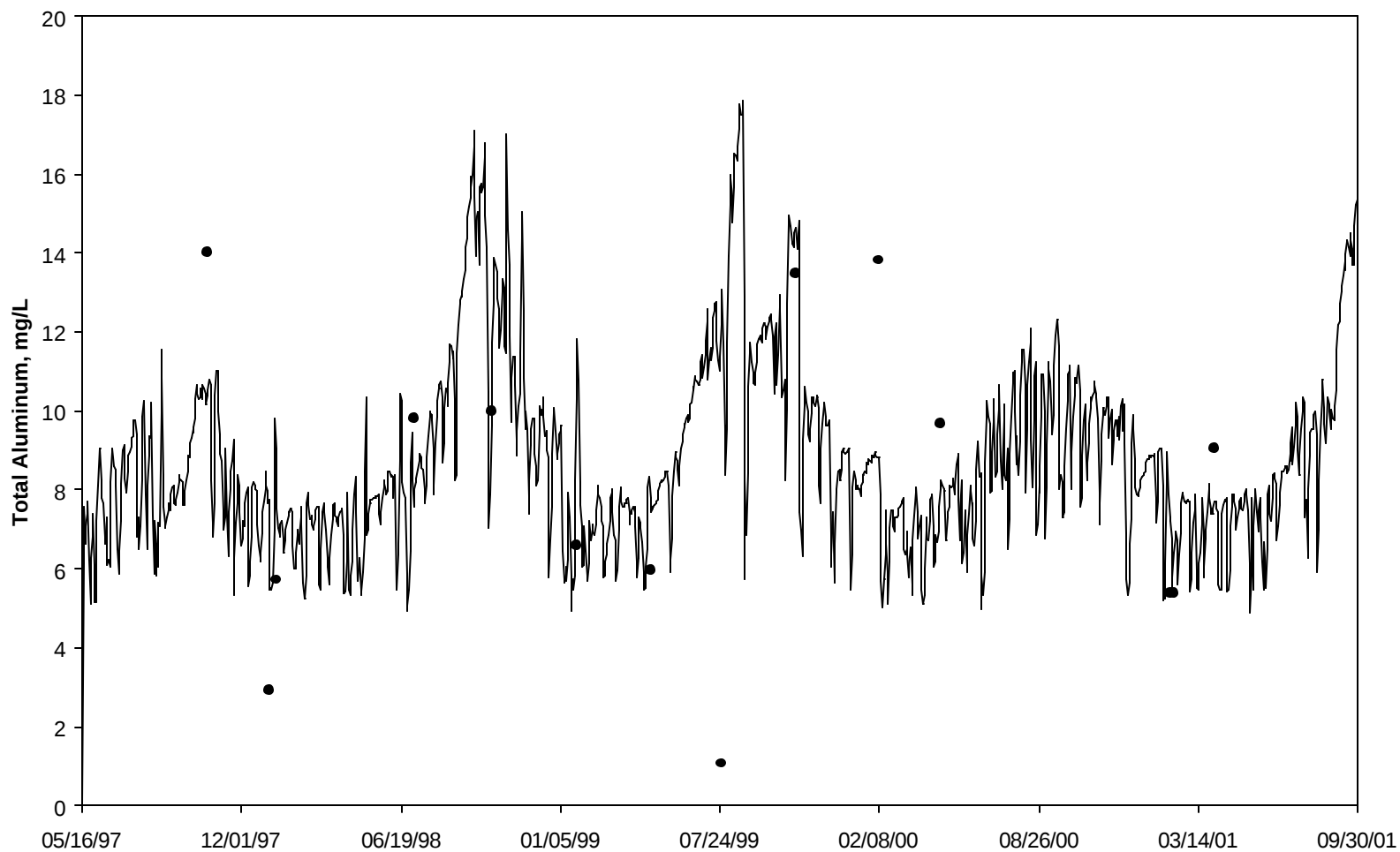


Figure 6. Simulated and Observed Aluminum Concentrations at Station JS-107-MC on Snow Fork of Monday Creek.

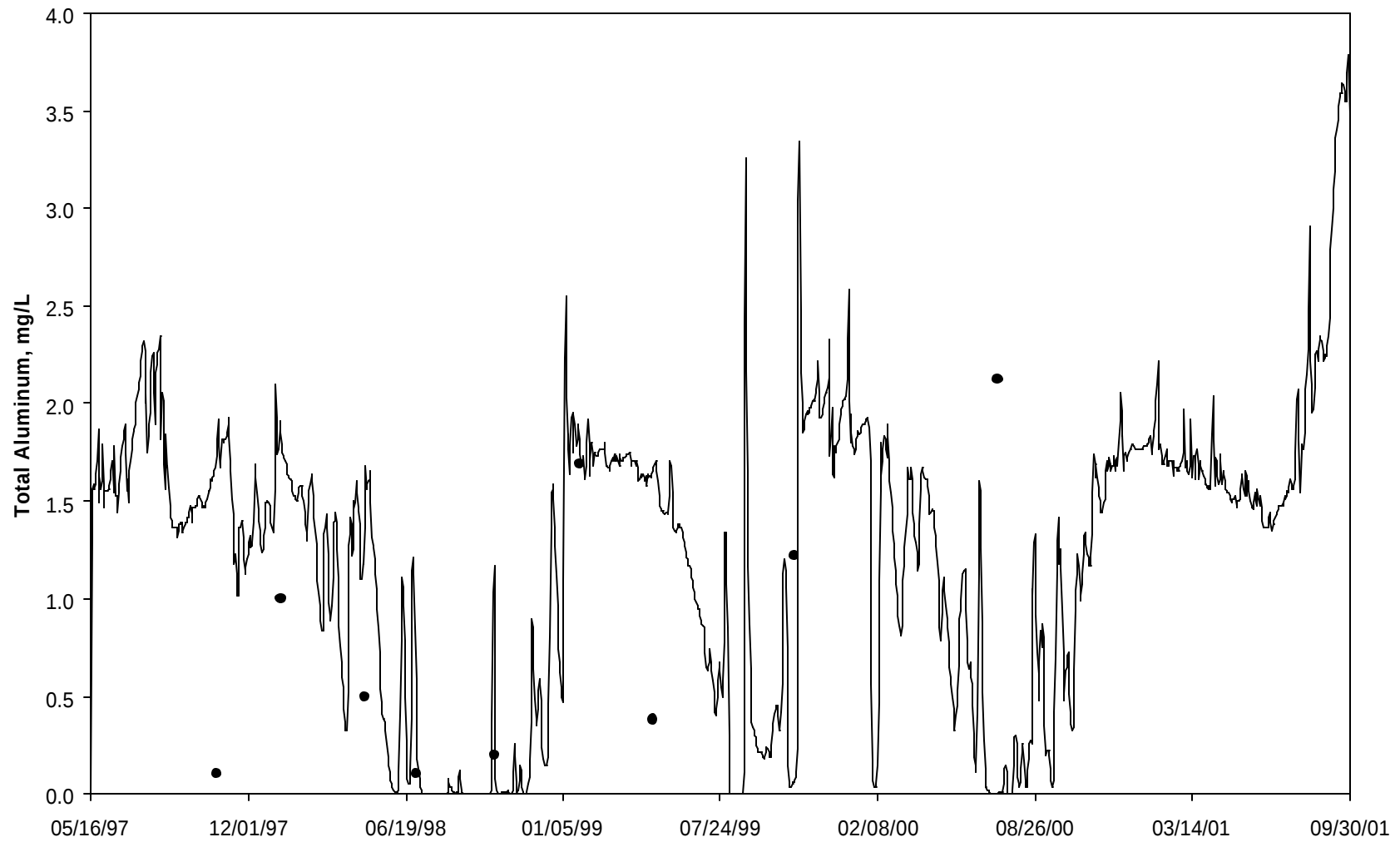


Figure 7. Simulated and Observed Aluminum Concentrations at Station JS-153-MC in Monday Creek.

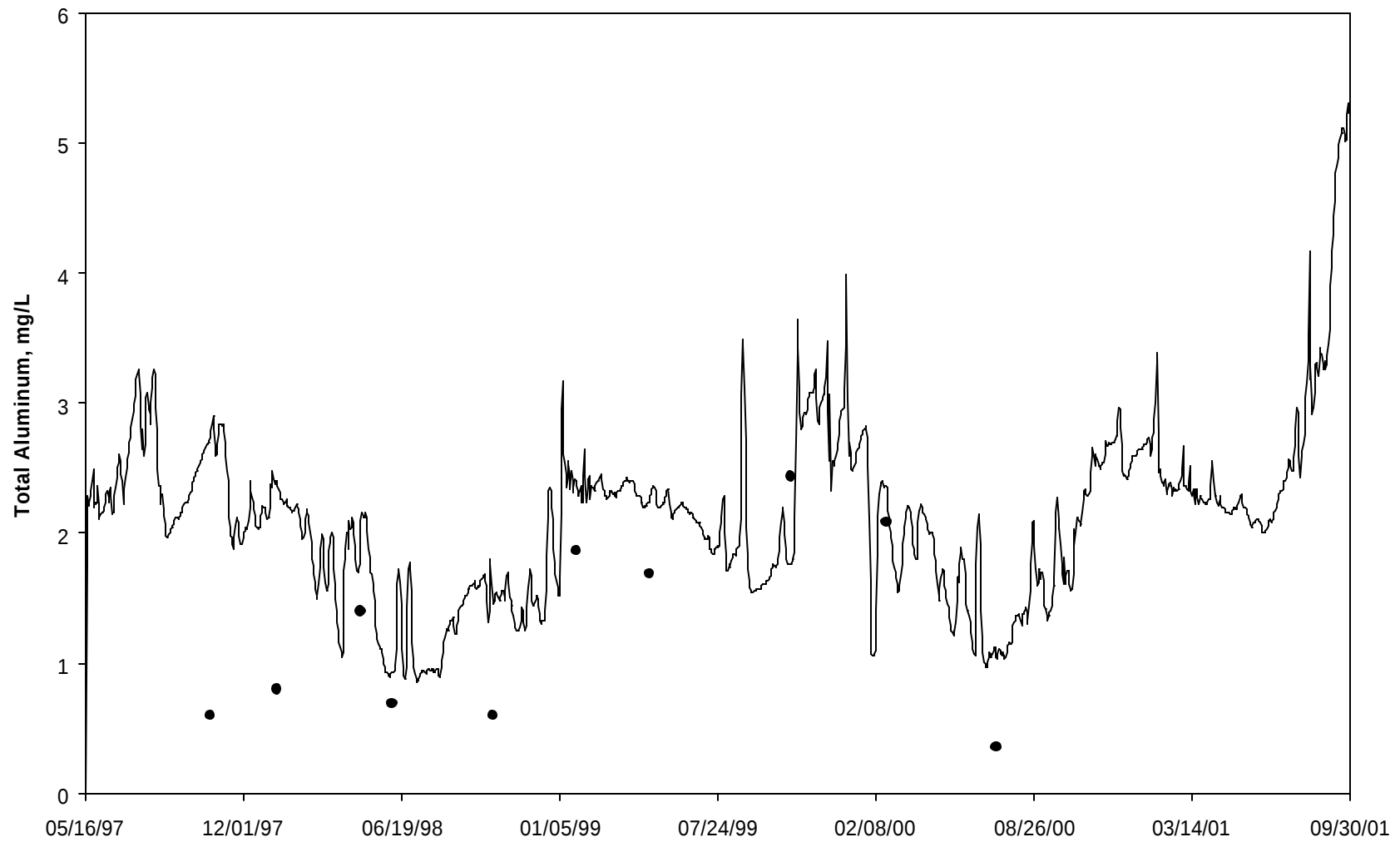


Figure 8. Simulated and Observed Aluminum Concentrations at Station JS-151-MC in Monday Creek.

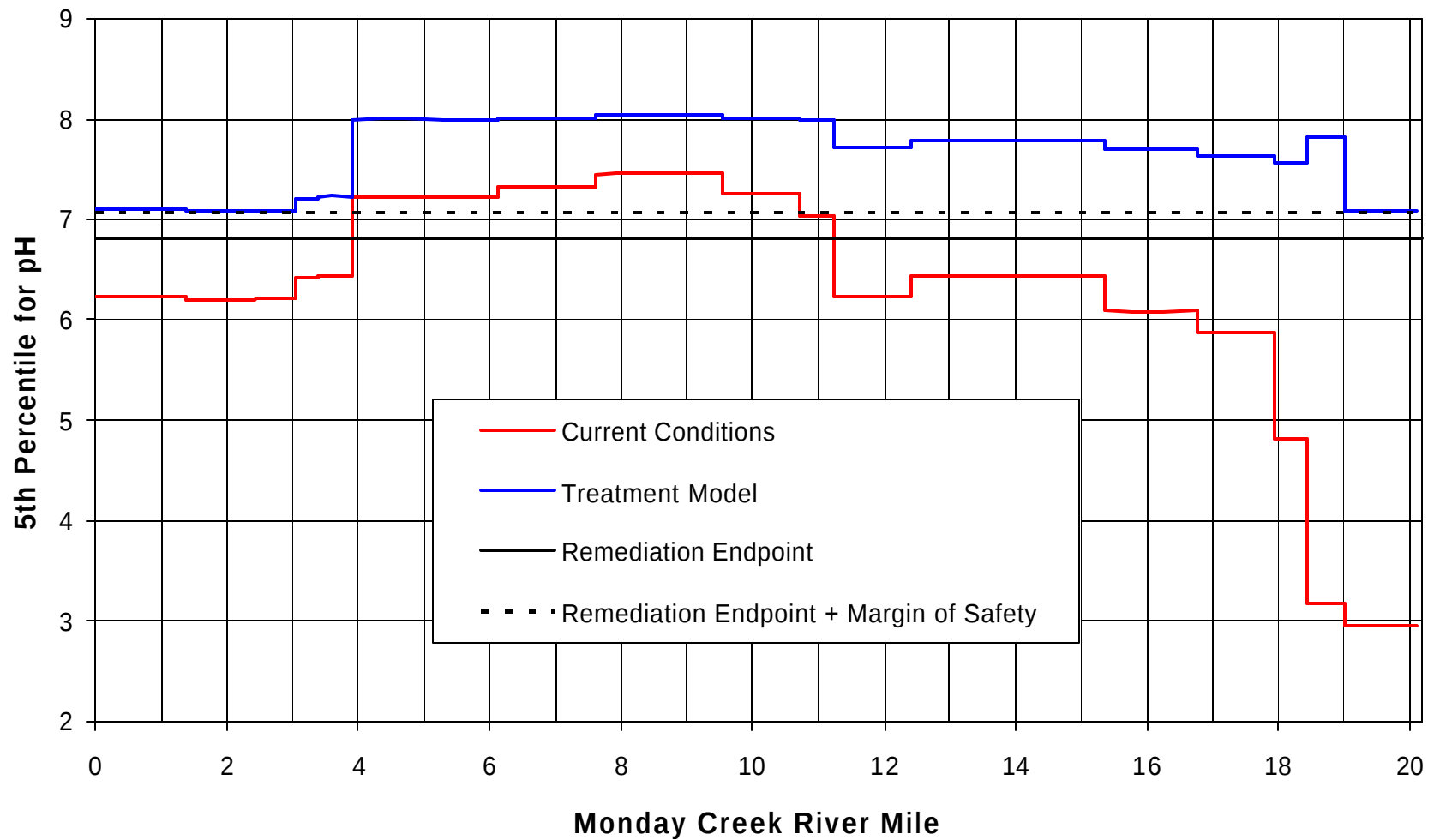


Figure 9. Simulated Pre- and Post-Treatment 5th Percentile of Stream pH for Monday Creek Mainstem.

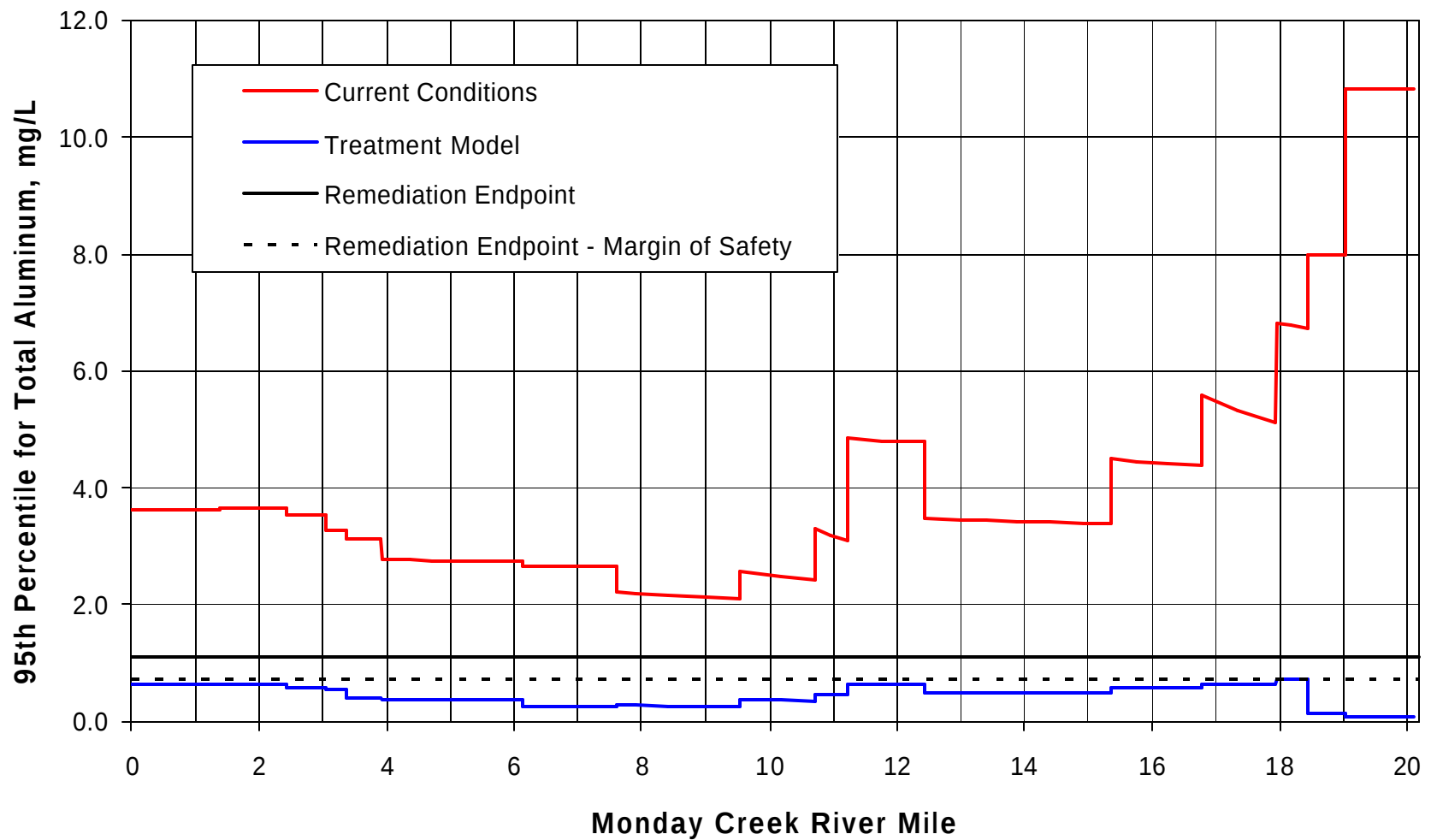


Figure 10. Simulated Pre- and Post-Treatment 95th Percentile of Aluminum Concentration for Monday Creek Mainstem.

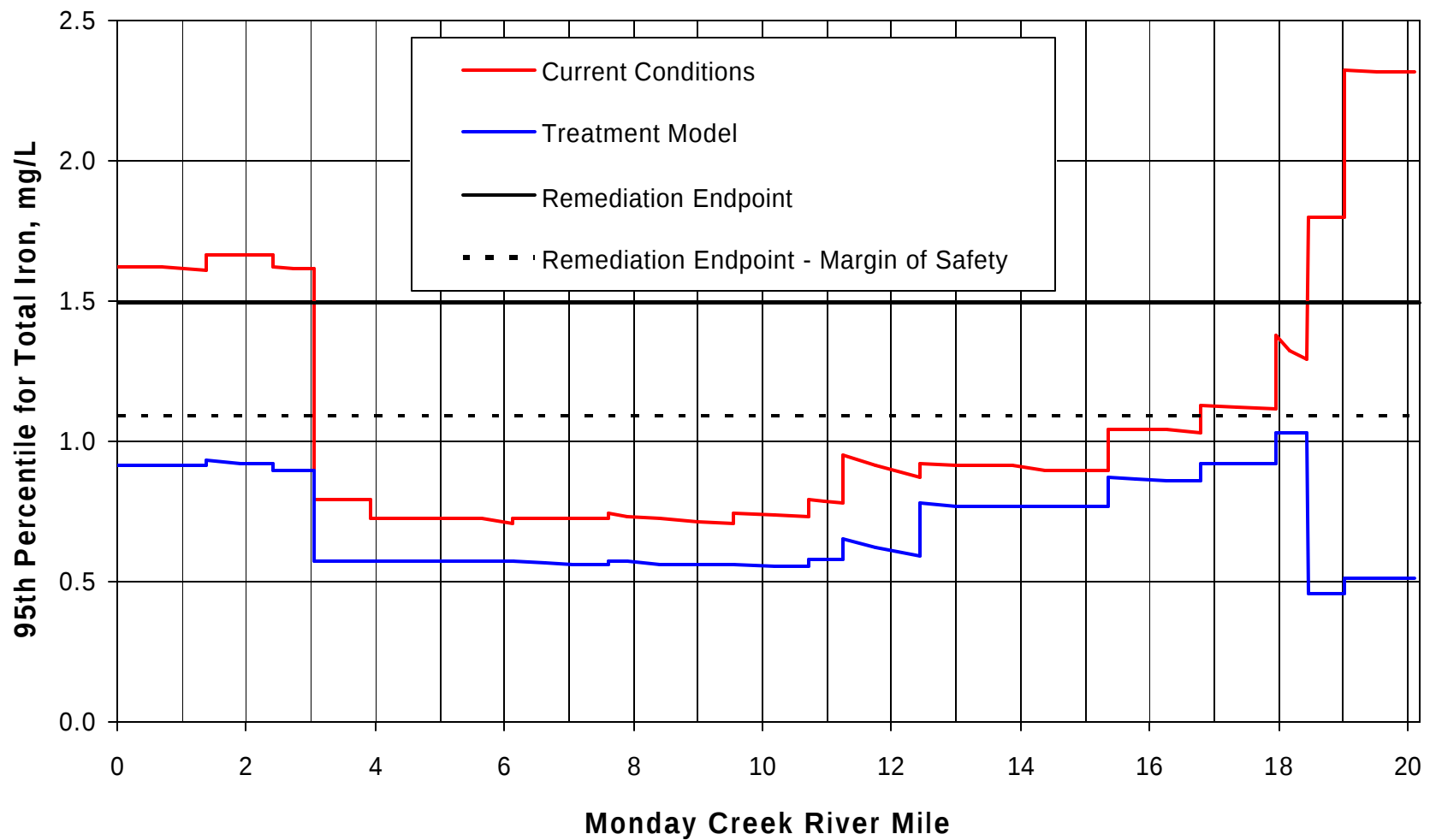


Figure 11. Simulated Pre- and Post-Treatment 95th Percentile of Iron Concentration for Monday Creek Mainstem.

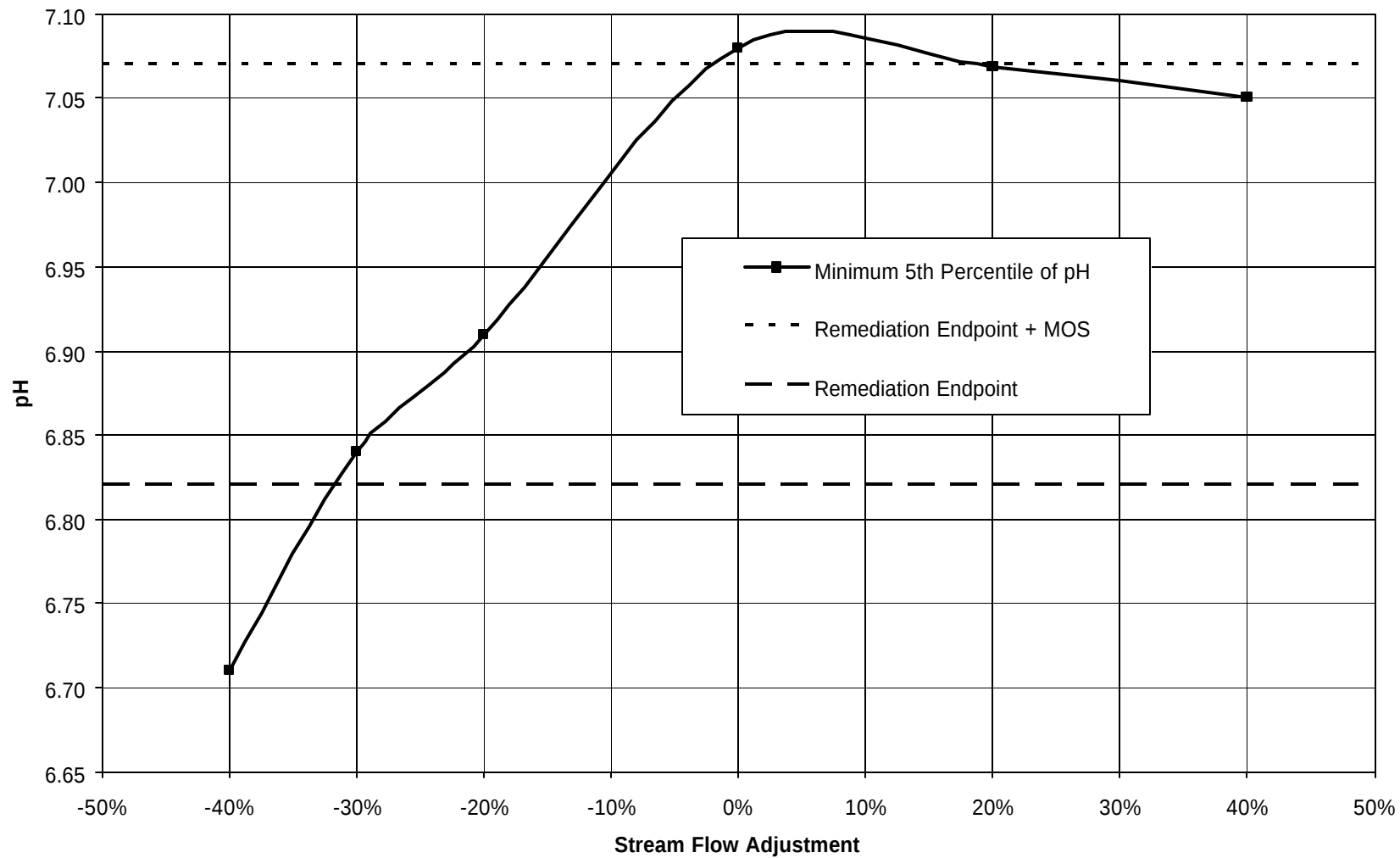


Figure 12. Minimum 5th Percentile Mainstem Stream pH calculated by Parametric Study Simulations.

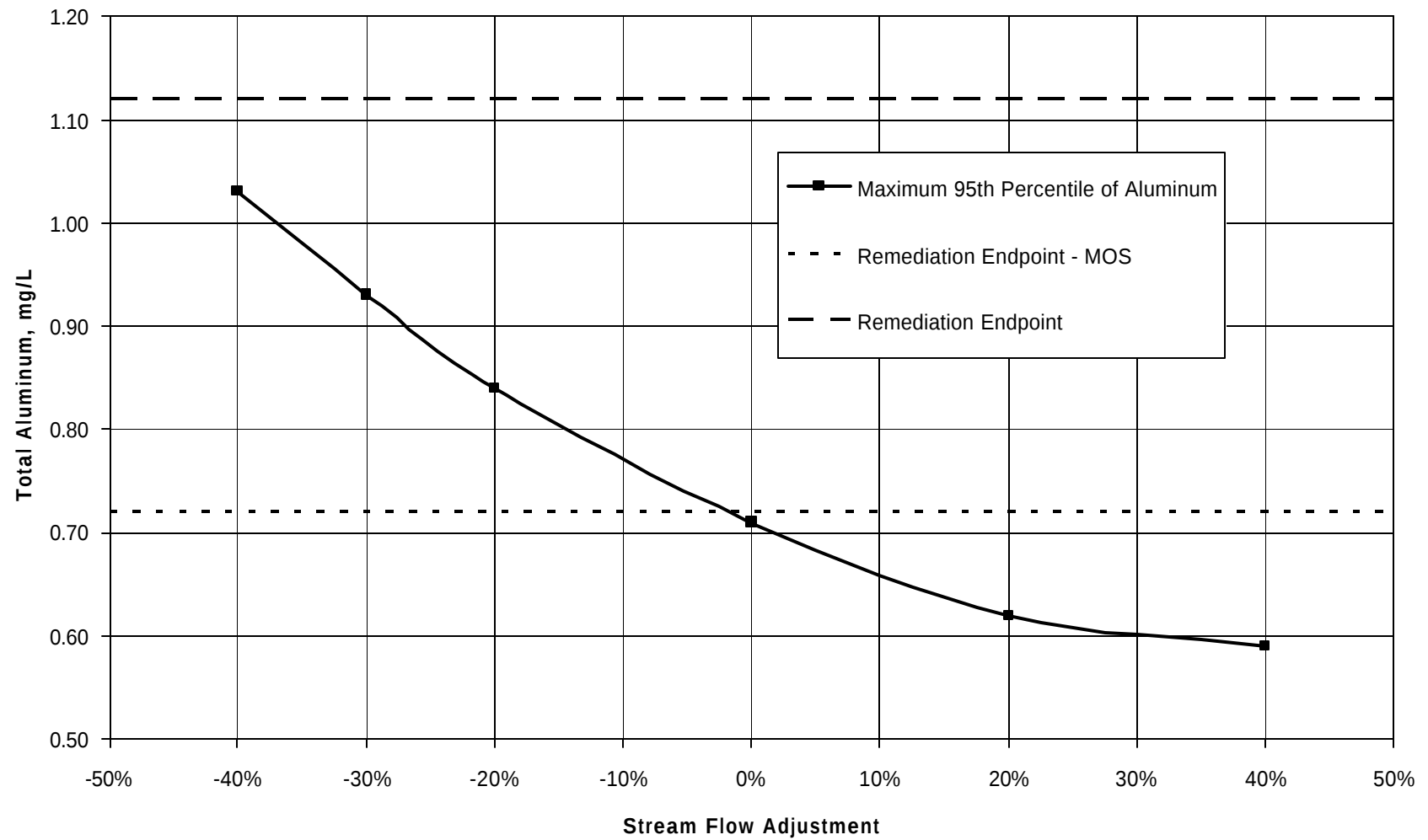


Figure 13. Maximum 95th Percentile Mainstem Aluminum Concentration calculated by Parametric Study Simulations.

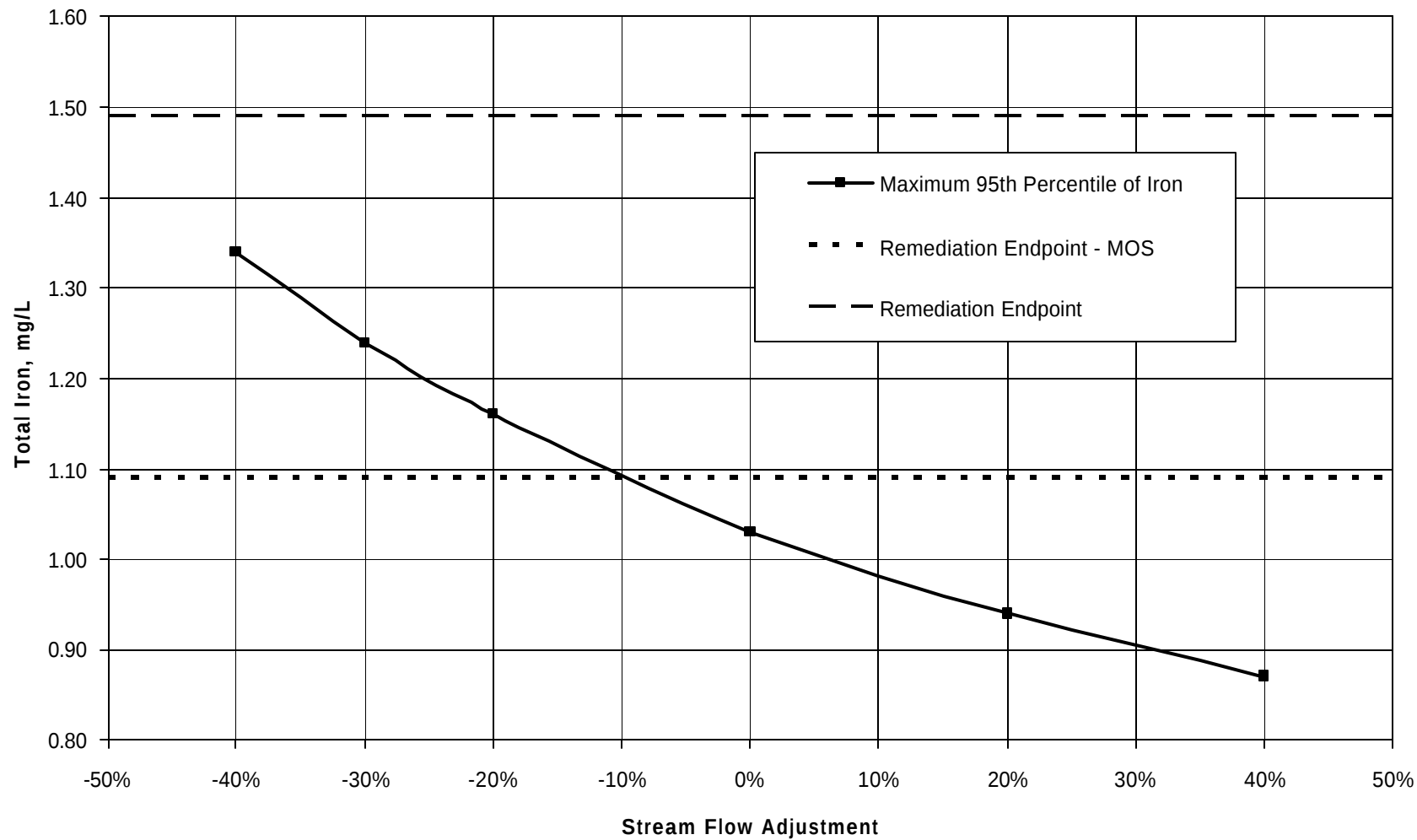


Figure 14. Maximum 95th Percentile Mainstem Iron Concentration Calculated by Parametric Study Simulations.

Monday Creek AMD Treatment

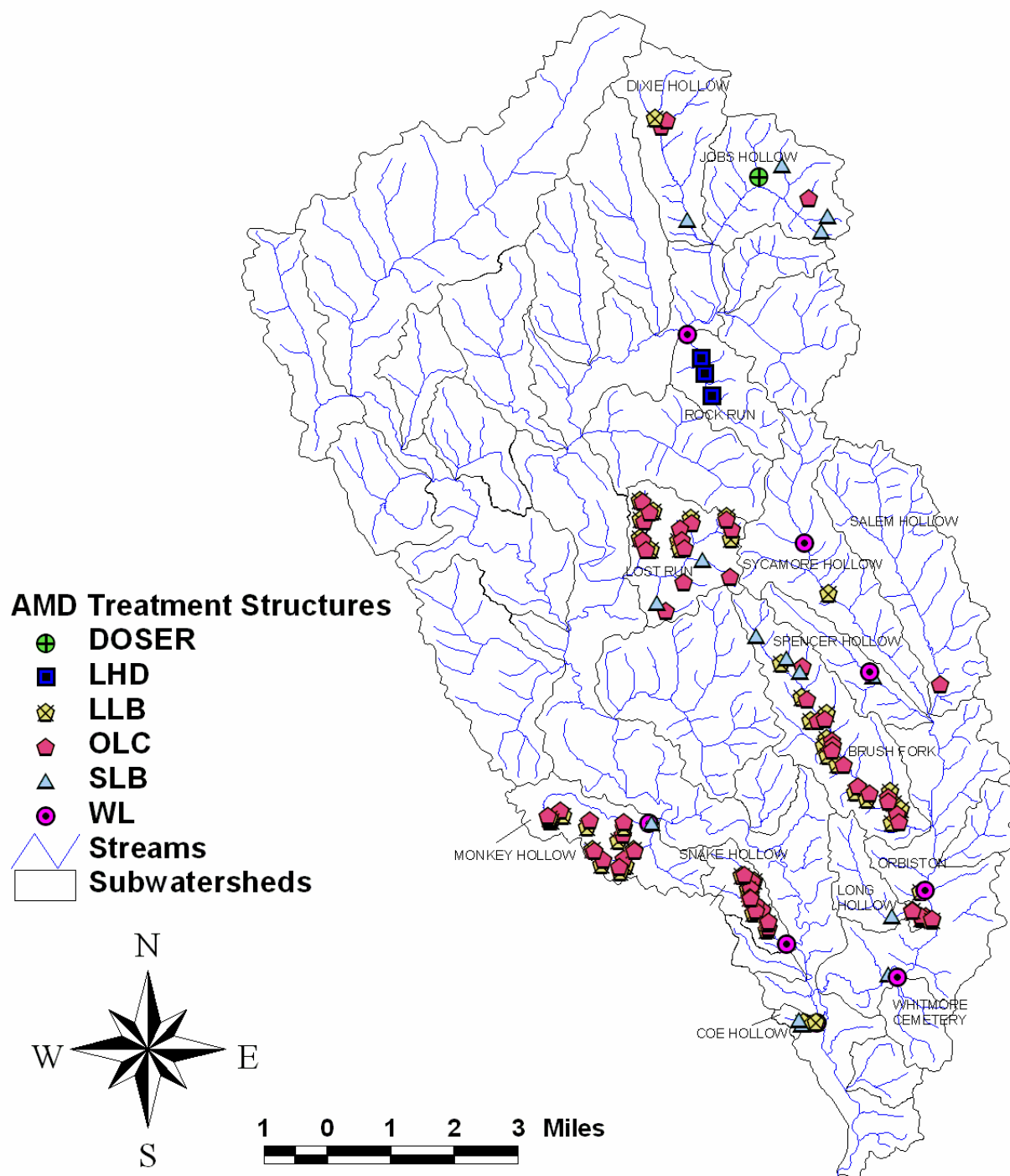


Figure 15. Designed AMD Treatment Structures for the Monday Creek Watershed.

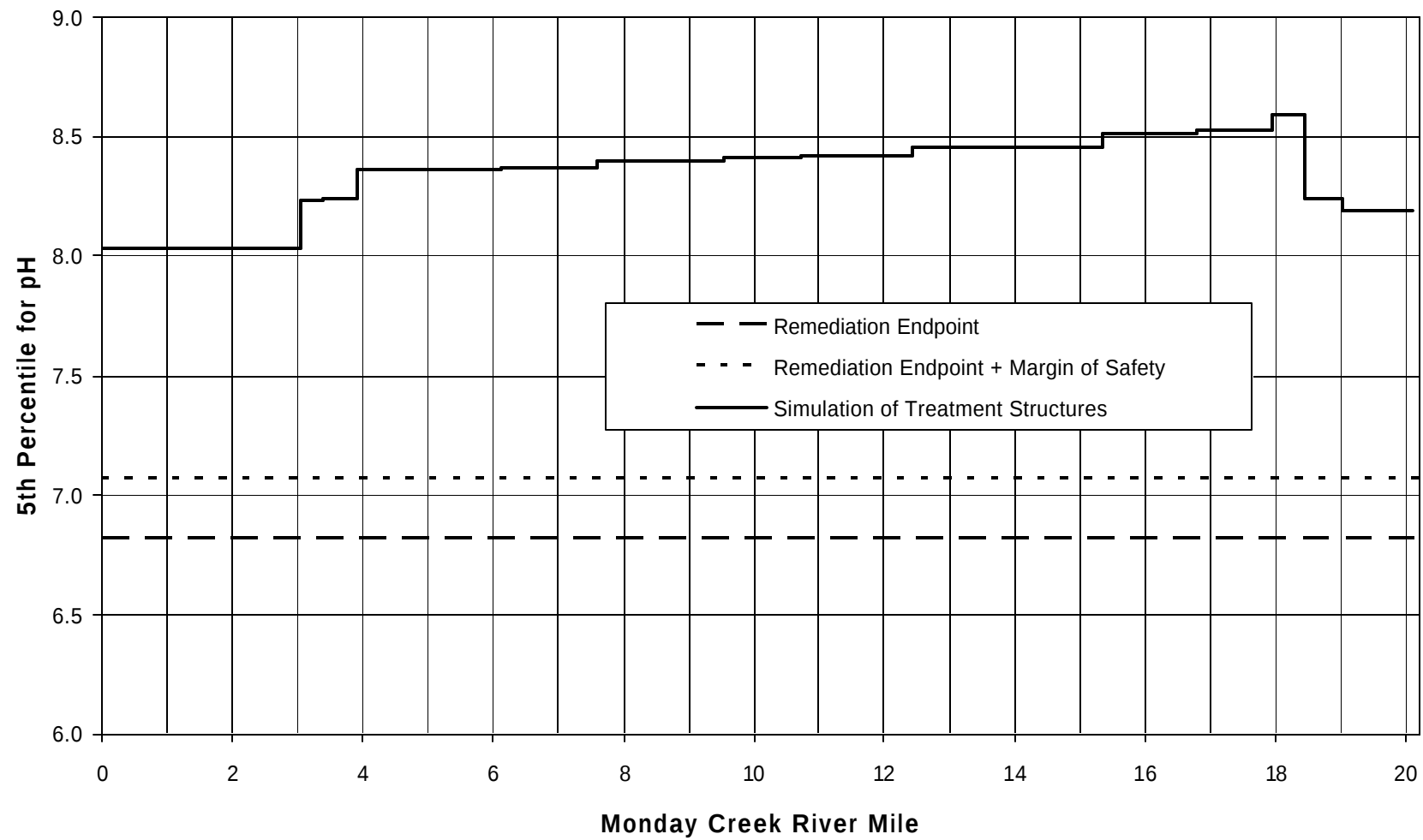


Figure 16. Simulated 5th Percentile Mainstem Stream pH Calculated by Direct Simulation of AMD Treatment Structures.

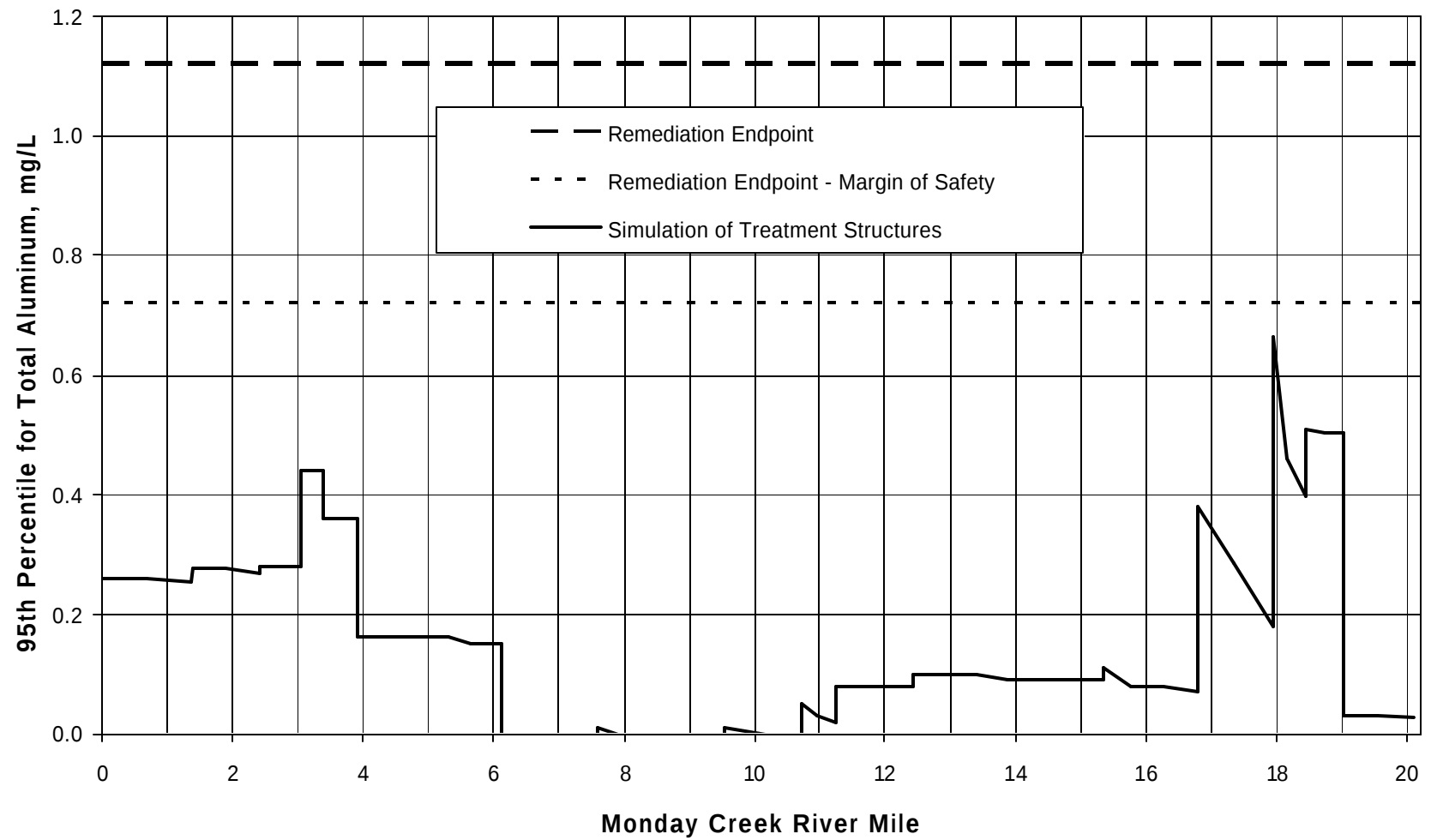


Figure 17. Simulated 95th Percentile Mainstem Aluminum Concentration Calculated by Direct Simulation of AMD Treatment Structures.

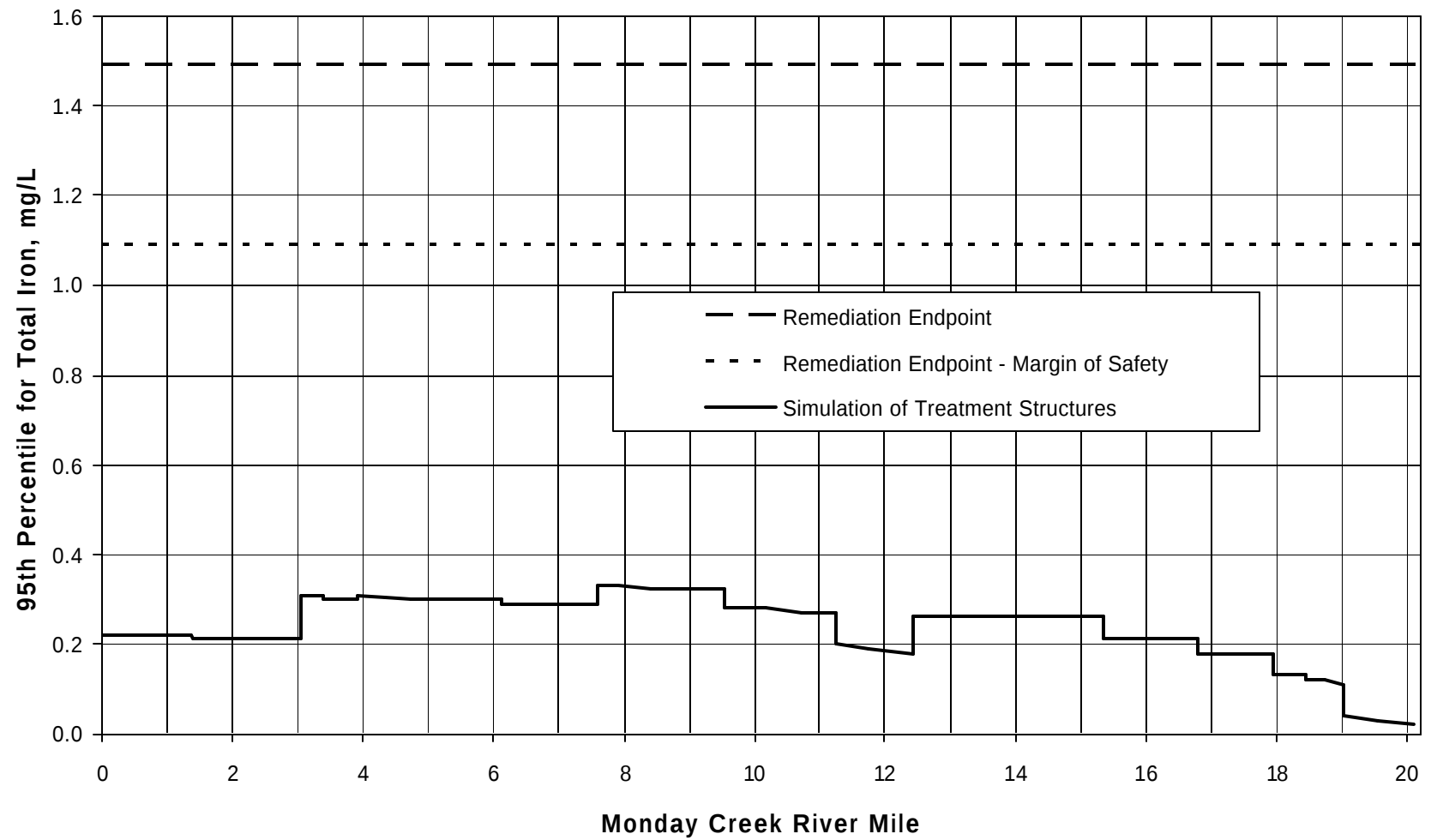


Figure 18. Simulated 95th Percentile Mainstem Iron Concentration Calculated by Direct Simulation of AMD Treatment Structures.

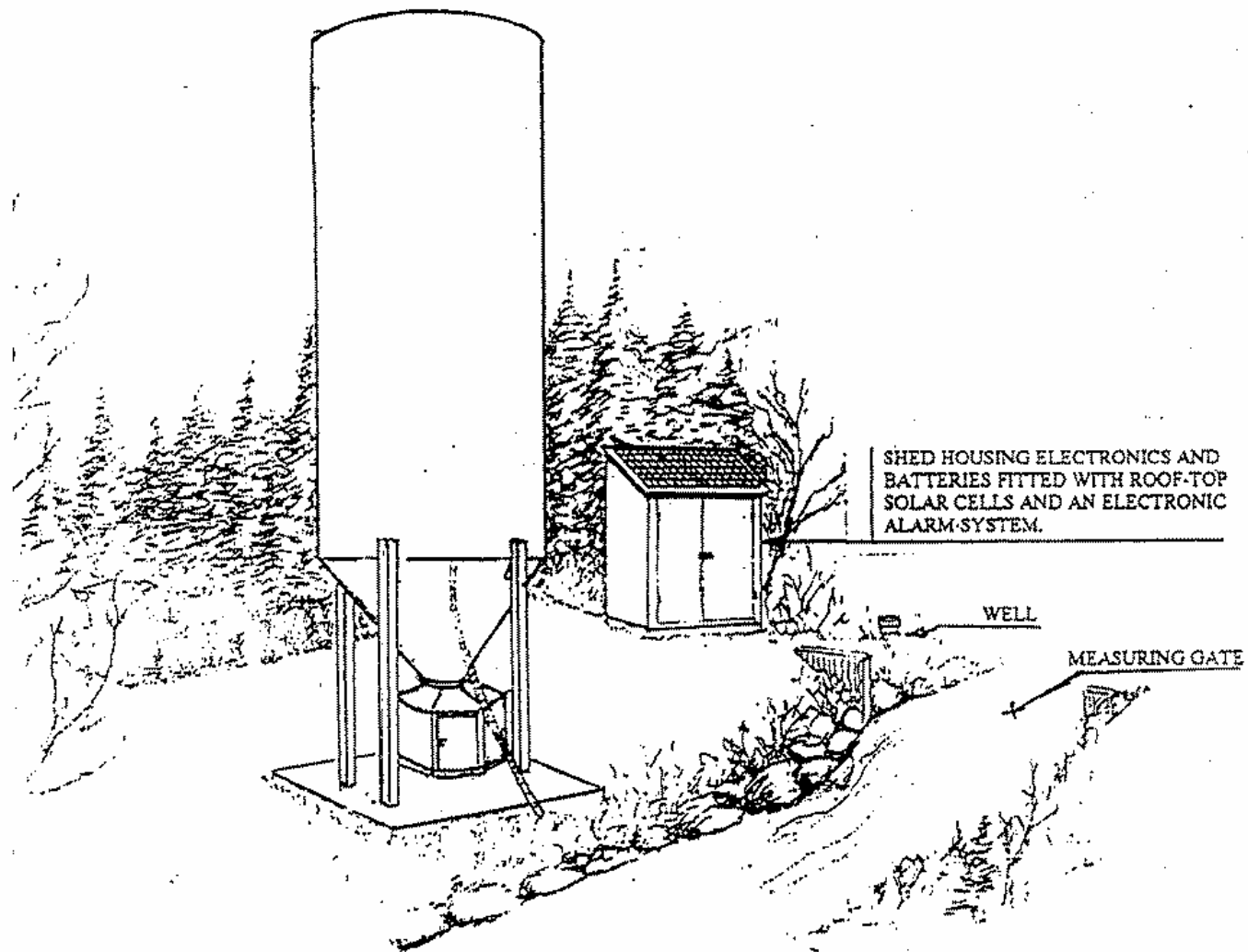


Figure 19. Generic Layout of a Lime Kiln Dust Doser (DOSER).

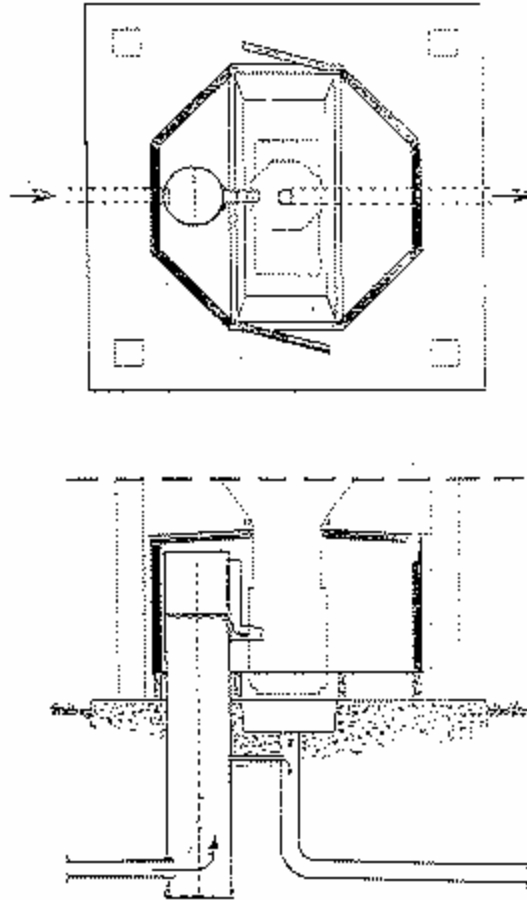


Figure 20. Generic Flow Control for a Lime Kiln Dust Doser (DOSER).

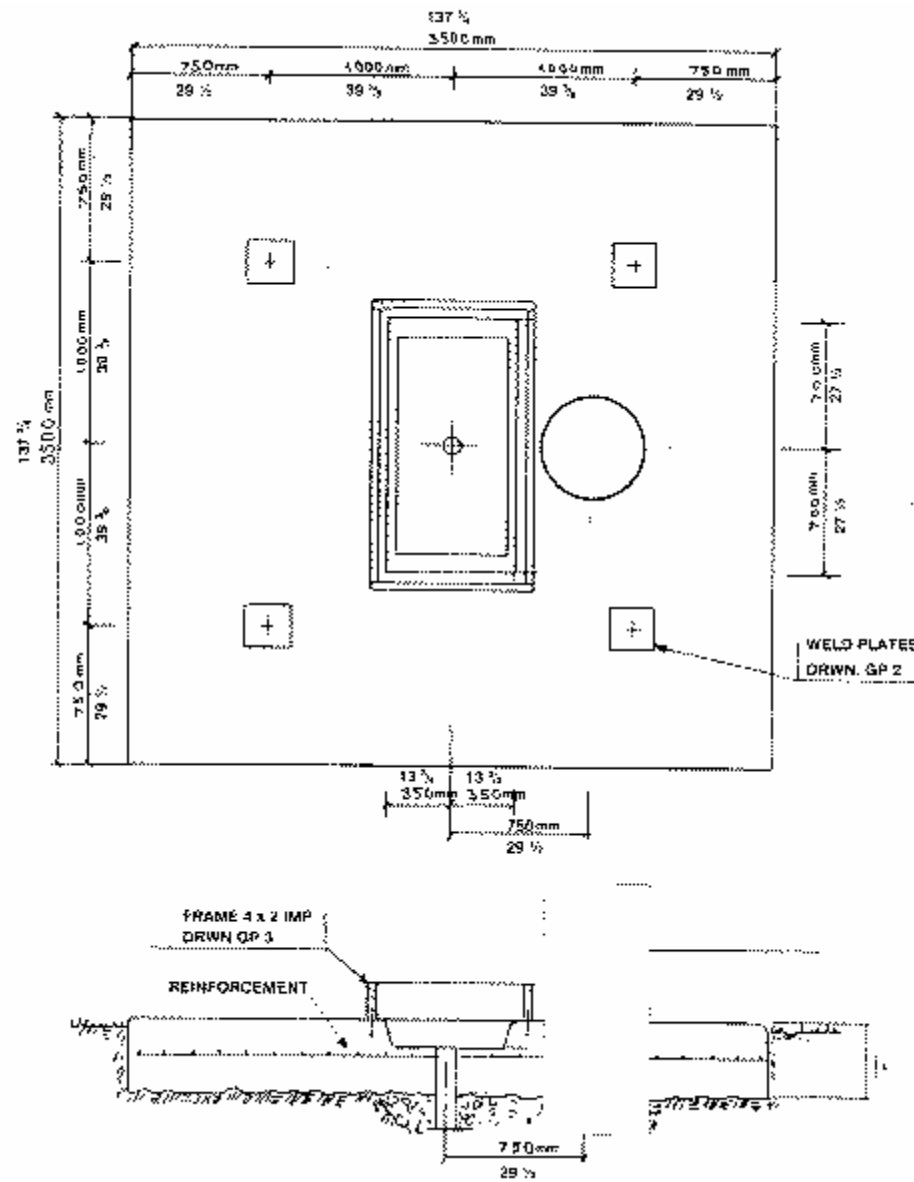


Figure 21. Generic Pad Design for a Lime Kiln Dust Doser (DOSER).

Low Head Dam

Direction of
Flow
↓

Limestone Volume $\cong 0.16HW^2$
Excavation $\cong 1.9W^2$

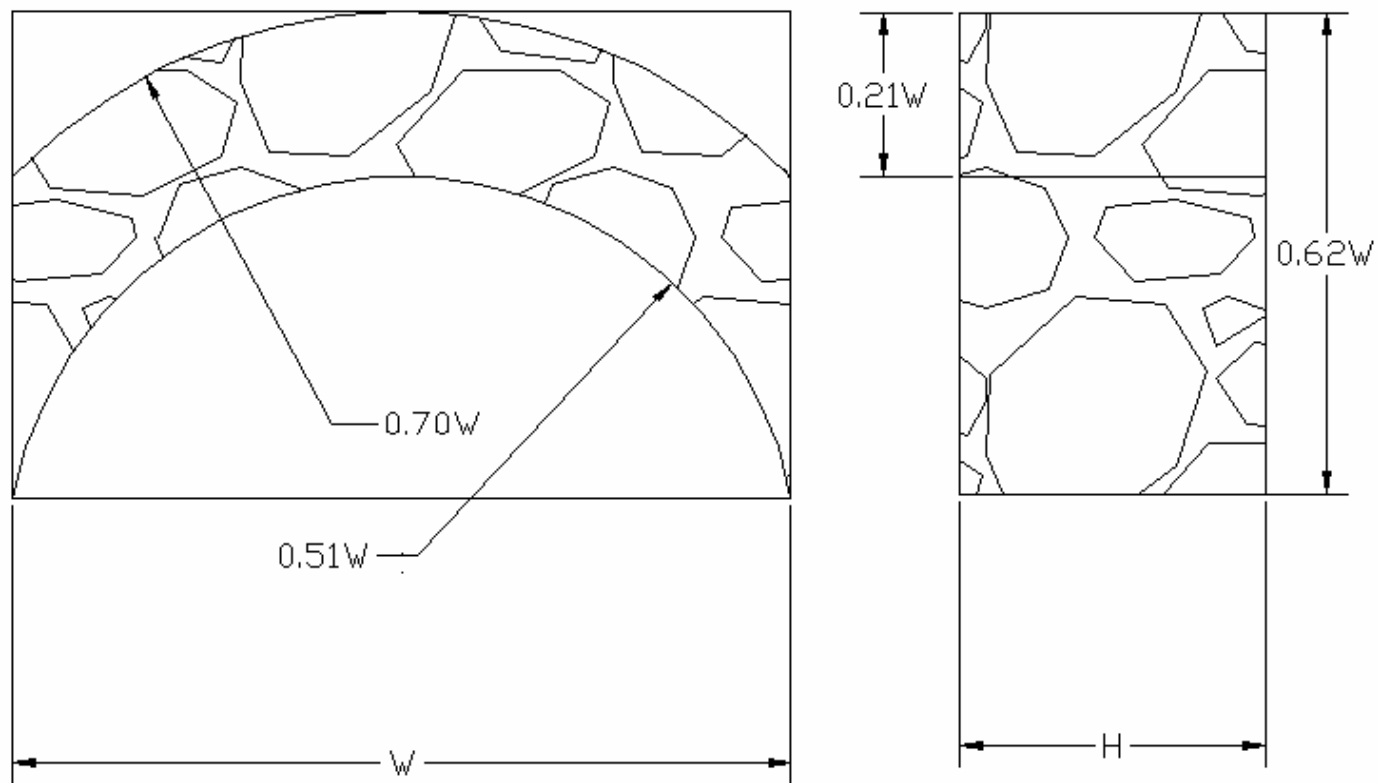


Figure 22. Generic Plan and Profile Views of a Low Head Dam (LHD).

Limestone Leach Bed

Not To Scale

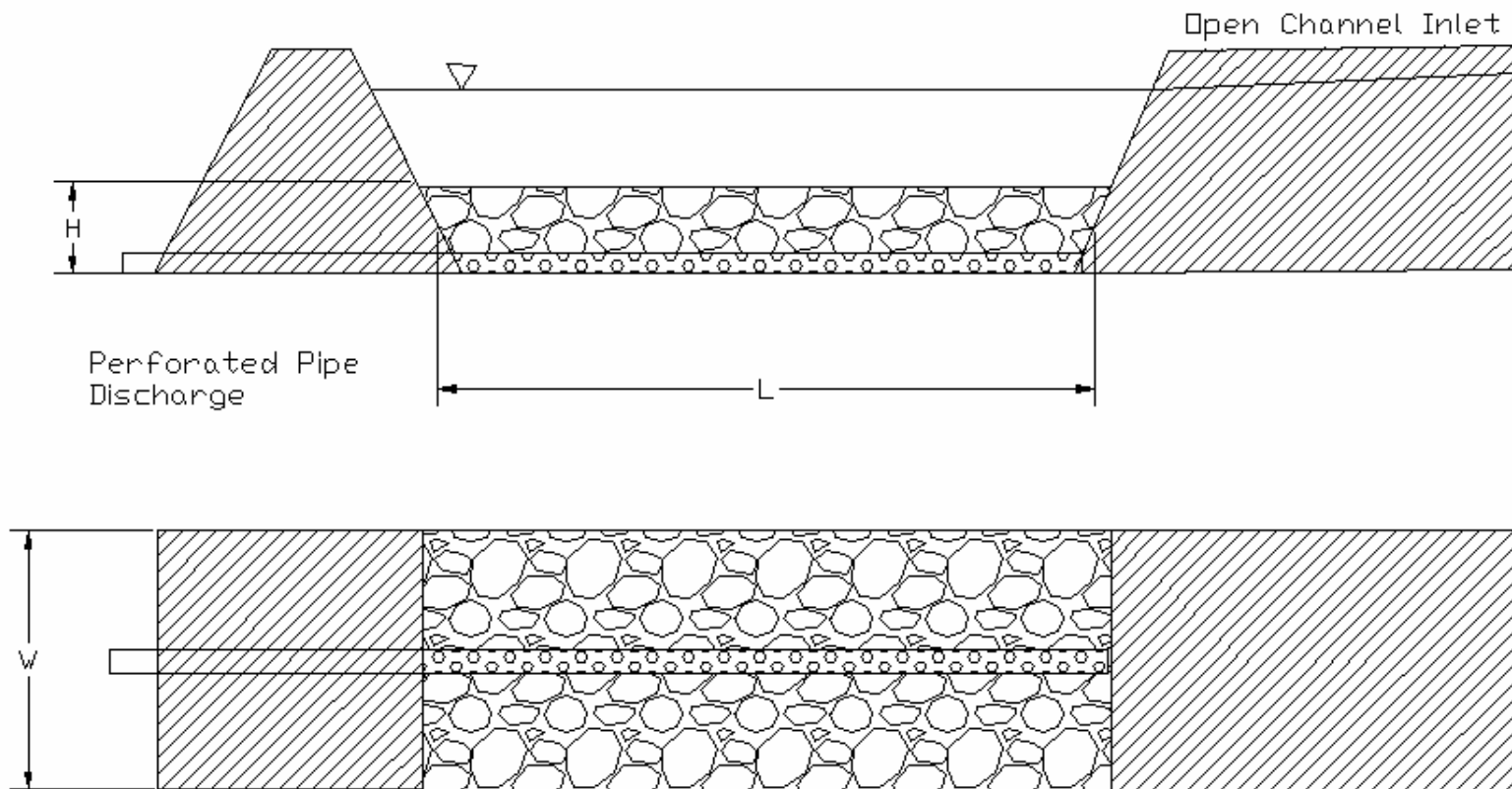


Figure 23. Generic Plan and Profile Views of a Limestone Leach Bed (LLB).

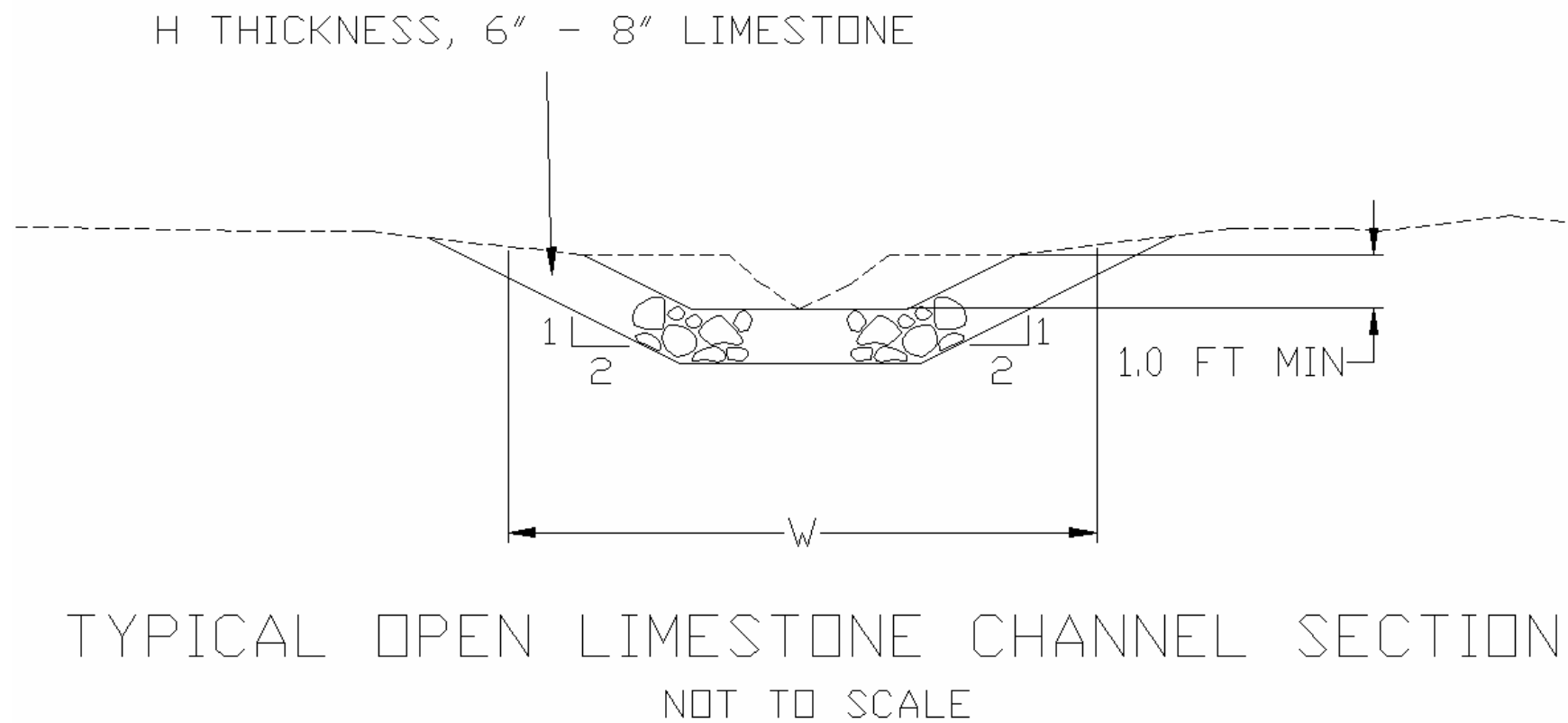


Figure 24. Generic Cross Section View of an Open Limestone Channel (OLC).

Steel Slag Leach Bed

Not To Scale

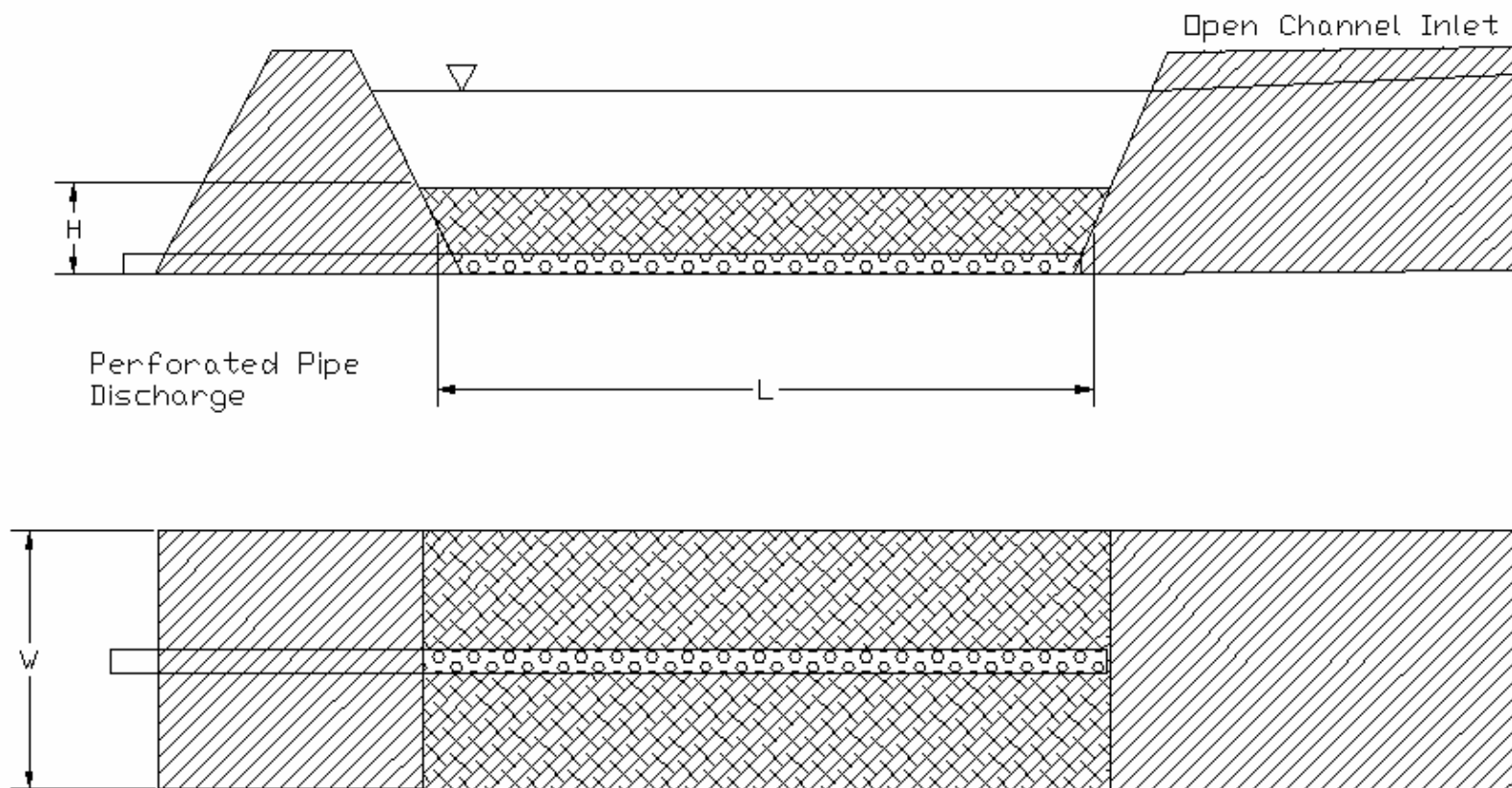


Figure 25. Generic Plan and Profile Views of a Slag Leach Bed (SLB).

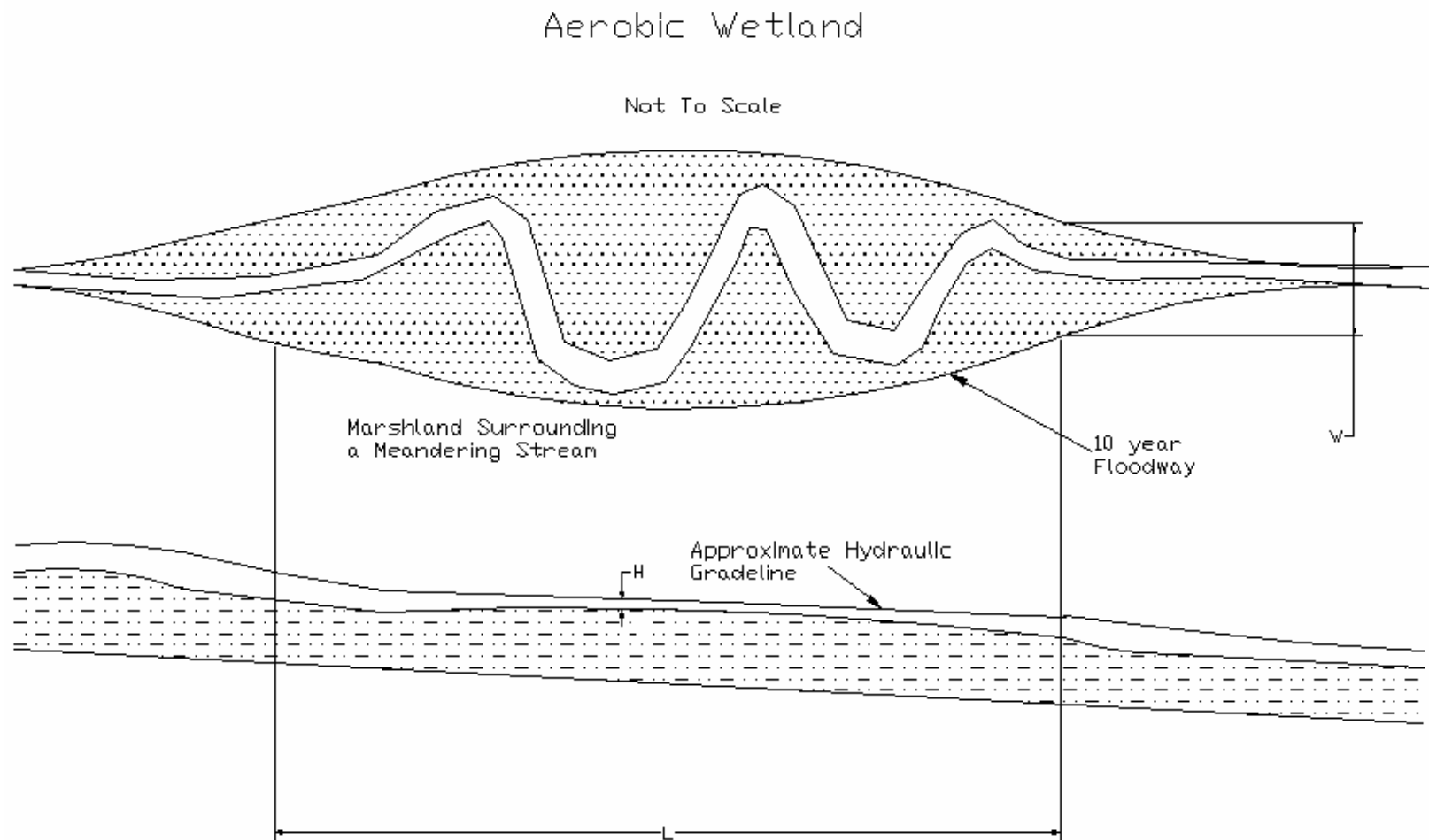
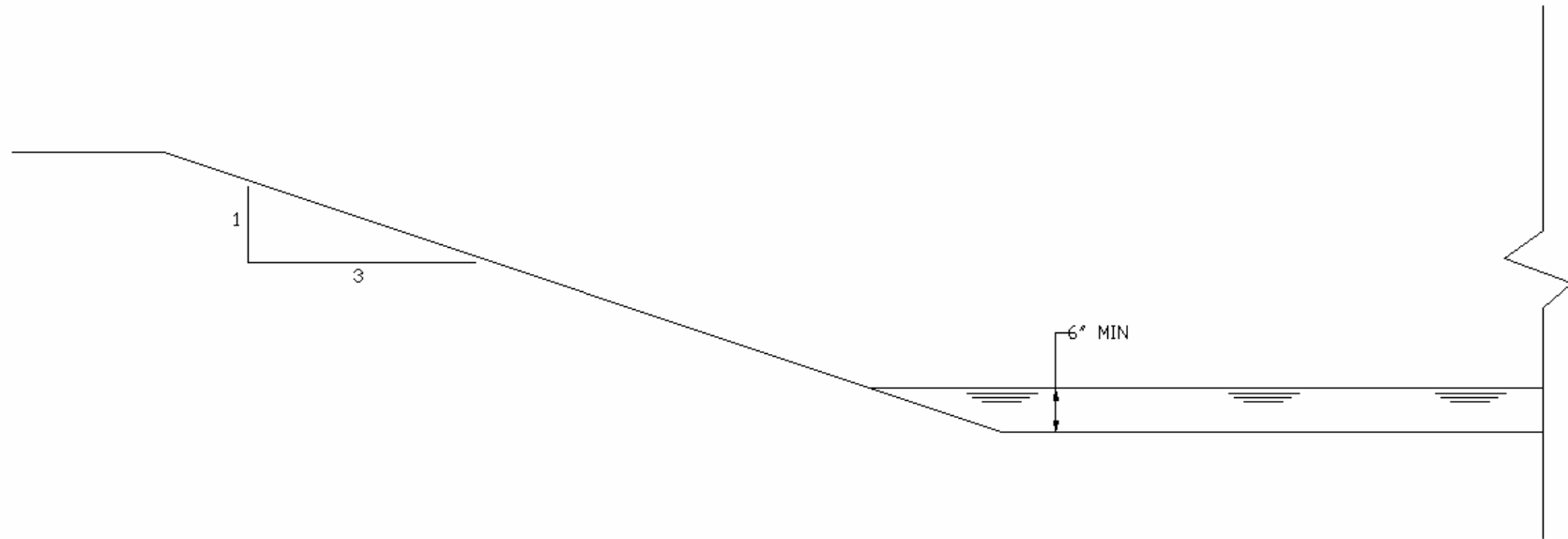


Figure 26. Generic Plan and Profile Views of an Aerobic Wetland (WL).



TYPICAL SECTION - AEROBIC WETLANDS
SCALE: N.T.S

Figure 27. Generic Cross Section of an Aerobic Wetland (WL).

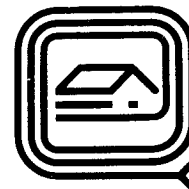
APPENDIX D

AGENCY COORDINATION

Ohio Historic Preservation Office

567 East Hudson Street
Columbus, Ohio 43211-1030
614/ 298-2000 Fax: 614/ 298-2037

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November 9, 2004

Brantley Jackson
U.S. Army Corps of Engineers
Planning, Environmental Analysis Section
502 Eighth Street
Huntington, WV 25701-2070

Dear Mr. Jackson:

Re: Monday Creek Watershed Acid Mine Discharge Reduction
Athens, Hocking and Perry Counties, Ohio

This is in response to your letter of August 13, 2004 and additional information dated September 29th and October 20th concerning the proposed project. Our comments submitted in accordance with the provisions of Section 106 of the Historic Preservation Act (36 CFR 800).

Thank you for providing details of the work locations and descriptions of the 79 construction actions located on private property. I have carefully reviewed the information you provided. A check of our records shows that a number of the projects have been included in cultural resource surveys conducted for the Wayne National Forest. Although there are sites and structures located in the vicinity, none are located in the construction areas. I have enclosed maps showing the location of these properties for your information.

Based on the information you provided we concur that no historic properties will be affected by the undertaking. No further coordination is required unless the scope of the project changes or historic properties are accidentally discovered.

Any questions concerning this matter should be directed to me at (614) 298-2043 or through electronic mail to jquinlan@ohiohistory.org. Thank you for your cooperation.

Sincerely,

Julie Quinlan, Program Reviews Manager
Resource Protection and Review

enclosures: site maps

(614) 469-6923/FAX (614) 469-6919
June 2, 2004

Colonel William E. Bulen
District Engineer
Huntington District, Corps of Engineers
502 Eighth Street
Huntington, WV 25701-2070

Attention: Ms. Amy Franz, Planning Division

Dear Colonel Bulen:

In accordance with your August 28, 2003 Scope of Work, we are providing you with our Planning Aid Letter on a draft Feasibility Report and Environmental Assessment for the Hocking River Basin, Ohio, Monday Creek Subbasin, Ecosystem Restoration Project in Athens, Hocking, and Perry Counties, Ohio (Figure 1). Over the years this project has involved many partners, such as the Monday Creek Watershed Group, Ohio DNR, Ohio EPA, U.S. EPA, U.S. Geological Survey, Office of Surface Mining, Wayne National Forest, Natural Resource Conservation Service, Ohio University, Hocking College, and many local businesses and agencies.

During the past couple years the Huntington District, U.S. Army Corps of Engineers and other partners have been collecting data for the Corps' Comprehensive Feasibility Study for the Watershed and the Watershed Group's Monday Creek Watershed Restoration Management Plan. Each partner has provided its expertise, including detailed information on the fishery resource and general information on the wildlife resources. So as not to duplicate the above information, the Service will limit its comments to Federal trust resources that, is Federally listed or candidate species and migratory birds.

Monday Creek is a tributary of the Hocking River in the above counties and covers an area of 116 square miles. The main tributaries are Little Monday Creek and Snow Fork. About 45 percent of Monday Creek watershed streams have been degraded with acid mine drainage (AMD). Figure 2 is a map of the Monday Creek watershed illustrating the extent of underground mines, and Figure 3 is a schematic map of the watershed illustrating pH levels in various tributaries and volume of flows. Numerous gob piles and other mining debris mar the landscape and add to the pollution load in the watershed. Eighty-seven percent of the watershed is forested, and about 40 percent is owned by the Wayne National Forest (Figure 4).

The major components of the mixed mesophytic forest in the watershed include yellow popular, red oak, white oak, chestnut oak, sugar maple, American beech, several species of hickory, eastern sycamore, and white ash. The understory tree and shrub species include several dogwood species, hornbeam, black cherry, redbud, and spice bush. Additional information about the forest in the watershed is in the Feasibility Report.

The goal of the Monday Creek Restoration Project is to sufficiently treat specific discharges to aid in the restoration of both the structural and functional components of the ecosystem of Monday Creek downstream of the discharges. The restoration objective is to restore a portion of Monday Creek to conditions generally consistent with the functioning ecosystem of warm-water habitat criteria.

At this time several projects have been completed by Monday Creek Watershed partners. For example, Ohio EPA is completing a Total Maximum Daily Load (TMDL) study in the watershed. Gob piles have been capped or removed. Limestone drains have been installed to adjust pH of AMD. Subsidence has been plugged on tributaries of Sycamore Hollow and Orbiston. A “doser” has been installed last year in Jobs Hollow to add alkaline to headwaters of Monday Creek. Finally, volunteers have planted trees in the watershed and have adopted six miles of the Buckeye Trail.

At recent Monday Creek Restoration Project meetings, the total number of projects considered by the Corps was 140. At the last meeting on May 14, 2004, the number was up to 214 projects. Thus, we believe the restoration project is dynamic in the number of sites considered and proposed. Table 1 includes the total number of each treatment type by subwatershed.

The Monday Creek Watershed Feasibility Report includes the following descriptions of most treatment types included in Table 1.

- Compost or Anaerobic Wetland (Passive): The wetlands are usually 1 to 6 acres in size. Some limestone can be added to the organics. A compost wetland generates alkalinity through a combination of bacterial activity and limestone dissolution. In some cases, an aerobic settling pond may be needed for metal precipitation reactions before the compost wetland.
- Aerobic Wetland (Passive): The wetlands are usually 1 to 6 acres in size. It typically requires pretreatment such as an ALD to raise the pH above 4. Aerobic wetlands are typically designed to promote precipitation of iron hydroxide and thus often require periodic dredging.
- Slag Leach Beds (SLB) (Passive): Steel-making slag are often locally available in large quantities at low cost. When fresh, they have NPs ranging from 45 to 90 percent. Studies indicate that columns of steel slag maintain constant hydraulic conductivity over time and produce highly alkaline leachate ($>1,000$ mg/l as CaCO_3). Steel slag can be used as an alkaline amendment as well as a medium for alkaline recharge trenches. Slag are produced by a number of processes so care is needed to ensure that candidate slag are not prone to leaching metal ions such as Cr, Mn, Ni, or Pb.
- Open Limestone Channels (OLC) (Passive): An adequately sized open channel containing large limestone that carries and treats the mine discharge. Sizing takes into account expected armoring (from metal precipitation). The OLC must be on a fairly steep slope (greater than 10 percent) to ensure sufficient amount of oxygen necessary to precipitate metals and to transport the metal precipitates down the channel. An OLC is suited for AMD with high dissolved oxygen and metal concentrations and low pH.

- Low Head Dams (Passive): The purpose of these low head dams is to aerate the stream and ensure that most, if not all, of the iron in the stream is in the ferric oxidation state. The limestone, or any other non-acid producing rock, used to build these dams should have a diameter no less than 20% of the total stream width.
- Limestone Dosing (Active): A process where limestone is introduced into a stream in regular increments. The limestone particles may be in a large hopper or from a plant-type operation. The doser can be electric or water driver. Maintenance, weather, regular access, vandalism, and the lack of variability in dosing are concerns. While dosing can be effective treatment for low pH, dosing does not address metal precipitants.
- Limestone Dumping (Active): Similar to limestone dosing where limestone fines are added directly into a stream. Unlike dosing where the limestone is released incrementally, limestone dumping is when an entire truck's worth of limestone is literally dumped into the stream. Additional limestone is dumped after the previous dump has dissolved.
- Anoxic Limestone Drain (ALD) (Passive): An ALD is an adequately sized buried channel containing limestone that is designed to limit oxygen contact with the mine discharge. An ALD requires relatively low metal concentration and low dissolved oxygen. Typically, an ALD is used in conjunction with aeration and a wetland system of settling ponds to allow for metal precipitation reactions. If the acidity or dissolved oxygen is very high, pretreatment may be provided by a compost wetland to reduce one or both of these parameters.
- Successive Alkalinity Producing Systems (APS or SAPS) (Passive) combine the use of an ALD and an anaerobic wetland. Oxygen concentrations are often a design limitation for ALDs. They are generally ineffective where DO concentrations are greater than 1 or 2 mg/l. In situations where the DO concentrations are above 1 or 2 mg/l, the water can be introduced into a pond. In APS and SAPS, a drainage system is installed in the bottom of the pond. The drainage pipes are overlain by limestone which is then overlain by organic material. Four to eight feet of water are ponded on top of the organic layer. The principle is to introduce the semi aerated water into the pond and cause the water to move down through the organic matter to filter out ferric iron or reduce it by microbial iron reduction to ferrous iron. The reduced water then continues downward into the limestone, picking up additional alkalinity by limestone dissolution. The water then discharges through the drainage system in the bottom of the pond, having a pH of 6.0 and a much higher level of alkalinity in the water. The treated water is then aerated and the metals precipitate in a sedimentation pond, aerobic wetland, or anaerobic wetland.
- Limestone Ponds (LSPs) (Passive): LSPs are a new passive treatment idea in which a pond is constructed at the upwelling of an AMD seep or underground water discharge point. Limestone is placed in the bottom of the pond and the water flows upward through the limestone.

- Diversion (Passive): Diverting surface water upstream of AMD sites to decrease the amount of water entering the mined area is highly recommended in acid-producing areas. Channeling surface waters or mine waters to control volume, direction, and contact time can be used to minimize the effects of AMD on receiving streams. The diversion of water from mining areas and from acid-producing materials is an abatement technique used in both surface and underground mines. Surface diversion of runoff involves the construction of drainage ditches to move surface water quickly off the site before infiltration occurs, or to limit its movement into the backfill. The diversion is accomplished either by ditching on the uphill side of surface mines or by providing impervious channels for existing surface streams to convey water across the disturbed area.

Alternatively, pyritic material can be placed where it will be rapidly and permanently inundated, thereby preventing or minimizing oxidation of acid-forming materials. Inundation is recommended only where a water table may be reestablished to cover acid-producing materials (such as below drainage deep mines) and has not been recommended for surface mined lands or above drainage deep mines in the mountainous Appalachian United States region. Complete inundation has been used successfully in other areas where acid-producing materials are submerged in lakes or other permanent impoundments. Other methods of water management involve alkaline loading of water up gradient of mined areas to buffer the effects of subsequent acid water, and alkaline loading of the backfill with structured alkaline recharge systems.

- Inundation (Saturation) (Passive): The physical restriction of waters by constructing impoundments within an isolated area of a surface mine has been used to minimize or eliminate AMD. Inundation of acid-producing materials may be a less expensive reclamation technique on some areas than traditional reclamation by backfilling and planting, although the latter are typically required by law. Improvements in the quality of impounded waters flowing from acid areas have not always been the result. While pH has not always shown marked improvement, there has been some reduction in total acid and Fe. Even in the less satisfactory cases, the drainage has had a less deleterious effect on downstream water quality than that from unreclaimed areas. The creation of an impoundment in the final cut of a surface mine not only lowers the cost of reclamation, but also has several other advantages. It forms recreation areas, aids in recharging the water table in the local area, and can eliminate or greatly reduce the amount of pollution from AMD and silt. By carefully designing the impoundment size and depth so the body of water formed will cover all acid-producing and carbonaceous materials, and also completely flood any intercepted deep mine workings or auger mining holes, the pyrite oxidation process will be stopped and thus the formation of acid will cease. Field studies have confirmed this action, and have also shown that the resulting impoundment quickly flushes the oxidized acid salts from the contacted area and produces a body of water of near neutral to alkaline quality.

- Underground Mine Sealing (Passive): Deep mine sealing is defined as closure of mine entries, drifts, slopes, shafts, boreholes, barriers, outcrops, subsidence holes, fractures, and other openings into underground mine complexes. Deep mine seals are constructed to achieve one or more functional design goals including (1) eliminate potential access to the abandoned mine works following closure, (2) minimize AMD production by limiting infiltration of air and water into the deep mine, (3) minimize AMD production by maximizing inundation of the mine works, (4) minimize AMD exfiltration through periphery barriers to surface water systems, and (5) develop staged internal mine pools to regulate maximum hydraulic head and pressure.
- Stream Subsidence Closures (Passive): The goal of stream subsidence closure is to restore positive drainage to the stream and reduce AMD generation by preventing contact between stream water and pyritic minerals. Restoring positive drainage to the affected streams will improve the long-term performance of the other AMD treatment systems and should reduce human and animal hazards.

Since water is involved for most treatment sites, most of the above implemented measures include modifications to small segments of streams, ponds, or wetlands. We recommend that impacts to these aquatic habitats be minimized, while achieving the objectives of the treatment measure. For unavoidable impacts, best construction (management) practices must be fully implemented to minimize water quality impacts. We understand and support your efforts to have project limits which provide flexibility to avoid important or special habitats.

Access to some of the sites will be challenging. Again, we recommend that access roads be located to minimize the removal of woody vegetation, in particular, trees with potential Indiana bat roosting habitat. If temporary access is needed, the access routes should be restored with native vegetation of value to wildlife and monitored to guarantee favorable results

Considering the topography of the Monday Creek watershed, we are particularly concerned with possible erosion of denuded areas during construction of the treatment measure and access to the site. We recommend that projects be started and finished in phases, where feasible, to minimize water quality problems in downstream areas that are not degraded, in particular. Also, since 87 percent of the watershed is forested, most sites will have impacts to woody vegetation, including trees.

While the AMD problems have significantly impacted the aquatic resources in the Monday Creek watershed, they have had less impact on birds using the area. The dominant forest in the watershed (87 percent) provides habitat for a multitude of forest and forest edge birds. None of these birds, which are residents or migrants, are Federally listed; however, one bird species, in particular, is of concern to the Service. Currently, the cerulean warbler is under evaluation in response to a petition to list it as a threatened species. Several years ago the Wayne National Forest funded a survey of forest birds in the Forest. The cerulean warbler, as well as many other bird species, was found on the WNF during this survey. Birds have greater mobility than many aquatic species, therefore, we assume birds have easier opportunity to avoid AMD waters and search for more favorable conditions.

U.S. FISH AND WILDLIFE SERVICE GUIDANCE FOR FEDERALLY-LISTED SPECIES IN PERRY, HOCKING, AND ATHENS COUNTIES

INDIANA BAT (*Myotis sodalis*)

The proposed project lies within the range of the **Indiana bat** (*Myotis sodalis*), a Federally listed endangered species. Summer habitat requirements for the species are not well defined, but the following comments are thought to be important:

1. Dead or live trees and snags with peeling or exfoliating bark, split tree trunk and/or branches, or cavities, which may be used as maternity roost areas.
2. Live trees (such as shagbark hickory) which have exfoliating bark.
3. Stream corridors, riparian areas, and upland woodlots which provide forage sites.

Should the proposed site contain trees with any of the characteristics listed above, we recommend that they and surrounding trees be saved wherever possible. If they must be cut, they should not be cut between April 15 and September 15.

If desirable trees are present and if the above time restriction is unacceptable, mist net or other surveys should be conducted to determine if bats are present. The survey should be designed and conducted in coordination with the Endangered Species Coordinator for this office. The survey should be conducted in June or July, since the bats would only be expected in the project area from approximately April 15 to September 15.

We understand that you and your partners would comply with our recommendation to avoid the cutting of bat roosting habitat during the period from April 15 to September 15. Nevertheless, we recommend that you survey for bats to provide additional information in an area where Indiana bats have already been captured (Hocking County). Figure 5 includes the locations of the AMD structures, where bat surveys should be focused. We will continue to coordinate with you to provide you with a recommended schedule for bat surveys in the Monday Creek watershed.

The following measures were included as “Reasonable and Prudent Measures” in the Biological Opinion for the Wayne National Forest in 2001. Some of these measures may be applicable for management of adjacent areas to favor several species of bats, including the Indiana bat, as well as other species of wildlife. On portions of the Monday Creek watershed owned by the Wayne, these measures will be followed. We are also following the measures section with “Terms and Conditions” which the Wayne National Forest must follow to be exempt from the prohibitions of Section 9 of the Endangered Species Act, as amended. Hopefully, at least some of this information will be useful to the Corps, its partners, and contractors when providing access to, during construction and operation of treatment measures, and during restoration of the impacted and surrounding areas.

REASONABLE AND PRUDENT MEASURES

The Service believes the following reasonable and prudent measures are necessary and appropriate to minimize take of Indiana bats. The terms and conditions listed in the next section are specific actions on how the reasonable and prudent measures must be met.

1. Maintain adequate canopy cover in hardwood stands (depending on the size of the stands) to provide Indiana bat foraging habitat.
2. Provide roosting habitat by preserving shagbark hickory (*Carya ovata*) or shellbark hickory (*Carya laciniosa*) trees.
3. No snag removal (snags with a dbh 6 inches), except where they pose an imminent threat to human safety.
4. Maintain a component of large, over-mature trees, in hardwood stands, when possible. These trees will ensure a continuous supply of large roost trees for the bat.
5. Tree removal activity will be closely monitored and reported on a project-by-project basis to ensure that impacts of incidental take associated with future proposed projects are appropriately minimized.
6. Protect all known Indiana bat hibernacula on the Wayne NF.

TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of the ESA, the Wayne NF must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

1. When conducting hardwood timber harvests and completing TSI within hardwood stands, maintain at least 60 percent canopy cover whenever possible.
2. Shagbark hickory or shellbark hickory trees shall not be cut during TSI activities, unless the density of trees of these 2 species, combined, exceeds 16 trees/acre. If present, at least 16 live shagbark and shellbark hickory (combined) greater than 11 inches dbh must be maintained per acre.
3. Snags that are potential Indiana bat habitat shall not be removed for TSI purposes. Firewood cutting permits should clearly state that standing dead trees may not be taken.
4. To maintain a component of large, over-mature trees, at least 3 live trees per acre > 20 inches dbh should be maintained in the stand. The 3 trees should be any of the preferred

species listed below or a combination of the species listed below. (A tree with < 10 percent live canopy should be considered a snag and would not count towards the 3 trees to be left). These must be among the largest trees of these species remaining in the stand. An additional 6 live trees per acre > 11 inches dbh (of the species listed below) must also be maintained. (The "per acre" requirement can be expressed as the average per acre on a stand-wide basis, depending on the definition of a stand).

shagbark hickory (*Carya ovata*)
shellbark hickory (*Carya laciniosa*)
bitternut hickory (*Carya cordiformis*)
silver maple (*Acer saccharinum*)
green ash (*Fraxinus pennsylvanica*)
white ash (*Fraxinus americana*)
eastern cottonwood (*Populus deltoides*)
northern red oak (*Quercus rubra*)
post oak (*Quercus stallata*)
white oak (*Quercus alba*)
slippery elm (*Ulmus rubra*)
American elm (*Ulmus americana*)
black locust (*Robinia pseudoacacia*)

(This list is based on review of literature and data on Indiana bat roosting requirements. Possibility of adding other species as identified)

If there are no trees > 20 inches dbh to leave standing, 16 live trees per acre must be left, and these must include the largest specimens of the preferred species remaining in the stand.

5. During non-hibernation season, Wayne NF will retain all shagbark and shellbark hickory trees over 6 inches dbh and all live trees, of any species, over 6 inches dbh that are hollow, have major splits, or have broken tops, unless they are a safety hazard. Additionally, the Wayne NF will retain a minimum of 12 live trees per acre over 6 inches dbh, of any species, with large areas of loose bark, unless they are a safety hazard. Harvesting of shagbark and shellbark hickory is allowed on the forest during the Indiana bat hibernating season (after September 15 and before April 15) except as might be restricted by the preceding terms and conditions #2 and #4.

The following conservation recommendations for the Indiana bat are also taken from our 2001 Biological Opinion on the Wayne National Forest's Biological Assessment of its activities on Federally listed species. Some of these recommendations may be appropriate for your use as well in the Monday Creek watershed.

CONSERVATION RECOMMENDATIONS

Section 7(a) (1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

The Service provides the following conservation recommendations for the Wayne NF; these activities may be conducted at the discretion of the Wayne NF as time and funding allow. The Service requests notification of the implementation of any conservation recommendations that minimize or avoid adverse effects or provide a benefit to Federally-listed species or their habitats.

Indiana Bat

The Service recommends that the Wayne NF implement the following conservation measures for the benefit of the Indiana bat:

1. Conduct a mist netting and radio telemetry study of Indiana bats on the Marietta unit of the Wayne NF, as funds are available.
2. In consultation with the Service, continue to identify and support Indiana bat studies to gain a better understanding of the bat on the Wayne NF and throughout the range. The Wayne NF, in cooperation with the Service, has recently provided funding to a multi-year study concerning diurnal roost tree usage on the forest. We encourage continued participation between our agencies in the future as an aid to the recovery of the species.
3. In consultation with the Service and the ODNR-DOW, conduct training for employees of the Wayne NF on bats (including Indiana bat) occurring on the Wayne NF. Training should include sections on bat identification, biology, habitat requirements, and sampling techniques (including instructions on applicability and effectiveness of using mist net surveys vs. Anabat detectors to accurately determine the presence of various bat species). The proper training of Wayne NF biologists on bat identification and a reliable method for counting roosting bats will enable the Wayne NF to continue to monitor the status of this species independently of other agencies and research institutions.
4. Create upland waterholes for Indiana bats, as funding allows.
5. A quarter mile of undisturbed forested buffer should be retained surrounding all openings that are known Indiana bat fall swarming sites, where the Forest Service has jurisdiction. Undisturbed forested buffers should be maintained by reducing or eliminating human disturbances whenever possible.

AMERICAN BURYING BEETLE (*Nicrophorus americanus*)

A portion of the project area (the downstream portion of Monday Creek) lies within the range (10-mile radius from the reintroduction site (Waterloo Experiment Station) of the **American burying beetle** (*Nicrophorus americanus*), a Federally listed endangered species. This insect is a "generalist" as far as habitat preference is concerned, with a slight preference for grasslands, open woodlands and brushlands.

The Service has determined that no incidental take for this species is anticipated, therefore, no reasonable and prudent measures or terms and conditions are necessary and appropriate to minimize incidental take of American burying beetles on the Wayne NF.

We understand that another release of American burying beetles is planned in the near future; however, the location would be at The Wilds in Muskingum County, Ohio, a distance of much more than 10 miles from the Monday Creek Watershed.

BALD EAGLE (*Haliaeetus leucocephalus*) - Hocking County only

The project area lies within the range of the **bald eagle** (*Haliaeetus leucocephalus*), a Federally-listed threatened species. We recommend that you contact Mr. Mark Shieldcastle, with the Ohio Department of Natural Resources, Division of Wildlife, (419) 898-0960, for the location(s) of the eagle nest(s) in the county. If any nests are located within ½ mile of the project site, further coordination with this office is necessary. If the nest is active, we recommend that work at the site be restricted from mid-January through July to allow pre-nesting activities, incubation, and raising of the young.

FEDERALLY LISTED PLANT SPECIES

NORTHERN MONKSHOOD (*Aconitum noveboracense*) - Hocking County only

This project lies within the range of the Federally listed threatened **northern monkshood** (*Aconitum noveboracense*). The plant is found on cool, moist, talus slopes or shaded cliff faces in wooded ravines. We recommend that the project location be examined to determine if suitable habitat for the monkshood is present. If suitable habitat is found, surveys may be necessary to determine if the plant is present.

SMALL WHORLED POGONIA (*Isotria medeoloides*) - Hocking County only

The project lies within the range of the **small whorled pogonia** (*Isotria medeoloides*), a Federally listed threatened species. *Isotria medeoloides* occurs both in fairly young forests and in maturing stands of mixed-deciduous or mixed-deciduous/coniferous forests. The majority of small whorled pogonia sites share several common characteristics. These may include sparse to moderate ground cover in the microhabitat (except when among ferns), a relatively open understory canopy, and proximity to old logging roads, streams, or other features that create long-persisting breaks in the forest canopy. The soil in which the shallow-rooted small whorled pogonia grows is usually covered with leaf litter and decaying material. The spectrum of habitats includes dry, rocky, wooded slopes to moist slopes or slope bases crisscrossed by vernal

streams. We recommend that the project area be examined for the small whorled pogonia to determine if suitable habitat for either or both of these two plant species is present. If suitable habitat is found, surveys may be necessary to determine if the plant(s) is present.

SPECIES WITH CONSERVATION PLAN

TIMBER RATTLESNAKE (*Crotalus horridus horridus*)

The projects in Athens and Hocking Counties lie within the range of the **timber rattlesnake** (*Crotalus horridus horridus*), a large shy rattlesnake that is declining throughout its national range. No Federal listing status has been assigned to this species. Instead, the U.S. Fish and Wildlife Service has initiated a pre-listing Conservation Action Plan to support state and local conservation efforts. Your proactive efforts to conserve this species now may help avoid the need to list the species under the Endangered Species Act in the future. The timber rattlesnake is protected throughout much of its range and is listed as endangered by the State of Ohio. Due to its rarity and reclusive nature, we encourage early project coordination to avoid potential impacts to the timber rattlesnake and its habitat.

In Ohio, the timber rattlesnake is restricted to the un-glaciated Allegheny Plateau and utilizes the specific habitat types depending upon the season. Winters are spent in dens usually associated with high, dry ridges. These dens may face any direction, but southeast to southwest are most common. Such dens usually consist of narrow crevices in the bedrock. Rocks may or may not be present on the surface. From these dens, timber rattlesnakes radiate throughout the surrounding hills and move distances as great as 4.5 miles. In the fall, timber rattlesnakes return to the same den. Intensive efforts to transplant timber rattlesnakes have not been successful. Thus, protection of the winter dens is critical to the survival of this species. Some project management ideas include the following:

- 1) At a minimum, project evaluations should contain delineations of timber rattlesnake habitat within project boundaries. Descriptions should indicate the quality and quantity of timber rattlesnake habitat (den sites, basking sites, foraging areas, etc.) that may be affected by the project.
- 2) In cases where timber rattlesnakes are known to occur or where potential habitat is rated moderate to high, timber rattlesnake surveys may be necessary. If surveys are conducted, it may be helpful to inquire with local resource agency personnel who may know of timber rattlesnake sightings or from reliable local residents. In addition, local herpetologists may have knowledge of historical populations, as well as precise knowledge of the habits and especially the specific, local types of habitats that may contain timber rattlesnakes. Surveys should be performed during the periods of spring emergence from dens (usually a narrow window in April or May) and throughout the active season until October. The species is often easiest to locate during the summer months when pregnant females seek out open areas in early morning, especially after cool evenings.

- 3) In portions of projects where timber rattlesnakes will be affected, clearing and construction activities should occur at distances greater than 100 feet from known dens. Most importantly, tops of ridges and areas of exposed rock should be avoided.
- 4) In areas where timber rattlesnake dens are known, or likely to exist, maintenance activities (mowing, cutting, burning, etc.) should be conducted from November 1 to March 1, when timber rattlesnakes are hibernating.

My staff is ready to provide further assistance to you during project planning and implementation of the treatment measures. Please contact us for our input as you plan surveys and measures to benefit Federally listed species. If you have questions, or if we may be of further assistance in this matter, please contact Ken Lammers at extension 15 in this office.

These comments have been prepared under the authority of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.), the Endangered Species Act of 1973, as amended, and are consistent with the intent of the National Environmental Policy Act of 1969 and the U. S. Fish and Wildlife Service's Mitigation Policy.

Sincerely,

Mary Knapp, Ph.D.
Supervisor

cc: ODNR, Div. of Wildlife, SCEA Unit, Columbus, OH
ODNR, Div. of Real Estate and Land Management, Columbus, OH
Ohio EPA, Water Quality Monitoring, Columbus, OH

APPENDIX

1. Ohio EPA macroinvertebrate taxa associated with acid mine drainage (AMD) in the Monday Creek Basin, June-August 2001
2. Ohio EPA list of fish species collected in the Monday Creek Basin, June-August 2001



United States
Department of
Agriculture

Forest
Service

Wayne National Forest
Supervisor Office

13700 US Hwy 33
Nelsonville, OH 45764
(740) 753-0101
(740) 753-0119 1st FL Fax
(740) 753-0118 2nd FL Fax

File Code: 2360

Date: June 10, 2004

Route To:

Subject: Monday Creek Feasibility Study
Athens Ranger District – Various Locations
Summary of Heritage Investigations as per Section 106 of the National Historic
Preservation Act

To: Gary Willison
Watershed Group Team Leader

The following is a summary of Section 106 status on each of the ten (10) Monday Creek watershed improvement locations on Forest Service land, as proposed by the Corps of Engineers:

Brush Fork – all locations surveyed; no significant sites identified
Coe Hollow – all locations surveyed; no significant sites identified
Dixie Hollow – all locations west of T.R. 224 surveyed; no significant sites identified
 - all locations east of T.R. 224 will need to be surveyed
Long Hollow – all locations will need to be surveyed
Lost Run – New Straitsville topo. map: all locations surveyed; no significant sites identified
 - Gore topo. map: all locations in Hocking County surveyed and one site on ridgetop
 near construction locations LLB-1W1 and OLC-1W1 to be avoided; all
 locations in Perry County will need to be surveyed
Monkey Hollow - all locations surveyed; no significant sites identified
Snow Fork – all locations south of Orbiston will need to be surveyed; all locations north of
 Orbiston surveyed and no significant sites identified
Spencer Hollow – no Forest Service land involved
Sycamore Hollow - all locations surveyed; no significant sites identified
Whitmore Cemetery - no Forest Service land involved

In summary (of the locations involving Forest Service land), Coe Hollow, Monkey Hollow, and Sycamore Hollow have been completely surveyed with no sites identified; Brush Fork has been completely surveyed with one site to avoid; Dixie Hollow, Lost Run, and Snow Fork have only been partially surveyed; Long Hollow requires total survey. Site locations must remain confidential by law, but can be provided on an “as needed” basis. If you have any questions, don’t hesitate to call me (740) 753-0553.

/s/Ann C. Cramer

Wayne Forest Archaeologist



Caring for the Land and Serving People

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Ohio Department of Natural Resources

BOB TAFT, GOVERNOR

SAMUEL W. SPECK, DIRECTOR

Division of Mineral Resources Management
Mike Sponsler, Chief
1855 Fountain Square, Bldg. H-3
Columbus, Ohio 43224-1381
Phone: (614) 265-6633 FAX (614) 265-7999

June 27, 2003

Colonel John D. Rivenburgh, District Engineer
Department of the Army
Corps of Engineers, Huntington District
502 Eighth Street
Huntington, W. Va. 25701-2070

Re: Monday Creek Restoration Project

Dear Colonel Rivenburgh:

The Ohio Department of Natural Resources, Division of Mineral Resources Management (DMRM) is a non-federal sponsor of the Monday Creek Project Feasibility Study. As a sponsor of the project DMRM intends to participate in the review of the environmental analysis for the study.

The partnership established to date has successfully addressed multiple challenges. It is our belief that this project will ultimately lead to the restoration of the impaired ecosystem in Monday Creek. Such restoration should bring the stream back to a condition that has not existed for decades due to the impacts of unregulated resource extraction.

Our Division looks forward to working with your staff in bringing this endeavor to a successful conclusion.

Sincerely,

A handwritten signature in black ink, appearing to read "Harry Payne".

Harry Payne

Manager, Acid Mine Drainage Abatement Program



United States
Department of
Agriculture

Forest
Service

Wayne National Forest
Athens Ranger District

13700 US Hwy 33
Nelsonville, OH 45764
(740) 753-0101
(740) 753-0119 1st FL Fax
(740) 753-0118 2nd FL Fax
800-877-8339 TTY

File Code: 2500

Date: July 3rd, 2003

Colonel John D. Rivenburgh
US Army Corps of Engineers
Huntington District Office
502 Eighth Street
Huntington, West Virginia 25701-207

Dear Colonel Rivenburgh:

I am writing in response to your request that the United State Forest Service, Wayne National Forest, participates as a cooperating agency in the environmental review process for the Monday Creek Restoration Project (Feasibility Study).

Given that 40% of the Monday Creek Watershed falls within the Wayne National Forest, participation on an interdisciplinary team will provide adequate opportunities and benefits of enhanced cooperation among our agencies early in the analytical process, as well as close coordination during the NEPA process.

The Wayne National Forest looks forward to being a participating agency and working with you and your team to design the most practical solutions to the restoration issues facing the Monday Creek Watershed.

I may be reached at (740) 753-0684 or via email at gwillison@fs.fed.us if you have any concerns or questions.

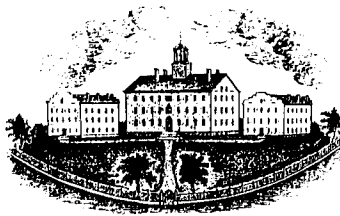
Sincerely,

GARY WILLISON
Watershed Group Leader



Institute for Local
Government Administration
and Rural Development

Technology and Enterprise
Building 143
Athens OH 45701-2979
740-593-4388 phone
740-593-4398 fax
<http://www.ilgard.ohiou.edu>



OHIO UNIVERSITY

Ohio Rural Universities
Program

Colonel John D. Rivenburgh
US Army Corps of Engineers
Huntington District Office
502 Eighth Street,
Huntington, West Virginia 25701-2070

March 27, 2003

Dear Colonel Rivenburgh:

I am writing in response to your request that the Institute for Local Government Administration and Rural Development (ILGARD) at Ohio University participate as a cooperating agency in the environmental review process for the Feasibility Study now underway in the Monday Creek (OH) watershed. ILGARD would be pleased to participate and offer our services in any way possible during the process. As you reference in your letter dated June 20, 2002, the benefits of enhanced cooperation among our agencies are many.

ILGARD looks forward to working with you and your team to design the best solutions possible to the issues facing the Monday Creek Watershed.

Sincerely,

A handwritten signature in cursive script, appearing to read "S. A. Miller".

Scott Miller
Senior Project Manager – ILGARD
(740) 593-0827
Miller@ilgard.ohiou.edu

Cc:
Mark Kessinger

Voinovich Center for Leadership and Public Affairs
College of Arts and Sciences



State of Ohio Environmental Protection Agency

SET ADDRESS:

Parus Government Center
122 S. Front Street
Columbus, OH 43215-1099

TELE: (614) 644-3020 FAX: (614) 644-2329

MAILING ADDRESS:

P.O. Box 1049
Columbus, OH 43216-1049

March 18, 2003

Colonel John D. Rivenburgh
Huntington District
U.S. Army Corps of Engineers
502 Eighth Street
Huntington, West Virginia 25701-2070

Dear Colonel Rivenburgh:

Thank you for your letter of June 20, 2002, concerning the Monday Creek Restoration Project. I would like to accept your invitation to participate on the interdisciplinary team to study the Monday Creek Watershed and look forward to helping with the review of the environmental analysis for Monday Creek.

I may be reached at (614) 644-2885 or via email at keith.orr@epa.state.oh.us.

Sincerely,

Keith Orr, ES2
Modeling & Assessment Section
Division of Surface Water

Bob Taft, Governor
Maureen O'Connor, Lieutenant Governor
Christopher Jones, Director



United States Department of the Interior

OFFICE OF SURFACE MINING

Reclamation and Enforcement

Oversight and Inspection Office

4480 Refugee, Rm. 201
Columbus, Ohio 43232

Three Parkway Center
Pittsburgh, Pennsylvania 15220

August 6, 2002

Colonel John D. Rivenburgh, District Engineer
Department of the Army
Corps of Engineers, Huntington District
502 Eighth Street
Huntington, W.Va. 25701-2070

Dear Colonel Rivenburgh:

I have received your letter of July 30, 2002, inviting the Office of Surface Mining to participate as a coordinating agency in the environmental review process for the Monday Creek Restoration Project. I welcome the opportunity to participate, and look forward to becoming involved as specific projects are proposed for construction. This will not only allow my agency to provide comments, but will assist us in fulfilling our NEPA responsibilities when OSM-granted funding is combined with other sources of funding for restoration work.

You or your staff may contact me by phone at 614-866-0578 extension 110, or by e-mail at mluehrs@osmre.gov as the need arises. Thank you for your consideration in this matter.

Sincerely,

Max A. Luehrs
Natural Resource Specialist

115 Main Street
P.O. Box 129
New Straitsville, OH 43766

**Monday
Creek
Restoration
Project**



December 4, 2003

Colonel William F. Bulen
Huntington District
U.S. Army Corps of Engineers
502 Eighth Street
Huntington, West Virginia 25701-2070

Dear Colonel Bulen:

On June 20, 2002, our office received a letter from Colonel John D. Rivenburgh inviting our organization to participate in an interdisciplinary review and comment on the environmental analysis of the Monday Creek Watershed Feasibility Study. Our staff and partners have been actively engaged in data collection and field investigations throughout the Feasibility Study.

We would like to continue this participation as a cooperating agency in the environmental review process. We look forward to the successful completion of the Feasibility Study and the ecological restoration of Monday Creek.

Sincerely,

MONDAY CREEK RESTORATION PROJECT

A handwritten signature in cursive script that reads "Mike Steinmaus". The signature is fluid and stylized, with the first letters of the first and last names being capitalized and prominent.

Mike Steinmaus
Watershed Coordinator
(740) 394-2047
mcrp@netpluscom.com

cc: Carol Kuhre, Rural Action
cc: Mark Kessinger

APPENDIX E

ECONOMIC APPENDIX

COST EFFECTIVENESS AND INCREMENTAL COST ANALYSIS



U. S. Army Corps of Engineers
Huntington District
502 8TH St.
Huntington, WV 25701

COST EFFECTIVENESS AND INCREMENTAL COST ANALYSIS

For

**Hocking River Basin, Ohio, Monday Creek Sub-basin
Ecosystem Restoration Project Feasibility Report
and Environmental Assessment**

July 2005

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INTRODUCTION

The purpose of this cost effectiveness and incremental cost analyses (CE/ICA) is to help identify the most effective and efficient plans for ecosystem restoration along Monday Creek. The following discussions describe the: (1) purpose and methodology of CE/ICA and (2) application of CE/ICA to Monday Creek ecosystem restoration.

COST EFFECTIVENESS AND INCREMENTAL COST ANALYSES

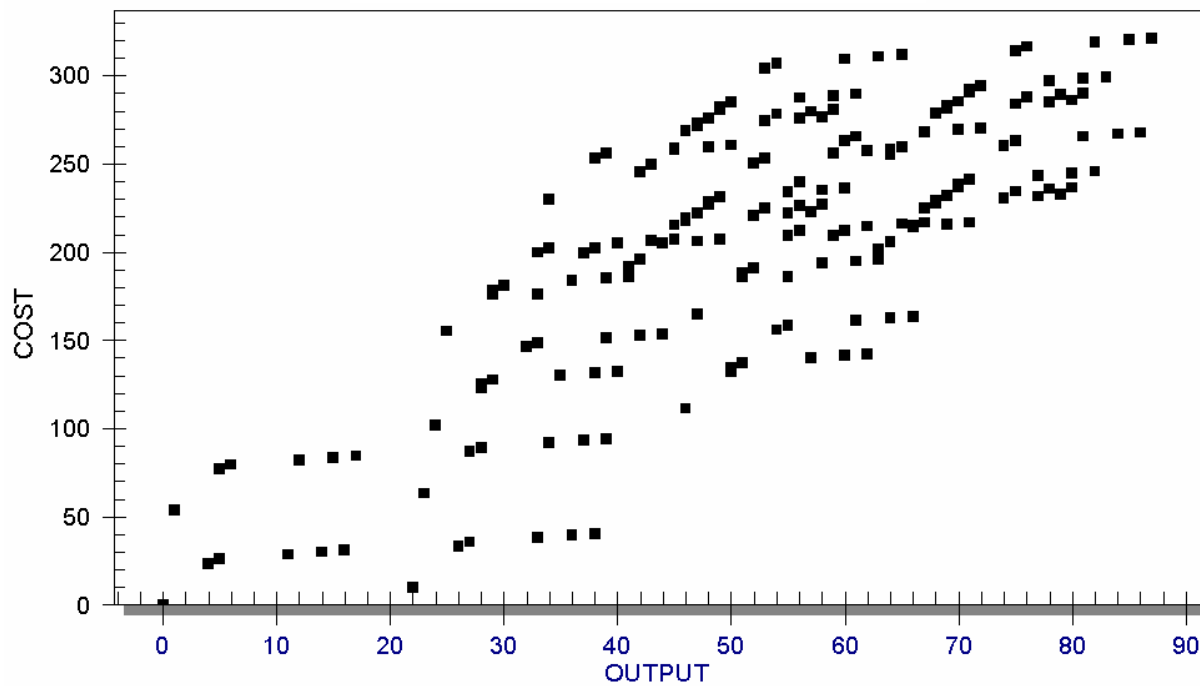
Ecosystem restoration projects differ from traditional Corps planning studies, since their benefits typically cannot be expressed in monetary terms. In practice, Corps ecosystem restoration studies often measure the ecosystem benefits of alternative plans in terms of physical dimensions, population counts, or various habitat-based scores. To promote effective decision making for ecosystem restoration projects, Corps environmental planning has incorporated CE/ICA to compare the relative costs and outputs of alternative ecosystem restoration plans.

Corps ecosystem restoration policies (including EC 1105-2-210, *Ecosystem Restoration in the Civil Works Program*, 1 June 1995 and EC 1105-2-214, *Project Modification for Improvement of the Environment and Aquatic Ecosystem Restoration*, 30 November 1997) require that restoration projects include CE/ICA to aid in the decision making process by evaluating possible combinations of management measures. Specifically, CE/ICA can be used to support ecosystem restoration studies through the: (1) formulation of alternative plans, (2) evaluation of their effects, and (3) identification of the plan which best meets restoration objectives at the least cost.

CE/ICA generates information that supports sound financial investments by comparing the costs and non-monetary outputs (benefits) of alternative investment choices. CE/ICA is conducted in a series of steps that progressively identify alternatives that meet specified criteria and screen out those that do not. These analyses help determine whether the additional environmental outputs for increasing levels of restoration are worth the additional monetary cost. Although neither cost effectiveness analysis (CEA) nor incremental cost analysis (ICA) necessarily result in the identification of a single “best” alternative, they contribute to informed decision making for ecosystem restoration.

As shown in Figure 1, CEA evaluates the full range of alternative plans. For environmental projects, outputs are typically expressed in physical units (e.g., hydrologic indicators) or biological units (e.g., habitat units). As illustrated in Figure 1, there may be many plans that could generate the environmental outputs desired for a particular ecosystem restoration project. These plans may be comprised of one or more structural or nonstructural measures.

Figure 1
Example - All Plans



CEA begins with a comparison of the costs and outputs of alternative plans to identify the least cost plan for every possible level of restoration output. CEA screens out plans that are inefficient or ineffective. Figure 2 illustrates how inefficient and ineffective plans are eliminated through CEA. As shown in this figure, Plan A produces the same amount of environmental output as Plan B, but at a higher cost. Plan A is therefore inefficient relative to Plan B and would be eliminated through the CEA process. The comparison of Plan C and Plan D indicates that Plan D produces more environmental outputs than Plan C at the same cost. Plan C is therefore ineffective relative to Plan D and would also be eliminated by the CEA process. The result of CEA is a cost effectiveness curve that consists of the most economically efficient plans for various output levels (see Figure 3).

Figure 2
Example – Screening Of Plans

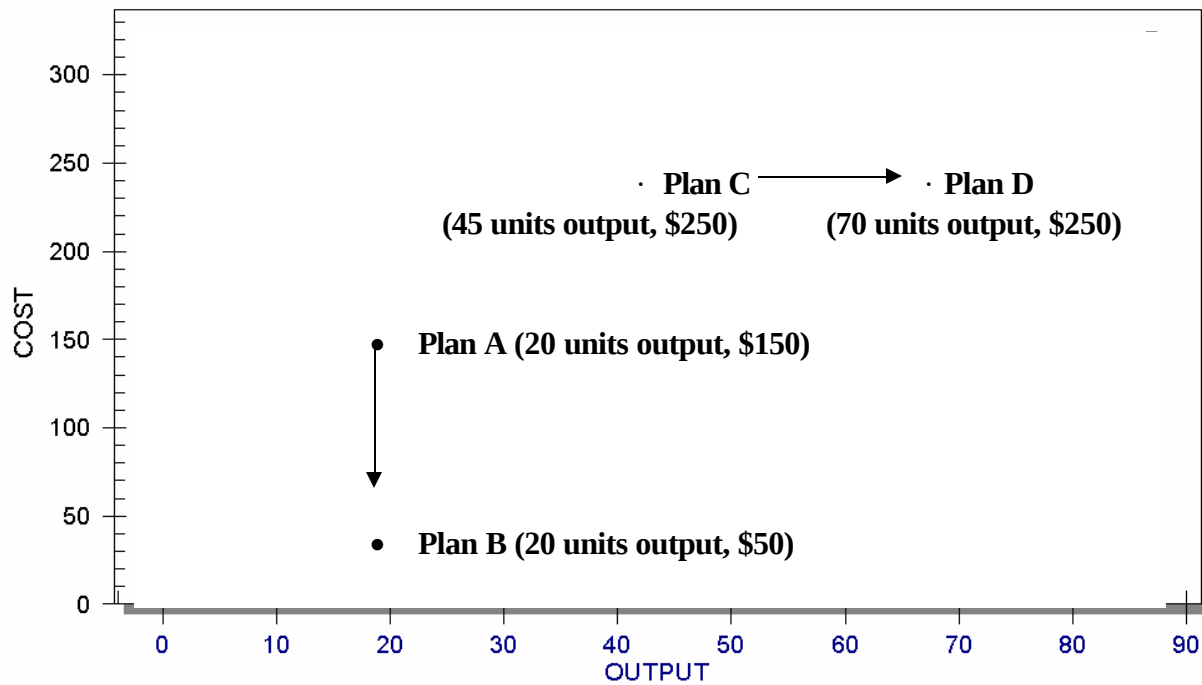
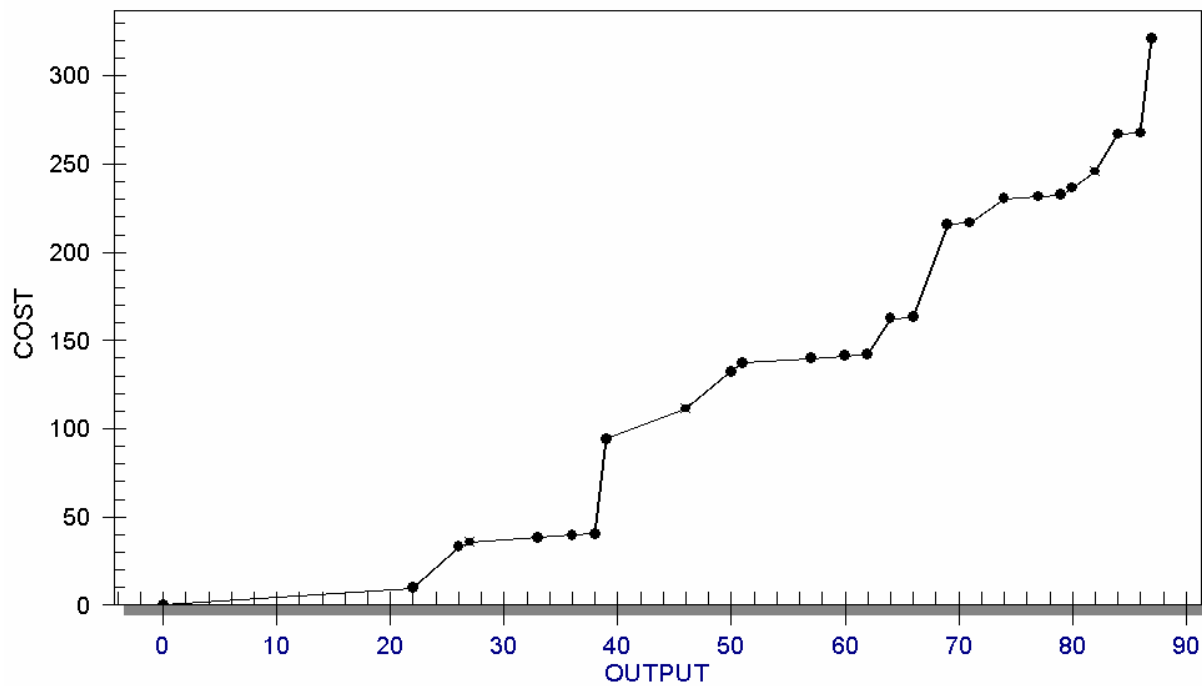
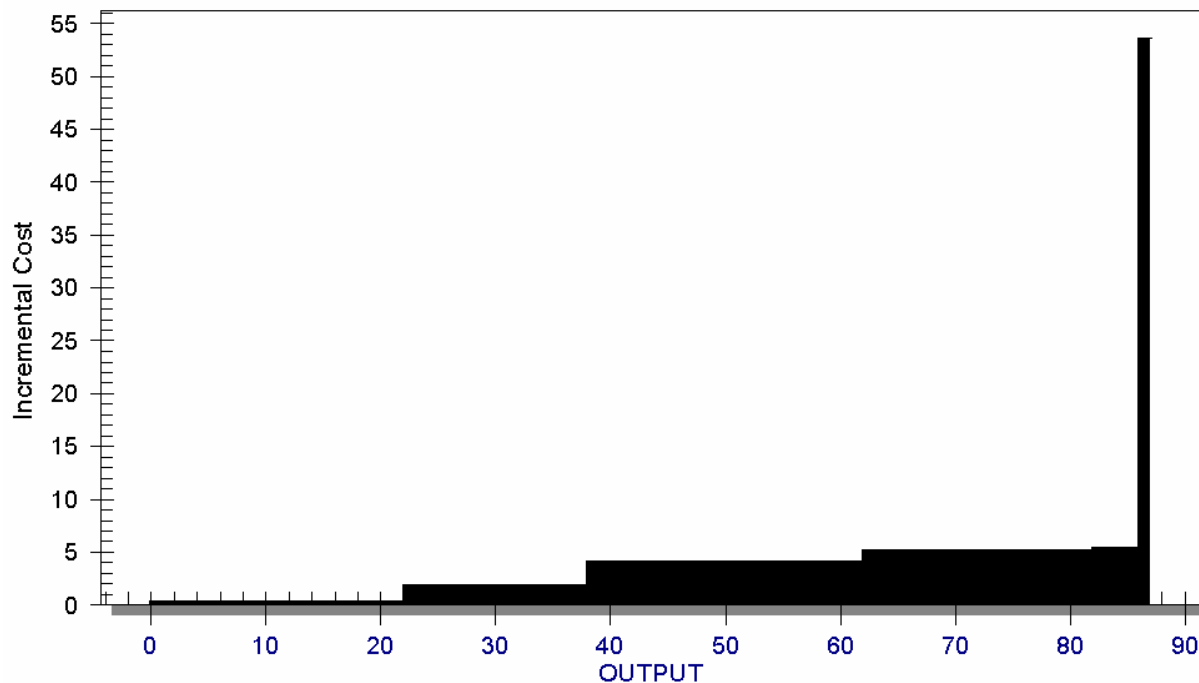


Figure 3
Example – Cost Effective Plans



After the cost effectiveness of the alternatives has been established, ICA can be used to reveal and evaluate incremental changes in costs for increasing levels of environmental output. The primary purpose of ICA is to explicitly compare the incremental costs and the incremental outputs associated with each successively larger restoration plan (see Figure 4). The explicit comparisons of incremental costs and outputs allow evaluation of alternative scales of plans and plan components. The incremental evaluation of project costs and outputs provides more insight than average or total costs, since it can be used to identify significant increases in project costs necessary to achieve additional units of ecological output for the full range of ecosystem restoration plans. CE/ICA does not provide a discrete decision criterion (*i.e.*, it does not identify the “best” plan). However, it does provide information to decision makers which allow explicit comparisons between the relative changes in costs and outputs for each plan.

Figure 4
Example – Best Buy Plans



The advantages of CE/ICA are that it ensures a rational approach for considering and selecting alternative methods to produce environmental outputs. It also provides decision makers with a range of implementable alternatives of varying scales, rather than an all-or-nothing choice, and it specifies the most cost effective plans for various output levels.

IWR-PLAN DECISION SUPPORT SOFTWARE

The Corps Institute for Water Resources has developed a computer model, *IWR-PLAN*, to facilitate incorporation of CE/ICA into the planning process. This software builds upon previous Corps CE/ICA efforts, such as (1) Evaluation of Environmental Investments Procedures Manual, Interim: Cost Effectiveness and Incremental Cost Analyses, May 1995, IWR Report #95-R-1 and (2) the *ECO-EASY* software which provided an earlier version of the model in DOS format.

IWR-PLAN can be used to: (1) formulate alternative plans by evaluating potential combinations of restoration measures and a variety of scales of individual measures, (2) perform CEA of the spectrum of potential restoration plans, and (3) conduct ICA on cost effective plans. The costs and outputs associated with each plan are input by the user. The user specifies structural or nonstructural management measures, plans (combinations of measures); or programs (combinations of plans often at the regional or national level), and potential scales of each measure.

The purpose of CE/ICA is to explicitly compare the incremental costs and the incremental outputs associated with moving to each successively larger restoration plan. Internally, *IWR-PLAN* calculates: (1) incremental costs by subtracting the cost of the last alternative under consideration from the cost of the next largest plan and (2) incremental outputs by subtracting the output of the last alternative under consideration from the output of the next largest plan. *IWR-PLAN* then automatically identifies the plan that produces the lowest average cost per unit of output when compared to the No Action plan. In the next step, all larger plans are compared incrementally to the lowest average cost plan. This process identifies the most efficient plan for producing the next higher level of output. All plans between the first and second selected plans are then eliminated. Incremental costs for the remaining larger plans are recalculated compared to the second selected plan. The successive comparison of incremental costs to the previously selected plan continues until the set is complete.

The final set of selected plans is referred to as “best buy plans.” The first “best buy” is the most efficient plan, producing ecological outputs at the lowest incremental cost per unit. If a higher level of output is desired for reasons other than cost efficiency, then successive “best buy” plans can be considered for implementation.

CE/ICA OF MONDAY CREEK

The CE/ICA of the Monday Creek alternatives began with the formulation of treatment sites. Fish and macroinvertebrate baseline data, in addition to water quality information, were utilized to prioritize the degraded subwatersheds in the Monday Creek basin. A total of eight subwatersheds were identified to be significant contributors to the (Acid Mine Drainage) AMD within the watershed. The eight subwatersheds included Jobs Hollow, Dixie Hollow, Rock Run, Lost Run, Monkey Hollow, Snake Hollow, Snow Fork and Coe Hollow.

AMD restoration technologies evaluated as possible restoration alternatives for this project included active and passive systems. Active restoration alternative technologies address pH problems however they may not address metal precipitants. Active restoration alternatives usually require routine operation and maintenance. Passive restoration alternative techniques on the other hand are designed to be more self-sufficient and are typically designed for a 20-30 year project life. Unlike active restoration alternatives, passive restoration alternatives require minimal operation and maintenance and are designed to eliminate precipitating metals in addition to raising pH. General descriptions of remediation technologies considered for the Monday Creek Watershed are described below.

Limestone Dosing (Doser) (Active): A process where limestone is introduced into a stream in regular increments. The limestone particles may be in a large hopper or from a plant-type operation. The doser can be electric or water driven. Maintenance, weather, regular access, vandalism, and the lack of variability in dosing are concerns. While dosing can be effective restoration alternative for low pH, dosing does not address metal precipitants.

Anoxic Limestone Drain (ALD) (Passive): An ALD is a buried channel containing limestone that is designed to limit oxygen contact with the mine discharge. An ALD requires relatively low metal concentration (dissolved Al <1 mg/L and >75% ferric iron) and low dissolved oxygen (<1 mg/L). Typically, an ALD is used in conjunction with aeration and a wetland system of settling ponds to allow for metal precipitation reactions.

Compost or Anaerobic Wetland (Passive): The wetlands consist of wetland vegetation, permeable organic mixtures of compost, straw/manure etc., and underlain or mixed with limestone. A compost wetland generates alkalinity through a combination of bacterial activity and limestone dissolution. In some cases, an aerobic settling pond may be needed for metal precipitation reactions before the compost wetland.

Open Limestone Channels (OLC) (Passive): An adequately sized open channel containing large limestone that carries and treats the mine discharge. The OLC must be on a fairly steep slope (greater than 10 percent) to ensure sufficient amount of oxygen necessary to precipitate metals and to transport the metal precipitates down the channel otherwise the metals will precipitate onto the limestone affecting the efficiency of the system. An OLC is suited for AMD with high dissolved oxygen and metal concentrations and low pH.

Limestone Leach Bed (LLB) (Passive): LLBs are buried cells or trenches of limestone which the water flows through. The limestone dissolves in the water and adds alkalinity. The purpose of these leach beds is to provide alkalinity to fresh water streams upstream of any AMD sources.

Slag Leach Beds (SLB) (Passive): Steel slag, a by-product of steel making, is produced during the separation of the molten steel from impurities in steel-making furnaces. Steel

slags are often locally available in large quantities at low cost. When fresh, they have NPs ranging from 45 to 90 percent. Studies indicate that columns of steel slag maintain constant hydraulic conductivity over time and produce highly alkaline leachate ($>1,000$ mg/l as CaCO_3). Steel slag can be used as an alkaline amendment as well as a medium for alkaline recharge trenches. Slags are produced by a number of processes so care is needed to ensure that candidate slags are not prone to leaching metal ions such as Chromium (Cr), Manganese (Mn), Nickel (Ni), or Lead (Pb).

Underground Mine Sealing (Passive): Deep mine sealing is defined as closure of mine entries, drifts, slopes, shafts, boreholes, barriers, outcrops, subsidence holes, fractures, and other openings into underground mine complexes. Deep mine seals are constructed to achieve one or more functional design goals including (1) eliminate potential access to the abandoned mine works following closure, (2) minimize AMD production by limiting infiltration of air and water into the deep mine, (3) minimize AMD production by maximizing inundation of the mine works, (4) minimize AMD exfiltration through periphery barriers to surface water systems, and (5) develop staged internal mine pools to regulate maximum hydraulic head and pressure.

Low Head Dams (Passive): The purpose of these low head dams is to aerate the stream and ensure that most, if not all, of the iron in the stream is in the ferric oxidation state. The limestone, or any other non-acid producing rock, used to build these dams should have a diameter no less than 20% of the total stream width.

Development of the Monday Creek Total Acid Mine Drainage Loading (TAMDLC) model was a cooperative effort between the U.S. Army Corps of Engineers, Huntington District and West Virginia University (WVU). This model simulated the transport and reaction of the water quality constituents of iron, pH, and aluminum all which are related to AMD. Recovery potential for aquatic species for these constituents require a pH range of 6.0-7.0 standard units, aluminum to range between 0.72-1.12 mg/L and iron range of 1.09-1.49 mg/L. The model was used to calculate the required load reductions from each of the constituents. Designs of the alternative restoration plans were developed and simulated in the TAMDLC model for each of the eight subwatersheds. The plans were then adjusted until the pH, aluminum and iron concentrations were achieved.

Corps policy requires the team to look at all feasible and reasonable alternatives. During the formulation process, the team recognized that 4 subwatersheds had numerous (greater than 20) sites recommended by the TAMDLC model. Since dosers are feasible alternatives, the team added this feature into the final array of alternatives plans at the mouths of Lost Run, Monkey Hollow, Snake Hollow and a tributary of Snow Fork (Brush Fork) to be analyzed during the CE/ICA process. These four alternatives brought number of alternative plans to twelve.

In addition to the 12 alternative plans in the final array, the National Environmental Policy Act requires that the Future Without Project Conditions (FWOPC) or No Action be

evaluated with the alternative plans. Therefore, a final total of 13 plans were analyzed for CE/ICA. The alternative plans features are described in Table 1.

Table 1
Description of Alternative Plans Analyzed

Plan	Location	Description
A	Jobs Hollow	1 doser, 3 SLB* and 1 OLC*
B	Dixie Run	1 SLB, 2 OLC and 1 LLB*
C	Rock Run	3 LHD* and 1 wetland
D	Lost Run	30 + 16 spoil blocks and 12 subsidences
E	Lost Run w/ Doser	1 doser + 16 spoil blocks and 12 subsidences
F	Monkey Hollow	25 + 9 spoil blocks and 6 subsidences
G	Monkey Hollow w/ Doser	1 doser and 9 spoil blocks and 6 subsidences
H	Snake Hollow	1 SLB, 4 OLC and 4 LLB
I	Snake Hollow w/ Doser	1 doser
J	Snow Fork	6 SLB, 19 OLC, 20 LLB, 8 dissipating streams, 9 spoil blocks, 7 subsidences, and 2 wetlands
K	Snow Fork w/ Doser	1 doser, 3 SLB, 5 OLC, 6 LLB, 8 dissipating streams, 9 spoil blocks, 7 subsidences and 2 wetlands.
L	Coe Hollow	2 SLB, 1 OLC, 4 LLB, 3 dissipating streams and 1 Subsidence
M	FWOPC	No Action, Future Without Project Conditions

*SLB – slag leach bed; LLB – limestone leach bed; OLC open limestone channel; LHD – low head dam

For ecosystem restoration projects, the CORPS looks at environmental outputs versus costs to determine benefits. For this project, sustainability metrics were developed by determining the acreage of stream habitat (quantity) improved by the plans multiplied by the minimum ICI score to meet the project goals (quality) and then multiplied by the Importance Ranking. Each plan was evaluated between the existing conditions and the Future With Project Condition (FWPC) over the life of the project. The generated scores are used only to provide an understanding of the magnitude of the improvement and to provide an equal basis for comparing the efficiency and effectiveness of various alternative plans. Scores for FWPC and FWOPC are displayed in Table 2.

Sustainability = Quantity x Quality x Importance* = Score (units)

*Importance is measured by the following ranking

- 1 = No connectivity – Does not cause any impact to headwaters or mainstems. FWOPC.
- 2 = Connectivity with the mainstem Monday Creek only. For example: a doser at the confluence of the subwatershed with mainstem Monday Creek
- 3 = Connectivity of headwaters of subwatershed with mainstem of Monday Creek.

Table 4-8.

Future With Project and Without Project Output

FWPC Plan	Impact Area	Quantity (acres)	Minimum Quality (ICI Score)	Importance	FWP Score (Units)	FWOP Score (Units)
A - Jobs Hollow Plan	Jobs and MC	10.38	36	3.9	1444	93
B- Dixie Hollow Plan	Dixie and MC	14.16	36	5.4	2733	127
C – Rock Run Plan	Totals	46.31			27908	46
	Rock Run	1.43	36	16.7	860	13
	Monday Creek	44.88	36	16.7	27048	1346
D - Lost Run Plan	Totals	46.07			43372	1688
	Lost Run	7.47	36	26.2	7046	67
	Monday Creek	38.6	36	26.2	36326	1621
E - Lost Run w/ Doser only Plan	Totals	38.72			19343	1622
	Lost Run (D)	0.12	36	13.9	60	1
	Monday Creek	38.6	36	13.9	14283	1621
F - Monkey Hollow Plan	Totals	37.52			18501	1812
	Monkey Hollow	4.75	36	13.7	2343	43
	Monday Creek	32.77	36	13.7	16158	1770
G - Monkey Hollow w/ Doser only Plan	Totals	32.89			13957	1771

**Cost Effectiveness &
Incremental Cost Analyses**

	Monkey Hollow (D)	0.12	36	11.8	51	1
	Monday Creek	32.77	36	11.8	13906	1770
H - Snake Hollow Plan	Totals	11.3			1735	688
	Snake Hollow	1.99	36	4.3	308	18
	Monday Creek	9.31	36	4.3	1427	670
I - Snake Hollow w/ Doser only Plan	Totals	9.43			1147	671
	Snake Hollow (D)	0.12	36	3.4	15	1
	Monday Creek	9.31	36	3.4	1132	670
J – Snow Fork Plan	Totals	51.44			43630	946
	Snow Fork	49.76	36	23.6	42203	896
	Monday Creek	1.68	36	23.6	1427	50
K - Snow Fork w/ Doser only Plan	Totals	45.24			34402	573
	Snow Fork (D)	43.56	36	21.1	33125	523
	Monday Creek	1.68	36	21.1	1276	50
L - Coe Hollow Plan	Totals	17.65			4042	841
	Coe Hollow	0.54	36	6.4	124	19
	Monday Creek	17.11	36	6.4	3918	821
M - FWOPC	Existing Conditions	234.83	^	^	6243	6243

^The values for the FWOPC = existing ICI scores x acreage x 1

The next step in the CE/ICA process was to develop annualized costs for each of the 13 plans to be used in the Plan. Total average annual costs of the Monday Creek restoration plans are presented in Table 3. These costs are based on average annual implementation costs and annual operation, maintenance, repair, replacement and rehabilitation (OMRR&R) costs. Average annual implementation costs include capital

costs, real estate costs, and interest during construction and utilized an interest rate of 5.375%. The project life was determined to be 20 years.

Table 3
Alternative Plans Cost

Plan	Subshed	Project Cost	O&M	IDC	Total Annual Cost
A	Jobs w/ Doser	\$1,005,276	\$1,147,943	\$92,835	148,336
B	Dixie	\$268,135	\$78,230	\$25,139	28,199
C	Rock Run	\$559,214	\$282,646	\$51,465	64,705
D	Lost	\$5,304,532	\$372,917	\$490,491	498,553
E	Lost w/ Doser	\$382,729	\$705,636	\$35,752	69,938
F	Monkey	\$3,157,005	\$2,697,852	\$292,814	420,585
G	Monkey w/ Doser	\$1,020,007	\$705,636	\$98,597	127,918
H	Snake	\$514,533	\$117,776	\$46,978	52,390
I	Snake w/ Doser	\$367,245	\$705,636	\$33,530	68,471
J	Snow Fork	\$6,890,536	\$3,644,108	\$635,373	805,453
K	Snow Fork w/ Doser	\$4,688,091	\$3,193,305	\$430,720	583,573
L	Coe	\$635,276	\$87,250	\$58,143	61,787
M	FWOP	\$0	\$0	\$0	\$0

* Includes: construction costs; planning engineering and design costs; real estate costs; and contingency

Since the study effort looked at a top down approach to restoration of the watershed, the Plan allows for dependency within the combinations. For example, in the headwaters of Monday Creek, Dixie Hollow is located near the upper part of the mainstem. The Plan allows you to look at the cumulative impacts of adding Dixie Hollow benefits (2,733 units) plus Rock Run (860 units), in addition to the downstream benefits of Monday Creek mainstem (27,908 units). These downstream impacts were measured and accounted for the mainstem until the next significant contributing subwatershed was reached. As part of the IWR-Plan, the combined dependencies were also analyzed.

For example:

$$\begin{array}{r}
 2,733 \text{ units (Plan B Dixie Hollow)} \\
 860 \text{ units (Plan C Rock Run)} \\
 + \quad 27,048 \text{ units (Monday Creek Mainstem)} \\
 \hline
 31,641 \text{ total units}
 \end{array}$$

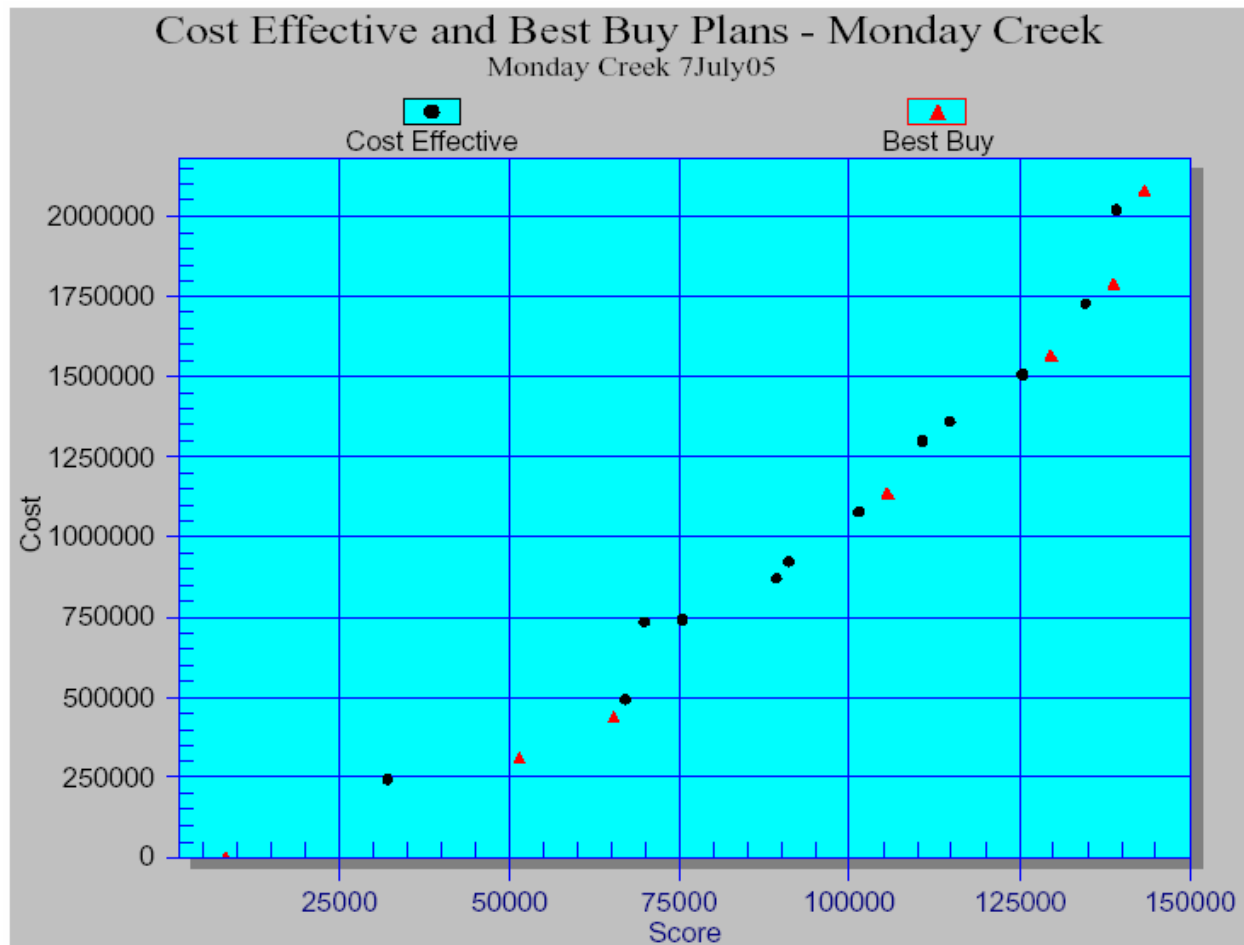
In addition to dependencies, the Plan also allows for constraints. An example of a constraint is that Plan D Lost Run would not be analyzed with Plan E Lost Run Doser since a doser can achieve the same results as the construction of a series of restoration alternatives. However, a sponsor may perceive dosers as operation and maintenance prohibitive. Dosers would not be considered in combination TAMDL recommended restoration alternatives. Table 4 shows a listing of plans that would not be combined within any plans.

Table 4
Non Combinability Constraints

Primary Plan	Alternative Plan
Plan D – Lost Run Plan (58 sites)	Plan E – Lost Run with Doser (29 sites)
Plan F – Monkey Hollow Plan (40 sites)	Plan G – Monkey Hollow with Doser (16 sites)
Plan H – Snake Hollow Plan (9 sites)	Plan I – Snake Hollow with Doser (1 sites)
Plan J – Snow Fork Plan (71 sites)	Plan K – Snow Fork with Doser (40 sites)

After the dependencies and non-combinability features were developed, this information, in addition to the annualized costs for each plan, was input into the IWR-Plan for analysis. IWR-Plan analyzed the cost effectiveness of each plan and full range of combination of plans. The full range of plans included 8,192 possible combinations. However, in the comparison of the costs and outputs of the combination of plans, IWR-Plan identified 51 plan combinations that are possible within the constraints, combinability, and dependency limitations. Cost effective plans are plans where no other plan provides the same output level for less cost, or no other plan provides a higher output level for the same or less cost. Only 19 plans were identified as cost effective plans and are shown in Figure 5 as black and red points.

Figure 5
Plan Combinations and Cost Effective Plans.



Of the 19 cost effective plans, 7 plans were found to be Best Buy Plan Combinations. The Best Buy Plans are plans that are a subset of the cost effective plans and are the most efficient in output production. The Best Buy Plans also have the greatest increases in the sustainability units for the least increase in costs and has the lowest incremental costs per sustainability unit output. The six plan combinations shown to be the Best Buy Plans are described in Table 5.

Table 5
Best Buy Plan Descriptions

Plan Combination	Plan Combinations
1	M (No Action or FWOPC)
2	A (Jobs) + B (Dixie) + C (Rock) + E (Lost w/ Doser)
3	A (Jobs) + B (Dixie) + C (Rock) + E (Lost w/ Doser) + G (Monkey w/ Doser)
4	A (Jobs) + B (Dixie) + C (Rock) + E (Lost w/ Doser) + G (Monkey w/ Doser) + H (Snake) + K (Snow Fork w/ Doser) + L (Coe)
5	A (Jobs) + B (Dixie) + C (Rock) + D (Lost) + G (Monkey w/ Doser) + H (Snake) + K (Snow Fork w/ Doser) + L (Coe)
6	A (Jobs) + B (Dixie) + C (Rock) + D (Lost) + G (Monkey w/ Doser) + H (Snake) + J (Snow Fork) + L (Coe)
7	A (Jobs) + B (Dixie) + C (Rock) + D (Lost) + F (Monkey) + H (Snake) + J (Snow Fork) + L (Coe)

The results of ICA for Monday Creek are presented in Table 6. The table includes the incremental cost and incremental output of six plan combinations which were identified by the CE/ICA as Best Buy plans. The average costs per unit presented in Table 6 indicates that Plan Combination 2, which includes Alternatives A (Jobs) + B (Dixie) + C (Rock) + E (Lost w/ Doser), is the most efficient plan, producing out at the lowest incremental cost per unit. Plan Combination 6, which includes alternatives A (Jobs) + B (Dixie) + C (Rock) + D (Lost) + G (Monkey w/ Doser) + H (Snake) + J (Snow Fork) + L (Coe) is the best plan that maximizes the cost per incremental output.

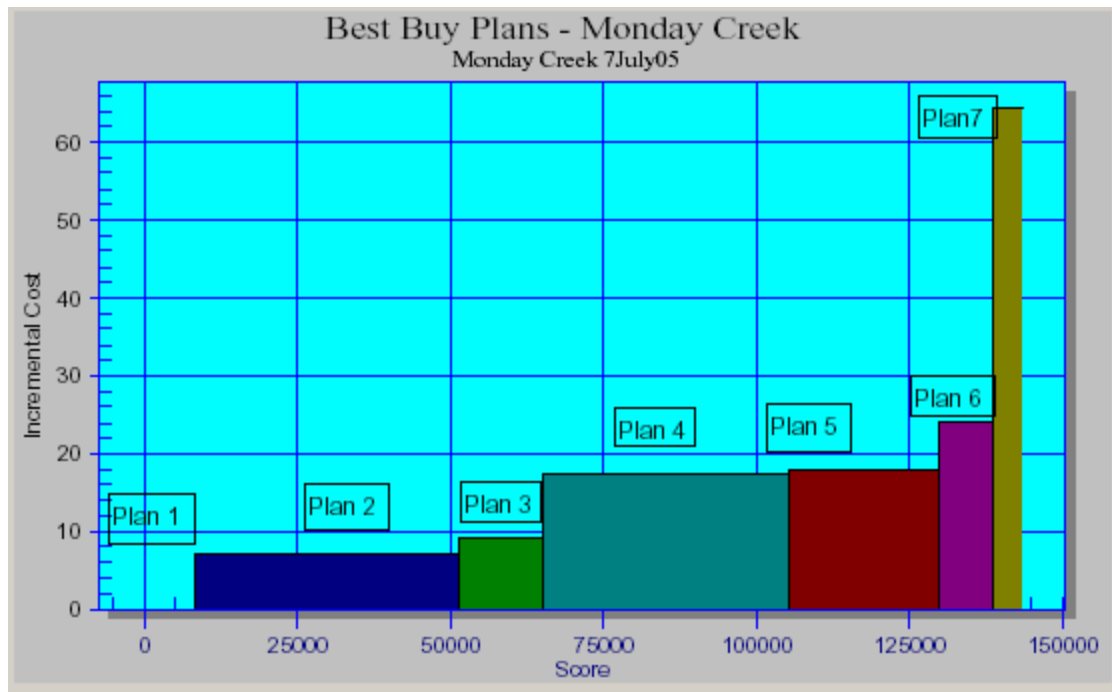
The average costs of the Monday Creek Best Buy Plan Combinations in dollars per restoration output (unit) are also presented in Table 6. Average costs per sustainability unit ranged from \$0.00 for the Plan Combination 1 - FWOPC to \$64.40 for Plan Combination 6.

Table 6
Average Costs and Incremental Cost Analysis
Of Best Buy Restoration Plans

Plan Combination	Score (Units)	Costs (\$)	Average Cost (\$ per unit)	Incremental Costs (\$)	Incremental Output (unit)	Incremental Cost per Output (\$ per unit)
1	8,269	0	0.00	0.00	8,269	0.00
2	51,428	311,178	6.05	311,178.00	43,159	7.21
3	65,385	439,096	6.71	127,918.00	13,957	9.17
4	105,564	1,136,846	10.76	697,750.00	40,179	17.37
5	129,593	1,565,461	12.07	428,615.00	24,029	17.84
6	138,821	1,787,341	12.87	221,880.00	9,228	24.04
7*	143,365	2,080,008	14.50	292,667.00	4,544	64.40

Figure 6 graphically displays the incremental costs and the breakpoint which indicates which plan has the most the incremental output versus costs and which plan is considered the best investment. Plan Combination 1 is the most efficient plan since benefits appear to be occurring with no costs. However, Plan Combination 1 displays the FWOPC plan or existing conditions. Plan Combination 6 has the greatest increase in output for least increase in cost and is considered the National Ecosystem Restoration Plan (NER) Plan. Plan Combination 7 is also a Best Buy Plan but costs more per sustainability unit at \$64.40/unit, respectively for gains of 4,544 sustainability units. Incrementally, Plan Combination 7 indicates that there is little gain in sustainability units versus the investment costs.

Figure 6
Best Buy Plans for Monday Creek Ecosystem Restoration Project



DISCUSSION

The selection of the recommended restoration plan for a given site can be a complex undertaking. The comparison of incremental costs and incremental outputs provides a way to evaluate alternative levels of ecosystem restoration. CE/ICA shows what additional costs would be incurred and what additional outputs would be gained if successively larger plans were implemented. Corps planning guidance does not require selection of a Best Buy alternative as the recommended restoration plan. In the case of Monday Creek, a variety of considerations outside of the CE/ICA may influence plan selection. Such considerations may include preferences of the non-Federal project partner, effects on threatened or endangered species, or input from Federal or state resource agencies. These considerations could tip the scales in favor of a plan that was not identified as a Best Buy plan over one that is.

Of the six plan combinations that were Best Buy Plans, only Plan Combinations 1 and 6 were retained for further consideration. The average costs per unit presented in Table 6 indicates that Plan Combination 2, which includes Alternatives A (Jobs) + B (Dixie) + C (Rock) + E (Lost w/ Doser) + G (Monkey w/ Doser), is the most efficient plan, producing out at the lowest incremental cost per unit. Plan Combination 6, which includes alternatives A (Jobs) + B (Dixie) + C (Rock) + D (Lost) + G (Monkey w/ Doser) + H (Snake) + J (Snow Fork) + L (Coe) is the best plan that maximizes the cost per incremental output.

PC 6 was the Best Buy Plan that had the greatest increase in output for least increase in cost. PCs 2, 3, 4, 5, and 7 were not the most efficient in production for the least increases in costs as compared to Plan Combination 6.

APPENDIX F

LONG-TERM MONITORING PLAN

**Recommendations for Long-Term Monitoring
Monday Creek Watershed**
**In conjunction with the Army Corps of Engineers feasibility study
January 16, 2004**

Committee members and logistics

The following names were provided for inclusion in this committee.

Mary Ann Borch	ODNR	Lead
Vince Marchese	ACOE	Water quality
Chuck Boucher	OEPA	Biologist
Keith Orr	OEPA	Water quality
Kelly Capuzzi	OEPA	Biologist (fish)
Jen Bowman	Sunday Creek WS	Sunday Creek Coordinator
Rebecca Black	Monday Creek WS	Monday Creek water quality
Ted King	USFS	Statistician
Kelly Johnson	OU	Biologist (bugs)

Issue Statement

Acid mine drainage restoration projects are being planned by the Army Corps of Engineers for the sub-basins within the Monday Creek watershed. Funding authorities for much of the restoration work requires that the environmental impact of restoration projects be monitored in order to determine the effectiveness of the restoration measures. The water quality information will serve to educate the technical team as well as to educate and inform the residents of the watershed and funders. Water quality characterization will take place before and after restoration is complete by collecting water chemistry and biologic samples. The cumulative impact of all restoration projects on water quality within the Monday Creek Watershed will be documented and understood.

Monitoring plan

The goal of reclamation efforts proposed by the Army Corps of Engineers is to rehabilitate the mainstem to restore aquatic habitat and life in Monday Creek. Reclamation efforts are targeted in sub-watersheds whose toxic loadings negatively affect the mainstem of Monday Creek. Therefore, long-term monitoring is proposed for the mainstem to do the following:

- Assess the impact of reclamation in the tributaries on Monday Creek
- Provide an assessment of water chemistry and biologic trends over time

The long-term monitoring plan will consist of water chemical and biologic monitoring. Long-term monitoring will take place in the mainstem of Monday Creek and Snow Fork in long established monitoring sites. The baseline dataset is robust with historic data dating back to 1997. In addition, the EPA's Total Maximum Daily Load (TMDL) monitoring sites are tied to these locations. The EPA data includes chemistry, sediment, biology (fish and macros) and flow.

Monitoring of water chemistry will also be conducted in tributaries proposed for reclamation projects. This effort will be confined temporally to pre and post-construction projects.

Water chemistry

Parameters

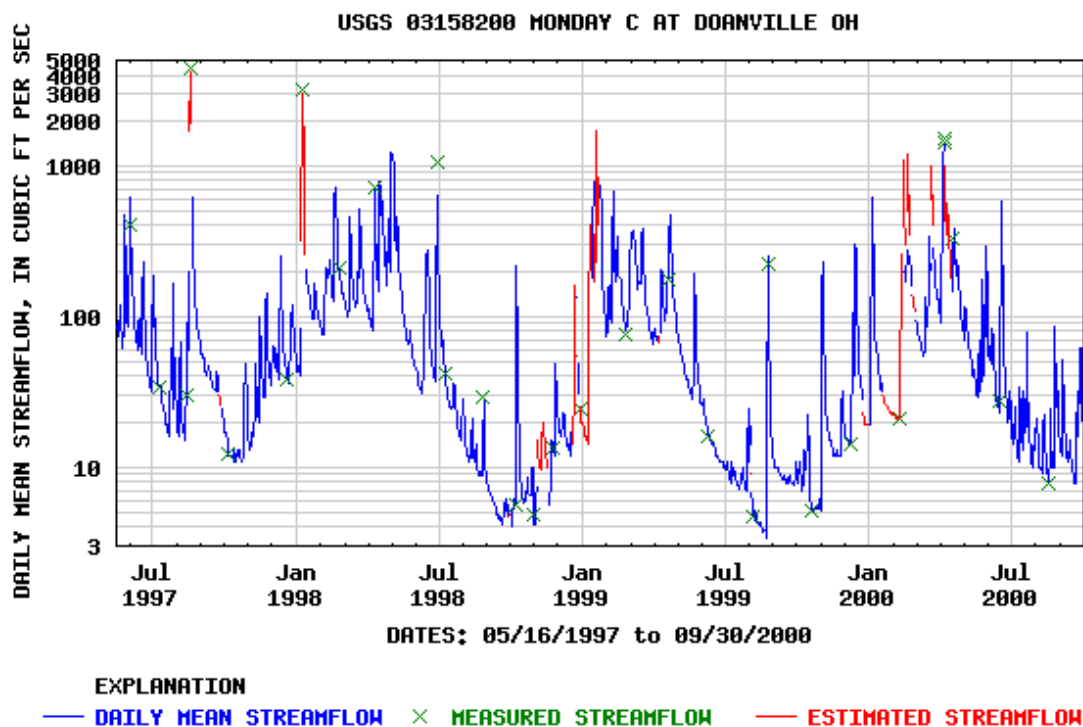
The following water quality parameters will be collected;

Specific conductance	Field and lab	Us/cm
pH and Temp	Field and lab	SU and C
Total Dissolved Solids	Laboratory	mg/L
Acidity (total hot)	Laboratory	mg/L
Alkalinity (total)	Laboratory	mg/L
Sulfate (total)	Laboratory	mg/L
Aluminum (total and dissolved)	Laboratory	mg/L
Manganese (total and dissolved)	Laboratory	mg/L
Iron (total and dissolved)	Laboratory	mg/L

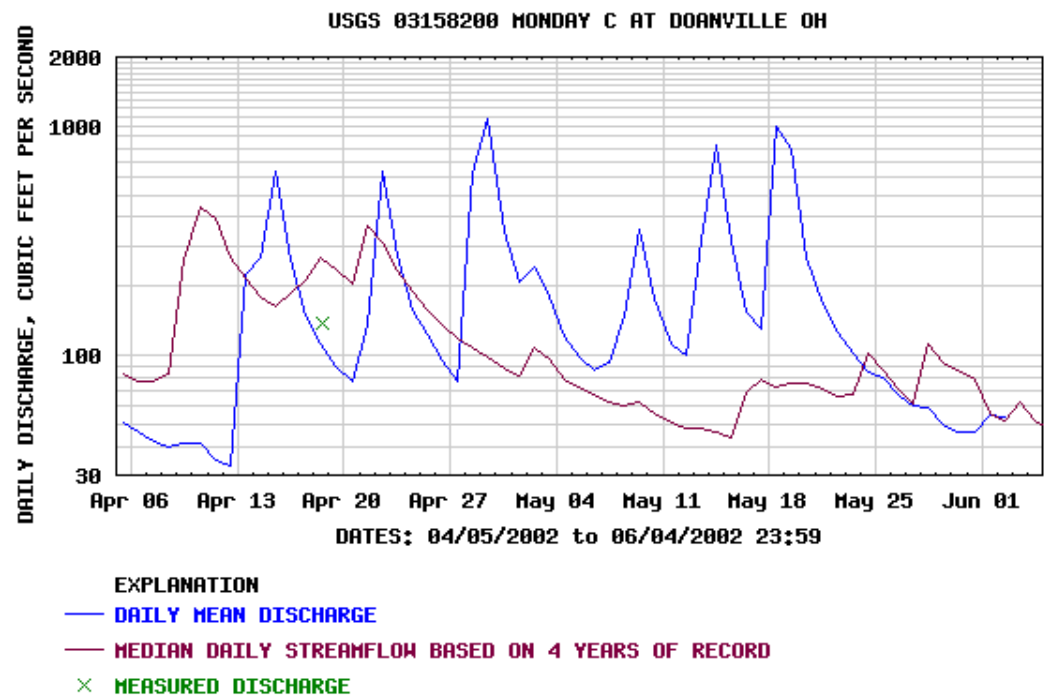
Calculate total net acidity.

Flow Data

Flow data will be compared against the USGS gage Doanville station flow measurements so that relative conditions can be established for flow during sampling events and in order to calculate loading rates. The graph below shows flow conditions for three years. This type of information provides a benchmark for yearly fluctuations.



The next USGS graph from the Doanville gage station shows daily mean discharge and median daily stream flow for four years of record for flow conditions several weeks prior to sampling. When collecting flow in the field, do not measure the extreme high flows that occur after a precipitation event, but monitor during the baseline (as represented on the hydrograph, not baseflow) conditions. These are more manageable to measure and easier to plan a sampling event when organizing equipment and field crew.



Daily mean flow statistics for 6/4 based on 5 years of record in ft ³ /sec						
Current Flow	Minimum	Mean	Maximum	80 percent exceedence	50 percent exceedence	20 percent exceedence
	26	105	232	28.0	52.0	221
Percent exceedence means that 80, 50, or 20 percent of all daily mean flows for 6/4 have been greater than the value shown.						

Sampling locations

The following sites are located in Monday Creek mainstem from downstream to upstream. All the historic monitoring sites are located just downstream of the proposed reclamation projects with the exception of Oreville (103) and Carbon Hill (153). Oreville should still be included as it provides a transition point between Lost Run and Rock Run, a distance of seven miles. Carbon Hill (153) should be relocated below the input from the Monkey Hollow tributary. The new station would be renamed Carbon Hill B ?? (154), approximately 1.1 miles downstream at RM 10.4. Unfortunately, there would not be historic baseline data for this site. (see map)

- | | | | |
|----|--------------------------------------|---------|---|
| 1 | Doanville at USGS gage station (108) | TR 1042 | dst Coe Hollow (RM 1.7) |
| 2 | Below Snake Hollow | 151 | Loop Rd dst McKnight Seep (RM 4.3) |
| 3* | Below Carbon Hill Run | 153 | SR 278 (RM 10.4) (Eliminate? Can we fit it in?) |
| 3 | Carbon Hill Below Monkey | 154 | dst of Monkey Hollow (RM 9.29-Establish) |
| 4 | Below Lost Run | 131 | Adj. SR 595 (RM 16.0) |
| 5 | Above Oreville | 103 | @ Monday Cr. Junction (RM 19.7) |
| 6 | Below Rock Run | 127 | (RM 23.4) |
| 7 | Below Jobs Hollow/Above Dixie Hollow | 148 | Portie Flamingo Rd (RM 26.5) |

Snow Fork enters Monday Creek at RM 3.5.

Sites along Snow Fork mainstem from downstream to upstream:

- | | | | |
|----|-----------------------------------|-----|------------------------------------|
| 8 | Snow Fork at Buchtel gage station | 109 | SR 685 dst Orbisten Seep (RM 2.4) |
| 9 | Snow Fork above Goose Run | 107 | Dst Snow Fk Mainstem Seep (RM 4.3) |
| 10 | Murray City Bridge | 106 | Dst Murray City Seeps 1&2 (RM 6.2) |

Add a new site downstream of Little Monday Creek. This location has the best water chemistry and may offer information on biologic refugia that could repopulate Monday Creek.

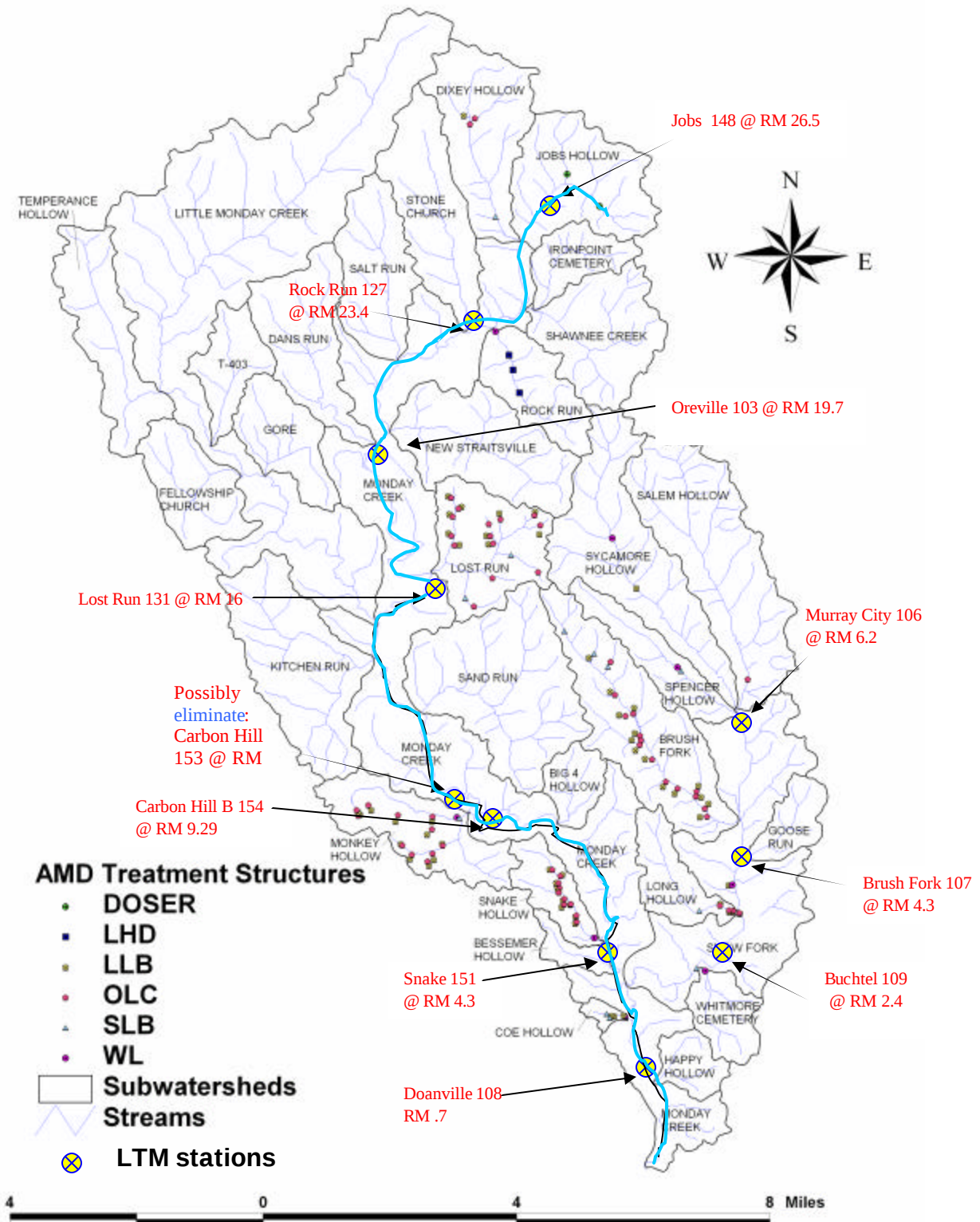
Frequency of collection

For the long-term monitoring, the chemistry and hydrologic data will be collected two times a year at low flow and high flow prior to initiation of restoration work, during construction, and for at least five years after restoration work is complete. The timeline for completion of reclamation work is an unknown and is dependent on funding. Attempt to correlate the low and high flows with fall and spring.

Tributary monitoring for pre- and post-construction

Both Ohio EPA (in 2001 TMDL survey) and Monday Creek group conducted sampling in the tributaries to Monday Creek and Snow Fork. Therefore, tributary level monitoring for reclamation projects should be located at the site of previous monitoring where some historic data exists. Construction monitoring will begin one year prior to reclamation construction and for one year after completion. Monitoring frequency will be every other month so that six sampling events are conducted for each year.

Monday Creek AMD Treatment Structures



Reporting

A standard report format will be developed and will include (but not be limited to) the following:

- A brief summary of historic water quality (a one-time effort already discussed in WV modeling report)
- The results will be reported for the same parameters and in units consistent with those already established on baseline long-term monitoring.
- Water chemistry reports will include calculated net-acidity and total metal concentrations and loading rates. Iron, manganese, and aluminum concentrations can be combined together as total metal concentrations and loads. In addition, remediation systems and targets are designed to accommodate each of these metals separately. Task: develop a table template for in-putting water chemistry with embedded formulas for calculating loadings and net acidity.
- Proposed methods of data interpretation:
 - ✓ Trend analysis will show 1) water quality changes through time at each station during a high and low flow and 2) changes along the mainstem at individual sampling sites. This will be done for the high and low flow showing the changes in water quality from the headwaters to the mouth. (This may be a reason to add a station at the mouth of Little Monday, to know how much alkalinity is contributed).
 - ✓ Graphics showing concentration and loading rate for metals and acidity
 - ✓ [A brief summary accompanying graphics to interpret changes and progress for each year](#)
 - ✓ Include a list or graphic of the treatment projects that have been completed, the date of completion and their location since they won't all be completed at the same time (or possibly a gantt chart)
 - ✓ (Mary Stoertz' performance measures analysis also using targets for comparison)
- Reporting shall be on an annual basis
- Proposed timeframe of long-term monitoring (i.e. life of project for funding purposes)
- Report any maintenance or repairs that are needed or conducted on any projects. Also include any issues or problems encountered
- Recipients of the Water Quality Monitoring Report
 - ✓ Watershed members,
 - ✓ funders (ODNR, EPA, OSM, ARMY CORPS, etc...),
 - ✓ technical advisory committee.

Sediment Monitoring

[Sediment sampling was conducted by Dr. Dina Lopez and graduate students of Ohio University that accompanies Ohio EPA's TMDL in 2001. However, a comparison of the methods used by Lopez to those used at EPA, determined that the two methods produced differences in results by an order of magnitude. Therefore, a new baseline will be established by Ohio EPA. These sediment-sampling sites will be located at the established \(and new\) long-term monitoring locations. Sampling will occur with the 10-year return of the TMDL update.](#)

Biological Monitoring

Fish and macroinvertebrate baseline data were collected by Ohio EPA in the 2001 TMDL survey. To document improvements to the watershed, fish and/or macroinvertebrate data will be collected following the same methodologies used by Ohio EPA. The Macroinvertebrate Aggregate Index for Streams (MAIS) method will also be used for a rapid assessment of macroinvertebrates. Baseline data should be collected using this methodology so that trends can be documented.

Below is a link to the web page for Ohio EPA's Biocriteria users manual:

<http://www.epa.state.oh.us/dsw/bioassess/BioCriteriaProtAqLife.html>

Explanation for the MAIS is included at the end of this document.

Sampling locations

The biological sampling locations should be conducted at chemical sampling locations (ODNR's long-term monitoring stations). As restoration projects are completed on the tributaries, biological monitoring stations should be added downstream from those projects to document improvements if a long-term monitoring station does not exist at that location.

Frequency of biologic monitoring

- ✓ EPA full biological assessment: Every 10 years to be sampled next in year 2011.
- ✓ MAIS family-level aggregate multimetric index -----
- ✓ Fish assemblage to be sampled by EPA SEDO, every five years to be sampled next 2006 and also on an as-needed basis.

All methodologies need sufficient baseline monitoring prior to reclamation. As individual restoration projects are completed in the tributaries, some monitoring should be conducted downstream from the project or at the mouth of the tributary.

Reporting (yet to be done)

Our committee will propose a format developing a standard report format:

- Items (parameters) to be reported on
- Units and/or indices
- Charts, graphs, interpretations
- Reporting frequency

Describe how work load will be allocated in terms of persons and funding. (this may have to wait till later or be answered by the funders)

Water chemistry: filtered vs non-filtered (totals vs. dissolved) or both. Sample for totals except under turbid conditions, where filtering is then preferred. Sometimes, iron especially and other metals are still somewhat present in higher concentrations for totals. This method has been used for the WVU model and all baseline data to date.

Regarding QAQC, I would like to have Rebecca Black provide Vince Marchese with the protocols you have been using for water chemistry sampling, transport, and also the laboratories QAQC.

Summary of the MAIS Method proposed by Kelly Johnson's (Dec. 19, 2003)

Our methodology has undergone several modifications over the last few years as we explored different options that provide a good basis for between-year and between-site comparisons. The core elements of the field methodology include both single habitat (1 meter kick net in riffles) and multiple habitat (20 D-frame dip net sweeps) sampling following the US EPA Rapid Bioassessment Protocols. Taxa are picked from the nets in the field and/or are transported to the laboratory and sorted under the stereoscope (see details below). For added continuity and our own research interests, we have also used Hester-Dendy multiplate samplers and collect Surber samples from riffles at sites we have identified as long-term sites, but these are not necessary for calculating the family level MAIS index. We've continued to collect them primarily to provide a basis for future calculations and comparisons with other metrics (e.g. OEPA's ICI).

Macroinvertebrates are identified to family by trained students/ volunteers or myself, and all are archived in the event that further taxonomic resolution or verification proves feasible at a later date. We have been using a family-level aggregate multimetric index (MAIS) to assign a numerical score to each site. The MAIS was developed using an ecoregion, reference site approach from data from six ecoregions in West Virginia, Virginia, Maryland, Pennsylvania, including the WAP, although proportionally fewer WAP sites were represented in the dataset. Thus, the current cut-off values for the four classification levels ("very good", "good", "fair" or "poor") may differ slightly for our ecoregion (but a study by the West Virginia DEP with a very similar index found no differences between biota in the WAP and neighboring Central Highlands ecoregion. However, the numerical values of the index (which range from 0 to 20) should provide a reasonable basis for year-to-year monitoring and local comparisons with unimpacted control sites. I have not been able to locate any studies that have investigated year-to-year variation in the index, but intend to do it with our own sites in the near future.

Its worth noting that the MAIS is the primary benthic index used by the Virginia Department of Environmental Quality in their TMDL reports, and also by the Forest Service as the rapid bioassessment tool of choice for pre and post monitoring of projects in national forest areas in Virginia and Kentucky, so it isn't regarded as a "volunteer" index by those agencies. They use a modified version for volunteers with some training (days, not weeks) because non-biologists tend to have more difficulty with identifications, even at the family level. I agree, but in my experience, dedicated volunteers who are willing to invest several weeks in training with appropriate supervision, can become skilled at family level identification. The West Virginia Department of Environmental Protection developed and tested a family level index (SCI) in 2000, based on US Rapid Bioassessment kick and dip protocols that contains metrics very similar those in the MAIS, and their "advanced" volunteer program calls for family level identification. As a caveat, however, it should be noted that state programs can vary in the precision and accuracy of their bioassessments, so just because another state uses it doesn't necessarily mean it is the best or only good protocol.

1. Field Sampling (for a 100 meter reach)

a) **three 1 meter kick net** samples from riffles (USEPA Single habitat Rapid Bioassessment Protocol, section 7.1 2 in EPA 841-B-99-002 (Barbour et al. 1999).

b) **twenty D-ring dip net jabs/passes** (approximately 30 minutes) taken in multiple habitats in proportional representation (USEPA Multiple habitat Rapid Bioassessment Protocol, section 7.1 2 in EPA 841-B-99-002 (Barbour et al. 1999).

Additionally, depending on resources:

c) **one set of Hester-dendy** multiplate samplers attached to a brick and placed for 5-7 weeks in a high flow area of the stream *

d) **three 60 second Surber samples** in riffles (If flow is insufficient, the top 2 cm of substrate delineated by the Surber are collected and picked for macroinvertebrates at the laboratory)*

** During years with low rainfall, flow at some sites drops too low for kick nets or Hester-dendy. In these years, the Surber+ dip samples provide some basis for comparison to previous years, although a MAIS score based on Surber+ dip might would not be comparable to one calculated from kick+ dip.*

These field methods follow the latest US Rapid Bioassessment protocols for kick net and multihabitat dip net (Barbour et al. 1999 from www.epa.gov/owow/monitoring/rbp , Sept 2003) and overlap reasonably well with Ohio EPA's macroinvertebrate protocol (Ohio EPA 1989). For example, the season (between June 15 and Sept 30), and the placement and collection of Hester-dendys and qualitative dip net method are similar, although for the former, we use four samplers per site. The most significant departures from OEPA protocol are the taxonomic resolution with which organisms are identified (many only to family, not genus), and the indices that are subsequently calculated (e.g. the MAIS, not ICI). All organisms are archived and stored, however, so follow-up identification and calculation of the Ohio ICI or some modification of the qualitative score (QCTV?) is possible if time and resources allow.

2. Sorting, subsampling and laboratory processing

a) Kick and dip net samples are hand picked in the field. We have not found it necessary to subsample, since macroinvertebrate abundances at even lightly impacted sites in this area tend to be relatively low. (This was the main reason we began collecting kick net samples instead/in addition to Surber samples in riffle areas after 2001). At many impacted sites we don't come close to even a 200 organism minimum count.

b) Hester-Dendy and Surber samples (the latter sometimes contain a lot of organic debris) are placed in containers (zip-loc freezer bags or large glass jars, respectively) with no preservative and kept in a cooler until transport to the lab. When Hester-Dendy's are retrieved, place a large diameter metal sieve downstream and underneath as we lift them out of the water to capture any potential escapees. At the laboratory *the same day*, multiplate samplers and organic debris are washed over a 600 µm (No. 30) screen and sorted under the stereoscope. We have found that the time required to pick a sample is significantly reduced (from 6 hours to 0.5 –1 hour) if the animals are alive and still moving; also fewer of the small organisms (eg. Chironomid larvae) are missed. Subsampling of Surber samples is occasionally necessary; to accomplish this, the entire mixture of substrate and organic matter is poured into a pan and one fourth to one half of the pan is delineated for picking. Following the procedure described above, we can typically complete the field work

and laboratory sorting for 4-5 sites a day. A field notebook is maintained for recording the sample date and notable habitat characteristics (eg. narrative description of flow) at each site.

3. Taxonomic identification

Although we routinely perform generic level identification of many of the taxa collected, the time and expertise needed for some groups exceeds our resources, and slows the processing time considerably. In contrast, family-level identifications can be performed by graduate students or dedicated volunteers after a course in entomology or a few weeks of training and appropriate supervision. We use Merritt and Cummins (1996) primarily, but have an array of other literature for non-insect taxa and cross-referencing. We are developing a reference collection and protocol for systematic verifications by outside experts, but it is not yet complete. As taxa are identified and enumerated, they are entered into a log book, which also contains the name of the person who conducted the identification, specific notes made during identification, the sampling method, and the location of the site (name, watershed basin, county).

4. Metric calculation and comparisons to reference or control sites

Any number of the common biological metrics (total taxonomic richness, % EPT taxa, family level Hilsonhoff Biotic Index, Simpson or Shannon-Weiner Diversity indices) can be calculated and compared to previous years and/or control sites within the same or nearby watersheds. We have also explored the use of a family-level aggregate multimetric index developed in 1997 for use in the central Appalachians (list the states). The MAIS (Macroinvertebrate Aggregate Index for Streams) was developed for wadeable streams in the mid-Atlantic highlands and is used for samples collected with open-net, natural substrate devices (kickseine, D-ring dip net, Surber sampler). It was developed from a database of 455 sites from six ecoregions in the mid-Atlantic highlands (including 90 sites from the Western Allegheny Plateau). Sixty nine possible metrics were statistically evaluated for redundancy and the ability to detect impairment (list types). Nine metrics (% 5 dominant taxa, modified Hilsenhoff biotic index, % haptobenthos, EPT index, # Ephemeroptera taxa, Simpson diversity index, # intolerant taxa and % scrapers) were selected. The final index provides a single numerical score between 0 and 20 that can be compared to nearby control sites, the same site in previous years, or to the regional reference sites from which the index was developed. The MAIS is used by the Virginia Department of Environmental Quality in their TMDL reports, and by the Forest Service as a rapid bioassessment method for all projects (including post project monitoring) in the George Washington and Jefferson National Forests (see web sources listed in references below). Interestingly, Virginia also just modified their volunteer SOS protocol to more closely match the "professional" MAIS based on a study by Engel and Voshell (2002) that showed conclusions about ecological conditions (attainment vs non-attainment) reached by volunteer and professional protocols agreed closely (96% of the time). However, the actual scores of the volunteer index were less well-correlated ($r = 0.60$), probably because the volunteer index required less taxonomic resolution than the family level MAIS. It should be noted that the volunteers in this study were citizens and only briefly trained and certified (e.g. for days, not weeks), whereas most in our group (to date) have degrees in biology, a course in entomology, or at least several weeks of training to do family level identifications.

It should be noted that because the index was developed primarily from data (and reference sites) in the mid-Atlantic highlands, the reference site expectations may be a bit different than if reference sites were specific to the WAP; however, the group who developed the index believes they are not that different (R. Voshell, personal communication, Sept 2003). A validation study with WAP reference sites would be valuable. Our preliminary analyses from 26 sites show that the

MAIS is sensitive to AMD impact and correlates reasonably well with pH and conductivity ($p < 0.05$, r^2 of 0.41 and 0.37, respectively) (Johnson et al. 2002). In addition, some of the long term sites we have monitored have been assessed by the OEPA (Sunday and Monday Creek watersheds) in recent years, direct comparison of MAIS versus IBI and ICI scores can be made to evaluate the calibration of the metric.

References

“A stream condition index for West Virginia wadeable streams” (2000). Prepared for US EPA Region 3 Environmental Services division and US EPA Office of Science and Technology, Office of Water by Tetra Tech, Inc., Owings Mills, MD. www.dep.state.wv.us/docs/536_WV-Index

Engel, S. R. and Voshell, J. R. (2002). Volunteer biological monitoring: Can it accurately assess the ecological condition of streams? *American Entomologist* 48(3):164-177.

Merritt, R. W. and K. W. Cummins (eds) 1996. An introduction to the Aquatic Insects of North America. 3rd ed. Kendall/Hunt Publishing, Dubuque, Iowa.

Ohio Environmental Protection Agency (1989). Biological criteria for the protection of aquatic life: Vol. III. Standardized biological field sampling and laboratory methods for assessing fish and macroinvertebrate communities.

Smith, E. P. and J. R. Voshell (1997). Studies of benthic macroinvertebrates and fish in streams within EPA Region 3 for development of biological indicators of ecological condition. Part 1. Benthic macroinvertebrates. Report to U.S. Environmental Protection Agency. Cooperative Agreement CF821462010. EPA, Washington, DC.

Virginia Department of Environmental Quality (2003). Benthic TMDL for Quails Run, Rockingham County, Virginia. www.deq.state.va.us/tmdl/apptmdls/shenrvr/quailbc

George Washington and Jefferson National Forest system (2003)
www.southernregion.fs.fed.us/gwj/resource info.htm#Aquatic%20Ecology

APPENDIX G

PUBLIC COMMENTS

Writers Direct Number
740 746 2219

**Columbia Gas
TransmissionSM**
A NiSource Company

301 Maple Street
PO Box 330
Sugar Grove, OH 43155-0330

May 31, 2005

Chief, Environmental Analysis Section
Attn: Peter Dodgion
US Army Corps of Engineers
Huntington District
502 Eight Street
Huntington, WV 25701-2070

**Subject: Hocking River Basin
 Monday Creek Subbasin Ecosystem Restoration Project
 Draft Feasibility Report and Environment Impacts**

Affected Pipeline: H – System and C-106

Dear Mr. Dodgion:

Mr. S. Michael Worley's letter dated April 29, 2004, and report related to the referenced project have been reviewed. By comparison to our operating maps and records it is evident that Columbia Gas Transmission Corporation (Columbia) may have facilities located within the limits of the proposed construction.

A map is enclosed showing the approximate location of Columbia's facilities. It is imperative that the location and depth of Columbia's pipelines be assessed as determined from actual survey. Impact of remediation activities could adversely affect Columbia facilities. Mike Ruchti at 740-416-2566 should be contacted to arrange a meeting to accurately locate Columbia's pipeline and determine depth.

As further plans are developed copies should be submitted to my attention for further review.

Based on the extent to which the project scope affects Columbia's facilities, reimbursement for Columbia personnel involvement and for facility modification may be required. This requirement will be evaluated when preliminary plans are received for Columbia's review.

Enclosed for use and reference is a copy of Columbia's "Minimum Standards for Construction Near Natural Gas Pipeline Facilities". Please be aware that these standards represent the minimum conditions required to conduct construction activities in close proximity to, or directly affecting, Columbia facilities. More restrictive measures may be necessary based on particular parameters associated with each individual project and site-specific conditions related to that project.

This letter shall not be considered as authorization to proceed with the contemplated project in the vicinity of Columbia facilities. Consent to proceed with construction in the vicinity of Columbia facilities will only be provided at a future date when these and any future stipulations deemed

necessary have been met and you have received written consent of the project plans from Columbia.

Sincerely,



Wally Welch
Resident Engineer

Note: Involvement status relates solely to facilities owned and/or operated by Columbia Gas Transmission Corporation

Enclosure: Minimum Standards For Construction Near Natural Gas Pipeline Facilities

Copies: R-691 Line File
Bob Achauer
Charlie Pinson
Rod Atkins

Frantz, Amy K LRH

From: Dodgion, Peter K LRH
Sent: Friday, June 03, 2005 9:18 AM
To: Frantz, Amy K LRH
Subject: FW: 05-0113; USACE Monday Creek Subbasin Ecosystem Restoration Project.
Attachments: data.dbf; data.sbn; data.sbx; data.shp; data.shx; indiana bat.dbf; indiana bat.sbn; indiana bat.sbx; indiana bat.shp; indiana bat.shx; ma.dbf; ma.sbn; ma.sbx; ma.shp; ma.shx; sites.dbf; sites.sbn; sites.sbx; sites.shp; sites.shx

Amy,

Are these comments yours????

Peter

-----Original Message-----

From: Sanders, Randy [mailto:Randy.Sanders@dnr.state.oh.us]
Sent: Friday, June 03, 2005 9:01 AM
To: Dodgion, Peter K LRH
Subject: 05-0113; USACE Monday Creek Subbasin Ecosystem Restoration Project.

ODNR COMMENTS TO Chief, Environmental Analysis Section, U.S. Army Corps of Engineers, 502 Eighth Street, Huntington, West Virginia 25701

Location: The Monday Creek Watershed is located entirely within the State of Ohio in the counties of Hocking, Athens and Perry. Monday Creek drains a 116 square mile (724, 240 acres) area in an unglaciated portion of the Allegheny Plateau region of southeastern Ohio. The main stem of Monday Creek runs 27 miles before eventually emptying into the Hocking River.

Project: This report is an evaluation of the Monday Creek Watershed stream ecosystem and the potential impacts to the natural, physical, and human environment associated with the proposed ecosystem restoration alternatives.

The Ohio Department of Natural Resources (ODNR) has completed a review of the above referenced project. **As the non-federal sponsor, ODNR is very supportive of this project and looks forward to the environmental benefits that will result from the implementation of this project.** These comments were generated by an inter-disciplinary review within the Department. These comments have been prepared under the authority of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.), the National Environmental Policy Act, the Coastal Zone Management Act, Ohio Revised Code and other applicable laws and regulations. These comments are also based on ODNR's experience as the state natural resource management agency and do not supersede or replace the regulatory authority of any local, state or federal agency nor relieve the applicant of the obligation to comply with any local, state or federal laws or regulations.

Rare and Endangered Species: We have Natural Heritage data within the Monday Creek Subbasin Ecosystem Restoration project area. I have attached shapefiles showing our natural heritage data, Indiana Bat records, managed areas and conservation sites. Sensitive areas with rare species and conservation sites should not be impacted.

<<data.dbf>> <<data.sbn>> <<data.sbx>> <<data.shp>> <<data.shx>> <<indiana bat.dbf>> <<indiana bat.sbn>>
 <<indiana bat.sbx>> <<indiana bat.shp>> <<indiana bat.shx>> <<ma.dbf>> <<ma.sbn>> <<ma.sbx>>
 <<ma.shp>> <<ma.shx>> <<sites.dbf>> <<sites.sbn>> <<sites.sbx>> <<sites.shp>> <<sites.shx>>

Fish and Wildlife: Prior to start of the project, contact Carolyn Caldwell at the ODNR, Division of Wildlife for information on the location of burying beetles in relation to the project location. She can be reached at (614) 265-6329, 2045 Morse Road, Building G-3, Columbus, Ohio 43229-6693. The project is within the historical range of the Timber rattlesnake, (*Crotalus horridus horridus*), a state endangered species as well as a species for which a Federal pre-listing conservation plan exists or is being developed. If a Timber rattlesnake is encountered during construction of the project, work should immediately be stopped, and the DOW should be contacted.

ODNR appreciates the opportunity to provide these comments. Please contact Randy Sanders at 614.265.6344 if you have questions about these comments or need additional information.

Randall E. Sanders

Environmental Administrator

Division of Real Estate & Land Management

Ohio Department of Natural Resources

2045 Morse Rd, C4

Columbus, Ohio 43229-6693

614.265.6344

Fax 614.267.4764

randy.sanders@dnr.state.oh.us

Frantz, Amy K LRH

From: Dodgion, Peter K LRH
Sent: Wednesday, June 08, 2005 1:28 PM
To: Frantz, Amy K LRH
Subject: FW: 05-0113; USACE Monday Creek Subbasin Ecosystem Restoration

-----Original Message-----

From: Mike Smith [mailto:Mike.smith@epa.state.oh.us]
Sent: Wednesday, June 08, 2005 12:54 PM
To: Dodgion, Peter K LRH
Cc: Bruce Goff; Chuck Boucher; Keith Orr; Kelly Capuzzi; Randy Bournique; Rutherford, Rebecca A LRH
Subject: 05-0113; USACE Monday Creek Subbasin Ecosystem Restoration

Ohio EPA Comments to Chief, Environmental Analysis Section, U.S. Army Corps of Engineers, 502 Eighth Street, Huntington, West Virginia 25701

1. Ohio EPA commented on previous drafts of this report and those comments have been incorporated into the report.
2. Please be aware that during construction Best Management Practices should be used to control erosion of sediment from the disturbed areas to the streams. Projects over one-acre in disturbed area will require a stormwater permit from Ohio EPA including a Storm Water Pollution Prevention Plan prior to construction start. To apply please contact Ohio EPA, Southeast District Office, 2195 Front Street, Logan, Ohio 43138, 740-385-8501.
3. Some of the projects may require an individual Section 401 water quality certification from Ohio EPA. Ohio EPA recommends that Corps Regulatory program staff review the projects to determine what type of permit is needed. If nationwide permits apply, the project should meet the conditions for use of that nationwide. If a nationwide permit does not apply or the Ohio EPA conditions on that nationwide are not met, please contact Randy Bournique, Ohio EPA, Division of Surface Water, P.O. Box 1049, Columbus, Ohio 43216-1049, 614-644-2013, to coordinate on the Ohio EPA certification.
4. Some of the projects may need to obtain Permits to Install or NPDES permits. Please coordinate with Ohio EPA, Southeast District Office, 2195 Front Street, Logan, Ohio 43138, 740-385-8501 regarding these permits.
5. Ohio EPA would like to receive copies of water quality monitoring reports for the various projects.

If there are any questions, please call me at 614-644-2326.



United States Department of the Interior

FISH AND WILDLIFE SERVICE

Ecological Services
6950 Americana Parkway, Suite H
Reynoldsburg, Ohio 43068-4127
(614) 469-6923/FAX (614) 469-6919
June 14, 2005

Colonel William E. Bulen
District Engineer
Huntington District, Corps of Engineers
502 Eighth Street
Huntington, WV 25701-2070

Attention: Mr. Amy Franz, Planning Division

Dear Colonel Bulen:

This is in response to Mr. Worley's April 29, 2005 letter requesting our review and comment on the provided copy of the **Hocking River Basin, Ohio, Monday Creek Sub basin Ecosystem Restoration Project Draft Feasibility Report and Environmental Assessment**. The Report is located in portions of Athens, Hocking, and Perry Counties, Ohio. The purpose of the project is to identify and evaluate any potential environmental impacts that may be associated with the proposed projects. Reference should be made to the U.S. Fish and Wildlife Service's June 18, 2004 Planning Air Letter for this project.

Ohio Department of Natural Resources (DNR) has been a partner with Wayne National Forest on Monday Creek Watershed projects within the Forest. The following projects have been completed under that partnership.

Goose Run
Snow Fork subsidences
Majestic Mine
Happy Hollow
Job's Hollow doser
Big 4 Hollow
Snake Hollow Reclamation Project

Big Bailey gob
Jobs Hollow gob pile
Rock Run gob pile
Lost Run
Grimmett
Murray City subsidences

At this time over 200 projects are included in the Corps of Engineers' Monday Creek Restoration Project, although that number could increase or decrease depending on shifting priorities on the Wayne, or by the local partner, the Ohio DNR. The projects include the following treatment measures:

>Compost or Anaerobic Wetland
(Passive)
>Aerobic Wetland (Passive)
>Slag Leach Beds (SLB) (Passive)
>Open Limestone Channels (OLC)
(Passive)
>Low Head Dams (Passive)

>Limestone Dumping (Active)
>Anoxic Limestone Drain (ALD)
(Passive)
>Successive Alkalinity Producing
>Systems (APS or SAPS) (Passive)
>Limestone Ponds (LSPs) (Passive)

- >Limestone Ponds (LSPs) (Passive)
- >Diversion (Passive)

The Service has reviewed the Feasibility Report and has the following comments on the Report and the project. Overall, the Service supports the proposed water quality restoration projects in the Monday Creek Watershed that are addressed in the Feasibility Report. With the resulting improved water quality in the watershed, aquatic flora and invertebrates should flourish, along with those species that depend on those primary and secondary producers. With the streams' pH within acceptable limits and with food available, these streams will soon be inhabited with a diverse fishery resource.

At this time Service biologists need to become familiar with the array of treatment measures that have been proposed for the Monday Creek Restoration Project. With that knowledge we will be able to review sites proposed for treatment and provide our input to minimize impacts to fish and wildlife resources, in particular, Federal trust resources. Our biggest concern is with impacts to the Indiana bat (*Myotis sodalis*), a Federally-listed endangered species. To protect habitat for this species and many other wildlife species, such as songbirds, we will recommend alignments or locations which minimize the removal of trees, especially those with high quality habitat characteristics.

The amount of disturbance to potential Indiana bat habitat near a treatment measure, along with survey data indicating the presence of Indiana bats, and possibly hibernacula habitat, will indicate whether there is a need for formal section 7 consultation for this project. At this time we know little about the total number of "bat" trees that will need to be removed to locate and construct the various treatment measures. After we have made a number of site-specific reviews, we should have a better handle on the anticipated impacts to Indiana bat habitat and provide subsequent guidance relative to section 7 consultation.

We have the following recommendations/concerns with implementing individual projects:

1. Select sites that minimize the removal of habitat (especially trees with bat roosting characteristics), such as riparian trees. Select sites that also minimize secondary impacts due to erosion during construction, in particular.
2. The new access roads will provide access for unwanted visitors on off-road vehicles. In some cases temporary barriers may be required to keep ORV's from entering unauthorized areas.
3. Some of the projects require the placement of limestone in and along the stream. This procedure could adversely impact existing wildlife habitat along the stream.
4. In some areas with dense understory, access roads could be placed to open the understory that may be beneficial for foraging bats.

In the Service's June 18 Planning Aid Letter, we included portions of the language from our 2001 Biological Opinion for the Wayne National Forest activities, and information regarding the Federally-listed species in portions of the project area. Most of this information and recommendations was included in your April 29, 2005 Feasibility Report. The only update to that language pertains to our guidance for the Indiana bat, which follows in this letter.

The proposed project lies within the range of the Indiana bat (*Myotis sodalis*), a Federally-listed endangered species. Since first listed as endangered in 1967, its population has declined by nearly 60%. Several factors have contributed to the decline of the Indiana bat, including the loss and degradation of suitable hibernacula, human disturbance during hibernation, pesticides, and the loss and degradation of forested habitat, particularly stands of large, mature trees. Fragmentation of forest habitat may also contribute to declines. Summer habitat requirements for the species are not well defined but the following are considered important:

1. Dead or live trees and snags with peeling or exfoliating bark, split tree trunk and/or branches, or cavities, which may be used as maternity roost areas.
2. Live trees (such as shagbark hickory and oaks) which have exfoliating bark.
3. Stream corridors, riparian areas, and upland woodlots which provide forage sites.
4. Should the proposed site contain trees or associated habitats exhibiting any of the characteristics listed above, we recommend that the habitat and surrounding trees be saved wherever possible. If the trees must be cut, further coordination with this office is recommended. Additionally, suitable bat roost trees should not be cut between April 15 and September 15.

If desirable trees are present and must be cut, mist net or other surveys may be warranted to determine if bats are present. Any survey should be designed and conducted in coordination with the Endangered Species Coordinator for this office. The survey should be conducted in June or July, since the bats would only be expected in the project area from approximately April 15 to September 15.

Since water is involved for most treatment sites, most of the implemented measures include modifications to small segments of streams, ponds, or wetlands. We recommend that impacts to these aquatic habitats be minimized, while achieving the objectives of the treatment measure. For unavoidable impacts, best construction (management) practices must be fully implemented to minimize water quality impacts.

Access to some of the sites will be challenging. Again, we recommend that access roads be located to minimize the removal of woody vegetation, in particular, trees with potential Indiana bat roosting habitat. If temporary access is needed, the access routes should be restored with native vegetation of value to wildlife and monitored to guarantee favorable results

Considering the topography of the Monday Creek watershed, we are particularly concerned with possible erosion of denuded areas during construction of the treatment measure and access to the site. We recommend that projects be started and finished in phases, where feasible, to minimize water quality problems in downstream areas that are not degraded, in particular. Also, since 87 percent of the watershed is forested, we assume that most sites will have impacts to woody vegetation, including trees.

We understand and support your efforts to have project limits which provide flexibility to avoid important or special habitats.

While the acid mine drainage (AMD) problems have significantly impacted the aquatic resources in the Monday Creek Watershed, they have had less impact on birds using the area. The dominant forest in the watershed (87 percent) provides habitat for a multitude of forest and forest edge birds. None of these birds, which are residents or migrants, are Federally listed; however, one bird species, in particular, is of concern to the Service. Currently, the cerulean warbler is under evaluation in response to a petition to list it as a threatened species. Several years ago the Wayne National Forest funded a survey of forest birds in the Forest. The cerulean warbler, as well as many other bird species, was found on the WNF during this survey. Birds have greater mobility than many aquatic species, therefore, we assume birds have easier opportunity to avoid AMD waters and search for more favorable conditions.

These comments have been prepared under the authority of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.), the Endangered Species Act of 1973, as amended, and are consistent with the intent of the National Environmental Policy Act of 1969 and the U. S. Fish and Wildlife Service's Mitigation Policy.

We look forward to extensive review of sites for treatment measures and sites for Indiana bat surveys with your staff in the near future. If you have questions, or if we may be of further assistance in this matter, please contact Ken Lammers at extension 15 in this office.

Sincerely,



Mary Knapp, Ph.D.
Supervisor

cc: ODNR, Div. of Wildlife, SCEA Unit, Columbus, OH
ODNR, Div. of Real Estate and Land Management, Columbus, OH
Ohio EPA, Water Quality Monitoring, Columbus, OH

Frantz, Amy K LRH

From: Dodgion, Peter K LRH
Sent: Monday, June 27, 2005 8:23 AM
To: Frantz, Amy K LRH
Subject: FW: comment/monday creek restoration report

Perhaps this is for you...

-----Original Message-----

From: fgriffin [mailto:fgriffin@wanadoo.nl]
Sent: Monday, June 27, 2005 4:38 AM
To: Dodgion, Peter K LRH
Cc: mcrp@mondaycreek.org
Subject: comment/monday creek restoration report

Chief, Environmental Analysis Section
Planning, Programs and Project Management Division
Dept. of the Army/Huntington District, Corps of Engineers

Dear Sirs Dodgion/S. Michael Worley,

RE: Hocking River Basin, Ohio, Monday Creek Subbasin Ecosystem
Restoration Project Draft Feasibility Report and Environmental
Assessment

I wish to register an official comment on the above mentioned report. Specifically, regarding the proposal to use a steel slag leach bed treatment on the lower section of Dixie Hollow Branch of the main stem of Monday Creek, I want to request a reassessment of that proposal and consideration of the use of natural material for treatment, if necessary, ie; limestone or other alternatives.

I own the property in the area of the proposed treatment. It is unclear just where the exact location is on the information provided, but in an onsite review with staff of the Monday Creek Restoration Project, it seems to be near the border of my property and the National Forest. There is a "gobpile" form an old mine where my grandfather worked at this location, which has been unsuccessfully planted with pine trees twice in the last 30 years, the last time +/- 6-8 years ago. The creek water was tested there and down stream from this location on the above mentioned site visit and found to be in the mid-4 range. The water is also showing signs of improving visually, with some aquatic life and iron oxides being replaced with alumina and other minerals in coloration. Based on these further onsite assessments, and the actual soil and surrounding site conditions, and MCRP staff's idea that other treatments such as a limestone channel may be more appropriate, I want to request that the "gobpile" be covered/disposed of and a limestone treatment be used, if necessary.

Thank you for your consideration in this matter, and I look forward to your response and to work with you as you proceed with the project.

Sincerely,

Fritz Griffin

<http://www.zerenedeepity.com>
<http://www.griffinkommer.com>

(OR)

GERALD A. WILEY
1020 1/2 North Street
Caldwell, OH 43724-1048

May 21, 2005

Department of the Army, Huntington District,
Corps of Engineers, 502 Eighth Street,
Huntington, WV 25701; Chief S. Michael Worby.
Dear Mr. Worby, Preliminary Analysis.

RE: Hocking River Basin, Ohio, Munday
Creek Subbasin Ecosystem Restoration
Project Draft Feasibility Report and
Environmental Assessment. (My comments are;

① Specifications for levee for
Noble County (Ohio) Jail / could be used
nationwide for levees to be built to
protect from fast flowing flood waters) (enclosed)

② Noble County (Ohio) and worldwide
flood control Program Map (enclosed) (enclosed)

③ Caldwell Express, dated February 11, 2005,

④ With a Geiger counter, check for
flood uncovered radioactive materials
in the about Basin and ^{uranium} from strip-
mining operations in Ohio and WV,
as well as other radioactive elements.

(OR) ⑤ Check the spawning of fish. Salmon
in state of Washington are refusing to go
(See page 2) (more)

GERALD A. WILEY
1020 1/2 North Street
Caldwell, OH 43724-1048

③ U.S. Army Corps of Engineers
S. Michael Willey
GERALD A. WILLEY
1020 1/2 North Street
Caldwell, OH 43724-1048

May 21, 2005. ②

(OR) Up river to spawn, Check for regeneration, such as frogs with 3 legs or no legs.

⑥ Check ducks and geese for eggs that don't hatch and for acid pollutants. Sterile birds, both wild, and on land and water.

⑦ Report to Health Departments of Ohio and WV, and to Centers for Disease Control and Prevention, any mercury or other toxic substances found in fish and wild ducks and geese. Also, report presence of toxic air pollutants from power plants and factories in the Ohio River area. Make public news releases of any problems found.

⑧ Check for uranium and other radioactive elements and their effect on plants and animals and birds. Especially check for eggs that don't hatch.

⑨ Check for causes of erosion and provide plans for stopping erosion and landslides.

⑩ Make plans to build lakes, levees, and outflow channels to conserve water for any future droughts and to help prevent flooding.

Very truly,
Gerald A. Willey
(B.Sc.)

GERALD A. WILLEY
1020 1/2 North Street
Caldwell, OH 43724-1048

Mailbox letter to Editor in Washington D.C. on May 21, 2005. 3 pages plus enclosure (see) (see) (see)

NOTE: Danny Harmon
is running for
U.S. House of Representatives.

GERALD A. WILLEY
1020 1/2 North Street
Caldwell, OH 43724-1048

May 18, 2005.

Danny Harmon, Noble Co. Commissioner
Court House, Caldwell, Ohio 43724.

Here are the specifications
for the levee to help protect the
Noble County Jail: (my recommendations)

① Levee must be 120 feet
high, with a base 110 feet thick
at the base and tapering down
to 10 feet thick at the top.

② To prevent ^{current} erosion and ^{weathering} debris damage, this levee must
have a steel plate, two inches
thick, to cover the ^{upstream} center face of
this levee up to 72 feet up from
the base of this levee.

WITNESS:

G. A. Willey (Former Scientific Research
Writer and Medical Research Writer,
Gerald A. Willey

GERALD A. WILLEY
1020 1/2 North Street
Caldwell, OH 43724-1048

MAILBOX

MWCD concerns

Editor:

This is directed to concerned citizens of the Seneca Reservoir back water area. A number of our neighbors have recently formed a citizen group to discuss with the Muskingum Water Conservatory the need for better control of flood waters. Many of you know that in recent times flooding in the back water area has become a regular problem. Roadways, which you travel to work, are covered with water with moderate rainfall.

The MWCD holds back water to prevent flooding downstream and in the process we are unable to get home from our jobs due to the high water levels. The length of this flooding is also extended due to the MWCD holding of water.

In the last year we had a number of state routes, county and township roads under water for periods of not just days but weeks and up to a month at a time. Some of your neighbors must park vehicles outside of the flooded areas and actually travel by boat from their homes in order to go to work. Fire and rescue were unable to reach many of these areas. Local school services are also interrupted. Phone service was out weeks and the only means of communication was by those who had cell phone service. This is a problem that affects us all.

The MWCD has determined that due to the benefits that we receive from the reservoir, it is considering a tax levy on

us. It recently paid a Cincinnati company \$2.2 million to determine how much it should charge us for all of our so-called benefits. This tax is not up for vote by the citizens nor do we have any input as to the amount. The MWCD board of directors is appointed by a council of judges, not local citizens. These directors with a stroke of a pen can impose a tax and raise it whenever they feel the need for more of your hard-earned money. This is clearly a case of taxation without representation.

In phone conversations with the MWCD and the Army Corps of Engineers, it has been determined that MWCD has no written schedule as to the maintenance of the reservoir and we have been told they are "working on a plan." As we see it they are planning to tax us then decide what to do with all

our money later. When will the benefits be seen and paid back to the citizens?

If you see this as unfair, please join us in a meeting with MWCD April 13 at 7 p.m. at the Guernsey-Noble Career Center at Buffalo to let your voice be heard. If you wish to join us, call (740) 679-2422, or (740) 679-3173. We would love to hear what you think and have your ideas

expressed to us.

Stand up with us and let our voice be heard as one.

Rodney Postlewait

and the Coalition of Concerned

Citizens of the MWCD

"The Daily Jeffersonian"
Cambridge, Ohio 43725.
April 10, 2005.
Submitted by: Gerald A Wiley

HEED AND LEARN. People, nations, and their leaders neVer heed or learn the lessons of history.

CHURCHES REFUSE HELP. The churches of Caldwell, Ohio 43724 have refused to help local people with natural gas bills and transportation. Since June 1998 three massive flood have hit Caldwell City Hall. I warned officials before September 1997 that there would be 10 feet of water in City Hall here.

CHARITY BEGINS AT HOME. The USA should help its own poor people and poor veterans before helping other nations.

WARNING IGNORED. Early in 2004 I warned the Washington County Emergency Management Director and "The Marietta Times" that Marietta, Ohio 45750 faced massive flooding. My warnings were ignored and my letter to the editor of "The Marietta Times" was not printed. Marietta merchants complained that they were not warned of pending massive flooding.

BOSTON TEA PARTY. During this event, American colonists dressed as Mohawk Indians boarded three British tea ships and threw the tea into Boston Harbor in protest of excessive taxation of tea and taxation without representation. The British Townshend Acts placed taxes on various imported products and resulted in the Boston Tea Party and the Boston Massacre of American colonists and also resulted in the Revolutionary War (1775-1783). These events show that violence and revolution can be caused by repressive leaders, unjust acts against poor people, and excessive taxation.

KRAKATOA VOLCANO, INDONESIA erupted August 26-28, 1883 and caused a tidal wave more than 100 feet high and killed 36000 people in Java and Sumatra. Dust and ashes and smoke rose to a height of 17 miles. Indonesia has long been earthquake prone.

RENROCK, OHIO EARTHQUAKE was centered in Noble County in 1776. This earthquake occurred during the Revolutionary War and is another indication that internal strife and violence often result in earthquakes, volcanoes, and tidal waves (tsunamis). King George III of England imposed unjust taxation, coercion, and murder of colonists, and his actions resulted in revolution.

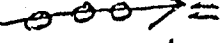
CHINA should have been a leader in detection of earthquakes and volcanoes because that nation has experienced massive earthquakes that killed thousands and thousands of people.

TSUNAMIS or tidal waves can travel up to 250 miles per hour and can reach heights of at least 300 feet. The December 26, 2004 earthquake and tidal wave occurred near Banda Aceh, Indonesia, a province that has been involved in violence and revoltion against the Indonesian government. This disaster is another indication that a country's repression of its people can result in violence and revolution and can result in a massive earthquake and tsunami (tidal wave).

USA IN DANGER OF EARTHQUAKES AND TSUNAMIS BECAUSE of poor environmental policies, repression of people, excessive taxation, and excessive foreign aid can lead to unrest, riots, crime, and even revolution. History here repeats itself, thus the stability of the USA is in danger. One of the major causes of the downfall of the Roman Empire was excessive foreign aid.

HALF OF THE USA WILL BE FLOODED because of global warming and the melting of the glaciers and ice caps. I first gave this warning to one of the leaders of a Caldwell church in June 2004. I also warned the Ohio Department of Transportation and other State and Federal agencies.

NATURAL GAS AND ELECTRIC COMPANIES should have converted to wind power and fuel cells and other forms of heating and lighting techniques. About 14,000,000 people in the USA, especially Columbus, Ohio, were without electricity for as long as three weeks because of untrimmed trees and power lines covered with ice.

SYMBOLS:  =
IRRIGATION DITCHES.

GERALD A. WILLEY
1020 1/2 North Street
Caldwell, OH 43724-1048

August 30, 1999.

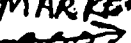
NOBLE COUNTY, OHIO AND WORLDWIDE FLOOD-CONTROL PROGRAM IDEAS:

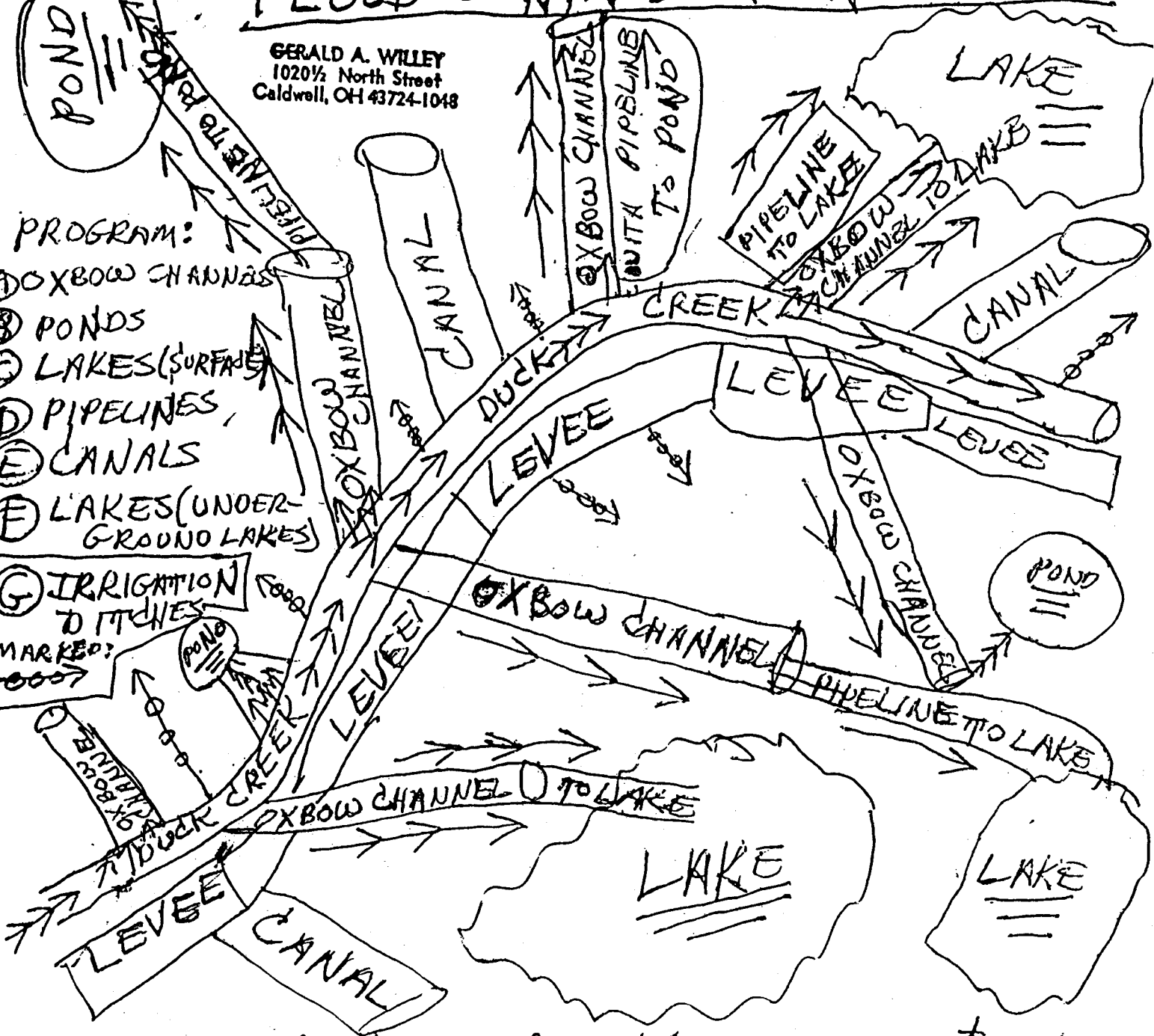
GERALD A. WILLEY
1020 1/2 North Street
Caldwell, OH 43724-1048

PROGRAM:

- (A) OXBOW CHANNELS
- (B) PONDS
- (C) LAKES (SURFACE)
- (D) PIPELINES
- (E) CANALS
- (F) LAKES (UNDER-GROUND LAKES)

(G) IRRIGATION
DITCHES

MARKED:




Idea by: Gerald A. Willey: August 30, 1999.

Witness: Daniel M. Lusk : 8-30-99

GERALD A. WILLEY
1020 1/2 North Street
Caldwell, OH 43724-1048

APPENDIX H

DISTRICT RESPONSES

PUBLIC COMMENTS AND RESPONSES

Comment 1. Columbia Gas. Impacts of remediation activities could adversely affect Columbia facilities. Mike Ruchti at 740-416-2566 should be contacted to arrange a meeting to accurately locate Columbia's pipeline and determine depth. As further plans are developed copies should be submitted to my attention for further review. **District Response: Concur. During design phase and plans and specifications, Columbia representatives will be contacted concerning the locations and depth of their pipelines. All plans will be submitted to Columbia for further review.**

Comment 2. ODNR. Prior to start of the project, contact Carolyn Caldwell at ODNR, Division of Wildlife for information on the location of burying beetles in relation to the project location. **District Response: Concur. The Corps will contact ODNR Division of Wildlife for information concerning the burying beetle and the project locations during Engineering and Design phase.**

Comment 3. ODNR. The project is within the historical range of the Timber rattlesnake, (*Crotalus horridus horridus*), a state endangered species as well as a species for which a Federal pre-listing conservation plan exists or is being developed. If a Timber rattlesnake is encountered during construction of the project, work should immediately be stopped, and the DOW should be contacted. **District Response: Information concerning stop work requirements for the Timber Rattlesnake will be incorporated to the plans and specifications.**

Comment 4. OEPA. "...Best Management Practices should be used to control erosion of sediment from the disturbed areas top the streams. Projects over one-acre in disturbed area will require a stormwater permit from OEPA including a Storm Water Pollution Prevention Plan prior to construction start." **District Response: BMP for erosion control of sediment have been discussed in the EA and will be incorporated to the plans and specifications. The Corps will coordinate with OEPA for the stormwater permit.**

Comment 5. OEPA. "Some of the projects may require an individual Section 401 water quality certification from Ohio EPA. Ohio EPA recommends that Corps Regulatory program staff review the projects to determine what type of permit is needed." **District Response: Water quality permits will be coordinated through the Corps Regulatory staff and OEPA prior to starting any construction activities.**

Comment 6. OEPA. Some of the projects may need to obtain Permits to Install or NPDES permits. **District Response: Coordination with OEPA Southeast District Office will occur to determine if Permits to Install or NPDES permits are necessary for any of the project features.**

Comment 7. USEPA. Uncertain about the segmentation/HUC etc. - should state somewhere 05030204 060 for Monday Creek Watershed. **District Response: Concur. The information has been added to Chapter 2 of the report.**

Comment 8. USEPA. Page 22 Iron Toxicity

How much will eliminating iron reduce your siltation impairment, with iron as the surrogate for siltation? This could increase the impairments addressed in the TMDL. Also in this same chapter, when you discuss flow alteration, it is also listed as an impairment in the Ohio 2004 Integrated Report, can you speak more to the issue that the flow alteration may not be an impairment after you do the remediation in chapter 4.4 on Passive and Active Treatment Alternative Descriptions. **District Response: Text has been added to address the siltation impairment within the watershed. Estimates for reduction are difficult to ascertain with these types of projects, however, with the acidity reduction of 90% throughout the watershed, the Corps anticipates at least >50% reduction in siltation. Also, text has been added to reflect the flow alteration. Within the four subwatersheds where flow alteration will occur, we anticipate the impairment will be greatly reduced, however, aerial extent dissipating streams (subsidence cracks) are difficult to map. However, we feel confident that we will have a great influence for flow alternation in those areas due to the previously field work that has occurred.**

Comment 9. USEPA. Page 42 since Ohio does not have criteria for Al, Fe and pH how were the numbers derived as targets? From USEPA's past work, reference site, West Virginia? Please give more information on how these targets were determined. They appear compatible with a past AMD TMDL in Ohio. **District Response: Concur. The criteria for Al, Fe and pH were derived from previous work ODNR and WVU performed in both Ohio and West Virginia. These targets are the levels in which fish and macroinvertebrates can survive and reproduce without toxic side effects of elevated metals and acidity concentrations.**

Comment 10. USEPA. Page 44 since ICI is an important measure for this evaluation, the reader needs to know the ICI metric before you show the results on this page. For example, EWH = 46, WWH = 36, MWH = 22, LRW = 8. **District Response: Concur. Information describing the ICI metric has been added to the text for clarification.**

Comment 11. USEPA. Page 54 the table should be 4-6 not 4-7. **District Response: Concur. Text has been modified to reflect change.**

Comment 12. USEPA .Modeling document: There is a lot of discussion of sedimentation issues related to Fe. Since the Creek is listed for siltation, can you say anything else to link the ferric iron sedimentation chapter to siltation? More linkage discussion could possibly address siltation/sedimentation pollutant through addressing Fe as a surrogate for siltation. You also touch on it when discussing "yellow boy" in chapter 2.0 of the main document, and in the Iron Toxicity chapter. **District Response: Concur. Information has been added in Chapter 5 and 6 to describe Fe as a surrogate for siltation. In addition, information was inserted describing the removal of the Fe and**

the reduced sedimentation load on the ecosystem due to the effectiveness of the restoration alternatives.

Comment 13. USFWS. “..we recommend alignments or location which minimize the removal of trees, especially those with high quality habitat. **District Response: Concur. The Corps will work closely with the Service during detailed design to minimize the impacts to trees within the project areas.**

Comment 14. USFWS. Select sites that minimize removal of habitat (especially trees with bat roosting characteristics), such as riparian trees. Select sites that also minimize secondary impacts due to erosion during construction, in particular. **District Response: Concur. The Corps will work closely with the Service during detailed design to minimize the impacts to trees within the project areas.**

Comment 15. USFWS. The new access road will provide access for unwanted visitors on off-road vehicles. In some cases temporary barriers may be required to keep ORV's from entering unauthorized areas. **District Response: Concur. The Corps will work with the Service and the US Forest Service to identify ORV unauthorized areas. If barriers are needed, they will be incorporated into the plans and specifications.**

Comment 16. USFWS. Some of the projects require the placement of limestone in and along the stream. This procedure could adversely impact existing wildlife habitat along the stream. **District Response: Concur. Placement of limestone in and along streams will be minimized to the extent practicable without compromising the effectiveness of the restoration site.**

Comment 17. USFWS. In some areas with dense understory, access roads could be placed to open the understory that may be beneficial for foraging bats. **District Response: Concur. The Corps will work closely with the Service to add habitat value during access road construction where possible.**

Comment 18. USFWS. Summer habitat requirements for the species are not well defined but the following are considered important.

1. Dead or live trees and snags with peeling or exfoliating bark, split tree trunk and/or branches, or cavities, which may be used as maternity roost areas.
2. Live trees (such as shagbark hickory and oaks) which have exfoliating bark.
3. Stream corridors, riparian areas and upland woodlots which provide forage sites.
4. and should the proposed sites contain trees or associated habitats exhibiting any of the characteristics listed above, the habitat and surrounding trees be saved wherever possible. If the trees must be cut, further coordination with the USFWS will occur. Suitable bat roost trees should not be cut between April 15 and September 15.
5. If desirable trees are present and must be cut, mist net or other surveys may be warranted to determine if bats are present. Any survey will be designed and conducted in coordination with the Endangered Species Coordinator of the

Reynoldsville Field Office. The survey should be conducted in June or July, since the bats would only be expected in the project area from approximately April 15 to September 15.

District Response: Concur. The Corps will work closely with the Service during detailed design to minimize the impacts to trees within the project areas. Coordination with the Service will continue throughout construction of the project. This information will be incorporated into the plans and specifications.

Comment 19. USFWS. If temporary access is needed, the access routes should be restored with native vegetation of value to wildlife and monitored to guarantee favorable results. **District Response: Concur. This information will be incorporated into the plans and specifications.**

Comment 20. USFWS. We recommend that projects be started and finished in phases, where feasible, to minimize water quality problems in downstream areas that are not degraded, in particular. **District Response: Concur. Concur. The Corps will work closely with the Service during detailed design to minimize the impacts to downstream water quality.**

Comment 21. Griffin. Dixie Hollow "...I want to request a reassessment of that proposal and consideration of the use of natural material for treatment, if necessary, ie; limestone or other alternatives. ...I want to request that the "gobpile" be covered/disposed of and a limestone treatment be used, if necessary." **District Response: Each treatment site is designed to treat a specific amount of acidity, metal concentrations, pH and/or any combination. The water quality typically dictates which method will work best in any given area. The team will revisit the Dixie Hollow water quality to see if any changes have occurred to warrant changing the treatment. Our current plans do not address the gob pile at Dixie Hollow. The team felt the best investment of funding was to focus on the water quality issues in the watershed first.**

Comment 22. Wiley. Specifications for levee for Noble County (Ohio) jail (could be used nationwide for levees to be built to protect from fast flowing flood waters.) (Enclosed) **District Response: This project is an ecosystem restoration project and is not located in Noble County Ohio. (The rest of Mr. Wiley's letter discussed worldwide flood control program and spawning salmon in Washington State.)**

APPENDIX I

NOTICE OF AVAILABILITY

NOTICE OF AVAILABILITY

The U.S. Army Corps of Engineers, Huntington District, by this notice, advises the public that the Draft Environmental Assessment (DEA) for the Hocking River Basin, Ohio Monday Creek Subbasin Ecosystem Restoration Project Draft Feasibility Report and Environmental Assessment, Athens, Perry and Hocking Counties, Ohio is complete and available for public review. The Monday Creek project is situated in central Ohio on Monday Creek and its tributaries. A Finding of No Significant Impact (FONSI) is anticipated for the proposed ecosystem restoration project.

In compliance with the National Environmental Policy Act (NEPA) and 40 CFR 1501.4, the DEA and draft FONSI must be available to interested parties in the affected area for thirty (30) days for review and comment. Final determination regarding the need for additional NEPA documentation will be made after the public review period, which begins on or about May 2, 2005. Copies of the documents may be viewed at the following locations.

New Straitsville Public Library
102 East Main Street
New Straitsville, Ohio

Logan-Hocking County District Library
230 East Main Street
Logan, Ohio

Nelsonville Public Library
95 West Washington
Nelsonville, Ohio

<http://www.lrh.usace.army.mil>

Copies of the DEA and draft FONSI may be obtained by contacting the Huntington District Office of the Corps of Engineers at 304-399-5712. Comments pertaining to the documents should be directed by letter to:

Peter Dodgion, Chief
Environmental Analysis Section Planning Branch
Huntington District Corps of Engineers
502 8th Street
Huntington, West Virginia 25701-2070

Athens Messenger Phone – 740-592-6612 Fax 740-592-4647
Logan Daily News Phone – 740-594-8219 Fax 740-592-5695
Perry County Tribune Phone – 740-385-2107 Fax 740-385-4514

APPENDIX K
DRAFT AND FINAL FONSI

Hocking River Basin, Ohio
Monday Creek Subbasin
Ecosystem Restoration Project
Draft
FINDING OF NO SIGNIFICANT IMPACT

1. The Huntington District, in coordination with the Ohio Department of Natural Resources, Mines and Minerals Section, has conducted a Draft Environmental Assessment (DEA) concerning consideration of a number of Acid Mine Drainage (AMD) restoration alternatives including limestone leach beds, slag leach beds, limestone dumping, aerobic wetland complexes, limestone ponds, open limestone channels, low head dams, and limestone dosers. Various alternatives were found to effectively reduce acidity and metals entering the ecosystem. More detailed evaluations determined that combinations of the alternative methods were functional in abating the impacts of AMD. These alternatives along with the No Action alternative have been evaluated in detail and the results documented in the feasibility report and in the Draft Environmental Assessment (DEA). In addition to evaluating the ecosystem restoration measures for the Monday Creek watershed and the surrounding area, the natural resources that will be impacted by these alternatives have been examined.

The federal action concerning the proposed ecosystem restoration project is congressional authority to study the impacts of previous resource extraction activities in the watershed and determine a solution to minimize these impacts to the aquatic ecosystem.

2. The possible consequences of the project have been studied for environmental, social and economic effects.

3. In evaluation of the project and viable alternatives, the following points were considered pertinent:

a. Environmental Consideration. The Huntington District has taken reasonable measures to assemble and present the foreseeable environmental impacts of the restoration alternative project on aquatic and terrestrial resources, wetlands, air quality, and other natural resources.

There will be an elevation in suspended sediment during the period of construction. This will have a temporary impact on water quality. Construction of the proposed project will impact approximately 962 feet of streams through the construction of access roads, 1,300 ft of Sycamore Branch through the construction of a wetland, and 5,969 ft of streams through the construction of the restoration alternatives. However, overall water quality will be improved due to the construction of the restoration alternatives that will significantly reduce acidity levels and metal concentrations within the watershed therefore, the proposed

project is considered to not significantly impact water quality and fishery resources. Wetlands in the vicinity of the project areas have been avoided; therefore none will be affected. There will be construction of approximately 67 acres of wetlands construction within the watershed.

Impacts to terrestrial habitat will occur during excavation and construction of the proposed project. Due to the abundance of this type of terrestrial habitat in the project area, these impacts are considered minor. Measures to minimize impacts to the Indiana Bat (*Myotis sodalist*) have been incorporated into the project in coordination with the US Fish and Wildlife Service. No impacts are expected.

In accordance with established Corps of Engineers Hazardous, Toxic, and Radioactive Waste (HTRW) policies (ER 1165-2-132), a Limited Phase I HTRW assessment has been completed. As a result, no potential sites or impacts were identified.

During the period of construction, there may be local and minor deterioration of air quality from fugitive dust and emissions from equipment. However, *de minimis* levels of direct emissions of a criteria pollutant or its precursors will not be exceeded, as determined pursuant to Section 176 of the Clean Air Act, as amended.

b. Economic and Social Consideration. No adverse economic or social impacts are foreseen as a result of the proposed project. Construction of the ecosystem restoration project will positively impact economic and recreation resources within the project area by improving water quality with the watershed. Archaeological and historic surveys and investigations were conducted for the area and coordinated with the Ohio State Historic Preservation Office. Implementation of the preferred alternative will have no adverse impact upon cultural resources. The proposed project will have no effect on minority and low-income populations, and therefore is in compliance with Executive Order 12898.

c. Alternative Considerations. The Proposed Action alternative (Plan Combination 6) would have construction of project features in each of the eight subwatersheds affected by the AMD in Monday Creek. Features such as dissipating streams, stream blockages, and subsidences would be constructed to prevent surface water from flowing into underground mine workings and thus preventing the generation of AMD within the Monday Creek watershed and in adjacent watersheds. The AMD restoration sites would best contribute to the ecological restoration objective to restore Monday Creek ecosystem by treating the AMD at the source prior to its entering the aquatic ecosystem. This would allow the existing pockets of diverse fish and macroinvertebrate populations to repopulate areas currently impacted by AMD thus restore both the structural and functional components of the ecosystem to a less degraded state. The Recommended Plan is expected to result in significant benefits to the aquatic ecosystem from headwaters to Monday Creek's confluence with the Hocking River.

The plan includes the following features:

Table 5-1. Plan Combination 6.

Plan	Location	Description
A	Jobs Hollow	1 doser, 3 SLB* and 1 OLC*
B	Dixie Run	1 SLB, 2 OLC and 1 LLB*
C	Rock Run	3 LHD* and 1 wetland
D	Lost Run	30 sites + 16 spoil blocks and 12 subsidences features
F	Monkey Hollow	1 doser + 9 spoil blocks and 6 subsidences features
H	Snake Hollow	1 SLB, 4 OLC and 4 LLB
J	Snow Fork	6 SLB, 19 OLC, 20 LLB, 8 dissipating streams, 9 spoil blocks, 7 subsidences, and 2 wetlands
L	Coe Hollow	2 SLB, 1 OLC, 4 LLB, 3 dissipating streams and 1 Subsidence feature

*SLB – slag leach bed; LLB – limestone leach bed; OLC open limestone channel; LHD – low head dam

Currently, the project consists of 178 total restoration structures located within the following eight subwatersheds locations: Jobs Hollow, Dixie Hollow, Rock Run, Monkey Hollow, Lost Run, Snake Hollow, Coe Hollow, and Snow Fork (which is comprised of Salem Hollow, Sycamore Hollow, Spencer Hollow, Brush Fork, Long Hollow, Whitmore Cemetery and Orbiston). The locations of these subwatersheds may be found on Map 4-5 in Section 4 of this report.

Proposed structures include open limestone channels, low head dams, limestone leach beds, slag leach beds, aerobic wetlands and dosers. Other forms of construction activities involve the closure of stream-capturing subsidences, re-routing dissipating streams, and either breaching or removal of spoil blocks. The No Action alternative would entail the COE constructing any of the restoration structures and the existing degraded water quality would remain the same. Therefore, the No Action alternative would not provide adequate improvement of the aquatic ecosystem in the Monday Creek watershed.

d. Public Interest Consideration. Compliance with the National Environmental Policy Act and the Fish and Wildlife Coordination Act was achieved through the Environmental Assessment.

4. I find this ecosystem restoration project to be in accordance with current authorization and so described in the Draft Environmental Assessment. The project is consonant with national policy, statutes, and administrative directives. This determination is based on an analysis and evaluation of the project and the alternative courses of action. In conclusion, I find the proposed project will not have significant adverse effects on the quality of the human or natural environment.

Date

**William E. Bulen
Colonel, Corps of Engineers
District Engineer**

**Hocking River Basin, Ohio
Monday Creek Sub-Basin
Ecosystem Restoration Project**

**FINAL
FINDING OF NO SIGNIFICANT IMPACT**

1. The Huntington District, in coordination with the Ohio Department of Natural Resources, Mines and Minerals Section, has conducted an Environmental Assessment (DEA) concerning consideration of a number of Acid Mine Drainage (AMD) restoration alternatives including limestone leach beds, slag leach beds, limestone dumping, aerobic wetland complexes, limestone ponds, open limestone channels, low head dams and limestone dosers. Various alternatives were found to effectively reduce acidity and metals entering the ecosystem. More detailed evaluations determined that combinations of the alternative methods were functional in abating the impacts of AMD. These alternatives along with the No Action alternative have been evaluated in detail and the results documented in the feasibility report and in the Environmental Assessment (EA). In addition to evaluating the ecosystem restoration measures for the Monday Creek watershed and the surrounding area, the natural resources that will be impacted by these alternatives have been examined.

The federal action concerning the proposed ecosystem restoration project is congressional authority to study the impacts of previous resource extraction activities in the watershed and determine a solution to minimize these impacts to the aquatic ecosystem.

2. The possible consequences of the project have been studied for environmental, social and economic effects.

3. In evaluation of the project and viable alternatives, the following points were considered pertinent:

a. Environmental Consideration. The Huntington District has taken reasonable measures to assemble and present the foreseeable environmental impacts of the restoration alternative project on aquatic and terrestrial resources, wetlands, air quality, and other natural resources.

There will be an elevation in suspended sediment during the period of construction. This will have a temporary impact on water quality. Construction of the proposed project will impact approximately 962 feet of streams through the construction of access roads, 1,300 ft of Sycamore Branch through the construction of a wetland, and 5,969 ft of streams through the construction of the restoration alternatives. However, overall water quality will be improved due to the construction of the restoration alternatives that will significantly reduce acidity

levels and metal concentrations within the watershed therefore, the proposed project is considered to not significantly impact water quality and fishery resources. Wetlands in the vicinity of the project areas have been avoided; therefore none will be affected. Approximately 67 acres of wetlands will be constructed within the watershed. Best management practices will be fully implemented during construction to minimize water quality impacts.

Impacts to terrestrial habitat will occur during excavation and construction of the proposed project. Due to the abundance of this type of terrestrial habitat in the project area, these impacts are considered minor. All sites will be reseeded with native vegetation of value to wildlife and monitored to guarantee favorable results.

Measures to minimize impacts to the Indiana Bat (*Myotis sodalist*) have been incorporated into the project in coordination with the US Fish and Wildlife Service. The following information is considered important to the summer habitat requirements for the species:

- i. Dead or live trees and snags with peeling or exfoliating bark, split tree trunk and/or branches, or cavities, which may be used as maternity roost areas.
- ii. Live trees (such as shagbark hickory and oaks) which have exfoliating bark.
- iii. Stream corridors, riparian areas and upland woodlots which provide forage sites.
- iv. Should the proposed sites contain trees or associated habitats exhibiting any of the characteristics listed above, the habitat and surrounding trees be saved wherever possible. If trees must be cut, further coordination with USFWS will occur. Suitable bat roost trees should not be cut between April 15 and September 15.
- v. If desirable trees are present and must be cut, mist net or other surveys may be warranted to determine if bats are present. Any survey will be designed and conducted in coordination with the Endangered Species Coordinator of the Reynoldsville Field Office.

Coordination with U.S. Fish and Wildlife Service will continue throughout construction of the project. No impacts are expected.

The areas are also within the historical range of the Timber rattlesnake (*Crotalus horridus horridus*) which is a state endangered species for which a Federal pre-listing conservation plan exists. If a Timber rattlesnake is encountered during construction of the project, work will immediately be stopped and the Ohio Division of Wildlife will be contacted.

In accordance with established Corps of Engineers Hazardous, Toxic and Radioactive Waste (HTRW) policies (ER 1165-2-132), a Limited Phase I HTRW

assessment has been completed. As a result, no potential sites or impacts were identified.

During the period of construction, there may be local and minor deterioration of air quality from fugitive dust and emissions from equipment. However, *de minimis* levels of direct emissions of a criteria pollutant or its precursors will not be exceeded, as determined pursuant to Section 176 of the Clean Air Act, as amended.

b. Economic and Social Consideration. No adverse economic or social impacts are foreseen as a result of the proposed project. Construction of the ecosystem restoration project will have positive impacts on the economic and recreation resources within the project area by improving water quality, and subsequently habitat conditions in the watershed. Archaeological and historic surveys and investigations were conducted for the area and coordinated with the Ohio State Historic Preservation Office. Implementation of the preferred alternative will have no adverse impact upon cultural resources. The proposed project will have no effect on minority and low-income populations, and therefore is in compliance with Executive Order 12898.

c. Alternative Considerations. The Proposed Action alternative (Plan Combination 6) would have construction of project features in each of the eight subwatersheds affected by AMD. Features such as dissipating streams, stream blockages and subsidences would be constructed to prevent surface water from flowing into underground mine workings, thus significantly reducing the generation of AMD in the Monday Creek watershed and in adjacent watersheds. The AMD restoration sites would best contribute to the ecological restoration objective to restore Monday Creek ecosystem by treating the AMD at the source prior to its entering the aquatic ecosystem. This would allow the existing pockets of diverse fish and macroinvertebrate populations to repopulate areas currently impacted by AND, thus restoring both the structural and functional components of the ecosystem to a less degraded state. The Recommended Plan is expected to result in significant benefits to the aquatic ecosystem from headwaters to Monday Creek's confluence with the Hocking River.

The plan includes the following features:

Table 5-1. Plan Combination 6

<u>Plan</u>	<u>Location</u>	<u>Description</u>
A	Jobs Hollow	1 doser, 3 SLB* and 1 OLC*
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H	Snake Hollow	1 SLB, 4 OLC and 4 LLB

J	Snow Fork	6 SLB, 19 OLC, 20 LLB, 8 dissipating streams, 9 spoil blocks, 7 subsidences, and 2 wetlands
L	Coe Hollow	2 SLB, 1 OLC, 4 LLB, 3 dissipating streams and 1 Subsidence feature

*SLB – slag leach bed; LLB – limestone leach bed; OLC open limestone channel; LHD – low head dam

Currently, the project consists of 178 total restoration structures located within the following eight subwatersheds locations: Jobs Hollow, Dixie Hollow, Rock Run, Monkey Hollow, Lost Run, Snake Hollow, Coe Hollow and Snow Fork (which is comprised of Salem Hollow, Sycamore Hollow, Spencer Hollow, Brush Fork, Long Hollow, Whitmore Cemetery and Orbiston). The locations of these subwatersheds may be found on Map 4-5 in Section 4 of the Feasibility Report.

Proposed structures include open limestone channels, low head dams, limestone leach beds, slag leach beds, aerobic wetlands and dosers. Other forms of construction activities involve the closure of stream-capturing subsidences, re-routing dissipating streams and breaching or removing spoil blocks. The No Action Plan would allow the continuation of degraded habitat conditions without Federal, state or local intervention.

d. Public Interest Consideration. Compliance with the National Environmental Policy Act and the Fish and Wildlife Coordination Act was achieved through the Environmental Assessment.

4. I find this ecosystem restoration project to be in accordance with current authorization and so described in the Environmental Assessment. The project is consistent with national policy, statutes and administrative directives. This determination is based on an analysis and evaluation of the project and the alternative courses of action. In conclusion, I find the proposed project will not have significant adverse effects on the quality of the human or natural environment.

7.25.05
Date


For William E. Bulen LTC
Colonel, Corps of Engineers
District Engineer

APPENDIX L

404 (b) (1) Analysis

SECTION 404 (b) (1) EVALUATION
HOCKING RIVER BASIN, OHIO
MONDAY CREEK SUBBASIN
Plan Combination 6
ECOSYSTEM RESTORATION PROJECT
HOCKING, PERRY AND ATHENS COUNTIES, OHIO

This report concerning disposal of excavation materials at Hocking River Basin, Monday Creek Subbasin, Hocking, Perry and Athens Counties, Ohio is submitted in accordance with Section 404 of the Clean Water Act of 1977 (Public Law 95-217).

I. PROJECT DESCRIPTION

A. Location.

Monday Creek Watershed, located in the unglaciated portion of the Allegheny Plateau region of southeastern Ohio, is a 116 square mile (74,240 acres) area encompassing Monday Creek and its associated tributaries. The main stem of Monday Creek runs 27 miles before eventually emptying into the Hocking River. The watershed drains roughly 10 percent of the Hocking River system, which itself is part of the Greater Ohio River Watershed. Some 79.5 miles of the 270 stream miles in the watershed are perennial streams. The two main tributaries to the 27-mile mainstem of Monday Creek are Little Monday Creek (14.3 mi.) and Snow Fork (10.7 mi.). The Monday Creek Watershed lies in the heart of Ohio's Appalachian coal region in Athens, Hocking and Perry counties.

B. Description of Proposed Work.

The primary products of AMD formation, acidity and iron, impact water resources by lowering pH and coating stream bottoms with iron hydroxide, forming the familiar orange color called "yellow boy." Severe acid loadings and metal precipitants from AMD have greatly impacted the aquatic and terrestrial biological community and in some areas have left sections of the mainstem of Monday Creek and its tributaries unable to support aquatic life. The upper reaches of the watershed, primarily the Little Monday Creek sub-basin, are not significantly impacted by AMD and have relatively healthy aquatic ecosystems that support an existing Western Allegheny Plateau warm water ecosystem. Small pockets of relatively diverse fish and macroinvertebrate populations exist in areas where tributaries have good water quality. However, these healthy ecosystems do not contribute to the Hocking River ecosystem because of the poor water quality of Monday Creek and other tributaries.

Another problem associated with abandoned coal mines is subsidence. Subsidence impacts occur in the watershed when underground mine voids that are close to the surface collapse. The collapsed overburden captures surface water into the mine voids, allowing contact with sulfide minerals and oxygen, thus generating AMD within the watershed. Subsidence can take the form of large gaping holes in the stream bed or of hidden underground cracks that allow surface water to dissipate into the underground mine workings, thus continuing the generation of AMD.

Plan Combination 6 would have construction of project features in each of the eight subwatersheds affected by the AMD in Monday Creek. Features such as dissipating streams, stream blockages, and subsidences would be constructed to prevent surface water from flowing

into underground mine workings and thus preventing the generation of AMD within the Monday Creek watershed and in adjacent watersheds. The AMD restoration sites would best contribute to the ecological restoration objective to restore Monday Creek ecosystem by treating the AMD at the source prior to its entering the aquatic ecosystem. This would allow the existing pockets of diverse fish and macroinvertebrate populations to repopulate areas currently impacted by AMD thus restore both the structural and functional components of the ecosystem to a less degraded state. The Recommended Plan is expected to result in significant benefits to the aquatic ecosystem from headwaters to Monday Creek's confluence with the Hocking River. Proposed structures include open limestone channels, low head dams, limestone leach beds, slag leach beds, aerobic wetlands and dosers. Other forms of construction activities involve the closure of stream-capturing subsidences, re-routing dissipating streams, and either breaching or removal of spoil blocks.

The plan includes the following features:

Table 1. Plan Combination 6.

Plan	Location	Description
A	Jobs Hollow	1 doser, 3 SLB* and 1 OLC*
B	Dixie Run	1 SLB, 2 OLC and 1 LLB*
C	Rock Run	3 LHD* and 1 wetland
D	Lost Run	30 sites + 16 spoil blocks and 12 subsidences features
F	Monkey Hollow	1 doser + 9 spoil blocks and 6 subsidences features
H	Snake Hollow	1 SLB, 4 OLC and 4 LLB
J	Snow Fork	6 SLB, 19 OLC, 20 LLB, 8 dissipating streams, 9 spoil blocks, 7 subsidences, and 2 wetlands
	Coe Hollow	2 SLB, 1 OLC, 4 LLB, 3 dissipating streams and 1
L		Subsidence feature

*SLB – slag leach bed; LLB – limestone leach bed; OLC open limestone channel; LHD – low head dam

Currently, the project consists of 178 total restoration structures located within the following eight subwatersheds locations: Jobs Hollow, Dixie Hollow, Rock Run, Monkey Hollow, Lost Run, Snake Hollow, Coe Hollow, and Snow Fork (which is comprised of Salem Hollow, Sycamore Hollow, Spencer Hollow, Brush Fork, Long Hollow, Whitmore Cemetery and Orbiston). The locations of these subwatersheds may be found on Map 1.

C. Authority and Purpose.

The Corps is undertaking structural measures to alleviate resource extraction impacts experience in the Monday Creek Watershed as authorized by House Document 306, 74th Congress, First Session, and other pertinent reports, to,

“determine whether modifications are warranted to solve a variety of water and related resource problems in the Hocking River Basin with priority given to Sunday and Monday Creek sub-basins. Special emphasis shall be given to the need for environmental restoration of lands and waters that have been impacted by resource extraction and other land uses. This study is to be conducted in consultation with the Hocking Conservancy District.”

D. Description of Material.

1. General Characteristics of Proposed Fill Material.

Fill material will be composed of 17 access road culvert crossings located in Snow Fork (Brush Fork), Coe Hollow, Dixie Hollow and Lost Run to provide access to construction sites. In addition, the construction of 16 open limestone channels or limestone leach beds will require placement of limestone into the stream. Three of the 16 sites are low head dams placed in Rock Run which will allow metal precipitants to fall out of suspension. Three other sites call for the placement of steel slag in the channel to improve alkalinity within the stream.

2. Source of Material.

Limestone and steel slag will come from commercial sources.

E. Description of Proposed Discharge.

1. Location.

In Brush Fork, stream impacts include 602 feet of culvert which will be place in the stream to provide access to the restoration projects. The Corps estimates that the projects in Brush Fork will provide water quality improvement to approximately 6.75 miles of aquatic stream habitat. Improvements will include the reduction of metals and acidity concentrations and increased pH and alkalinity.

Table 2a.			
SUBWATERSHED	ID	Type of Impact	Stream Length (ft.)
Brush Fork	OLC2-LLB2	Access Road	60
Brush Fork	OLC3-LLB3	Access Road	65
Brush Fork	OLC5-LLB5	Access Road	70
Brush Fork	OLC8-LLB8	Access Road	65
Brush Fork	OLC9-LLB9	Access Road	65
Brush Fork	OLC10-LLB10	Access Road	60
Brush Fork	OLC14-LLB14	Access Road	62
Brush Fork	234-284	Access Road	50
Brush Fork	108	Access Road	65
Brush Fork	110	Access Road	40

In Coe Hollow , stream impacts include 50 feet of culvert which will be place in the stream to provide access to the restoration projects. Approximately 144 feet of stream will need to be utilized to construct a limestone leach bed/open limestone channel. The Corps estimates that the projects in Coe Hollow will provide water quality improvement to approximately 3.26 miles of aquatic stream habitat.

SUBWATERSHED	ID	Type of Impact	Stream Length (ft.)
Coe Hollow	LLB-OLC-E	Restoration	144
Coe Hollow	SLB-1	Access Road	50

In Dixie Hollow, stream impacts include 75 feet of culvert which will be place in the stream to provide access to the restoration projects. Approximately 1,365 feet of stream will need to be utilized to construct limestone leach bed/open limestone channels. The Corps estimates that the projects in Dixie Hollow will provide water quality improvement to approximately 4.41 miles of aquatic stream habitat.

SUBWATERSHED	ID	Type of Impact	Stream Length (ft.)
Dixie Hollow	SLB-1	Access Road	75
Dixie Hollow	OLC-2	Restoration	700
Dixie Hollow	OLC-1	Restoration	590
Dixie Hollow	LLB-1	Restoration	75

In Dixie Hollow, approximately 365 feet of stream will need to be utilized to construct slag leach beds. The Corps estimates that the projects in Dixie Hollow will provide water quality improvement to approximately 1.88 miles of aquatic stream habitat.

SUBWATERSHED	ID	Type of Impact	Stream Length (ft.)
Jobs Hollow	SLB-10	Restoration	160
Jobs Hollow	SLBUS	Restoration	100
Jobs Hollow	SLB-5	Restoration	100

In Long Hollow, approximately 100 feet of stream will need to be utilized to construct a limestone leach bed/open limestone channel. The Corps estimates that the projects in Long Hollow will provide water quality improvement to approximately 2.23 miles of aquatic stream habitat.

SUBWATERSHED	ID	Type of Impact	Stream Length (ft.)
Long Hollow	OLC3-LLB3	Restoration	100

In Lost Run, stream impacts include 80 feet of culvert which will be place in the stream to provide access to the restoration projects. Approximately 1,000 feet of stream will need to be utilized to construct limestone leach bed/open limestone channels. The Corps estimates that the projects in Lost Run will provide water quality improvement to approximately 12.52 miles of aquatic stream habitat.

SUBWATERSHED	ID	Type of Impact	Stream Length (ft.)
Lost Run	OLC-2E1	Access Road	80
Lost Run	OLC-LLB-3W1	Restoration	1000

In Rock Run, approximately 300 feet of stream will need to be utilized to construct the low head dams. The Corps estimates that the projects in Rock Run will provide water quality improvement to approximately 8.57 miles of aquatic stream habitat.

SUBWATERSHED	ID	Type of Impact	Stream Length (ft.)
Rock Run	LHD-1	Restoration	100
Rock Run	LHD-2	Restoration	100
Rock Run	LHD-3	Restoration	100

In Salem Hollow, approximately 950 feet of stream will need to be utilized to construct a open limestone channel. The Corps estimates that the projects in Salem Hollow will provide water quality improvement to approximately 0.53 miles of aquatic stream habitat.

SUBWATERSHED	ID	Type of Impact	Stream Length (ft.)
Salem	OLC1	Restoration	950

In Snake Hollow, stream impacts include 90 feet of culvert which will be place in the stream to provide access to the restoration projects. Approximately 1,750 feet of stream will need to be utilized to construct limestone leach bed/open limestone channels. The Corps estimates that the projects in Snake Hollow will provide water quality improvement to approximately 3.17 miles of aquatic stream habitat.

SUBWATERSHED	ID	Type of Impact	Stream Length (ft.)
Snake Hollow	OLC8-LLB8	Restoration	850
Snake Hollow	OLC6-LLB6	Restoration	180
Snake Hollow	OLC10-LLB10	Restoration	370
Snake Hollow	OLC5-LLB5	Access Road	45
Snake Hollow	OLC4-LLB4	Access Road	45
Snake Hollow	OLC9-LLB9	Restoration	350

In Sycamore Hollow, stream impacts include 65 feet of culvert which will be place in the stream to provide access to the restoration projects. Approximately 1,300 feet of stream will need to be utilized to construct a forested wetland. The Corps estimates that the projects in Lost Run will provide water quality improvement to approximately 3.35 miles of aquatic stream habitat.

SUBWATERSHED	ID	Type of Impact	Stream Length (ft.)
Sycamore	WL	Restoration	1300
Sycamore	LLB-1	Access Road	65

2. Size. Please refer to E.1.
3. Type of Disposal Site and Habitat.

Excess soil and rock excavation from the sites will be disposed of on sites designated by the Wayne National Forest.

4. Timing and Duration of Discharge.

The proposed construction work is expected to last over a period of 4 years. Construction will be performed during high, normal and low flow periods.

F. Description of Disposal Method.

The material for the construction of the culvert crossings and restoration sites will be placed with standard land-based construction machinery.

II. FACTUAL DETERMINATIONS.

A. Physical Substrate Determination.

1. Substrate Elevation and Slope.

The average bottom width varies within the watershed. The average side slope for the left and right banks is 2:1 (horizontal to vertical).

2. Sediment Type.

The existing substrate consists of sand, silt and clays.

3. Dredged/Fill Material Movement.

Project intent is to restore the water quality of much of the Monday Creek watershed to Warm Water Habitat status. Material excavated through construction of the restoration sites will be used for road construction. Excess material will be placed in an area designated by the Wayne National Forest. The restoration sites will be seeded with native vegetation once construction is complete. Standard sediment control measures will be used throughout the process.

4. Physical Effects on Benthos.

Any existing aquatic and terrestrial populations occupying subwatersheds and surrounding land will be disturbed during the construction of the restoration sites. Macroinvertebrates will colonize the restored streams rather quickly from undisturbed upstream and downstream sources. Placement of the fill material will have minimum disturbance on benthic populations since many of the areas have limited aquatic populations.

5. Other Effects.

Cultural /historical resources are not present within the project area.

6. Actions Taken to Minimize Impacts.

Action taken to minimize impacts include use of existing road throughout the watershed where possible, avoidance of wetlands, and minimize culvert use. Culvert impact would be permanent; however, the construction of the restoration sites will improve overall water quality throughout the Monday Creek watershed.

B. Water Circulation, Fluctuation, and Salinity Determinations.

1. Water.

a. Salinity. Not Applicable

b. Water Chemistry. Overall water quality will be significantly improved by construction of the project by increasing alkalinity, decreasing acidity, iron and aluminum concentrations. pH will also be improved. During construction, run-off may introduce some suspended solids into the Monday Creek watershed and temporarily increase sedimentation down stream to an extent.

2. Clarity. Only short term increases in turbidity are expected. Standard best management practices and seeding are planned to prevent run-off erosion.

C. Color. Color will be improved by the restoration sites by removing iron and aluminum from the aquatic system.

D. Odor. No effect.

E. Taste. No effect.

F. Dissolved Gas Levels. No effect.

G. Nutrients.

No significant nutrient effects aside from possible dissolution of carbonates since limestone will be used in site construction. In stream structures will aid in adding turbulence to aerate the water. The planting plan includes fast growing native grasses and shrub species to quickly help shade and add nutrients (detritus).

H. Eutrophication. No significant effect.

I. Other as Appropriate Not applicable.

1. Current Patterns and Circulation.

a. Current Patterns and Flow. The sites where instream channel work is required, the channel may be expanded in width in some locations, however, the flow gradient and channel length will not be affected by this project.

b. Velocity. Water velocity will not be affected by the proposed project.

c. Stratification. Not applicable.

d. Hydrologic Regime. No significant changes.

2. Normal Water Level Fluctuations.

Normal water level fluctuations will not be affected by this action. In-stream features will be constructed to mimic the natural stream bed.

3. Salinity Gradients. Not applicable.

4. Actions that will be taken to minimize impacts.

Appropriate measures have been identified and incorporated in the proposed plan to minimize adverse effects of the project on the aquatic environment. These measures include proper

design and construction, use of environmentally acceptable fill material, and revegetation with fast growing native grasses species of exposed soils.

J. Suspended Particulate/Turbidity Determinations.

1. Temporary changes in suspended particulates and turbidity levels are expected in vicinity of restoration sites. Fill materials consist of natural granular materials and are not expected to create significant turbidity or sedimentation.

2. Effects on chemical and physical properties of the water column.

a. Light Penetration. See Section II.B.(2). Minor reduction will occur during construction period due to turbidity. Best management practices will be employed during construction to minimize turbidity levels.

b. Dissolved Oxygen. Instream structures will be placed to mimic current conditions.

c. Toxic Metals and Organics. Phase I and II HTRW studies indicated the granular materials and natural stone fill are not likely to contain harmful contaminants. Toxic concentrations of iron and aluminum will be removed from the stream through the construction of the restoration sites.

d. Pathogens. See Section II.J.2.(c) , immediately above.

e. Aesthetics. Although the channel area may have an artificial appearance, over time natural succession of terrestrial resources in addition to the planting plan will enhance wildlife resources.

3. Effects on Biota. General – Fish and macroinvertebrates species in the watershed would shift from pollution tolerant species to more sensitive species. Diversity, abundance and mobility would be greatly improved.

a. Primary Production, Photosynthesis. Primary production and photosynthesis will be improved by the construction of the restoration sites.

b. Suspension/Filter Feeders. Suspension/filter feeders will be able to return to the sections of the stream currently impacted by AMD. Increased species diversity and populations would be realized in the watershed.

c. Sight Feeders. Suspension/filter feeders will be able to return to the sections of the stream currently impacted by AMD. Increased species diversity and populations would be realized in the watershed.

4. Action to Minimize Impacts. Fill areas will be protected by planting vegetation as soon as possible to prevent erosion.

K. Contaminant Determination. See Section II.J.2.(c) .

L. Aquatic Ecosystem an Organism Determinations.

1. Effects on Plankton. Turbidity levels may temporarily affect plankton populations through abrasions by suspended material and light transmission reduction. However, neither phyto- nor zooplankton are present in appreciable quantities.

2. Effects on Benthos. See Section II.A.4 and Section II.J.3.b.
3. Effects on Nekton. Ordinarily, impacts on fisheries would be possible due to construction of the stream crossings and restoration sites; however, overall diversity and species numbers would increase throughout the watershed.
4. Effects on Aquatic Food Web. Though impacts of the construction of the stream crossings and restoration sites will be realized, overall improvement of the aquatic food web would occur. Macroinvertebrate species would recolonized areas impacted by AMD.
5. Effects on Special Aquatic Sites.

a. Wetlands. Jurisdictional wetlands were found within the following project areas of Brush Fork, Snow Fork, Lost Run, Dixie Hollow, and Monkey Hollow. All proposed wetland areas would be avoided for the FWPC. The wetlands identified in Table 3 were flagged for avoidance purposes. The Snow Fork (Spencer & Orbiston) wetlands were very high quality wetlands. Treatment is proposed for the water entering and exiting the Snow Fork (Spencer) wetland. The Snow Fork (Orbiston) wetland is to be enhanced through sediment removal and an additional 7 acres of wetland is proposed to be created through excavation.

Table 3 Extent of Jurisdictional Wetlands

Sub-Watershed	Project ID Number	Approximate Wetland Area (acres)
Snow Fork-Brush Fork Area A	SLB2	0.2
Snow Fork-Brush Fork Area B	LLB1	0.2
Snow Fork-Brush Fork Area C	OLC3/LLB3	0.2
Snow Fork-Brush Fork Area D	OLC5/LLB5	0.5
Snow Fork (Spencer)	SLB	3.6
Lost Run	OLCMS1/LLB4E1	0.3
Dixie Hollow	LLB	0.2
Monkey Hollow	OLC10 /LLB10	0.2
Snow Fork (Orbiston)	Snow Fork	4.0

Wetland Avoidance Areas

The wetland areas identified in the areas listed below were found to be of exceptional quality. Due to the high quality, the team adjusted the project construction area to avoid those areas.

Coe Hollow LLBA Emergent Wetland located to the south-Should be

		monitored to determine if soils develop after construction of recommended alternative.
Lost Run	LLB1W1	Wetland located to the north
Snake Hollow	LLB7	Wetland located to the north

Wetland areas would be constructed in Rock Run, Coe Hollow and along Snow Fork. Thirty three acres of wetland would be created are listed below in Table 4.

Table 4. Wetlands Created

Rock Run	26.3 acres
Coe Hollow	0.02 acres
Snow Fork	7 acres
Total Wetland Acres Created	33.32 acres

b. Threatened and Endangered Species. Plan Combination 6 would not affect the endangered species found in the WNF. The following measures were included as "Reasonable and Prudent Measures" in the Biological Opinion for the Wayne National Forest in 2001. Some of these measures may be applicable for management of adjacent areas to favor several species of bats, including the Indiana bat, as well as other species of wildlife. On portions of the Monday Creek Watershed managed by the U.S. Forest Service, these measures will be followed. Measures for the "Terms and Conditions" which the Wayne National Forest must follow to be exempt from the prohibitions of Section 9 of the Endangered Species Act, as amended, will also be incorporated. This information, in addition to continued consultation with the U. S. Fish and Wildlife Service, would be incorporated to the project when providing access during construction and operation of treatment measures, and during restoration of the impacted and surrounding areas.

6. Other wildlife. Over the life of the project, wildlife habitat will be enhanced by the proposed restoration features.

7. Actions to Minimize Impacts. The proposed material placement activities would be accomplished under conditions that would minimize, to the extent practicable, adverse effects on aquatic ecosystem. Best management practices will be employed to avoid sedimentation.

M. Proposed Disposal Site Determinations.

1. Mixing Zone Determination. No discharge of liquid material would be involved with project construction.

2. Determination of Compliance with Applicable Water Quality Standards. Fill activities would be in conformance with the State of Ohio standards.

3. Potential Effects on Human Use Characteristics.

- a. Municipal and Private Water Supply. See II.I.
- b. Recreational and Commercial Fisheries. See II.J.3.b., II.J.3.c., and II.L.3.
- c. Water Related Recreation. No impact.
- d. Aesthetics. See II.J.2.e.
- e. Parks, National and Historical Monuments, National Seashores Wilderness Areas Research Sites, and similar Preserves. No impact.

N. Determination of Cumulative Effects of the Aquatic Ecosystem.

Future actions that may occur within the watershed and surrounding areas have both negative and positive effects on the resources. Analysis of the effects indicates that activities caused by man and includes mineral resource extraction, such as coal and natural gas have negative effects on the resources. Logging also has a negative effect. These impacts, when analyzed individually would not appear to affect the resources. However, over the project horizon (20 years), these activities would cause additional pressure on the already degraded aquatic ecosystem. Positive future actions include the WNF purchase of property to add to the existing property. AMD restoration activities have overall positive effects to the resources

O. Determination of Secondary Effects on Aquatic Ecosystems. See II.N.

III. FINDINGS OF COMPLIANCE OR NONCOMPLIANCE WITH THE RESTRICTIONS ON DISCHARGE.

A. No significant adaptations of the guidelines were made relative to this evaluation.

B. Alternatives. Two alternatives for restoration of the aquatic ecosystem of the Monday Creek watershed were considered for the project. Plan Combination 6 and the No Action Alternative.

1. Plan Combination 6. Plan Combination 6 would result in the construction of 178 restoration sites located in Monday Creek Watershed. Improvement to the aquatic ecosystem would be realized through the decrease of acidity, aluminum, and iron and an increase in alkalinity and pH levels. The proposed action will have long-term, direct and beneficial impacts to aquatic life and their habitat by reducing approximately 90 percent of the acidity entering surface waters. Seeps will be captured, treated, and returned to the stream channel. Fish and other aquatic life diversity, abundance, and mobility will be substantially improved to restore the watershed.

Fish and macroinvertebrate species in the watershed would shift from pollution tolerant species to more sensitive species. Diversity and species numbers would significantly improve for both fish and macroinvertebrate populations. Macroinvertebrate colonization would occur with one to two seasons in areas where populations are currently limited. Fish and other aquatic organisms would return quickly.

2. The No Action Alternative would result in continued degraded aquatic ecosystem within the Monday Creek watershed.

C. Description of Proposed Work. Work to be performed consists of Plan Combination 6, listed above.

D. The proposed placement of fill material will not result in significant adverse effects on human health and welfare, including drinking water supplies, recreation and commercial fishing, plankton, fish, shellfish, wildlife, or special aquatic sites. Aquatic life and other wildlife will not be adversely affected, but in fact, improved throughout the watershed. No significant adverse effects on aquatic ecosystem diversity, productivity and stability, or recreational, aesthetic and economic values will occur.

E. Appropriate steps to minimize potential adverse impacts from any discharges on aquatic systems have been incorporated.