


The Office of Surface Mining
MID-CONTINENT REGION

natural stream design
WORKSHOP

MAY 17-19TH, 2011
MOUNT VERNON, IL

U.S. DEPARTMENT OF THE INTERIOR
OFFICE OF SURFACE MINING

Special Thanks

Special Thanks to the following for their Participation and Support with the

2011 Natural Stream Design Workshop

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May 17-19, 2011 - Mt Vernon, IL

Welcome

NATURAL STREAM DESIGN WORKSHOP 2011

Arguably more than anywhere else in the United States, streams within the Midwest are highly impacted by centuries of anthropogenic impacts predominately rooted in agriculture, drainage improvements, and navigational development. Riparian buffers were reduced or lost and stream beds were channelized resulting in increased nutrient load, increased sedimentation, channel incision, and aquatic habitat loss. Traditional mining and reclamation methods often replace these streams with rock lined ditches or remove them entirely. However, due to today's modern advances in technology, it is now possible to design streams that mimic both the look and the functionality of nature. Steep rock lined ditches are replaced by meandering streams specifically designed to efficiently convey water without excessive erosion or sediment loading and provide a proper mix of habitat zones essential for sensitive aquatic life. Today, mine reclamation may provide a unique opportunity to not just return a Midwestern stream to its pre-mined state, but improve functionality and restore/create a more natural and ecologically sound system.

In recent years, increasing pressure has been put on the mining industry to improve landform reclamation and mitigation of stream impacts. In response, OSM sponsored a forum entitled "Geomorphic Reclamation and Natural Stream Design at Coal Mines" in Bristol, Virginia that addressed many aspects of natural landform and stream design from a national scale. Since that forum, state and industry personnel within the Mid Continent Region (MCR) have identified a need for more focused discussion and education on stream design, construction, and monitoring elements unique to the region. The response was to design a workshop more accessible to Midwestern personnel. The workshop will focus attention on the unique challenges and ecological benefits of utilizing natural stream design methods and practices for coal mine reclamation in the Midwest. In addition, this workshop will provide valuable support to OSM's and the State's current charge of improving protection for streams affected by surface coal mining.

FIELD TOURS

Both the Illinois and Indiana field tours will examine natural stream design approaches to reconstructing streams on surface mined lands. However, the tours differ substantially in both the scale and age of the sites to be visited. The Indiana tour will stop at five moderately sized sites featuring reclamation to ephemeral and smaller sized intermittent steams. All sites were reclaimed within the previous six years or are currently undergoing stream reconstruction. The Indiana Tour will also provide a balance of both regulatory and AML projects. The Illinois Tour will visit some of the largest full-scale stream reconstruction projects ever completed in the US. The tour will explore just two reclaimed surface mines but will feature multiple stops along over 11 miles of reconstructed perennial stream. The streams on the Illinois tour are more mature than those of the Indiana tour, up to 20 years since reconnection. Combined, the two tours will provide participants a unique opportunity to explore these unique sites and discuss the design and monitoring practices utilized with personnel directly involved with restoration efforts.

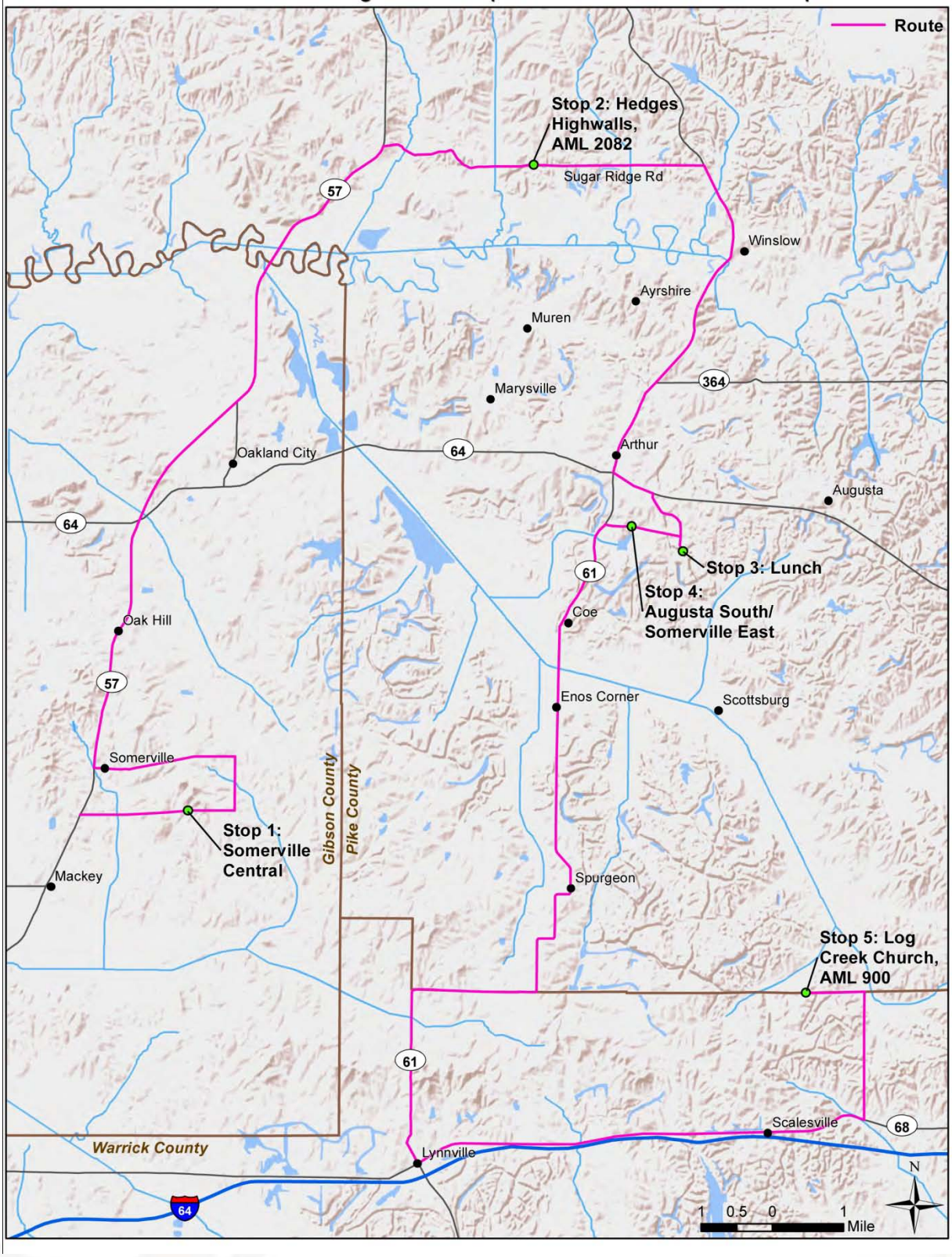
Indiana Stream Reclamation Field Tour

AGENDA for Tuesday, May 17th, 2011

Numbers in **BLUE** represent the stops on the tour and correspond to the map on page 4.

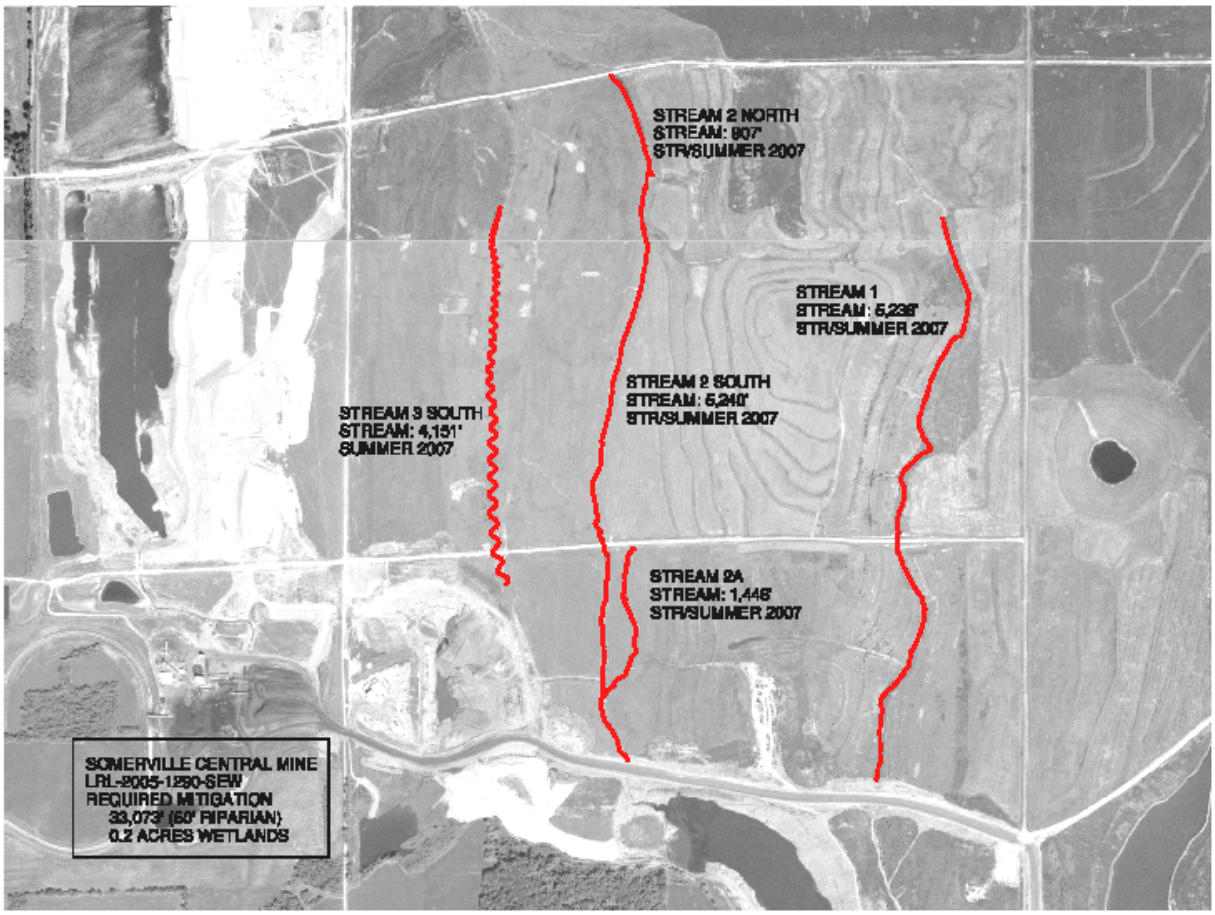
6:30 am		**Check IN**
7:00 am		**Depart – Mt Vernon Holiday Inn Hotel**
8:30 am		**Meet – Evansville North Holiday Inn Hotel**
8:40 am		Depart for Somerville Central Mine
9:00 am	1	**Arrive – Somerville Central Mine** *Rich Williams, Peabody Midwest Mining, LLC.*
10:00 am		Depart for Hedges Highwall AML Reclamation Project
10:30 am	2	**Arrive – Hedges Highwall AML Reclamation Project** *Danny Hause, Indiana AML Program*
11:15 am		Depart for Lunch (Augusta South Mine)
11:30 am		**LUNCH (Sponsored by Triad Mining Inc.)**
1:00 pm		Depart for Augusta South and Somerville East Mines
1:05 pm	3	**Arrive – Augusta South Mine** *David McLimore and Steve Denu, Triad Mining Inc.*
1:40 pm	4	**Arrive – Somerville East Mine** *Karen Risner, United Minerals Company, LLC.*
2:15 pm		Depart for Log Creek Church AML Reclamation Project
3:00 pm	5	**Arrive – Log Creek Church AML Reclamation Project** *Danny Hause, Indiana AML Program*
3:30 pm		Depart for Evansville Hotel
4:00 pm		**Arrive – Evansville Hotel**

Natural Stream Design Workshop: Indiana Field Tour Site Map



Somerville Central Mine

Peabody Midwest Mining's Somerville Central Mine includes 44,186 linear feet of ephemeral stream and 7,051 linear feet of intermittent stream impacts. USACE approved mitigation includes the replacement of 33,073 linear feet of streams. Beginning in 2007, stream mitigation has been occurring during the construction season including log vanes, j-hooks, root wads, and down-cut protection structures. Different conditions, challenges and evolving techniques can be viewed at this site.

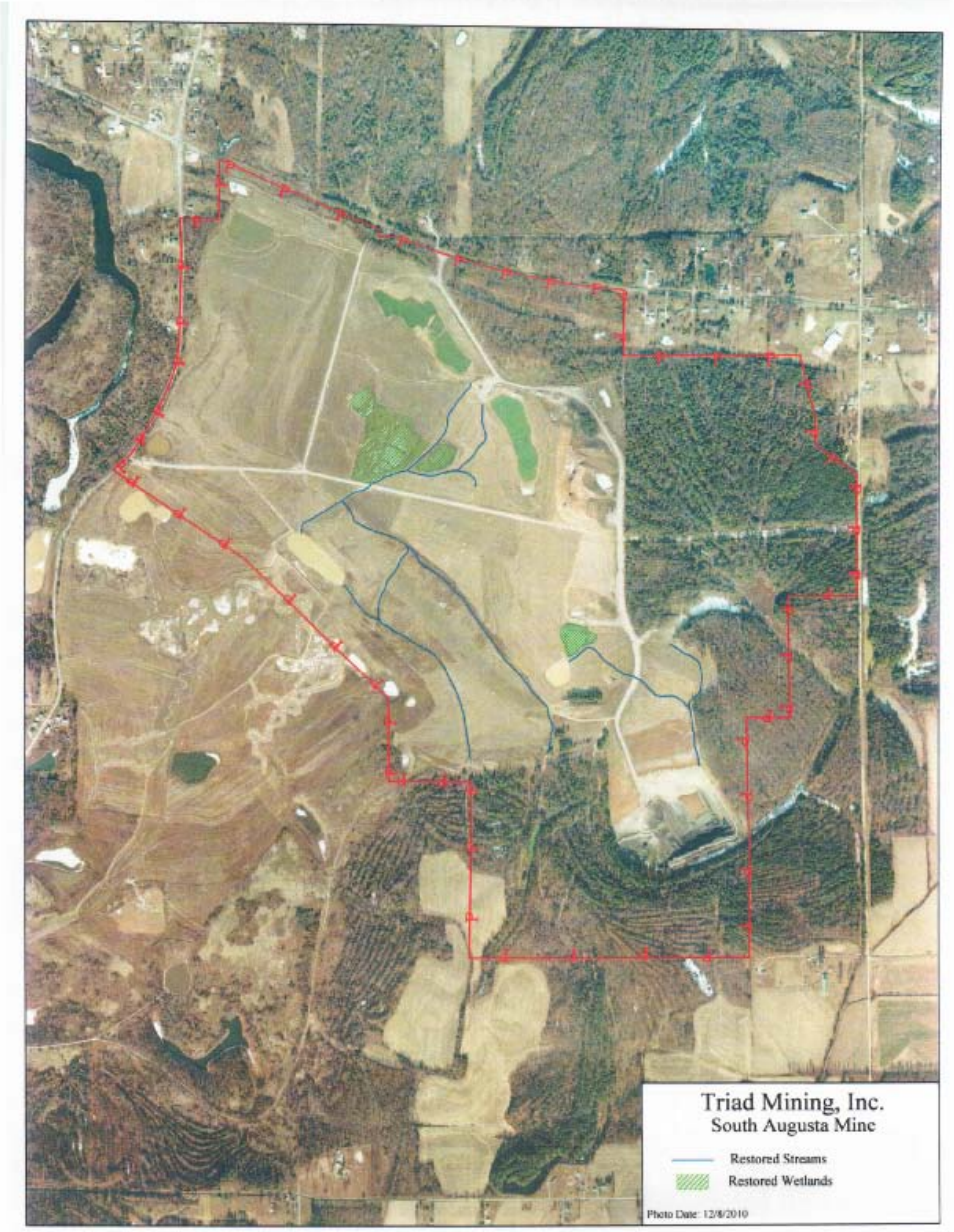


Hedges Highwall, AML Site 2082

This AML reclamation project consisted of 4,500 linear feet of dangerous highwall along a county road and was completed in October 2010. Most of the area is owned and managed by the Sugar Ridge State Fish and Wildlife Area, while a portion is owned and managed by the Patoka River National Fish and Wildlife Refuge. In order to eliminate the danger posed to local motorists and visitors of the fish and wildlife areas, the highwall was backfilled. During the backfilling process, several open water pits and wetland areas were impacted, requiring compensatory mitigation, which consisted of avoidance, enhancement and the replacement of 3,770 linear feet of natural stream design channel.

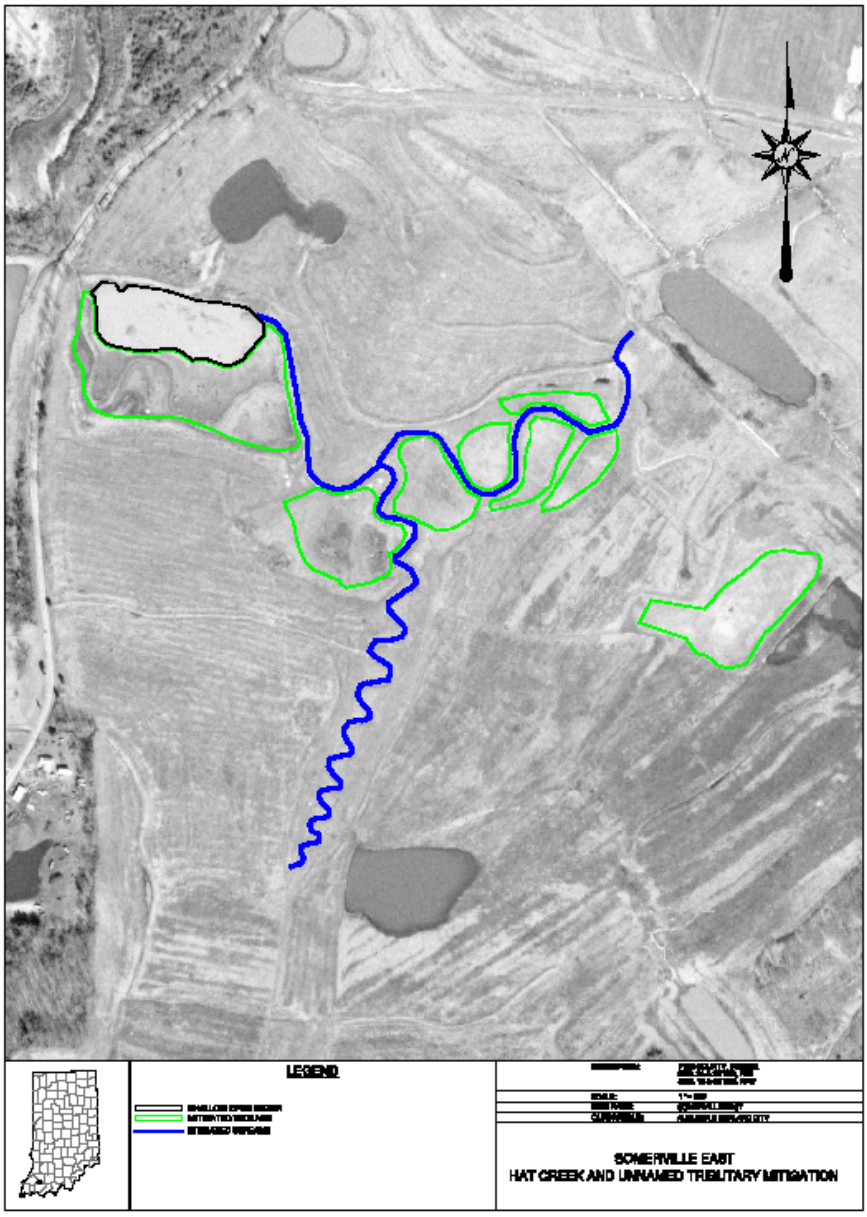
Augusta South Mine

Since the Augusta South mine opened in January 2005, Triad Mining has affected approximately 562 acres, including 15,735 linear feet of stream and 2.53 acres of wetlands. Stream and wetland restoration has been an ongoing project since the spring of 2005. Approximately 15,517 linear feet of stream and 13 acres of forested wetland have been restored. Most of the restored streams have forested riparian buffers around them. Triad Mining has made extensive use of native rock and brush from the mine in the restoration process.



Somerville East Mine

United Minerals Company has operated and reclaimed the Somerville East Mine on behalf of Peabody Midwest Mining. During mining operations, 20,298 linear feet of streams and 9.6 acres of forested wetlands were impacted. Mining operations have been completed and reclamation and mitigation efforts are ongoing. Stream mitigation includes reconstruction of an approximately 1/2 mile section of Hat Creek.



Log Creek Church, AML Site 900

As with the previous AML sites, this reclamation project, completed in November 2006, consisted of 1,900 linear feet of dangerous highwall along a county road and is owned and managed by the Sugar Ridge State Fish and Wildlife Area. This highwall was backfilled to eliminate the danger to local motorists and property visitors. Although wetland mitigation was not an issue at this particular highwall, it was still reclaimed using natural stream design, creating 2,600 linear feet of channel. Being the first time the Indiana AML Program used this design technique, a cost comparison between natural stream design and typical reclamation techniques was conducted as part of the bid process.

Natural Stream Design Workshop Presentations

AGENDA for Wednesday, May 18th, 2011

8:00 am **Welcome and Introductions**

Session 1: Characteristics of Midwestern Streams

8:15 am **The Interwoven Roles of Geologic Setting, Human Disturbance, and Time in Shaping the Geomorphic Characteristics of Midwestern Streams**
Faith A. Fitzpatrick, U.S. Geological Survey, Wisconsin Water Science Center

8:45 am **A Survey of Stream Restoration Projects in Illinois**
Don Roseboom, U.S. Geological Survey, Illinois Water Science Center

Session 2: Regulatory Issues

9:15 am **OSM's New Stream Protection Rule**
Paul Ehret, Office of Surface Mining

9:45 am **BREAK**

10:00 am **Mitigation and Monitoring Requirements**
Mike Ricketts and Sam Werner, US Army Corps of Engineers

Session 3: Design, Engineering, and Monitoring

10:30 am **Stream Restoration at Midwest Surface Coal Mines – Keys to Success**
Richard Williams, Peabody Energy

11:00 am **Lessons Learned from a Thousand Streams**
Wayne Kinney, Midwest Streams, Inc.

11:30 am **LUNCH**

1:00 pm **The Good, the Bad, and the Ugly**
Russell Retherford, US Army Corps of Engineers

1:30 pm **Hydrology and Sediment Transport Characterization and Management Considerations**
Timothy Straub, US Geological Survey, Illinois Water Science Center

AGENDA for Wednesday, May 18th, 2011

Session 4: Midwestern Stream Reclamation Case Studies

2:00 pm **Pipestone Creek and Pyramid State Park**
Pat Malone, Illinois DNR

2:30 pm **BREAK**

2:45 pm **CONSOL Burning Star 4**
Bill O'Leary, Illinois DNR

3:15 pm **West Fork Creek Mitigation Area**
Dave Beeson, ENVIRON Int.

3:45 pm **The Squiggly Ditch – The Third Time Around**
Dan Hause, Indiana DNR Division of Reclamation

4:15 pm **BREAK**

4:30 pm **Panel Discussion – Can We and Are We Restoring Natural Stream Function?**
Panelists: *Bill O'Leary – Illinois DNR*
Mike Ricketts – US Army Corps of Engineers
Paul Ehret - OSMRE
Bryce West- Peabody Energy
Don Roseboom –USGS
Moderator : *Jack Nawrot - SIUC*

5:30 pm **Adjourn**

The Interwoven Roles of Geologic Setting, Human Disturbance, and Time in Shaping the Geomorphic Characteristics of Midwestern Streams

Faith A. Fitzpatrick, U.S. Geological Survey

Given the relatively young geologic age of the Midwestern landscape, the natural geomorphic character of Midwestern streams is largely determined from their glacial and post-glacial geomorphic setting combined with bedrock geology and structure. Widespread human disturbances across the Midwest have vastly altered the hydrologic and sediment context of most modern fluvial systems, leaving few if any natural streams for comparison. Watershed-scale disturbances included widespread vegetation clearing for agriculture, logging, and urbanization and stream network alteration and extension from ditching, tiling, and storm sewers. Stream longitudinal connections have been altered by dams and road crossings. Channelization and incision has left many channels disconnected from their floodplains. Modern geomorphic processes reflect a combination of ongoing adjustments from past and present human disturbances, as many geomorphic feedbacks take decades to millennia to complete. In this presentation we'll discuss the major factors and the importance of time in understanding geomorphic characteristics and processes of Midwestern streams.

A Survey of Stream Restoration Projects in Illinois

Don Roseboom, U.S. Geological Survey

With IEPA 319 Program funds, the US Geological Survey inspected 54 stream restoration or enhancements projects on 45 streams that had been constructed since 1990. This effort was added by the Illinois EP, which has funded the evaluation of the implemented stream BMPS in both short term and long term studies.
This project is a continuation of previous IEPA research evaluation of Illinois stream projects (Stream Restoration in NE Illinois, 2004), which was hindered by the limited number of stream projects which had undergone multiple large floods. With series of large flood events occurring throughout the State of Illinois since 2007, the study was continued.

Illinois stream projects can be broadly classified into practices that protect properties and practices that enhance the stream ecosystems. While both types of stream practices can provide overlapping benefits resulting by limiting stream erosion, enhancement of stream ecosystems requires at least a "reach approach" more extensive than the protection of individual homes or agricultural fields.
Typically the re-meandering of a channelized stream is the most intensive stream ecosystem enhancement for Illinois stream management. Many stream management projects are stabilization of eroding channelized streams with both bank and streambed structures. Such stabilization BMPs can also enhance stream ecosystems but biotic response can be limited when BMPS limit sediment transport capacity – especially bed materials as sand and gravel.

Many EPA evaluations of stream quality are based upon biological surveys where the Index of Biological Integrity (IBI) for stream fishes and Macro-invertebrate Index of Biotic Integrity (MBI) determine stream quality based upon aquatic population response.

Overview of Office of Surface Mining's Efforts to Better Protect Streams from the Adverse Impacts of Coal Mining

Paul Ehret, Office of Surface Mining Reclamation and Enforcement

The Office of Surface Mining Reclamation and Enforcement (OSM) is developing a stream protection rule to better protect streams from the adverse effects of coal mining. As an integral part of the rulemaking process, OSM recently published a notice of intent to conduct an environmental impact statement for the proposed stream protection rule (Federal Register /Vol. 75, No. 117 /June 18, 2010). A draft of the proposed rule and an associated environmental impact statement will be released in 2011.

Under terms of a settlement agreement stemming from challenges to the 2008 Excess Spoil Minimization and Stream Buffer Zone Rule, OSM agreed to use the agency's best efforts to sign a final stream protection rule by end of 2012. Prior to this settlement agreement, OSM was a participant in the development of an interagency action plan (IAP) to significantly reduce the harmful environmental consequences of Appalachian surface coal mining operations. The IAP was outlined in a June 2009 MOU with the Department of Interior, Environmental Protection Agency, and the Department of The Army. The implementation of the IAP committed OSM to consider rule revisions, including but not limited to the 2008 rule. The rule revisions under consideration will be drafted under a holistic approach to better protect streams and related environmental values in all coal mining regions, an approach broader than the 2008 rule and the Appalachian region addressed in the 2009 MOU. OSM has stated in its notice of intent that "it would not be fair, appropriate, scientifically valid or consistent with the principles of SMCRA to apply the new protections only in central Appalachia".

All rule text drafts are currently predecisional, yet principal elements of the proposed rule will likely include: provisions for gathering more specific baseline data on hydrology, geology, and aquatic biology for permits impacting streams; revising the regulations governing mining activities in or near streams; and update of the definitions for perennial, intermittent, and ephemeral streams. The proposed rule will include a definition of the term "material damage to the hydrologic balance" and clarifications for determining the probable hydrologic consequences and producing cumulative hydrologic impact assessments. The proposed rule will also include revisions of the backfilling and grading rules, excess spoil rules, and approximate original contour restoration requirements to incorporate landform restoration principles and the development of more effective requirements for variances and exceptions from approximate original contour restoration.

Regulations and Monitoring Requirements
Mike Ricketts and Sam Werner, U.S. Army Corps of Engineers

Given the complexity of current surface mining operations present within the Illinois Basin Coal Field, many obstacles must be overcome to effectively and accurately permit these operations to allow work within "waters of the U.S.".. The Corps has broad authority to regulate under both Section 404 of the Clean Water Act as well as Section 10 of the Rivers and Harbors Act of 1899. While regulations are fluid and dynamic, the constitutional basis for these acts is rooted in interstate commerce and in providing for the protection of river-borne commerce. In this module, we will explain the authorities by which the Corps regulates and discuss some of the challenges that both regulators and the regulated public face when attempting to apply these rules to large scale surface mining operations impacting large quantities of aquatic resources. Authorization of surface coal mining operations generally includes compensatory mitigation requirements that must be assumed to ensure that there are either minimal or less than significant impacts to the aquatic resources. To add to the mix, a new compensatory mitigation rule was codified on April 10, 2008. We will provide an overview of this mitigation rule and how it applies to coal mining operations. The rule provides requirements for an in depth look at planning and documenting mitigation plans, ecological performance standards, monitoring and management of mitigation sites, and mitigation sequencing. We will provide the basic contemporary framework for what the Corps expects to be present within a basic compensatory mitigation plan.

Stream Restoration at Midwest Surface Coal Mines – Keys to Success
Richard Williams, Peabody Energy

Stream Restoration at Midwest Surface Coal Mines utilizing some form of natural channel design is a fairly modern concept that has precipitated from the drastic changes in the way the Clean Water Act (CWA) is being regulated. Common past reclamation practice was to minimize excess sedimentation from leaving the site through terracing, fescue-lined grass waterways, fescue-lined straight cut channels, permanent sediment basins and other best management practices. Keys to success for current CWA Section 404 permit mitigation requirements utilize either stream restoration on an existing stream that was not mined through or new stream construction in mine reclamation. Keys to success begin prior to the mining process and continue through the Section 404 final release process.

What does the stream mitigation planning process involve? How will a stream design be completed? How will the stream design get from the computer to the ground? How will the stream be restored or constructed to ensure long term sustainability? This presentation will address these issues, and processes involved primarily in new stream construction. Prior to the mining, process plans must be developed which restore the watershed into suitable terrain. During the mining process, the reclamation grade plan should be carefully followed or adjusted to ensure proper floodplain belt widths and slopes. Stream construction can then commence by skilled contractors or mine personnel utilizing the completed design. During the construction phase, stream structure, riffles and pools are installed in pre-determined locations. Proper installation techniques are required to make sure that the stream will be self sustaining for the long term. Several years of monitoring are then required to demonstrate the success (or failure) of the stream project prior to release from the Section 404 permit. The goal of this presentation is to provide a better understanding of the keys to success, benefits and challenges for Stream Restoration at Midwest Surface Coal Mines.

Lessons Learned from a Thousand Streams

Wayne Kinney, Midwest Streams, Inc.

To many people “stream restoration” implies intent to recreate some previous pristine condition. In reality, streams are dynamic systems that are continually adjusting to changes in their watersheds. Since we have drastically altered the watershed land use and stream geometry from its unspoiled “pre-settlement” conditions it is unrealistic to attempt to “restore” a stream to its original shape, pattern and profile. Stream restoration should instead be viewed as returning a stream system to a state of equilibrium that is consistent with its current watershed condition.

To accomplish this goal it is first necessary to understand the changes that have taken place, how the stream is reacting and adjusting to those changes while gaining some knowledge of what additional adjustments will occur naturally before the stream returns to a state of equilibrium.
This presentation will explore the practical experience gained from applying stream restoration techniques to “natural” streams in Illinois and how these experiences may relate to stream restoration projects in a mine reclamation setting.

The Good, the Bad, and the Ugly

Russell Retherford, U.S. Army Corps of Engineers

Given the complexity of stream restoration within surface coal mined areas in the Illinois Basin Coal Field, many obstacles must be overcome to effectively and accurately offset losses to “waters of the U.S.”.. The Corps has now had the chance to observe many of the mitigation projects which have been implemented as a result of their regulatory program. We will discuss lessons learned from these observations and potential pitfalls to avoid for future design and implementation plans. Some of the issues we will discuss are appropriate sizing of the channels, developing runoff coefficients for mined lands, appropriate structure types for streams, and stabilization of both the stream and the watershed feeding the stream. Timing of the implementation of mitigation plans in the field is a critical aspect of approved mitigation plans. Attempting to construct streams immediately following reclamation while watersheds are raw and in a sensitive state often leads to eroded banks and sedimentation of structures and any desirable substrate. Additionally, it’s imperative that field personnel are present on-site at all stages of stream construction and are educated about the mitigation plan and its’ implementing procedures.

Hydrology and Sediment Transport Characterization and Management Considerations
Timothy D. Straub, U.S. Geological Survey

The amount of water and sediment delivered in streams is affected by many natural and human factors that are constantly changing. Streamflow, sediment load, and geomorphic data are used to establish baseline information for water-resource managers to evaluate historical and current conditions. The planning of management alternatives due to a disturbance in the natural system continues to be a complex problem for water-resource managers. Utilizing the baseline information, modeling of streamflow and sediment transport for existing, disturbed, and alternative conditions is being used to help optimize efforts in implementing quality and cost-effective stream restoration projects. The results help managers visualize the problems and make thoughtful and effective management decisions to help ensure conveyance of water and sediment transport without excessive sediment erosion or deposition. The presentation will use selected ongoing and completed projects to characterize hydrology and sediment transport, and modeling tools to consider when making management decisions.

Pipestone Creek Restoration – Pyramid State Park
Pat Malone, Illinois Department of Natural Resources

Pre-mine assessments and post–restoration stream monitoring has been conducted since 1979 by staff of the IDNR Mining Program-Streams Section. Pipestone Creek, located in Perry County, Illinois was one of Illinois' largest permanent stream restoration projects monitored by the IDNR Mining program. Prior to establishment of the AMAX Leahy Mine (now Arch Denmark Unit) Pipestone restoration, approximately 11,300 feet of

Pipestone Creek was permanently diverted through the Arch of Illinois Captain mine upstream of the Leahy property. To facilitate mining downstream within the AMAX Leahy properties, Pipestone Creek was rerouted through a 22,700 foot straight-line temporary diversion that was constructed around the northern and eastern perimeter of the active Leahy surface mine. The temporary Pipestone Diversion was ultimately replaced with the permanent stream restoration corridor. The 22,288 foot Pipestone Creek corridor at the AMAX Leahy Mine in Perry County was the longest single stream restoration project on a reclaimed surface mine in southern Illinois. The 4.6 mile Pipestone Creek was the first Illinois stream re-established within the approximate original floodplain corridor constructed in reclaimed mine soils. Construction of the Pipestone Creek meander channels began in ~ 1979 with a small dragline, following grade and centerline profiles established by standard engineering practices of the 1970-80s. Meander channel segments of the Pipestone Creek restoration were constructed between 4 incline haul roads and vegetated as the active pit advanced beyond the future riparian corridor. Meander channel construction (ca 1980 – 1990) incorporated an average sinuosity (ratio of stream length (thalweg) to valley length) of 1.45 within the 300 – 750 foot wide Pipestone Creek corridor. When all segments of the permanent restoration channel were completed (Fall 1991), Pipestone Creek was reconnected to the 4.6-mile restored channel; inactive reaches of the temporary diversion were backfilled and reclaimed.

The IDNR Mining Program initiated pre-mining stream assessments for Pipestone Creek in 1983. Pre mine and Post reconnection (5 year) semiannual monitoring of the stream biotic community and water quality was also conducted by the AMAX Coal; and, staff of the Cooperative Wildlife Research Lab at SIUC to comply with state and federal regulations. Water quality and stream biota in the temporary diversion; and, eventually in the

restoration channel were monitored semi-annually (spring and fall) by CWRL staff and the coal operator from 1983- 1995. Unique species of aquatic invertebrates and fish more commonly associated with clear and cool flowing streams were recorded during monitoring of the channel reaches immediately below the incline basin sampling points; and, in the clear water below the last restoration channel segment. Reductions of stream water turbidity values from 36 NTU (upstream) to 8 NTU (below incline basin) were noted in those reaches of Pipestone Creek in which brook silverside (*Labidesthes sicculus*) minnows and stonefly (Perlidae) larvae were sampled during the semi-annual monitoring program. The occurrence of aquatic species indicative of high quality streams in a relatively short time following stream restoration suggests that physical features of stream restoration practices associated with deep water reconnection can provide immediate in-stream habitat improvement prior to longer term plant community development in the adjacent riparian corridor.

The streams, floodplain forested habitats, emergent wetlands, and row-crop reclamation associated with the Pipestone Creek restoration corridor are encompassed within the 16,000-acre IDNR Pyramid State Park (Denmark Unit). The AMAX Pipestone Creek corridor demonstrates the success of the Illinois stream restoration / reclamation program. The permanent riparian buffer area maintained within the Pyramid State Park property ensures long-term protection of the Pipestone Creek restoration. The pre-mine and post reconnection monitoring of the Pipestone Creek restoration represent an extremely valuable database for future evaluation of the long-term hydro-geomorphic and biotic recovery processes in previously restored stream habitats. This presentation highlights the history, restoration practices, and biological performance of the Pipestone Creek restoration initiated more than 25 years ago.

Consol's Burning Star 4

Bill O'Leary, Illinois Department of Natural Resources

Consolidation Coal Company mined the north field of their Burning Star #4 Mine, near Cutler, Illinois, during the 1980's, and 90's. The operation mined through Galum Creek, a large perennial stream, and a smaller but significant stream, Bonnie Creek. Consol's design for the reconstruction of both streams was approved by the Department of Mines and Minerals, with input from several agencies including Illinois Department of Conservation, Illinois EPA, Illinois Department of Transportation, and the Corps of Engineers. The Department considered a broad range of SMCRA requirements as well as what had been learned to date from other stream restorations at Illinois coal mines, in deciding upon the final restoration plan. The award winning Galum/Bonnie stream restoration was completed in the late 1990's and represents the state of the art in Illinois coal mine stream restoration. The site includes restored flood plains, meandering channels, pool and riffle habitat, riparian corridors, and associated wetlands. The site currently fulfills a number of hydrologic and biological stream functions.

West Fork Busseron Creek Mitigation Area

Dave Beeson, Environ Int.

Peabody Midwest Mining, LLC (Peabody) has reconstructed a portion of the West Fork Busseron Creek, near Farmersburg, IN, (Sullivan County) in response to mitigation of mining activities for Farmersburg Mine. A stream

survey was conducted from June 28-July1, 2010 at two locations in the West Fork Busseron Creek Mitigation Area (WFBCMA). The survey incorporated fish, benthos, and habitat evaluation. Benthic macroinvertebrates were also sampled at separate, undisturbed site upstream of WFBC for comparison. Data from a fish survey conducted prior to reconstruction was used for comparison of the fish community in the WFBCM. Monitoring in 2010 in the WFBCMA served as check on the stream biota to document the status of biological recovery following stream reconstruction.

Water quality field measurements and selected water chemistry results indicated a slight decrease downstream in concentration of conductivity and all major ions except potassium within the WFBCM. Dissolved oxygen, pH, and temperature showed typical diurnal fluctuation common to exposed stream systems. Habitat evaluations based on the Qualitative Habitat Evaluation Index (QHEI) and USEPA Rapid Bioassessment Protocols (USEPA 1989, 1999) resulted in habitat assessment scores that indicated mid-suboptimal habitat conditions for both the upstream reference area and the WFBCM. Habitat assessment scores indicated the WFBCM area was comparable to pre-mine conditions.

The benthic macroinvertebrate survey was based on the multi-habitat approach with riffle samples being kept separate from vegetation/debris dam samples. A total of 89 different taxonomic entities were identified, which represented specimens from the major aquatic insect groups plus a presence of clams, snails, worms, and crustaceans. Organisms representing the Diptera-Chironomidae (flies and midges) dominated the macroinvertebrate collections at all sites. Macroinvertebrate IBI results were based on Rapid Bioassessment Protocols (Plafkin et al., 1989) with use of a reference site. Results indicated slightly lower biological integrity (IBI score less than 79% of the reference score) within the WFBCM for the riffle samples, and only at the upstream portion of the WFBCM for the vegetation/debris dam samples. The downstream WFBCM vegetation/debris dam sample was over 100% of the reference IBI score indicating no loss of biological integrity or benthic community health condition for this sample.

A total of 15 different fish species were identified in the WFBCM. Fish survey results indicated a minnow-based assemblage at the pre-construction reference area compared to a sunfish-based assemblage in the upper portion of the reconstructed reach, and a sunfish and minnow-based assemblage in the lower portion of the reconstructed reach. The fish community was dominated by insectivores and only the largemouth bass represented a top carnivore/predator species at the reference site and the WFBCM. Fish Index of Biotic Integrity (IBI) scores ranged from 42-44 indicating fair biotic status at the pre-construction reference site and ranged from 40-44 for sites within the WFBCM. Fish IBI scores indicated negligible difference in the fish assemblage between WFBCM and pre-construction conditions.

Based on the findings of this study it is believed that current biological conditions in the WFBCM are similar to pre-construction conditions in Busseron Creek. The functional aspects of the hydrologic pattern in combination with the continuing maturity of the channel, bank, and riparian area of the WFBCM will enhance the habitat characteristics and promote further development of fish, benthos, and other aquatic-based communities. Over time, it is anticipated the compositional structure of the fish and benthic macroinvertebrate assemblages will mature and shift to mimic pre-mine (upstream) reference conditions for benthic macroinvertebrates that can support a more complex fish community of better quality and integrity than observed within the WFBCM prior to reconstruction.

The Squiggly Ditch – The Third Time Around

Dan Hause, Indiana Department of Natural Resources

As with the previous AML sites, this reclamation project, completed in November 2006, consisted of 1,900 linear feet of dangerous highwall along a county road and is owned and managed by the Sugar Ridge State Fish and Wildlife Area. This highwall was backfilled to eliminate the danger to local motorists and property visitors. Although wetland mitigation was not an issue at this particular highwall, it was still reclaimed using natural stream design, creating 2,600 linear feet of channel. Being the first time the Indiana AML Program used this design technique, a cost comparison between natural stream design and typical reclamation techniques was conducted as part of the bid process. The work completed demonstrates the applicability of using computer software (Carlson Natural Regrade) to design natural landform reclamation.

Illinois Stream Reclamation Field Tour

AGENDA for Thursday, May 19th, 2011

Alphanumeric designations in **LIGHT BLUE** represent the stops on the tour and correspond to the map on page 21. Sites with a **B** will be viewed from the bus only. ORANGE sites presented by: Bill O'Leary (IL DNR) and John Gefferth (CONSOL). **BLUE** sites presented by: Pat Malone (IL DNR) and Jack Nawrot (SIUC).

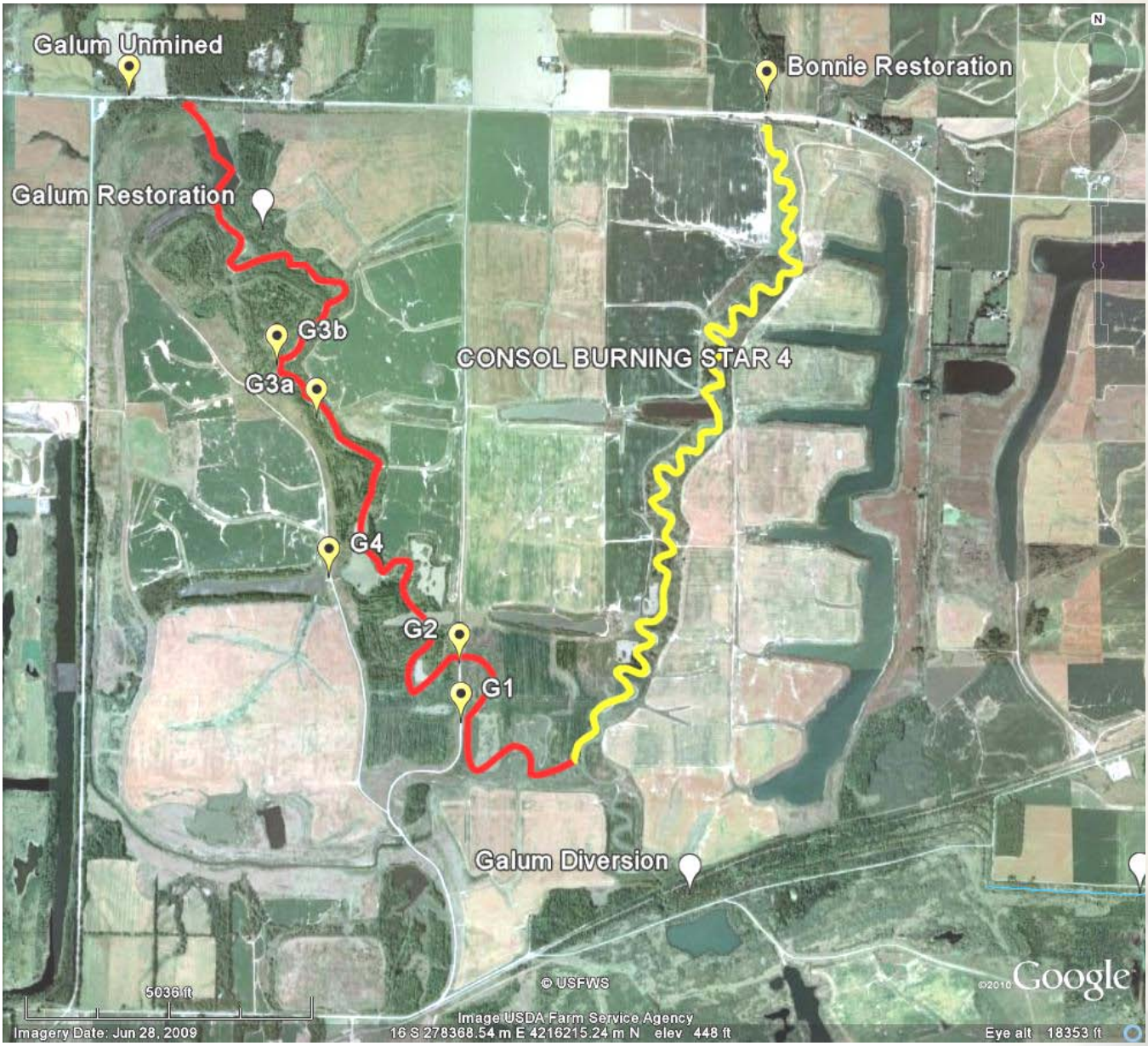
7:30 am		**Meet – Mt Vernon Holiday Inn Hotel**
8:00 am		**Depart – Mt Vernon Holiday Inn Hotel**
	B	Bonnie Creek Restoration
	B	Galum Creek – Upstream Ag Impacts
9:00 am		**Arrive – CONSOL Energy Burning Star 4 – Galum Creek Restoration**
	G1	Galum Restoration – Wetlands (East of Access Rd.)
	G2	Water Crossing Cypress (West of Access Rd. – Invert Seining - Demo)
	G3a	Forested Corridor Riffles
	G3b	Cypress Floodplain basin
	G4	Cypress Incline lake
11:15 am		**Depart – Burning Star 4**
	B	Jamestown Rd. Confluence / Permanent Diversion
	B	Arch of Illinois Galum Restoration (ca 1979)
	B	Pyramid State Park Captain Mine Unit
11:50 am		**Arrive – IDNR Pyramid State Park: Denmark Unit** **Pipestone Creek Restoration**
12:00 noon	P1	**LUNCH (Provided by CONSOL Energy)** *Welcome – IDNR Deputy Director Travis Loyd/ Cha Hill IDNR Pyramid State Park*
1:00 pm	P2	Pipestone Creek – Bridge Upstream Incline 4 (Invert Demo)
	P3	Pipestone Creek – NW Inlet Channel at Final Cut Plug
	P4	Pipestone Creek – Downstream Corridor – Riffles
3:00 pm	P5	Pipestone Permanent Diversion
3:30 pm		**Depart – Reclamation Sites**
4:25 pm		**Arrive – Mt Vernon Holiday Inn**

CONSOL Burning Star 4

Consolidation Coal Company engineers and reclamation staff designed and planned the nation's largest stream restoration effort to reconstruct more than 7 miles of meander channels through reclaimed mine soils at the Burning Star No 4 Mine (Anderson 1987). CONSOL"s 4.3- mile Galum Creek restoration and 3.7-mile Bonnie Creek restoration were constructed through replaced mine soils in the approximate location of the pre-mine riparian corridor. The complexity of integrating the restoration of two streams into the planning, mining, and reclamation process required 20 years from initial design to channel reconnection for Galum Creek (Table 4). The CONSOL Galum and Bonnie creek restorations clearly illustrated that stream restoration is a complex, long term hydrogeomorphic process.

The U.S. Office of Surface Mining National Award for innovative reclamation practices recognized the significance of the CONSOL Burning Star 4 stream restorations in September 2002. OSM noted that this was ...
".....the first time in Illinois that two major streams in a minefield were diverted during mining and then restored to their original locations. .....reclaimed as a habitat for wildlife and waterfowl....."
The CONSOL Burning Star 4 award-winning stream restoration practices implemented at both Galum and Bonnie Creek enhanced wildlife habitat within the stream channel and the floodplain corridor. The restoration practices included construction of meander channels, riffles, pools, and deep water habitat.

CONSOL – Burning Star 4



Galum Creek (RED) 4.3- mile restoration relocated through reclaimed soils in the approximate pre-mine riparian corridor. **Bonnie Creek** (YELLOW) 3.7- mile restoration relocated through reclaimed mine soils in the approximate pre-mine riparian corridor.

BEFORE - CONSOL Burning Star 4 Mine. Galum Creek restoration integrating meander channel construction with active mining. (Photo Date 1985)

AFTER - CONSOL Burning Star 4 Mine. Galum Creek restoration incorporating diverse reclaimed land use (row crop, forest, wetlands) with channel relocation (Photo Date 2005)

AMAX Leahy Pipestone Creek

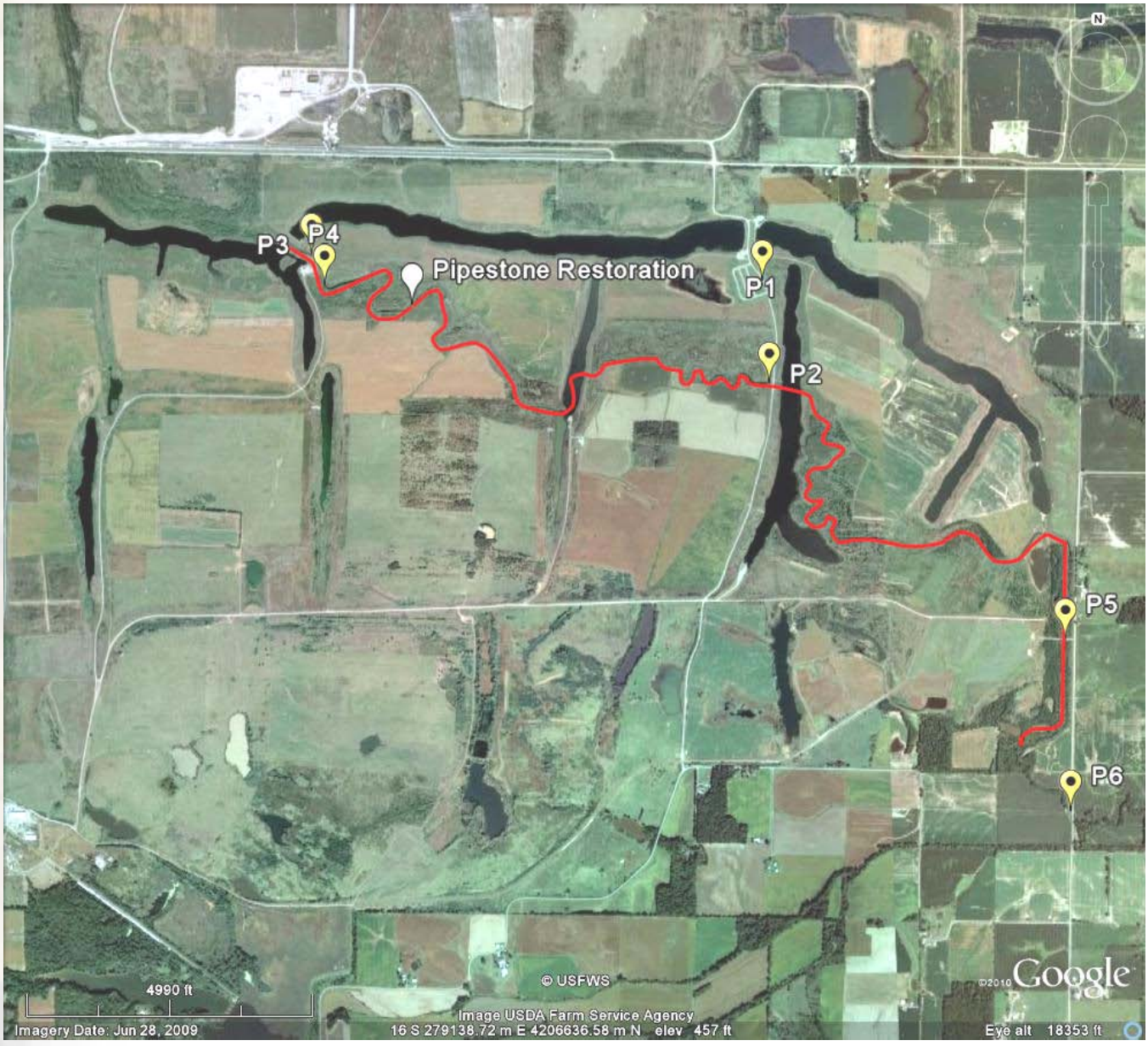
The ~ 4.6-mile reconstruction of meander channels and riparian corridor of Pipestone Creek at the AMAX Leahy Mine in Perry County was the longest single stream restoration project on a reclaimed surface mine in Southern Illinois. Similar to other (Galum and Bonnie Creek) post-law stream restorations, the Pipestone restoration followed the approximate original pre-mine floodplain location. Construction of the Pipestone Creek meander channels began in ~ 1979 with a small dragline, following grade and centerline profiles established by standard engineering practices of the 1970-80s. Meander channel segments of the Pipestone Creek restoration were constructed between 4 incline haulroads and vegetated as the active pit advanced beyond the future riparian corridor.

Stream restoration plans often identify the construction of a "stable" channel as a design feature. Ironically, channel stability conflicts with the true hydrogeomorphic definition of "meander" as a verb rather than a noun. If the restored stream is truly "restored", meandering of the channel within the floodplain should be expected to occur. A restored stream that meanders within its reclaimed floodplain is demonstrating the dynamic equilibrium that we expect to occur in natural streams. The lower reach of the Pipestone Creek restoration "meandered" within the floodplain, when storm flows rerouted the channel across the floodplain prior to reconnecting with an existing "meander". This natural abandonment of a constructed meander channel provides a desirable succession from a lotic to lentic stream channel environment that diversifies wetland habitats within a functionally restored floodplain.

Similar to the CONSOL Galum Creek restoration, the restored Pipestone Creek channel was designed to enhance deep water habitat connectivity provided by 3 incline lake basins. During the construction (ca 1980 – 1990) of more than 24,200 feet of meander channel stream restoration segments within the active mining complex, the main channel of Pipestone Creek was rerouted through a 22,700–foot straight-line temporary diversion that was constructed around the northern and eastern perimeter of the active surface mine. When all segments of the permanent restoration channel were completed (fall 1991) Pipestone Creek was reconnected to the 4.6- mile restored channel; and, inactive reaches of the temporary diversion were backfilled and reclaimed. Backfill conversion of portions of the temporary diversion channel to palustrine emergent season wetlands provided habitat for Illinois threatened and unique species such as the rice rat (*Oryzomys palustris*) and least bittern (*Ixobrhychus exilis*).

Water quality and stream biota in the temporary diversion; and, eventually in the restoration channel were monitored semi-annually (spring and fall) by CWRL staff and the coal operator from 1983- 1995. Unique species of aquatic invertebrates and fish more commonly associated with clear and cool flowing streams were recorded during monitoring of the channel reaches immediately below the incline basin sampling points; and, in the clear water below the last restoration channel segment. Reductions of stream water turbidity values from 36 NTU (upstream) to 8 NTU (below incline basin) were noted in those reaches of Pipestone Creek in which brook silverside (*Labidesthes sicculus)* minnows and stonefly (Perlidae) larvae were sampled during the semi-annual monitoring program.

AMAX - Leahy Mine



Pipestone Creek (RED) 4.6- mile meander channel restoration relocated in approximate pre-mine riparian corridor.

The occurrence of aquatic species indicative of high quality streams in a relatively short time following stream restoration suggests that physical features of stream restoration practices associated with deep water reconnection can provide immediate in-stream habitat improvement prior to longer term plant community development in the adjacent riparian corridor.

The streams, floodplain forested habitats, emergent wetlands, and row crop reclamation associated with the Pipestone Creek restoration corridor can now be viewed, 20 years post-construction, by visitors to the 16,000-acre IDNR Pyramid State Park (Denmark Unit). The AMAX Pipestone Creek restoration demonstrates the success of the Illinois stream restoration / reclamation program.

Pipestone Creek restoration. Channel “meander” (BLACK)

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