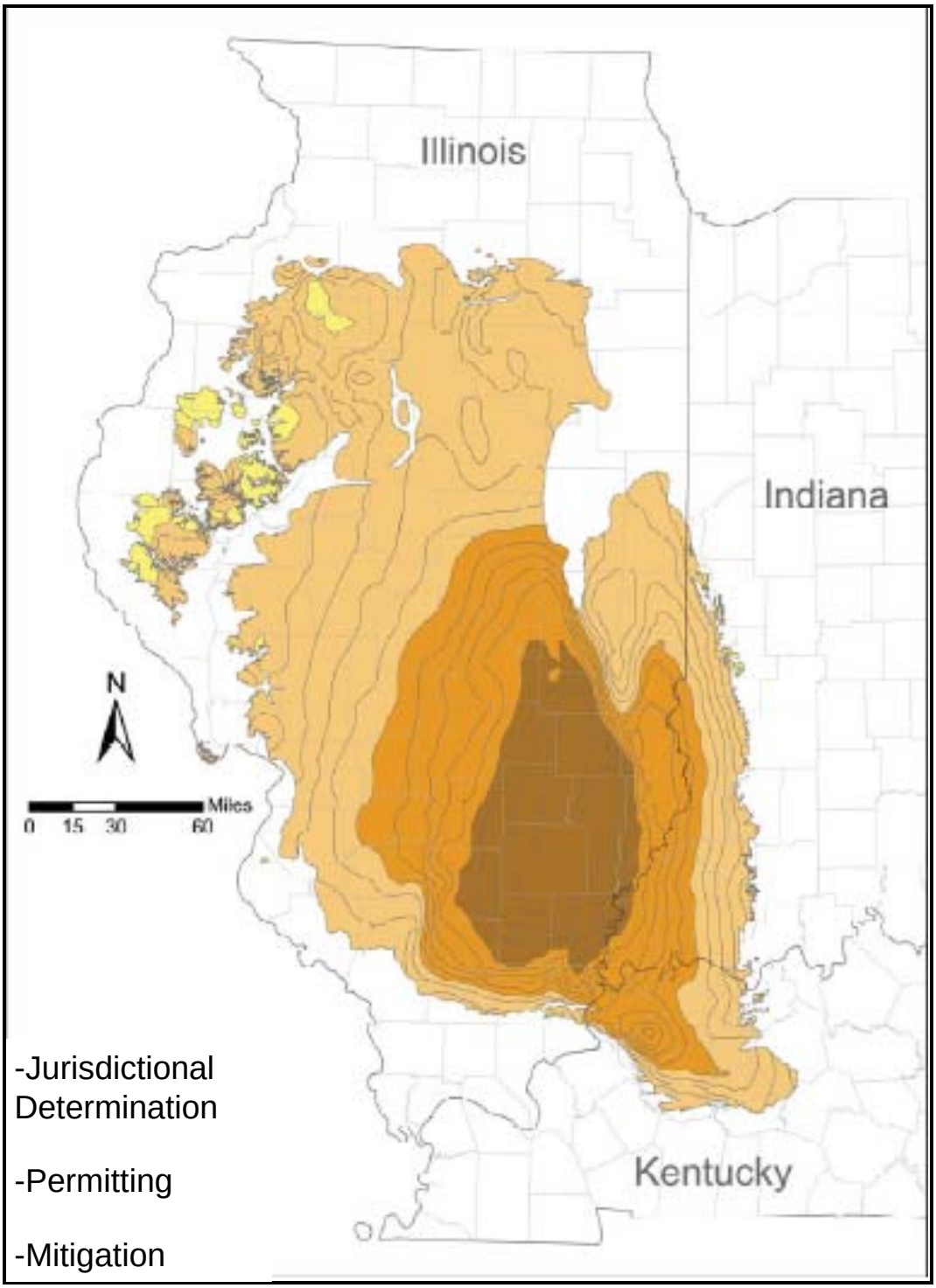
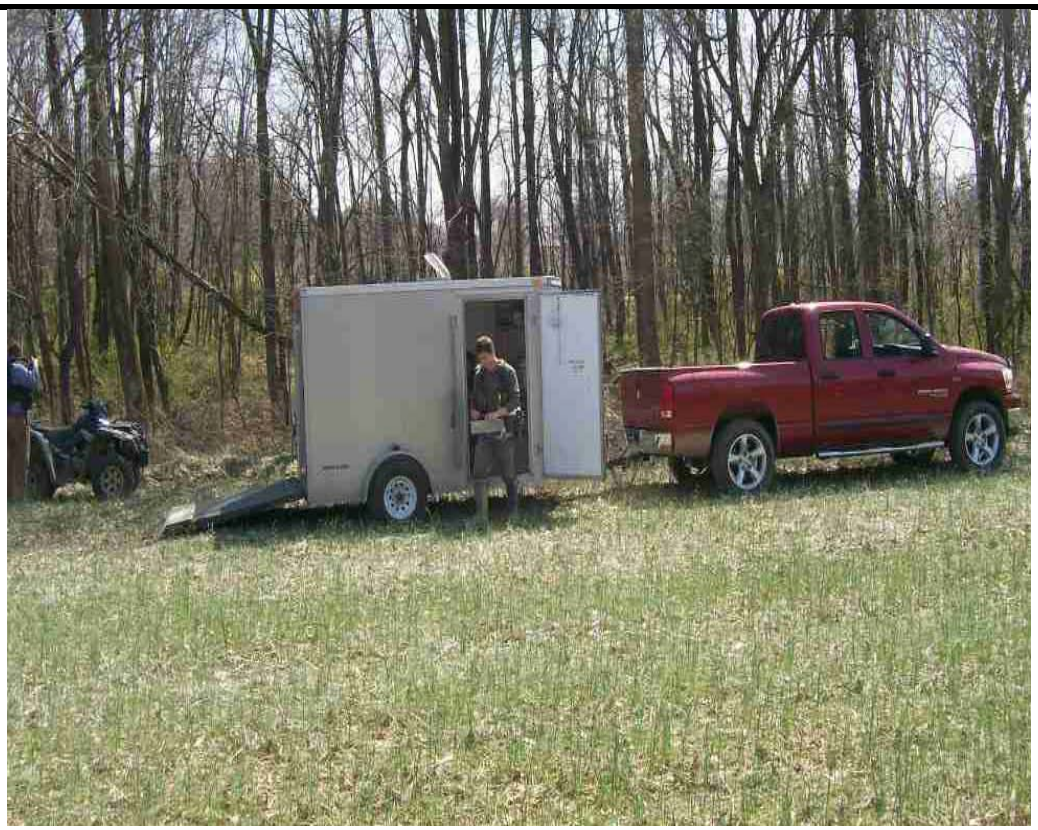
ANTHROPOGEOMORPHOLOGY OF STREAMS, WETLANDS & LANDSCAPES OF THE ILLINOIS BASIN, DATA COLLECTION & RESTORATION TECHNIQUES

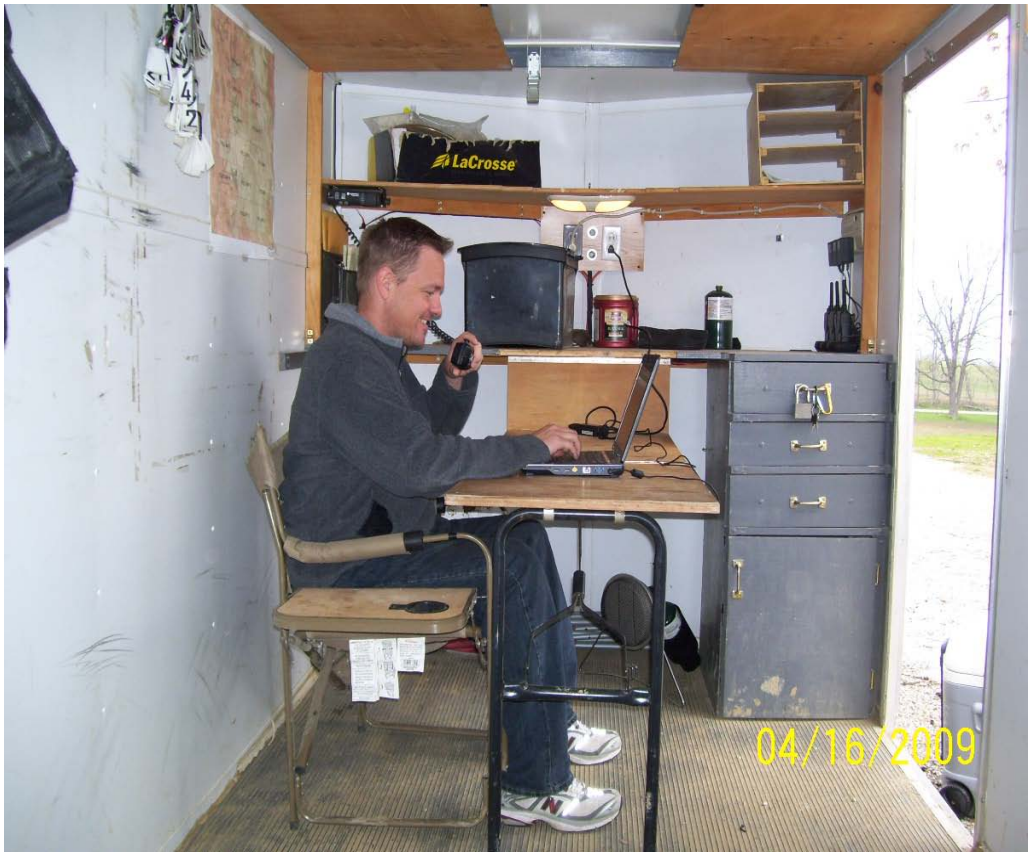


-Jurisdictional Determination

-Permitting

-Mitigation





Mobile Offices collect large datasets in remote locations.

Watershed Approach

Landuse Designations to reflect the conditions in which the jurisdictional waters are developed. These include Agriculture, Natural, Mixed, PreLaw, Reclaim, Excavated, Logged & Urban.

Unit Data	Unit Functionality	Cumulative Functionality
Length	Overall Stream	Linear feet of Fully Functional, Moderately Functional & Functionally Impaired Stream
Distance	Entrenchment	Average Floodplain Width
Sinuosity	Stream Type	Total Floodplain Area
Wbot	Vegetation Left Bank	Average Riparian Width
Wbkf	Vegetation Width	Total Riparian Area
Wfpa	Vegetation Right Bank	Existing conditions are compared to proposed mitigation to ensure a Net Cumulative Benefit in the watershed.
Dbkf	Vegetation Width	
Entrenchment Ratio	Bank Erosion	
Width/Depth Ratio	Channel Stability	
Classification	Aggradation/Degradation	
VegL	Alterations	
Width	Functionality determined by the Rosgen-based Missouri Protocol.	
VegR		
Width		
Flow		
Depositional Features		
Bank Erosion		
Agg/Deg		
Stability		
Alterations		
%Riffle		
%Run		
%Pool		

Agriculture after covering 60,000-acres it was determined that Ag has had the most widespread impact on streams in the Illinois Basin.

Mixed landuse streams generally occur on wooded sideslopes below a ridge that’s being farmed.

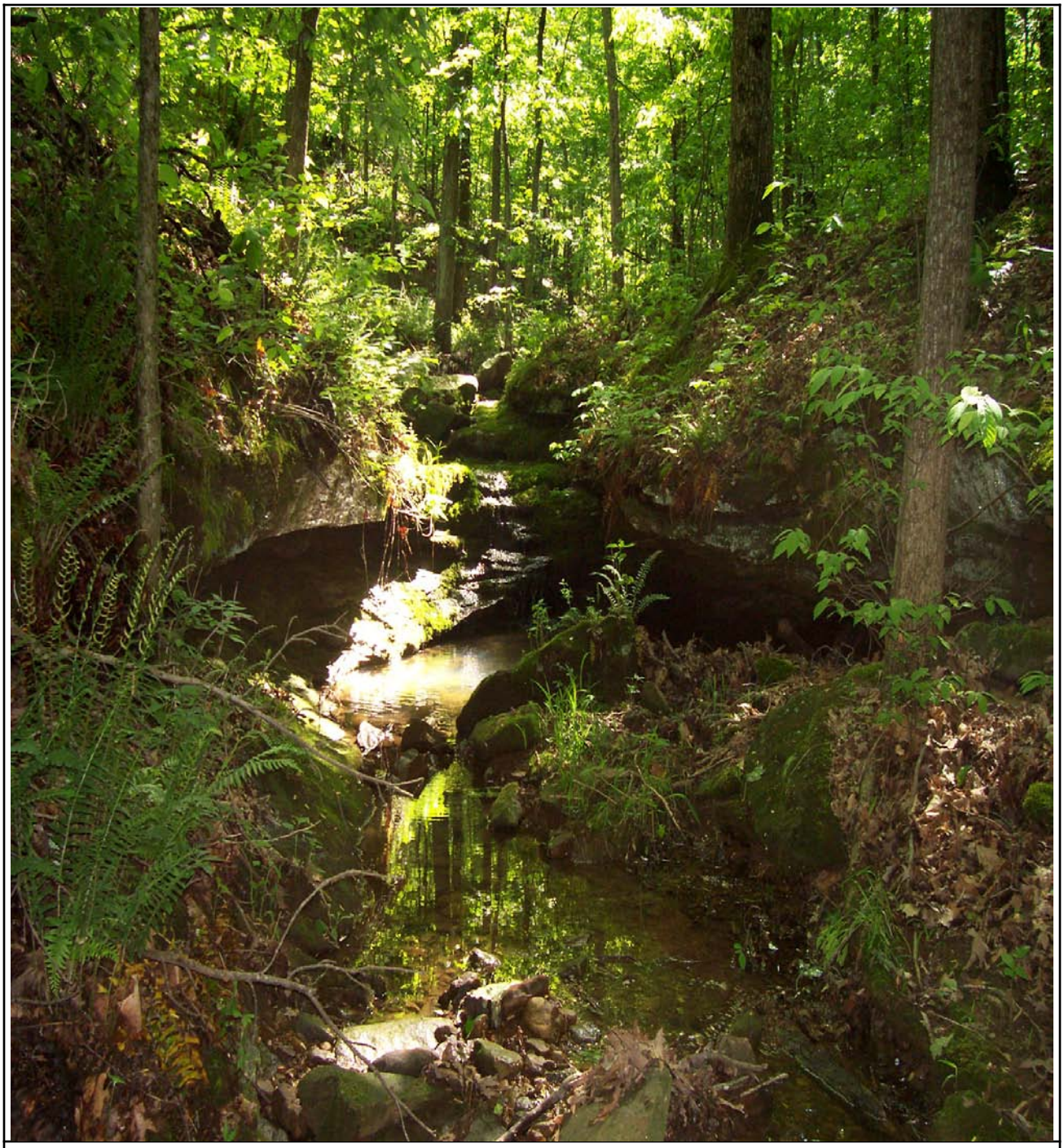
Natural streams generally still receive some degree of negative inputs.

PreLaw prior to SMCRA 1977.

Reclaim drains tend to be rock-lined either with overburden or rip-rap from local quarries.

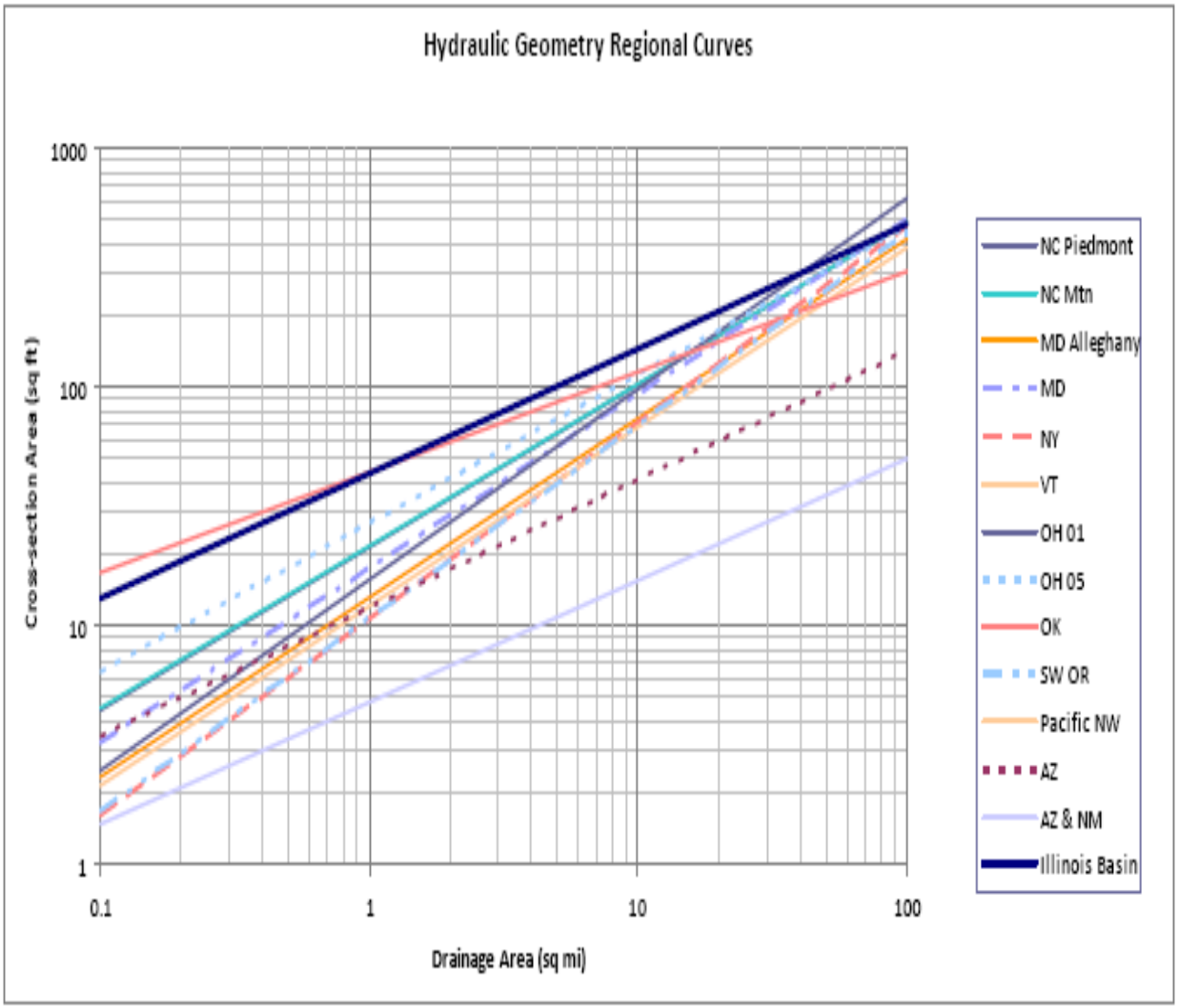
Logging without BMP's complicates stream assessment.

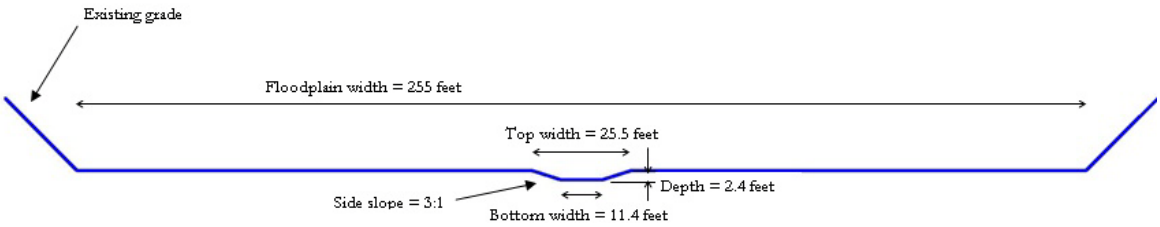
Excavated stream.



Undisturbed circumstances such as these are generally limited to high gradient forested areas controlled by state or federal agencies. The problem with using these areas as reference is that they are steeper than our target areas.

Restoration Goal: to develop a replicable stream construction program that creates a free-form channel, in dynamic equilibrium, with the ability to provide natural and sustainable stream function.	
Reference Parameters	
Bankfull Volume	Average velocity
Return Interval	Average shear stress
Width to Depth ratio	Meander length (L_m)
Channel average depth (D)	Beltwidth (W_{blt})
Channel top width - riffle (W_{riffle})	Riffle length (L_{riffle})
Channel cross-sectional area (A)	Run length (L_{run})
Channel depth - riffle (D_{riffle})	Pool length (L_{pool})
Channel bottom width (W_{bot})	Glide length (L_{glide})
Wetted perimeter (P)	Run depth (D_{run})
Hydraulic radius (R_h)	Glide depth (D_{glide})
Floodplain width (W_{fp})	Pool width (W_{pool})
Channel slope (S_{ave})	Pool depth (D_{pool})


Hydraulic Geometry Regional Curves
Cross-section Area (sq ft)
1000
100
10
1
0.1
1
10
100
Drainage Area (sq mi)
NC Piedmont
NC Mtn
MD Alleghany
MD
NY
VT
OH 01
OH 05
OK
SW OR
Pacific NW
AZ
AZ & NM
Illinois Basin


Existing grade
Floodplain width = 255 feet
Top width = 25.5 feet
Depth = 2.4 feet
Side slope = 3:1
Bottom width = 11.4 feet

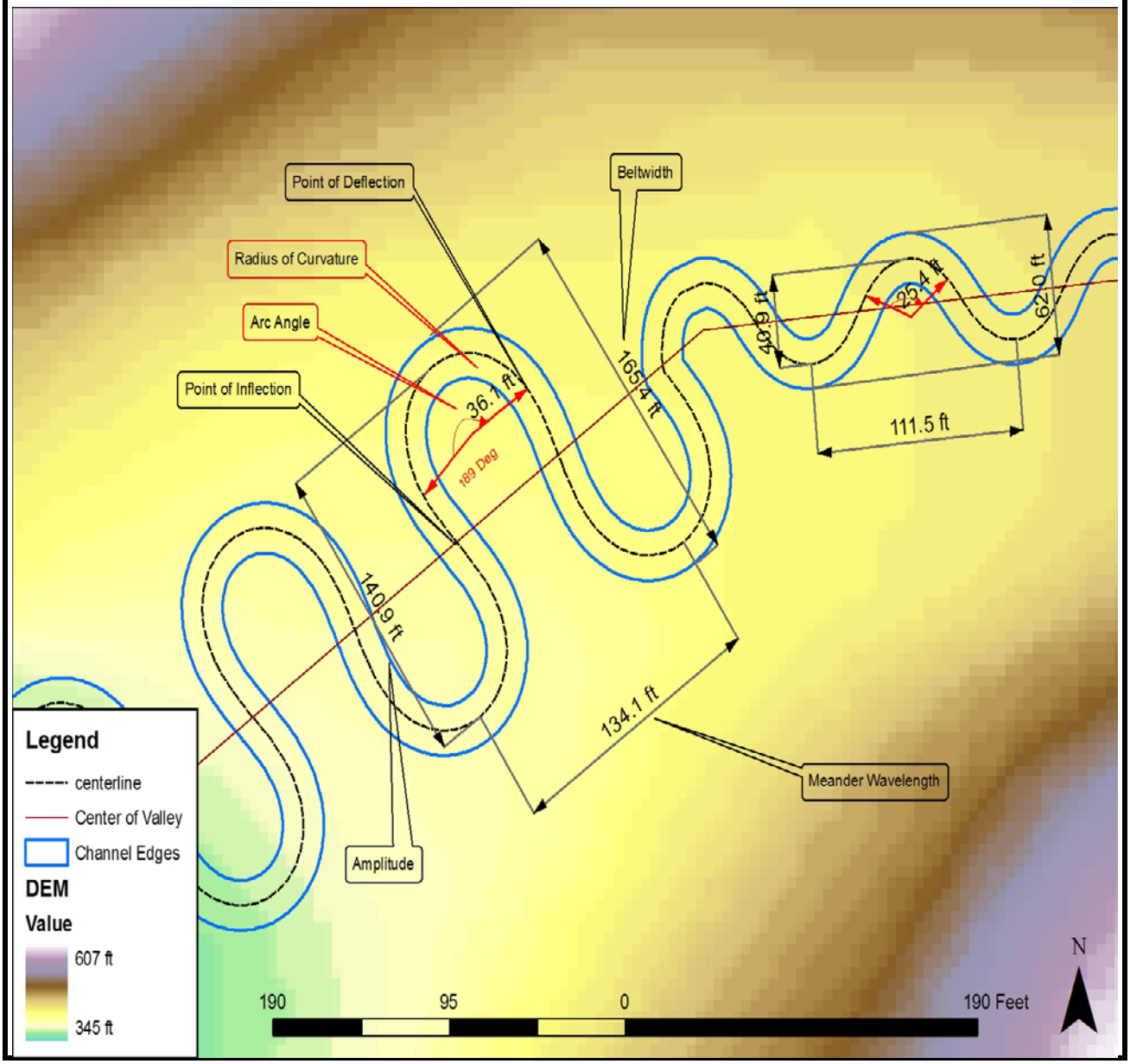
Stream Design The reference parameters were applied to database software. The user is required to input the Watershed Area & Valley Slope. The software outputs the stream design based on reference parameters.

Site-specific Input		
Watershed area =	640	acres
Valley slope =	0.01	ft/ft
Reference Parameters		
Width/Depth ratio =	15	
Manning's n =	0.035	
Channel side slope =	3	:1
Floodplain width ratio =	10	
Pool depth ratio =	2	
Point bar slope =	6	:1
Sinuosity =	1.3	
Meander length ratio =	9	

Riffle Cross-Section		
W_{fpa} =	102	ft
W_{riffle} =	10.2	ft
W_{bot} =	4.6	ft
D_{riffle} =	0.9	ft
M =	3	:1
W_{fp} =	102	ft
Pool Cross-Section		
W_{fpa} =	102	ft
W_{pool} =	18.7	ft
W_{bot} =	4.6	ft
D_{pool} =	1.9	ft
M =	3	:1
B =	6	:1
W_{fp} =	102	ft

Profile		
L_{riffle} =	20	ft
L_{run} =	9	ft
L_{pool} =	20	ft
L_{glide} =	9	ft
D_{riffle} =	0.9	ft
D_{run} =	1.3	ft
D_{pool} =	1.9	ft
D_{glide} =	1.3	ft
Plan View		
L_m =	92	ft
W_{blt} =	48	ft
W_{fp} =	102	ft
Riffle Material		
d84 =	64	mm
Substrate depth =	0.6	ft
Riffle length =	20	ft
Riffle width =	4.6	ft
Volume per riffle =	2.2	cu yds
Erosion Control Specs		
Average shear stress =	0.31	lbs/ft^2
Average velocity =	2.9	ft/sec

Implementation ArcView reads a DEM of the existing valley to continually resize and reconfigure the stream down slope.



Alluvial Valley ready for stream construction.

Layout and Construction of the basic channel. Materials including rock, logs, root wads should be spotted during the backhaul process.

3-year old channel with a high degree of both bank & channel stability .

Well vegetated bankfull indicators.

Ecological Lift & Net Cumulative Benefit in the watershed.

Laws

- Section 10 of the Rivers and Harbors Act

  Regulation of the placement of any structure or work that takes place in, under, or over a navigable water affecting course, location, or condition of navigable capacity.

- Section 404 of the Clean Water Act

  Regulation of the discharge of dredged or fill material into all waters of the U.S., including wetlands

Types of Permits

- Currently 2 permitting instruments for impacts as a result of mining

- Nationwide Permits- NWP 21, 49, 50
  * To use NWP's it's necessary to reach minimal impacts.
  * Timeline restrictions
- Individual Permits
  * Bar is lower than NWP's
  * Must achieve Finding of No Significant Impacts (FONSI)
  * Can be authorized for life of mining impacts

Mitigation Plan

- On-site restoration, enhancement or creation.
- Off-site restoration, enhancement or creation
- Mitigation Bank
- In-Lieu Fee
- See 33 CFR 332.3 for particular orders

Mitigation

Can be based on functional replacement and/or linear footage/acreage. Need to utilize baseline assessment information (location, size, type, and existing conditions) to determine mitigation requirements.

Mitigation

- Provide measurable Goals and Objectives

Provide a discussion and objective statement on the functions and values of the resources to be impacted and compare that to the functions and values proposed in the mitigation.

Mitigation

Site Selection

Detail the factors considered in the site selection process. These could include factors such as watershed considerations/needs and practicability.

Mitigation

Time

Provide expected time of mitigation construction and monitoring commencement.

Mitigation
Work Plan

At a minimum the plan should consist of:

- Construction methods, timing and sequencing
- Boundaries of proposed mitigation site
- Elevations and slopes
- Hydrology and hydrologic source (watershed size, discharge, regional curves)
- Connectivity to other waters
- Proposed plantings
- Control of volunteer and invasive vegetation, and

Mitigation

Work Plan cont.

- Erosion control
- Geomorphology and special stream structures
- Site management, maintenance plan, and long term plan for the site.
- Stream dimensions including: bankfull width/depth, bank height ratios etc.

Mitigation

Proposed plantings should target hard mast species, but can be project dependent.

Contact local Corps office for detailed planting, monitoring, and success rates.

Mitigation
Planting requirements

Notes:

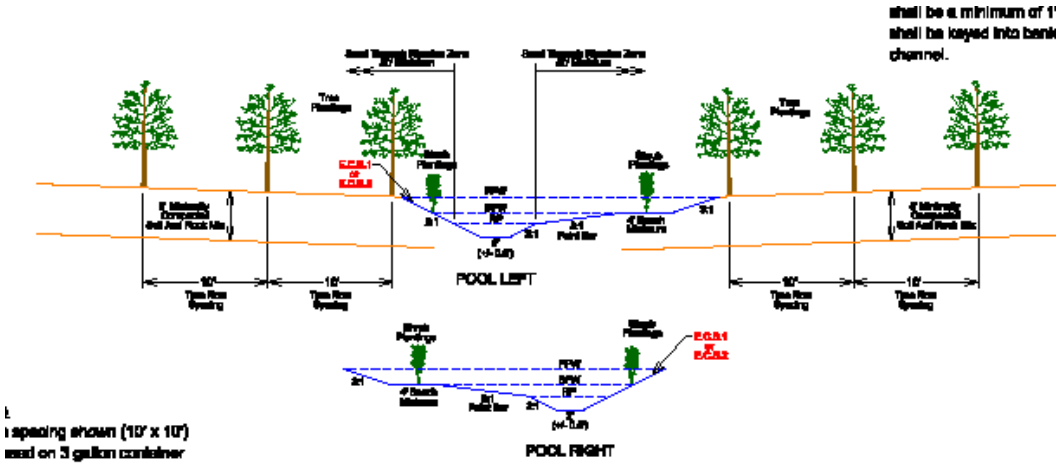
1 – All proposed planting lists must be resubmitted to the Corps for final approval prior to planting.

2 – Individual permit reviews may require that the vegetative mitigation zones be managed to provide 2 or 3 components. See project manager for specific criteria in those cases.

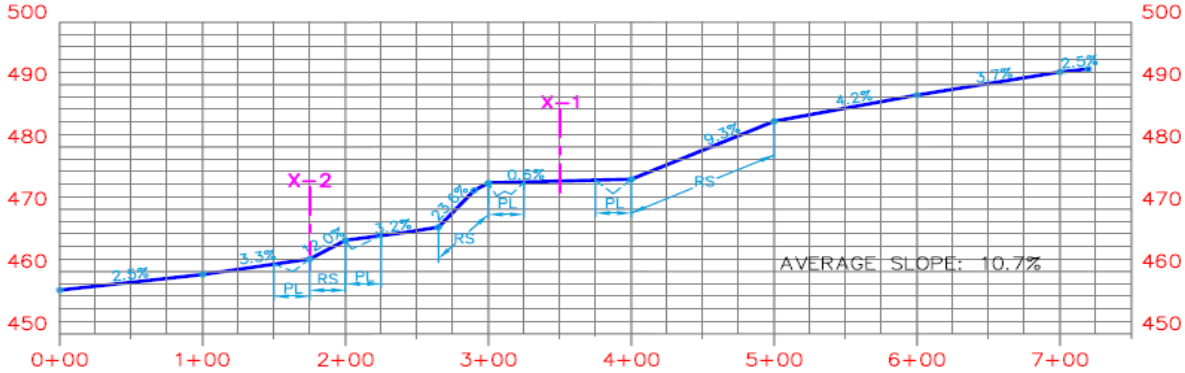
3 - These guidelines are subject to change according to permit needs and do not cover all mitigation monitoring and success requirements.

Mitigation

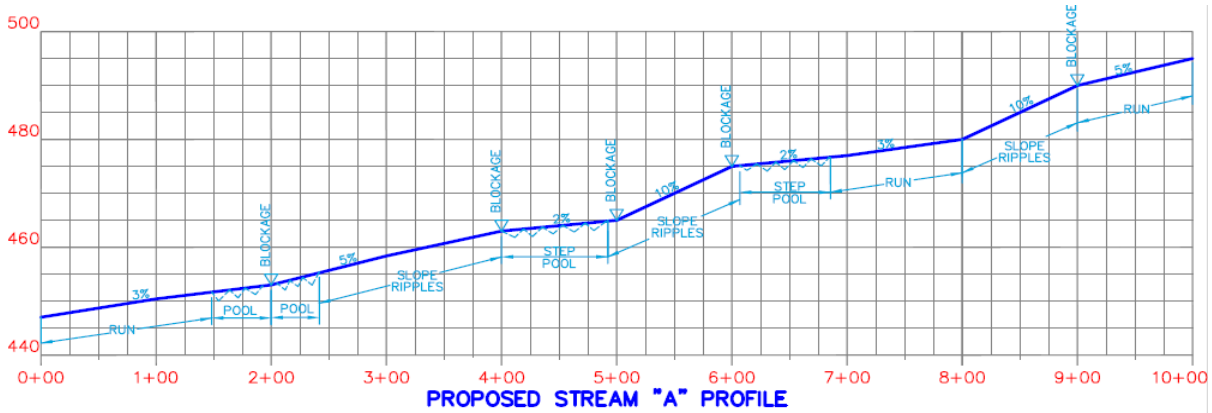
- Provide existing vs proposed pattern, profile and dimensions



Mitigation



EXISTING STREAM 015 PROFILE



PROPOSED STREAM "A" PROFILE

Pattern

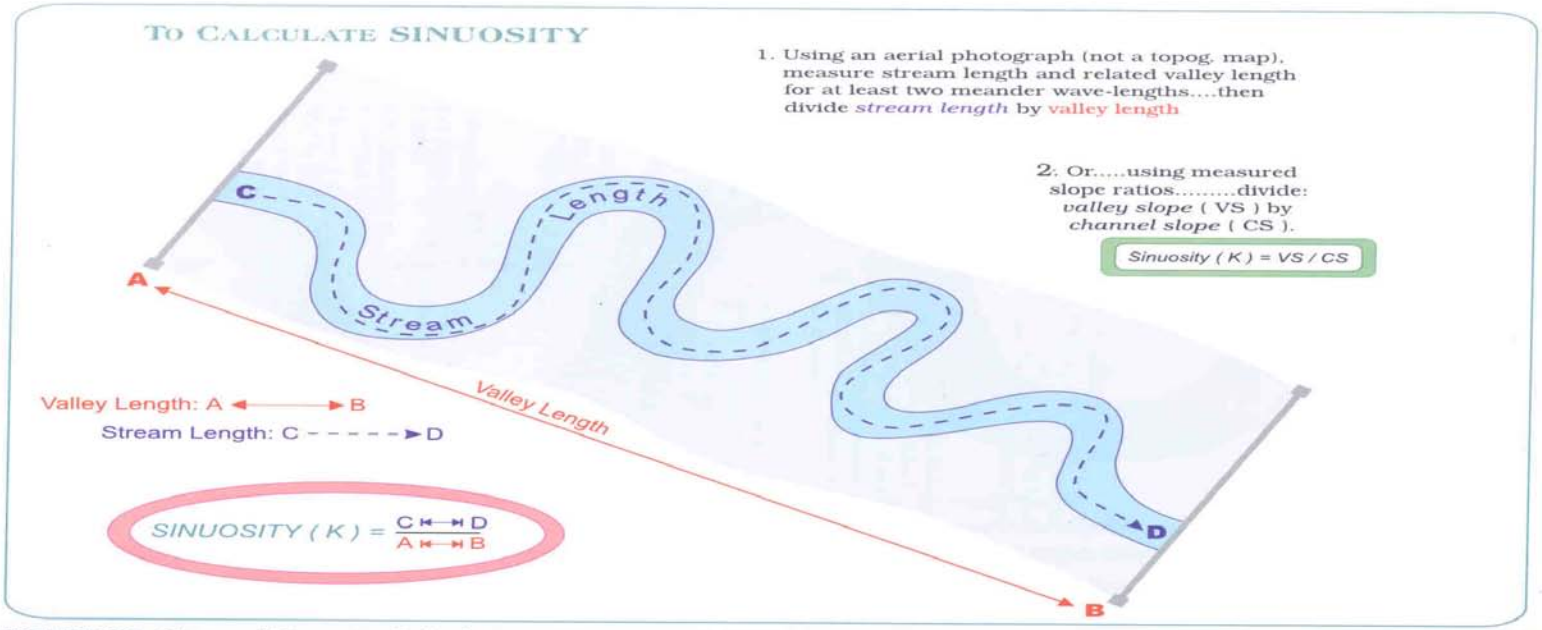
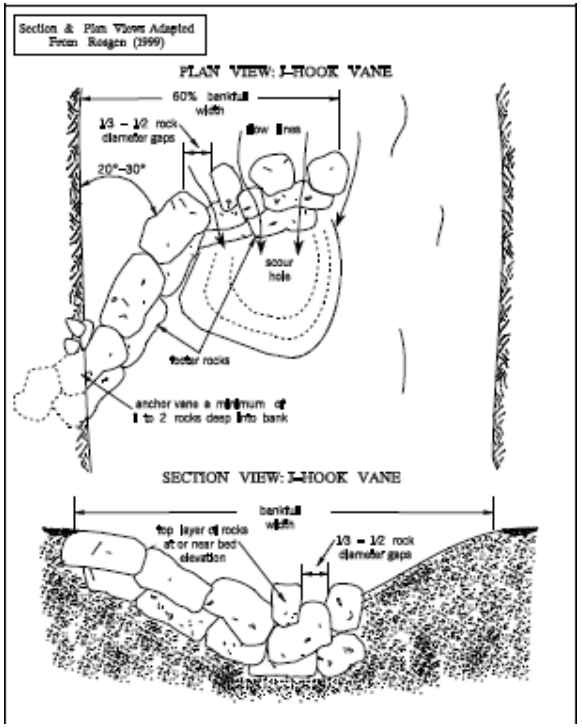
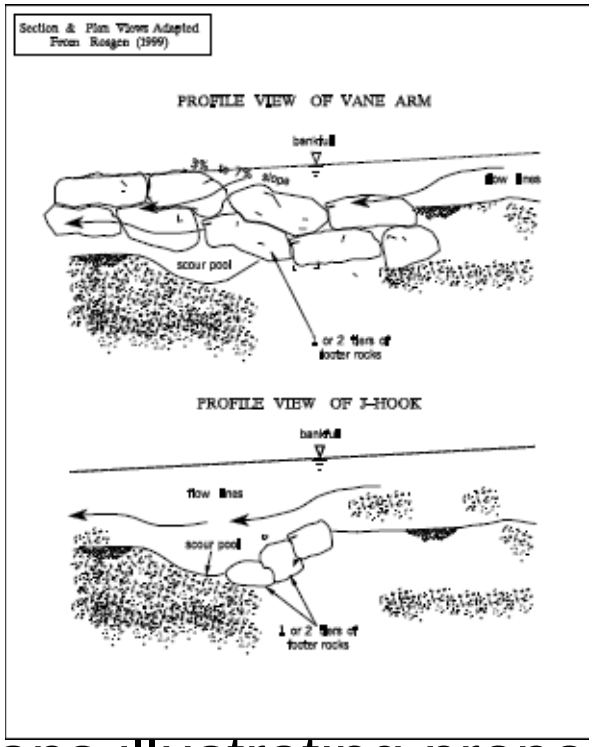


FIGURE 30. Channel Sinuosity Calculations

Submit a typical existing and proposed pattern.

Typical Stream Restoration/Creation

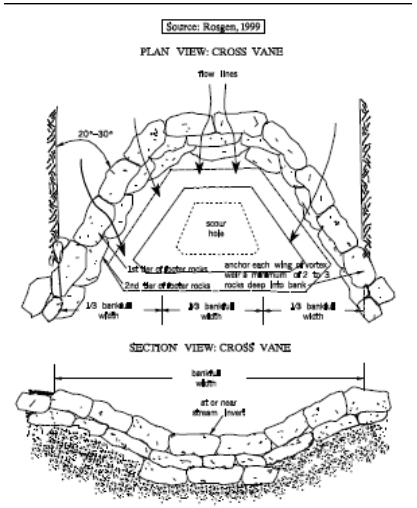


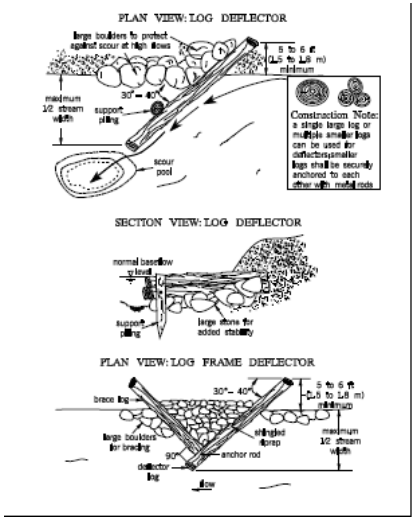


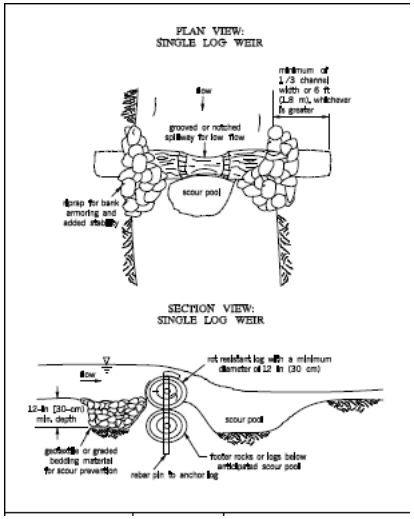
Provide typical design plans illustrating proposed structures to be utilized. These structures can be used to provide functional replacement and enhancement.

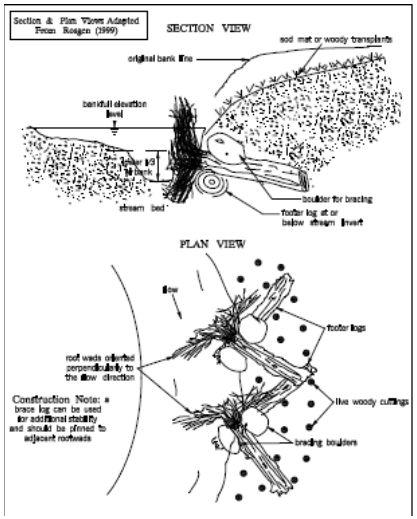
Typical Stream Restoration/Creation

Utilize what is available.

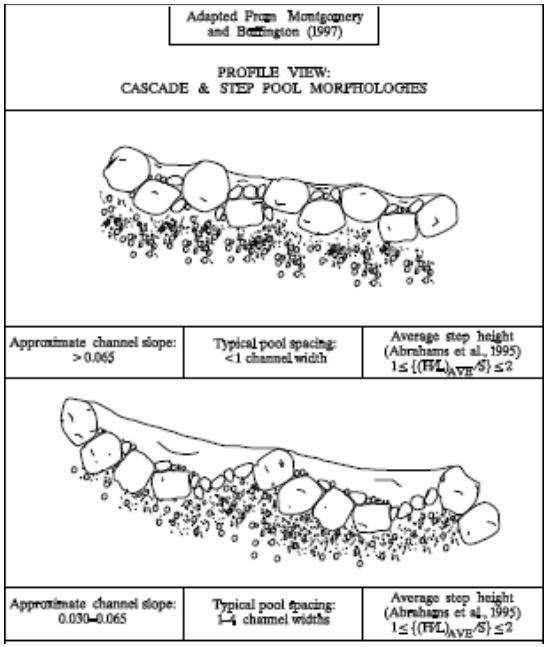


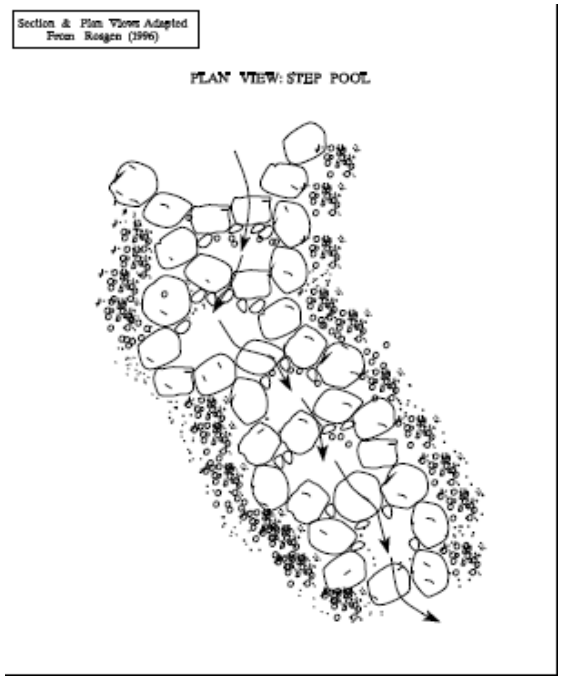






Typical Stream Restoration/Creation





Instead of utilizing uniform rip rap lined chutes/channels, design a stable channel to achieve a higher mitigation credit and a more stable site.

Wetlands

Provide existing wetland data such as a map showing delineation data collection points, source of hydrology and connectivity.

Wetland Design

Provide design information illustrating how wetland mitigation would be constructed. Avoid over designing a project with features (water control structures) that require long term management. Design mitigation to be self sustaining.

Contingency Plan

- Reporting Protocol:

  If a success criterion is not met for all or any portion of the compensatory mitigation project in any year, and/or if the success criteria are not satisfied, the permittee shall prepare an analysis of the cause(s) of failure and, if determined necessary by the Corps, propose remedial action for pre-approval.

- Response to unsuccessful remediation:

  Indicate course of action to be taken in the event that the Corps determines the compensatory mitigation cannot be successfully achieved at the intended site.

Other Required Info

- Description of the physical and chemical properties of the geologic strata that will be used for reclamation at the mitigation site (i.e. stream substrate and overburden).
- Pre and post mine land use information (i.e. text and map).

Mitigation Success

Mitigation Success

Mitigation Success

Mitigation Success

Mitigation Success

Mitigation Issues

Mitigation Issues

Mitigation Issues

Mitigation Issues

Mitigation Issues

- Mitigation Success

Current Stream Conditions

Mitigation Success

Mitigation Success

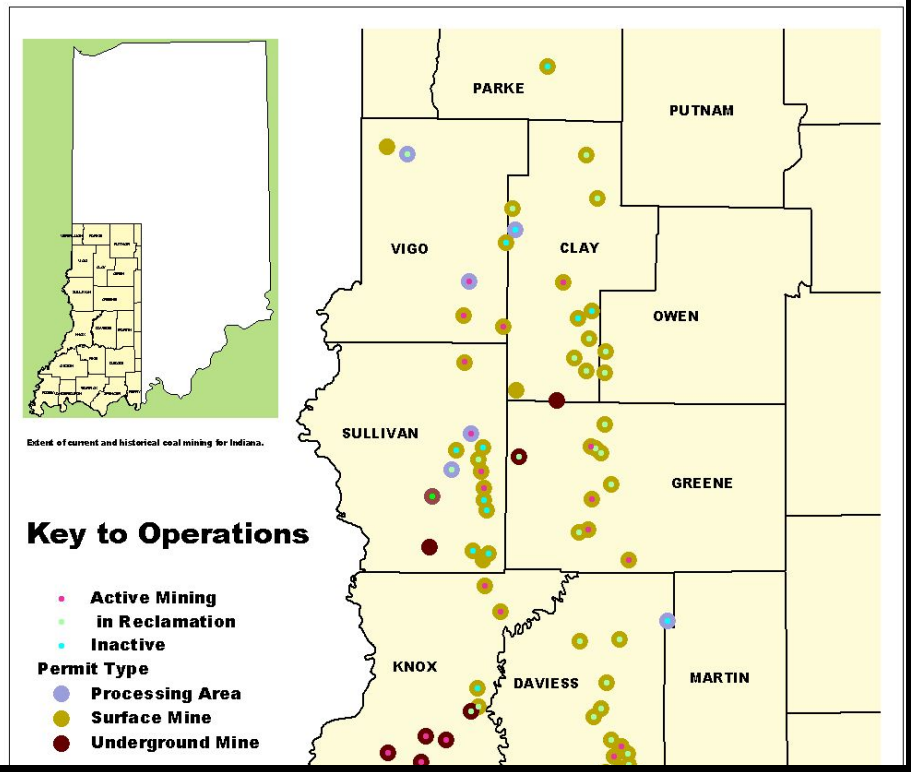
From Rip Rap to Riffles: The Evolution of Stream Reclamation in the Indiana Coal Fields

Indiana Department of Natural Resources

April 2009

Illinois Coal Basin

LOCATION OF COAL MINES IN INDIANA



INDIANA COAL MINING FACTS

- 32-35 million tons/year
- 68% Surface Production
- 32% Underground Production
- 10,000 Acres/Year affected and reclaimed.
- 97% of Indiana's electricity from coal
- Generally surface coal reserves are <200 feet

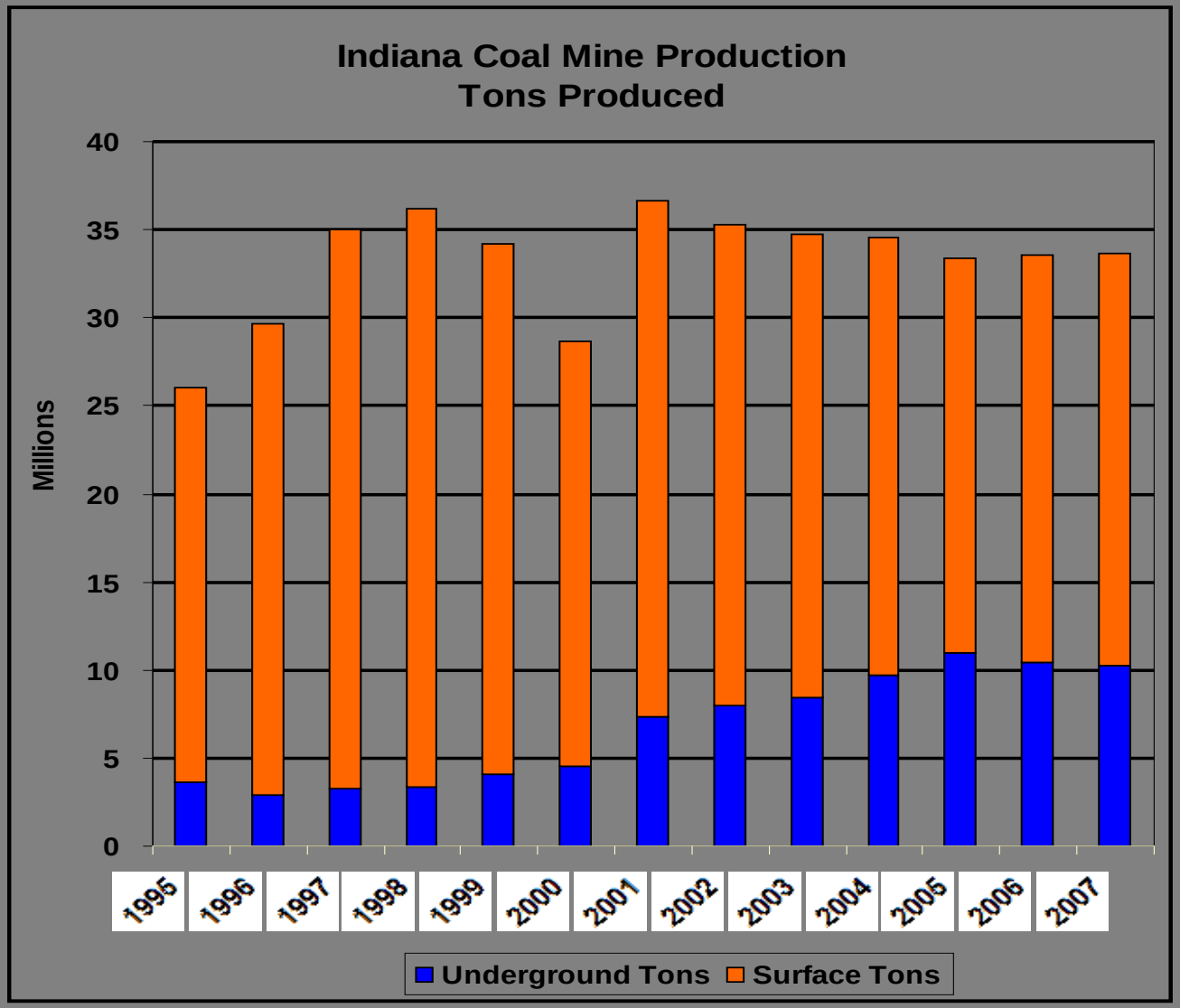
INDIANA COAL MINING FACTS

- **Truck/shovel operations dominate, 2 draglines operating**
- **No steep slope mining**
- **No mountaintop mining**
- **Little topographic relief**
- **USGS Area 32 Report- 62% of landuse is agriculture**

INDIANA COAL MINING FACTS

- Underground depths range from 200’ to 1000’
- Underground access to coal via slopes or shafts
- Room & Pillar
- No Longwall operations to date
- Coal Refuse Disposal

Indiana Production

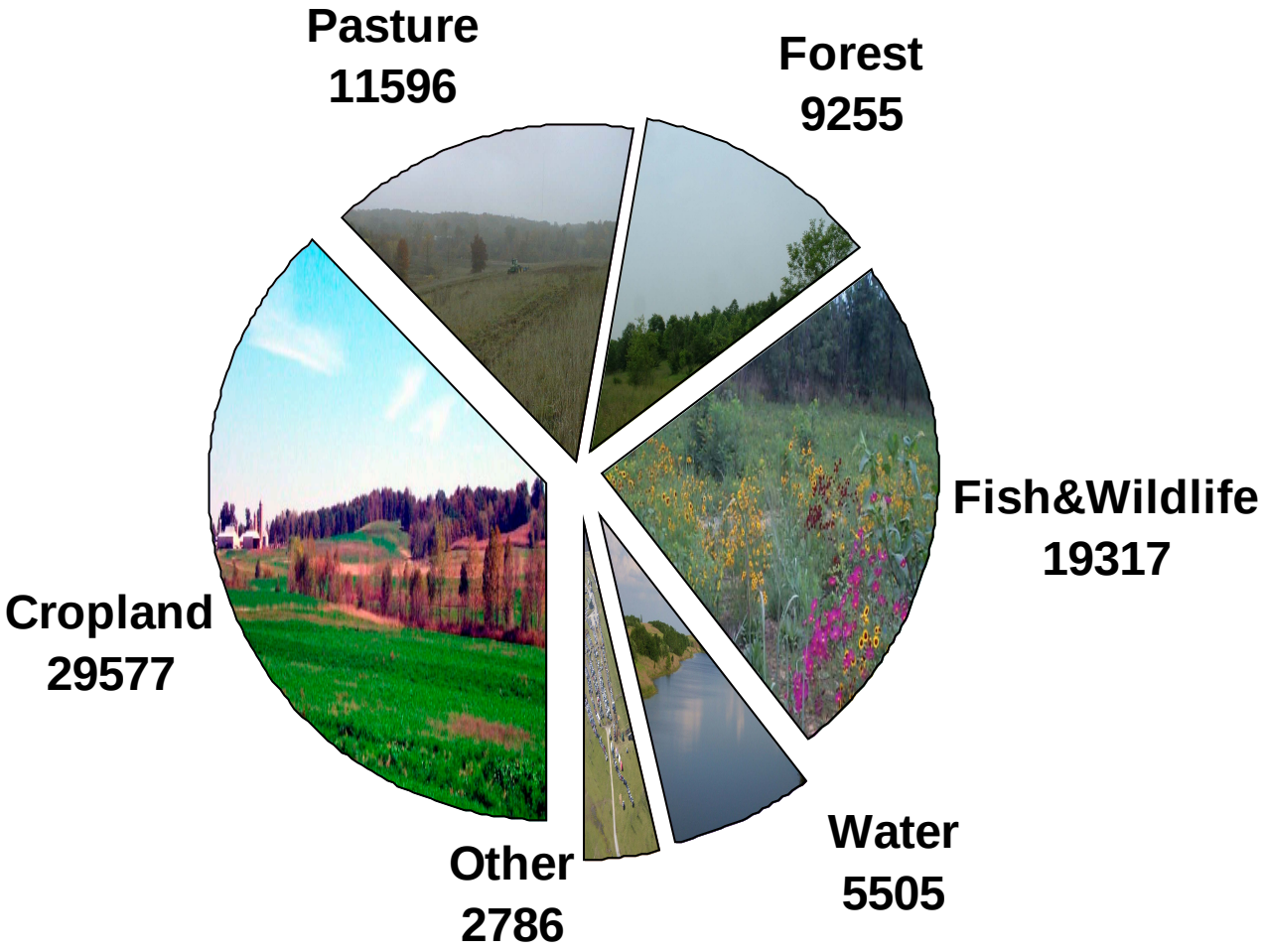


SURFACE WATER AVAILABILITY

- **Annual Precipitation Ranges from 40-45 Inches**
- **10yr/24hr Storm Ranges from 4.3 to 4.6 Inches**
- **100yr/24hr Storm Ranges from 6.0 to 6.5 Inches**
- **“7day/10yr low flow values for the (Wabash) lowland are minimal, owing to the absence of surficial aquifers.”**

USGS Open-File Reports 81-498
Hydrology of Area 32

Landuse Acres Returned to Landowners Between 1996-2007



AGRICULTURE

TYPICAL DRAINAGE PATTERNS

UNAFFECTED AREA STREAMS

PAST PRACTICES

- Focus: soil stability water transport, water quality
- Rip rap
- Terraces
- Heavy vegetation
- Straight channelized drainages

CURRENT PRACTICES

- Focus: soil stability, water transport, water quality AND wildlife values
- Natural stream channel design
- Native vegetation
- Establishment of wooded riparian corridors

BENEFITS

- Wildlife habitat diversity
- Less maintenance
- Aesthetics
- Better flood control
- Water quality

CHALLENGES

- Land use restrictions
- Landowner concerns
- Multi agency jurisdiction
- Conflicting regulations
- Learning curve
- Review complexity
- Swell factor
- Personal values

STRIKING A BALANCE

- Environmental protection
- Maximizing coal recovery
- Landowner concerns
- Environmental laws and regulations
- I-SMCRA Law ”Assure that the coal supply essential to the nation's energy requirements and economic and social well-being is provided and <u>strike a balance</u> between protection of the environment and agricultural productivity and the nation's need for coal as an essential source of energy.”

Ramona Briggeman, Reclamation Biologist

Indiana Division of Reclamation/Fish and Wildlife
R.R. #2, Box 129, Jasonville, IN 47438-9517
812-665-2207
800-772-6463 (Indiana only)

Website: http://www.state.in.us/dnr/reclamation/

Email: rbriggeman@dnr.in.gov

GEOMORPHIC RECLAMATION AT COAL MINES

WESTERN KENTUCKY PROSPECTIVE

PAST AND CURRENT PRACTICES , BENEFITS AND CHALLENGES

PRESENTED BY

ASSOCIATED ENGINEERS, INC.

ENGINEERS • GEOLOGISTS • SURVEYORS

T. H. E. Engineers, Inc.

GEOMORPHIC RECLAMATION

- **Working Explanation of Geomorphic Reclamation:** Geomorphology generally is the study of landforms and the processes that shape them. This includes the substances that make up the land (i.e. rock and soil of various consistencies, hardness and cohesiveness) as well as the forces that act upon the substances (i.e. erosion forces such as wind and water and uplifting geological forces.) For our purpose, we are most concerned with the erosion capabilities of water and how it interacts with the substances that make up the land.

PAST PRACTICES

- HISTORIC CHANNEL DESIGN CONSIDERATIONS

  FLOW CAPACITY
  CHANNEL VELOCITIES

- HISTORIC ACCOMPLISHMENTS

  MAINTENANCE OF FLOW
  JURISDICTIONAL CONNECTIVITY

TYPICAL ISSUES

- VELOCITY MODIFICATION

HEAD CUTS

SEDIMENT DEPOSITION

CURRENT CONDITIONS

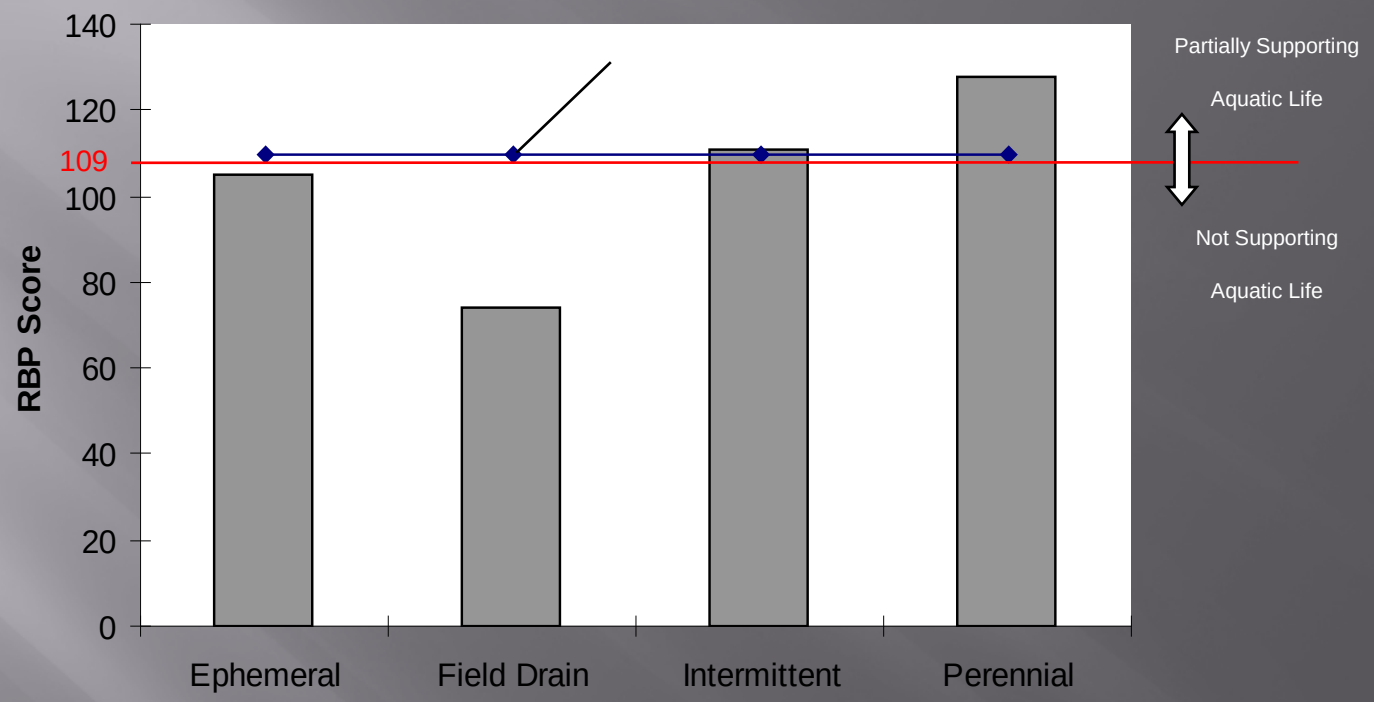


Figure 1. Weighted mean Rapid Bioassessment Protocol scores for 411 Western Kentucky Coal Field stream reaches. A score of 109 is the threshold for non-support of aquatic life in the ecoregion (KDOW, 2002).

REGIONAL LAND USES

- FORESTED / AGRICULTURAL 47%
- DEVELOPED AREAS 2.4%
- MINING ACTIVITIES 0.4%
- ALL OTHER LAND USES 50.2%

POTENTIAL BENEFITS

- REGULATORY APPROVALS
- REDUCED LIFECYCLE MAINTENANCE COST
- IMPROVED WATER QUALITY
- INCREASED ECOLOGICAL VALUE
- IMPROVED POST MINING LAND USE
- ENHANCED POST MINING VALUE

CHALLENGES

- REGULATORY COORDINATION
- INDUSTRY EDUCATION
- OPERATOR BUY IN
- AGENCY COOPERATION

RESULTS

- INCREASED ECOLOGICAL VALUE
- CONTINUED COMPETITIVELY PRICED ENERGY

Illinois Stream Restoration Habitat Opportunities

Jack Nawrot
Cooperative Wildlife Research Lab.
SIUC Carbondale IL

William O'Leary
Illinois DNR Office of Mines and Minerals

June 1999

ILLINOIS REGULATION

Sec. 1816.43 Diversions (Temp or Permanent)

Design Construct Maintain

- Stable
- Flood Protection
- Sediment Control
- Riparian Vegetation Establishment
- Natural Channel – Cross Section
  - Meander, Gradient
- Aquatic Habitats - Riffles Pools
- Floodplain -

62 ILLINOIS ADMIN. CODE CH I

Sec. 1816.43 Diversions (Temp or Permanent)

Design - Hydraulic

Channel Capacity: Equal to Upstream and Downstream

Channel Bank and Floodplain

Pass – 100 yr 6 hour precip. event

62 ILLINOIS ADMIN. CODE CH I

Sec. 1816.57 Hydrologic Balance

Stream Buffer Zones

Protection – > 100 ft Top of Bank

Restoration –(Sec. 1816.43)

- Channel
- In-stream habitat
- Riparian Buffer – Floodplain

STREAM ASSESSMENT[1]
Diversions Restorations

IDNR Stream Restoration Program

CWRL - SIUC

Baseline (Up – Downstream)

1979 – 1994

Industry

Regulatory Compliance -5[+] yr post

1980 – 2005[++]

[1] Perry Co IL [2] CWRL [3] CONSOL

STREAM ASSESSMENT[1]

Diversions

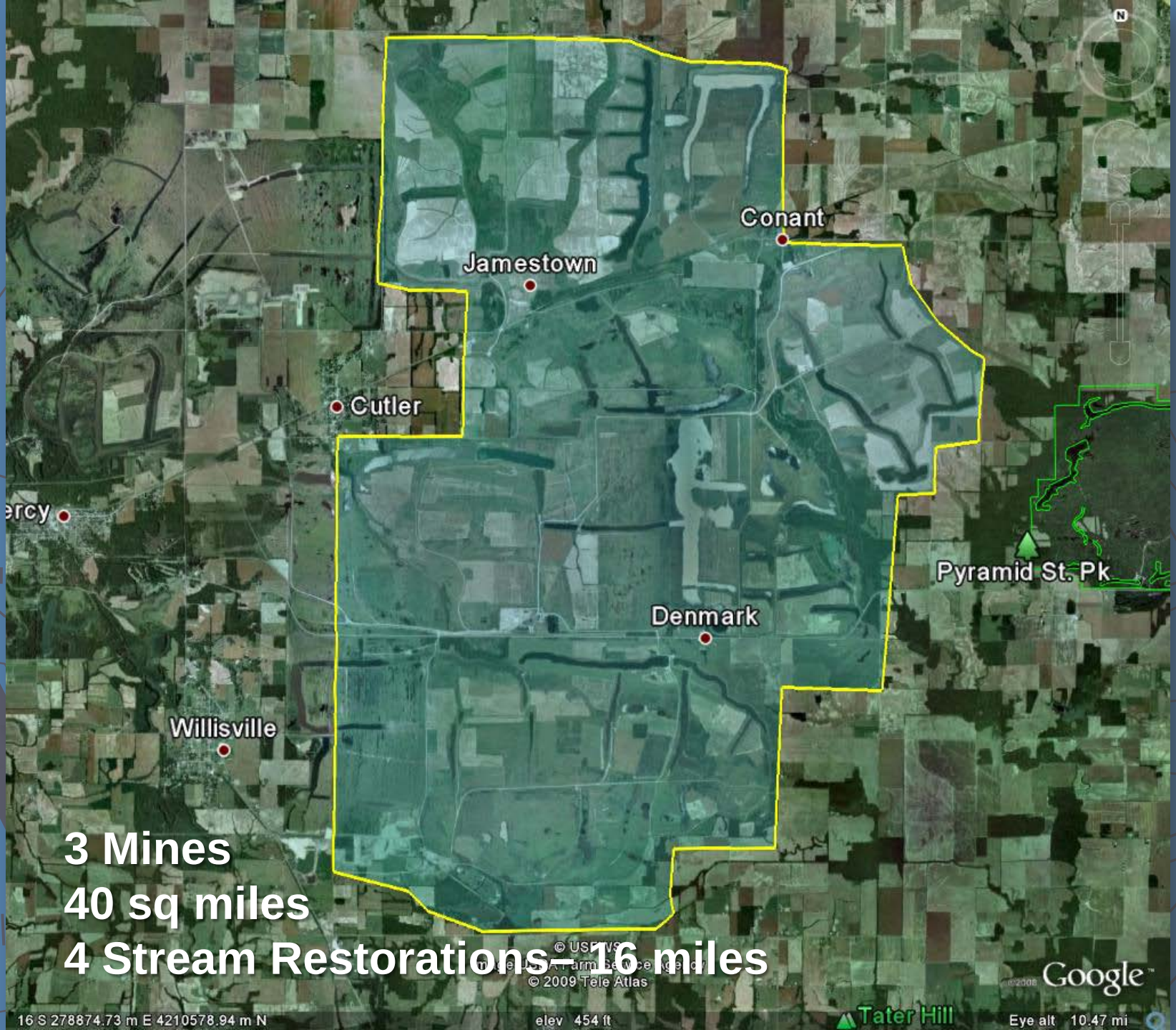
Galum[2]	1981-1982
Panther Creek[2]:	1981-1982
Pipestone[2]	1983-1994

Restorations

Pipestone[2]	1990-1994
Galum ARCH[2]	1981 1988
Galum CONSOL[3]	2002-2006
Bonnie[2]	2002-2006
White Walnut[3]	2002-2005

[1] Perry Co IL [2] CWRL [3] CONSOL

CAP. 550 LBS
5

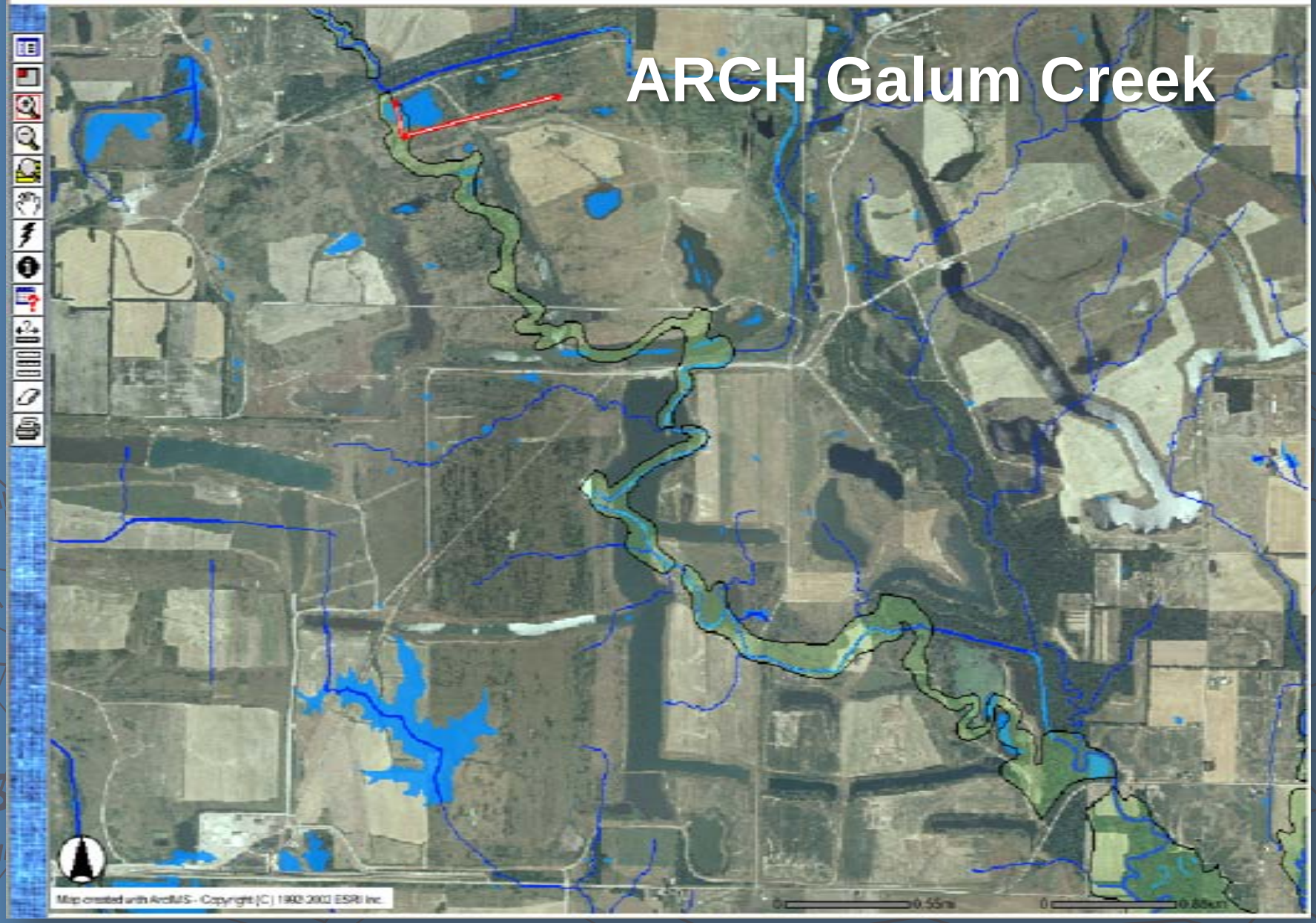


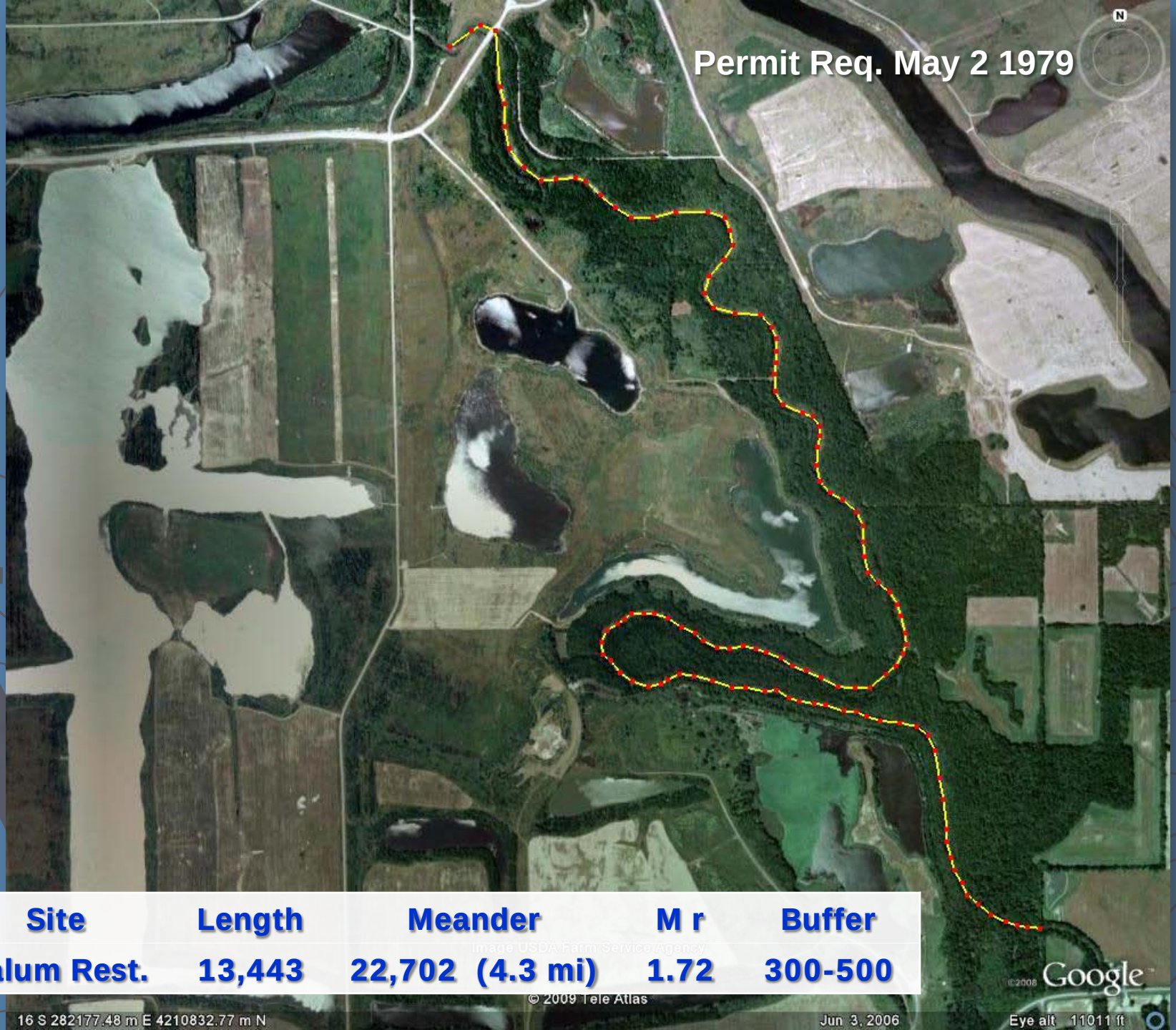
3 Mines
40 sq miles
4 Stream Restorations– 16 miles

SITE	LENGTH ft	MEANDER ft	M ratio	BUFFER ft
CONSOL Burning Star 4				
Galum Rest.	13,443	22,702 (4.3 mi)	1.72	300-500
Bonnie Rest.	11,842	19,311 (3.7 mi)	1.63	500-750
Galum Diver.	16,400	-	-	
ARCH Captain				
Galum Rest.	9,135	18,480 (3.5 mi)	2.02	
Pipestone Diver.	11,342	-	-	85
AMAX Leahy				
Pipestone NW Diver.	5,808			
Pipestone Rest.	16,685	24,288 (4.6 mi)	1.45	300-750
Pipestone SE Div.	4,115	-		
Pipestone Temp Div.	22,704	-		
TOTAL Restoration 4	51,095	84,781 (16 mi)	1.66	
TOTAL Diversion P 4	37,665			

Illinois Department of Natural Resources
Office of Mines & Minerals
Land Reclamation Division

ArcIMS Illinois Coal Mine Permit Viewer

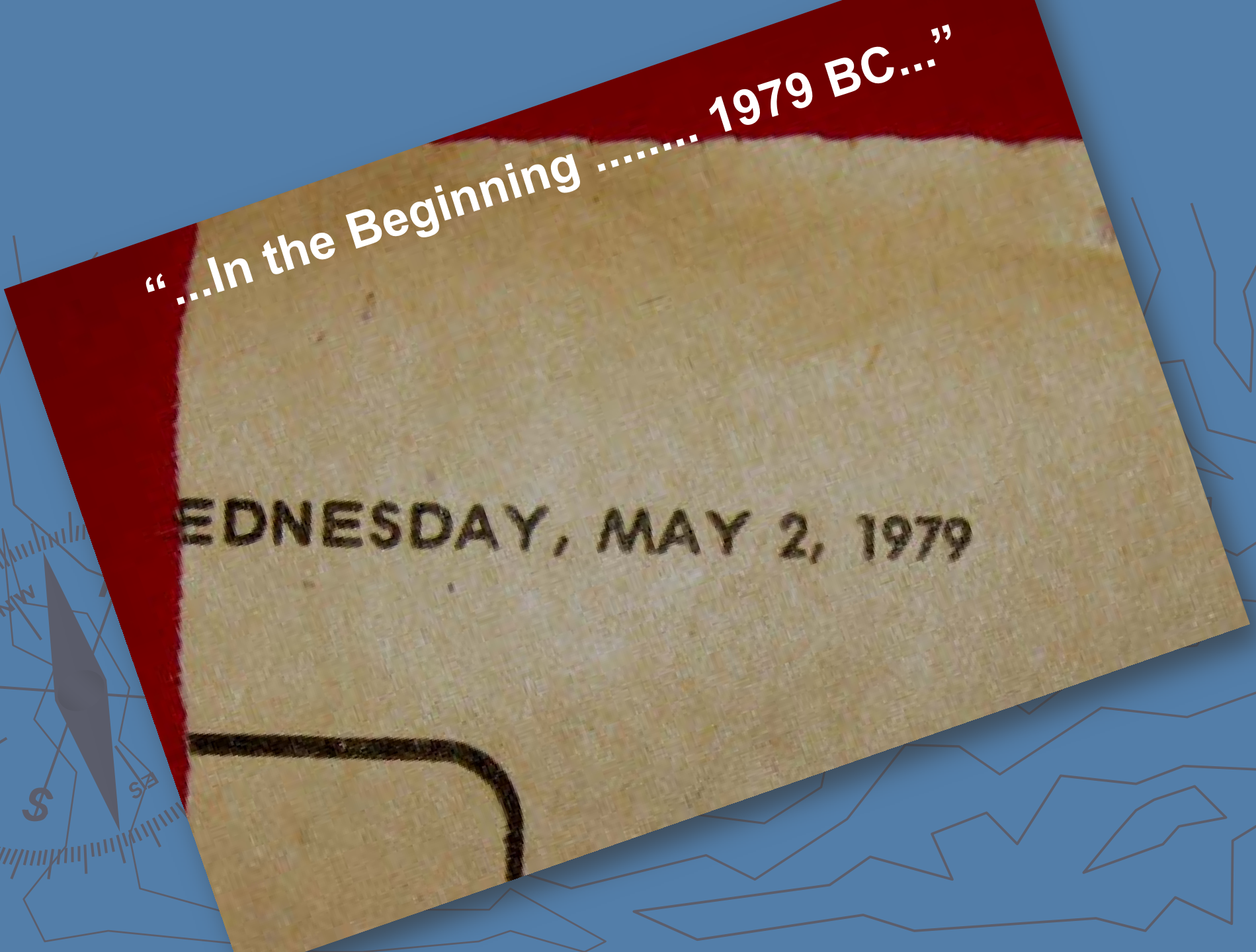




Site	Length	Meander	M r	Buffer
Galum Rest.	13,443	22,702 (4.3 mi)	1.72	300-500

ARCH GALUM

“...In the Beginning ..... 1979 BC...”



ARCH – Galum Creek Restoration March 1979

Perry County

Plan to move creek supported at hearing

By Evan M. Davis
Of The Southern Illinoisan

A plan to move about 3.5 miles of Galum Creek in southwestern Perry County prompted several questions, no outright objections and the support of a zoology instructor of Southern Illinois University-Carbondale at a public hearing in Du Quoin Tuesday night.

The plan was presented by Southwestern Illinois Coal Corp., which wants to surface mine the land under and around the stream bed. It calls for construction of a new section of the stream to the northeast of the current section. The version is designed to closely resemble the current stream in length, amount of curvature, water flow characteristics and, eventually, in plant and animal life.

Southwestern needs permission from both the U.S. Army Corps of Engineers, which held the public hearing, and the Illinois Department of Transportation's Division of Water Resources to move the creek section. A division spokesman, David R. Boyce, said the division probably will grant its permit, pending further information from Southwestern.

Perhaps the most supportive testimony for the plan came in a written statement sent by and read for professor W.D. Klimstra, a Southern Illinois University-Carbondale zoologist who has been involved with coal mine reclamation laws as they affect wildlife. He said the Southwestern plan is "a unique situation for studying man's ability to change the course of a stream" and rebuild the life around it.

Most questions at the hearing came from farmers, particularly those with land south of the proposed diversion, who are afraid the flow of water on their land might significantly increase, despite Southwestern's computer-based predictions to the contrary.

One of them, Charles Greer, said he thinks the plan will work, but asked, "What if this does not work? How am I protected?"

John Kilker, chief of the regulation functions branch in the Corps' St. Louis office, told Greer the Corps has the power to tell a permitee to revise its program if it is not functioning in the public interest.

Most of Southwestern's presentation was made by Robert Holloway, the company's manager of land resources. He discussed two basic reasons Southwestern wants to move the creek: economics and environment.

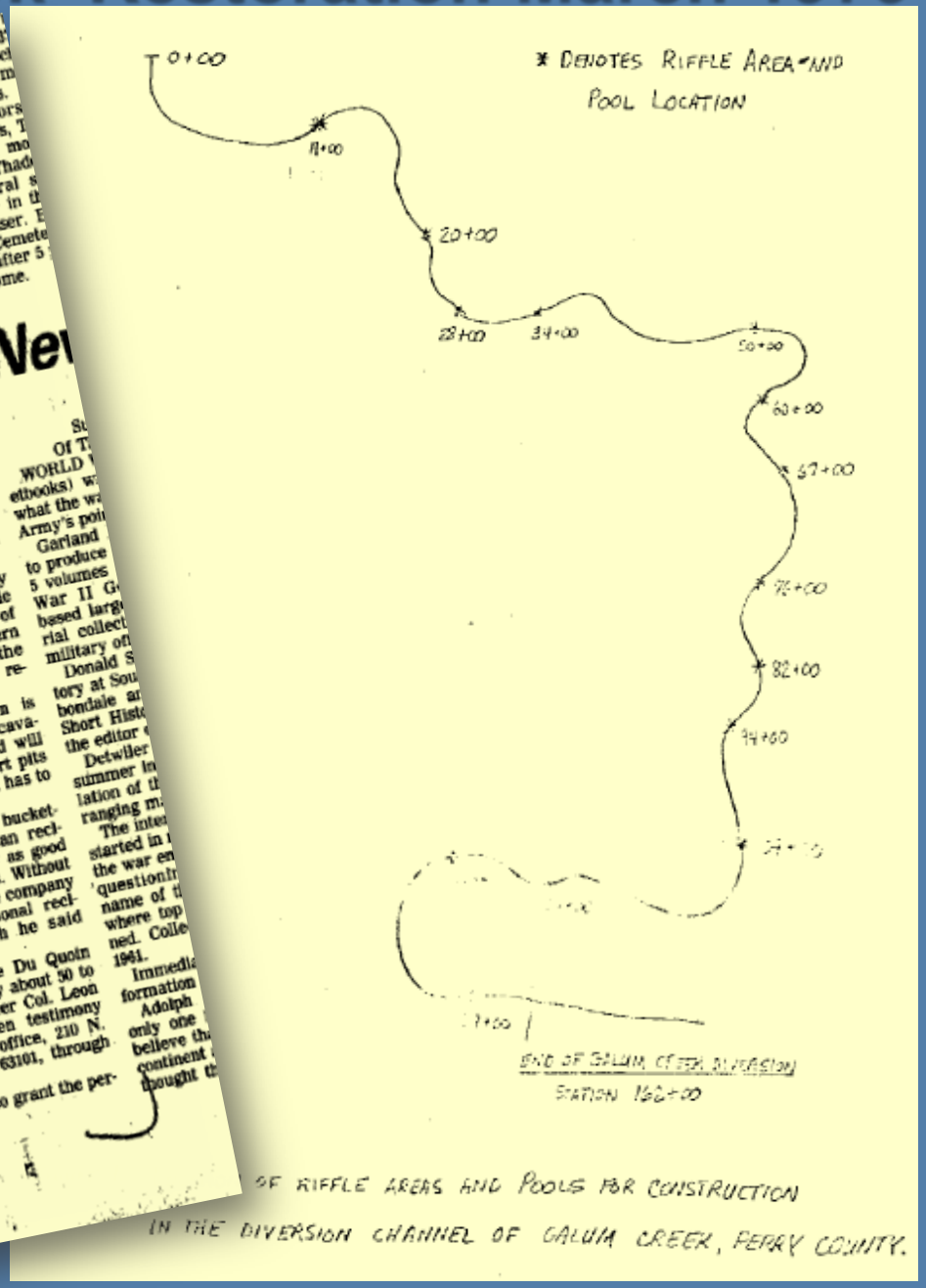
First, Holloway said, the company would lose nine million tons of mineable coal either under or within 100 feet of the creek. Also, he said, Southwestern would not be able to reclaim the stripped land as well if the creek remains where it is.

Southwestern's reclamation plan is based on a huge bucket-wheel excavation system, which Holloway said will not operate efficiently in the short pits Southwestern would have left if it has to jump over the creek.

Holloway said that with the bucket-wheel system, Southwestern can reclaim the land to a productivity as good or better than it currently has. Without moving the creek, he said, the company would have to use conventional reclamation machinery, which he said would not be as effective.

The hearing, held in the Du Quoin VFW Hall, was attended by about 50 to 60 persons. Presiding officer Col. Leon E. McKinney said written testimony will be accepted at his office, 210 N. 12th St., St. Louis, Mo., 63101, through May 11.

The decision whether to grant the permit is up to McKinney.

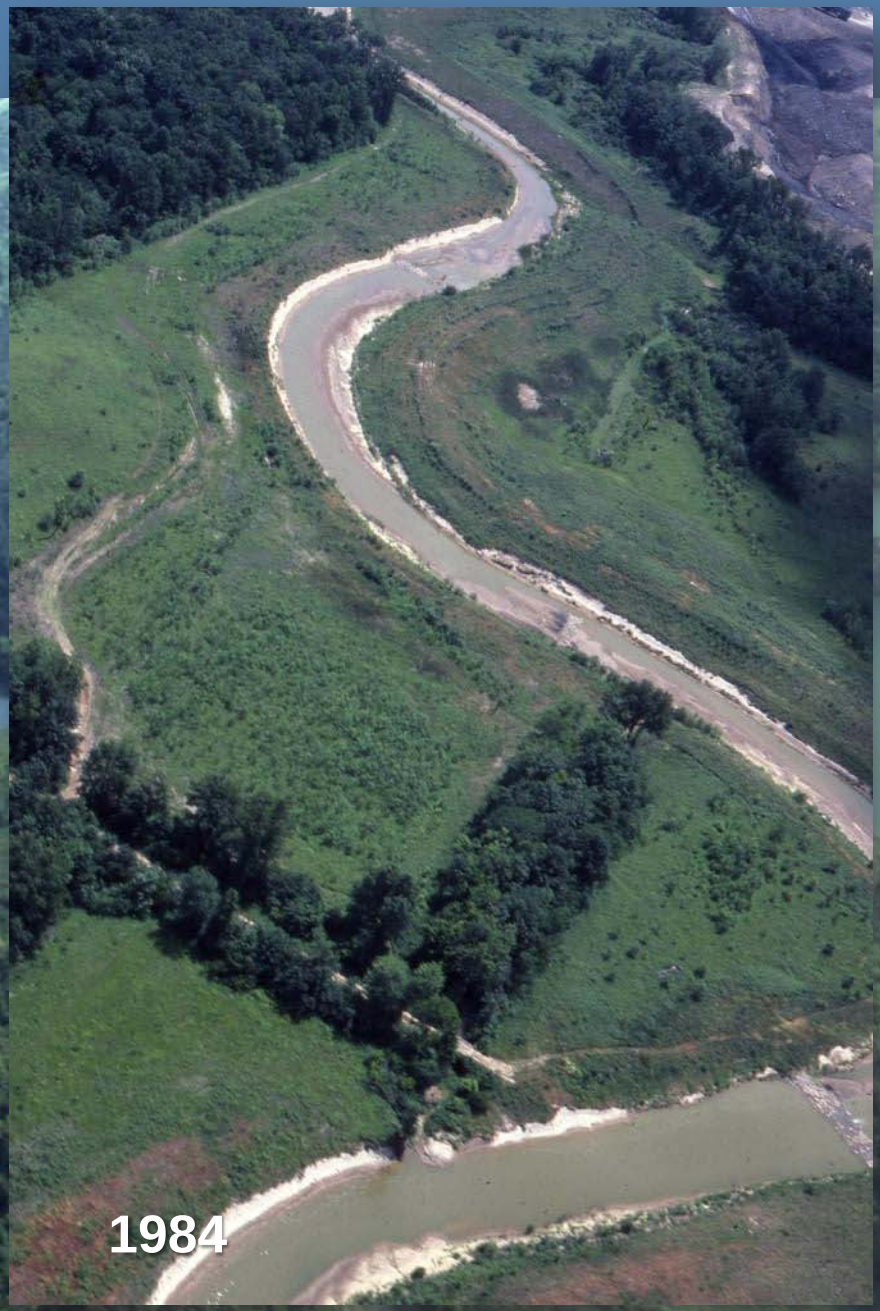


"...unique .....studying man's ability to change the course of a stream ...and rebuild life..."

Perhaps the most supportive written mony for the plan came in a written statement sent by and read for professor W.D. Klimstra, a Southern Illinois University-Carbondale zoologist who has been involved with coal mine reclamation laws as they affect wildlife. He said the Southwestern plan is "a unique situation for studying man's ability to change the course of a stream" and rebuild the life around it.

Most questions at the hearing came

August 1987


1984

ARCH Restoration 2005

DESIGN AND ENGINEERING

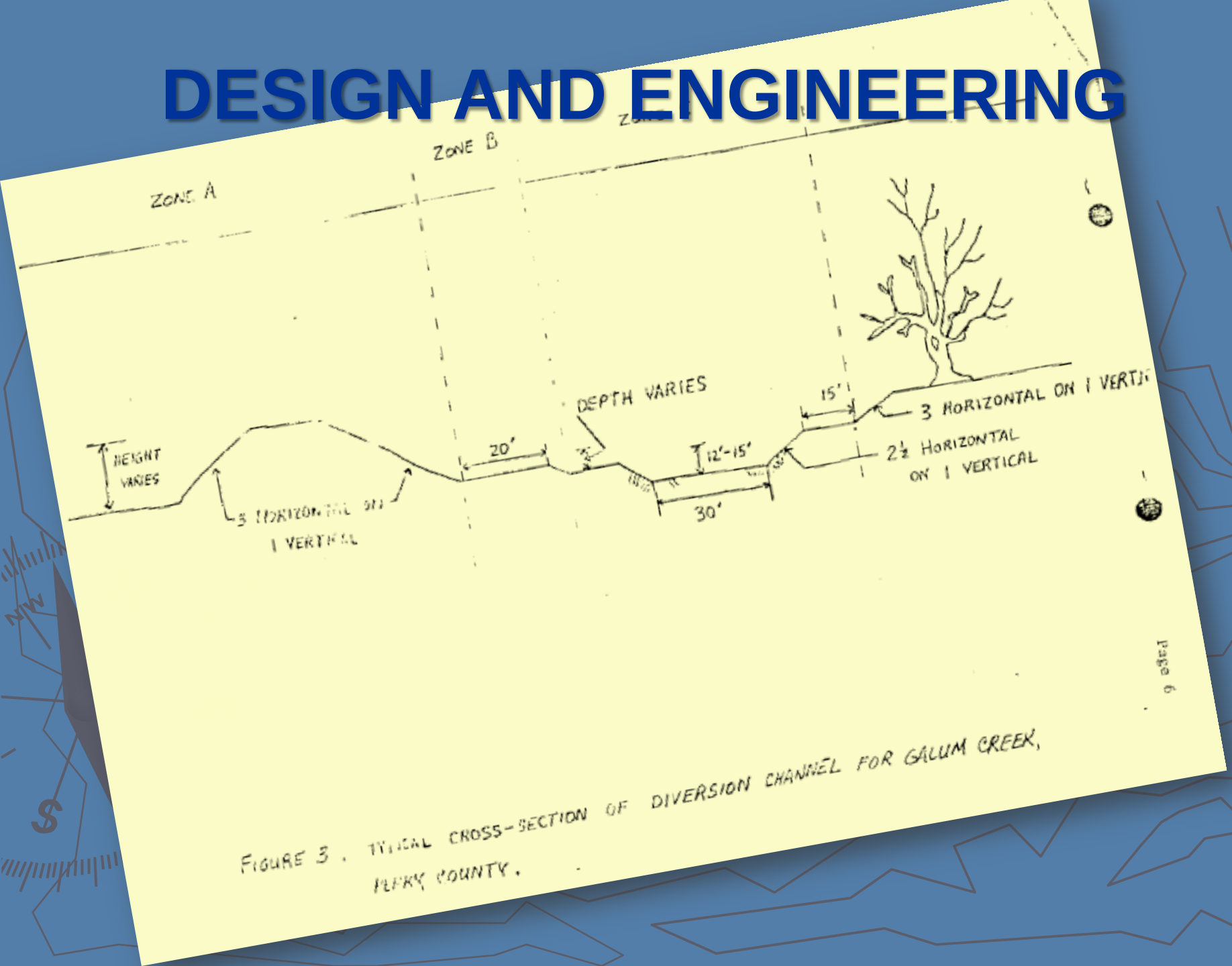


FIGURE 3. TYPICAL CROSS-SECTION OF DIVERSION CHANNEL FOR GALUM CREEK, PERRY COUNTY.

USACE DESIGN CRITERIA

MINIMUM CRITERIA FOR AN ACCEPTABLE DIVERSION CHANNEL FOR GALUM CREEK

On the basis of a preliminary assessment by St. Louis District, a replacement channel satisfying the following conditions would not be expected to produce significant environmental effects:

1. During construction of the new 50-foot wide diversion channel:

a. Construction activities will be restricted to the right bank facing downstream. All channel excavation will be done from the right bank. All excavated material will be disposed of along the right bank.

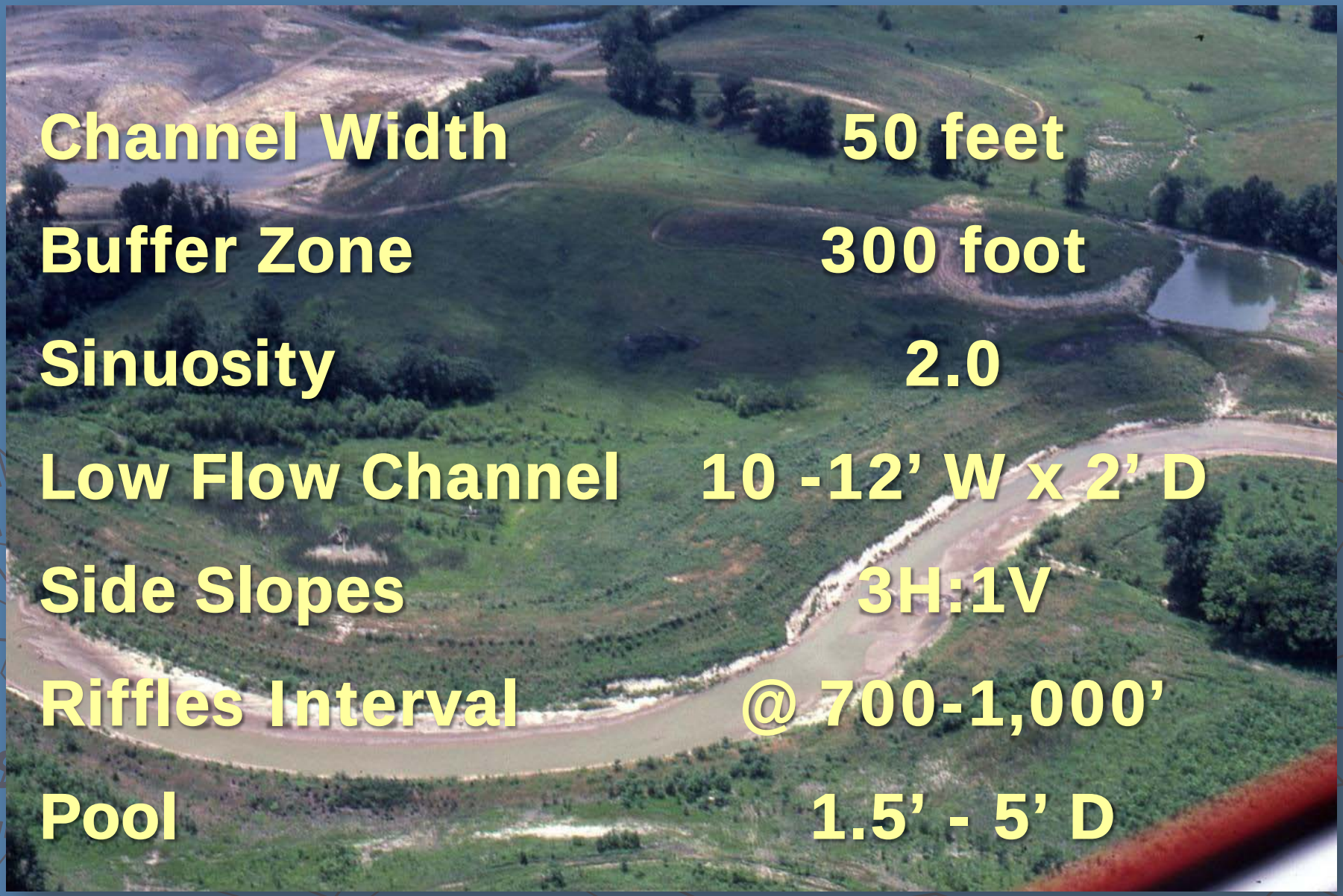
b. A 300-foot wide buffer strip shall be established and maintained along the entire left bank of the diversion channel, as measured out from the top of the left side slope. No disturbance through clearing, burning, draining, grazing, or mowing will be permitted in this strip as long as the applicant owns the property.

c. The diversion channel will be constructed to meander throughout its length to provide a sinuosity measurement of 2.0 or greater.

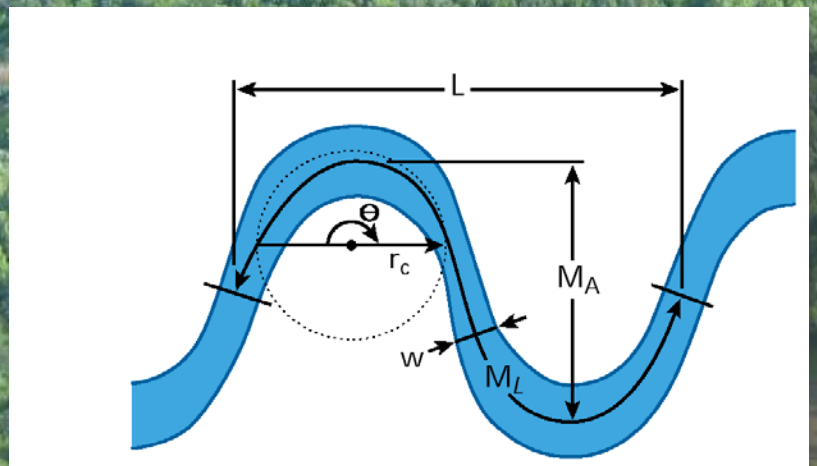
d. A low flow channel 10 to 12 feet wide and 2 feet deep must be constructed in the bottom of the diversion channel. The low flow channel must meander from side to side of the larger channel at intervals of 100 to 150 feet.

e. The side slopes of the diversion channel must be constructed in a horizontal to vertical ratio of 3 to 1.

USACE DESIGN CRITERIA



Channel Width	50 feet
Buffer Zone	300 foot
Sinuosity	2.0
Low Flow Channel	10 -12’ W x 2’ D
Side Slopes	3H:1V
Riffles Interval	@ 700-1,000’
Pool	1.5’ - 5’ D



L meander wavelength
M_L meander arc length
w average width at bankfull discharge
M_A meander amplitude
r_c radius of curvature
θ arc angle

2005

CHANNEL DESIGN : Riffles Pools

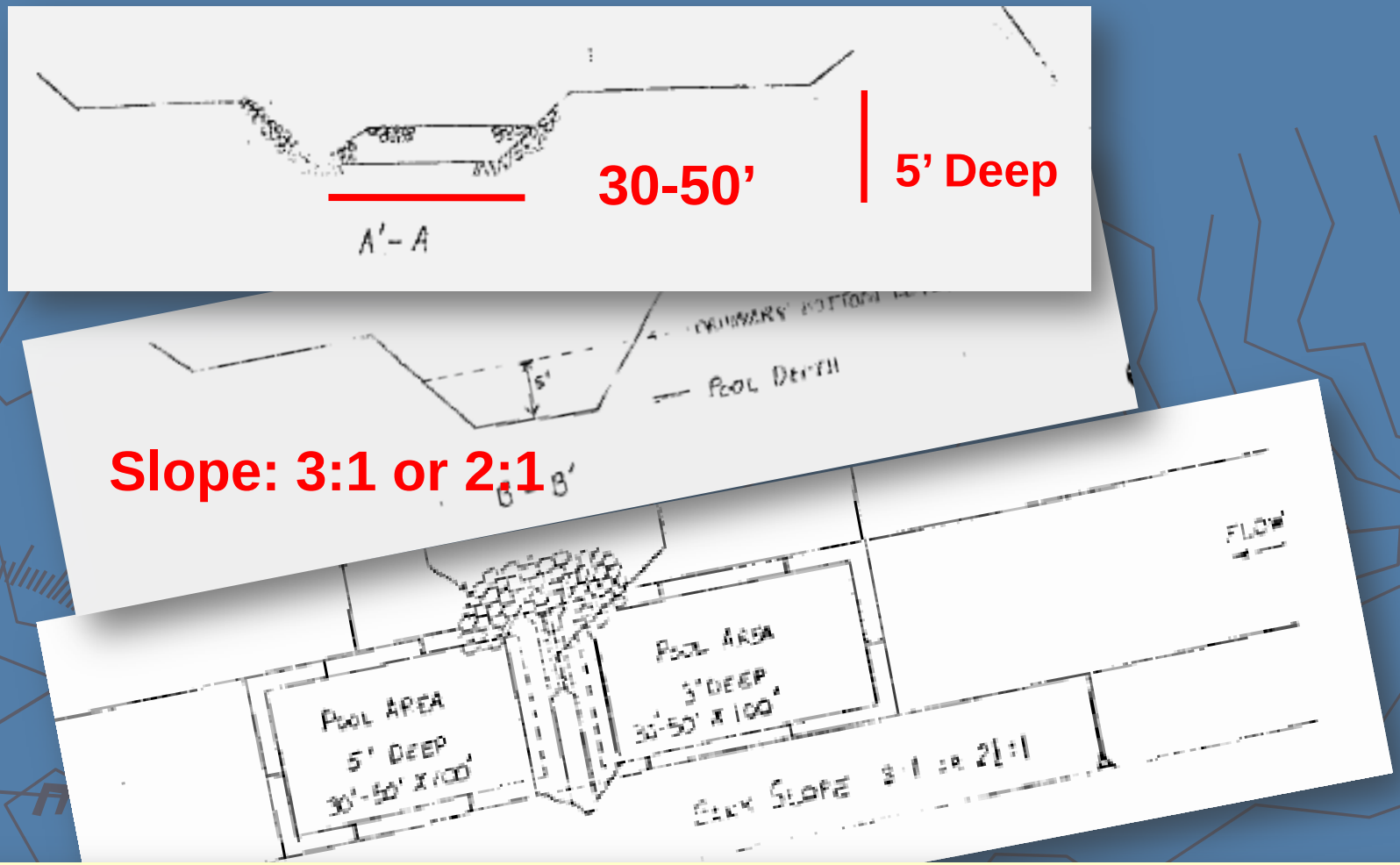


FIGURE 2. TYPICAL RIFFLE AREA DESIGN FOR PLACEMENT IN THE DIVERSION CHANNEL OF GALLIM CREEK, PERRY COUNTY.

ARCH Galum Restoration June 1986

ARCH Galum Restoration Plan-1979 : Vegetation

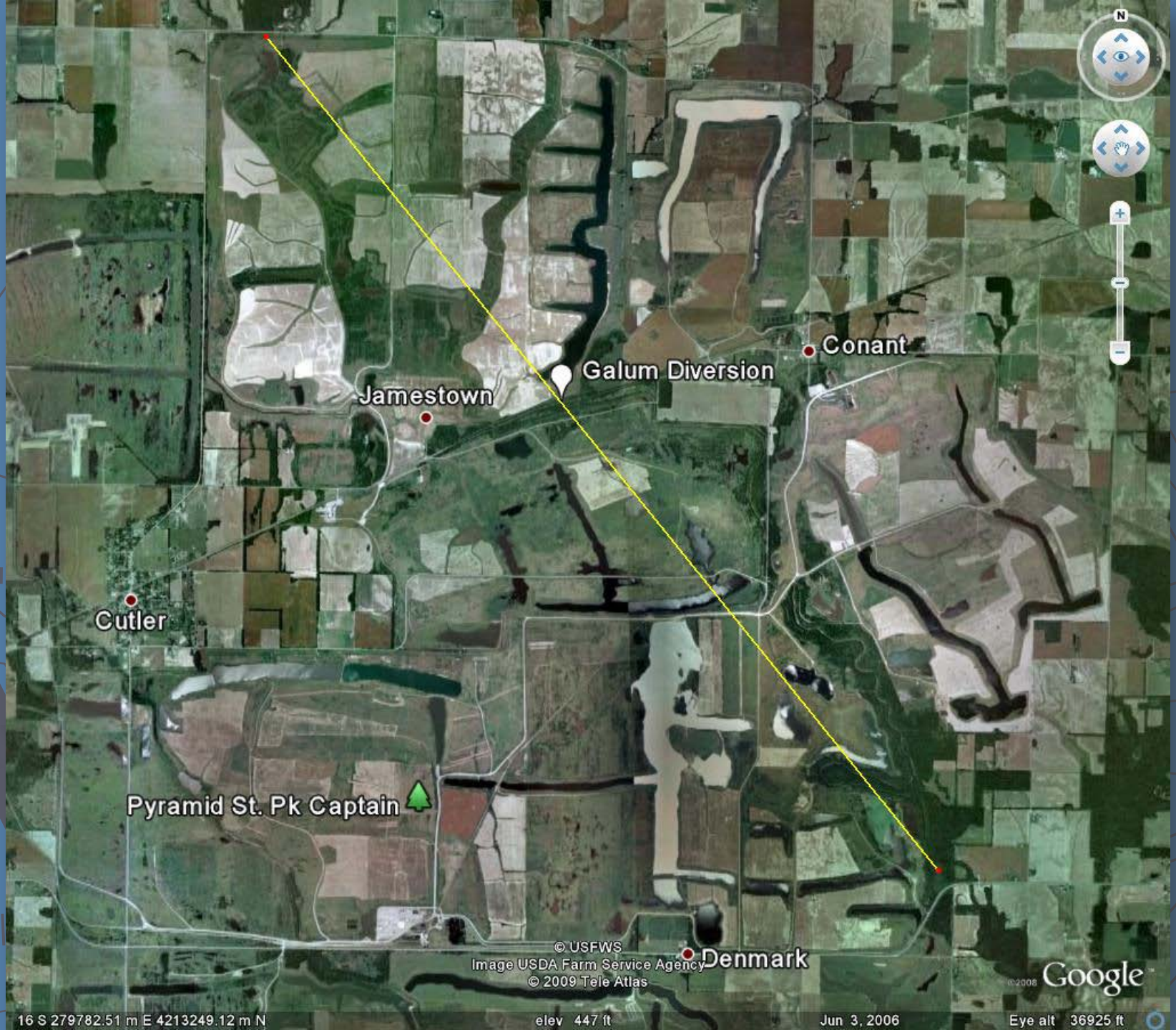
Floodplain	Riparian Corridor	Transition Forest
Bald Cypress	Bald Cypress	Pecan
River Birch	Sweet Gum	Bitternut Hickory
Black Willow	Overcup oak	Shagbark Hickory
Green Ash	Green Ash	Shellbark hickory
Hackberry	Hackberry	Water hicory
Cottonwood	Black Walnut	Black Walnut
Pin Oak	Pin Oak	Bur Oak
Silver Maple	Silver maple	Cherrybark Oak
	Swamp White Oak	Shumard Oak
	Honey Locust	S. Red Oak
		Swamp Chestnut Oak

FIGURE 3. TYPICAL CROSS-SECTION OF DIVERSION CHANNEL FOR GALUM CREEK, PERRY COUNTY.

ARCH Galum Restoration 1981

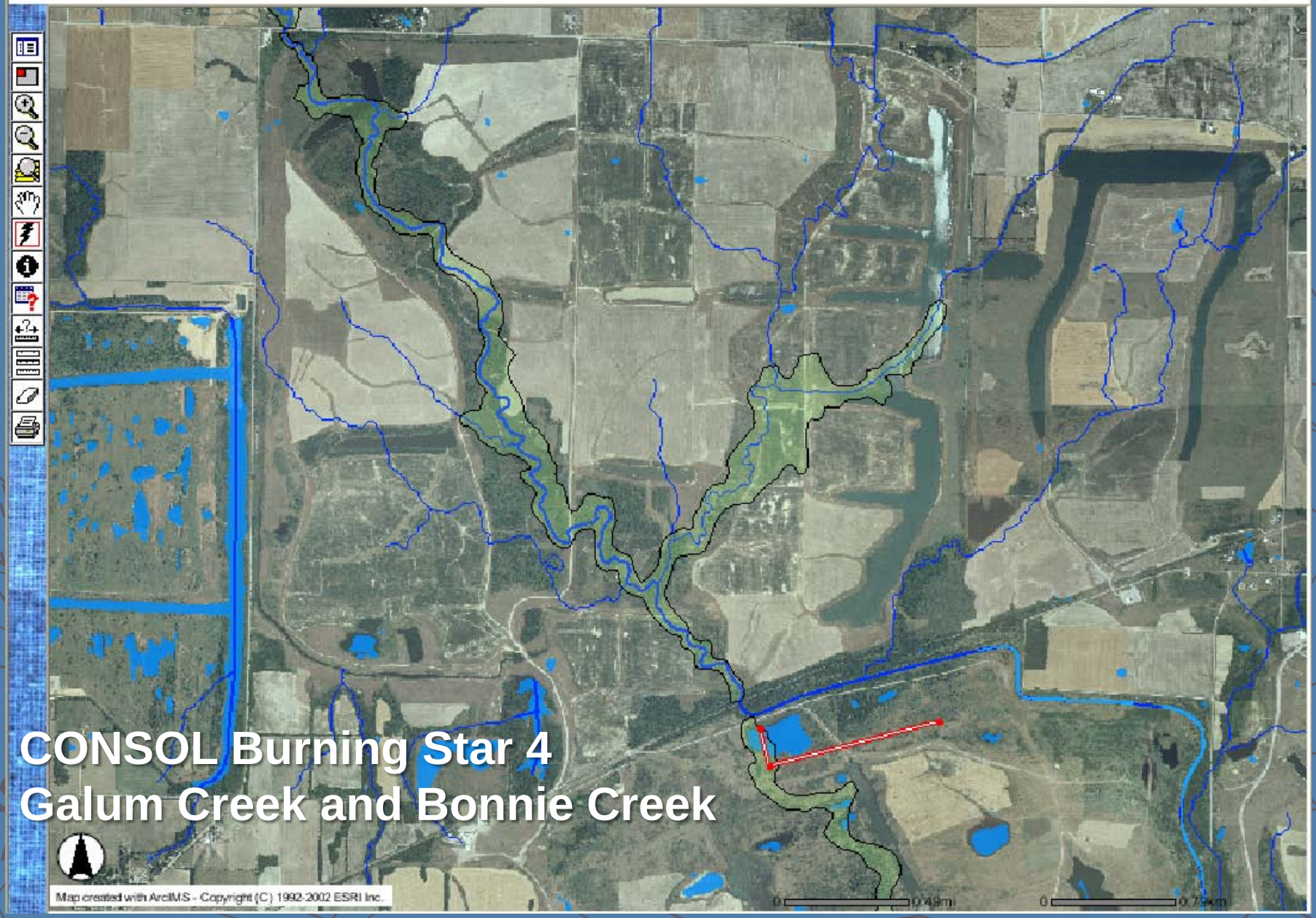
ARCH Galum Restoration April 09

ARCH Galum Downstream
April 2009


Conant
Galum Diversion
Jamestown
Cutler
Pyramid St. Pk Captain
Denmark
© USFWS
Image USDA Farm Service Agency
© 2009 Tele Atlas
Google
16 S 279782.51 m E 4213249.12 m N
elev 447 ft
Jun 3, 2006
Eye alt 36925 ft

Illinois Department of Natural Resources
Office of Mines & Minerals
Land Reclamation Division

ArcIMS Illinois Coal Mine Permit Viewer



CONSOL Burning Star 4
Galum Creek and Bonnie Creek

Site	Length	Meander	M r	Buffer
Galum Rest.	13,443	22,702 (4.3 mi)	1.72	300-500

Site	Length	Meander	M r	Buffer
Bonnie Rest.	11,842	19,311 (3.7 mi)	1.63	500-750

N
Jamestown
Jamestown Rd
© USFWS
Image USDA Farm Service Agency
© 2009 Tele Atlas
©2008 Google
16 S 278358.16 m E 4214647.66 m N
elev 428 ft
Jun 3, 2006
Eye alt 5765 ft

CONSOL Galum & Bonnie Creek

Active Mine	2 million tons /yr production 4,800 acre permit area Seam 6 @ 70 - 95 feet
Watershed	18 sq miles
Channel Length	21,000 ft (Galum)
Channel Gradient	4 –7 ft/mi
Channel Restoration	Reconstructed Mine Soils
Riparian Forest Restoration	140 acres
Bonnie Creek – Restoration	19,000 ft

(From: Ervin Anderson CONSOL 1987)

CONSOL Burning Star 4
Galum & Bonnie Creeks

Design and Engineering	May 1979
Permit Approval	November 1982
Construction (8.0mi)	June 1984 - ~1998
Floodplain Restoration	1984 - 1998
Channel Reconnection	June 1999
Monitoring	2002 – 2006
OSM National Award	2002

News Release

CONSOL Energy Wins National Reclamation Award; Former Surface Mine in Illinois Now Home to Wildlife, Waterfowl

WASHINGTON, Sept. 18 2002 -- The U.S. Office of Surface Mining ..... 2002 OSM National Award for innovative reclamation practices at the company's Burning Star No. 4 Mine property in southern Illinois....

...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.

Design – Enhancement

- Channel
  - Riffles
  - Pools
  - Deep Water Habitat
    - Sediment Control
    - Base Flow
- Connectivity
  - High Water Flow – Wetlands
  - Corridor
  - Confluence – Bonnie Ck. Restoration

Floodplain

Storm Retention –
<0.5 ft Upstream W.L increase
Flow & Velocity (downstream)
June 2006

Habitat Enhancement

Habitat – Riparian PFO1A, PSSC, PEMA/C
(inundate - 2 yr design storm)
Buffer – Protection
300-500 ft.

Design – “Enhancement”

Deep Water Habitat Connectivity

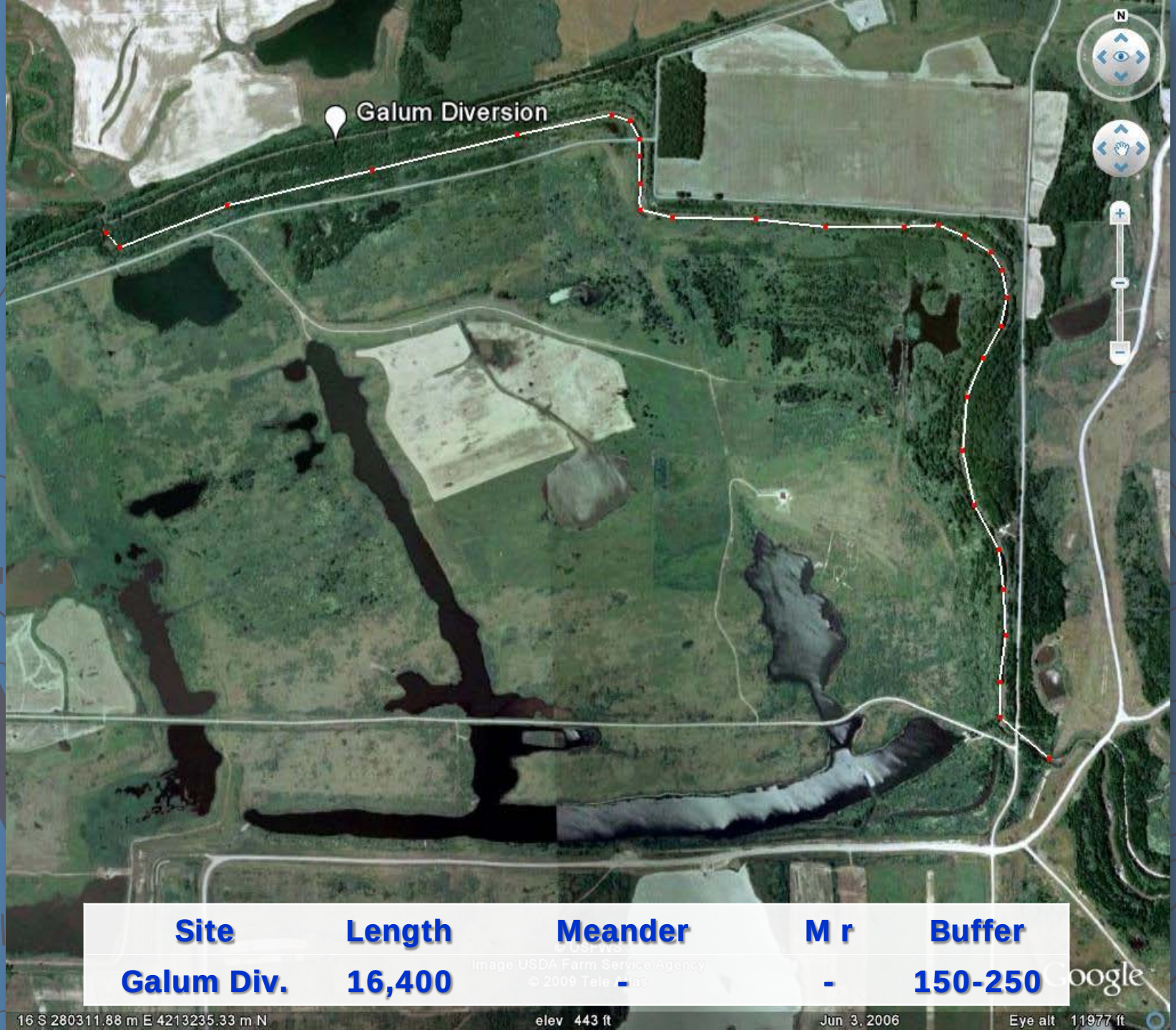
Sediment Control

Base Flow

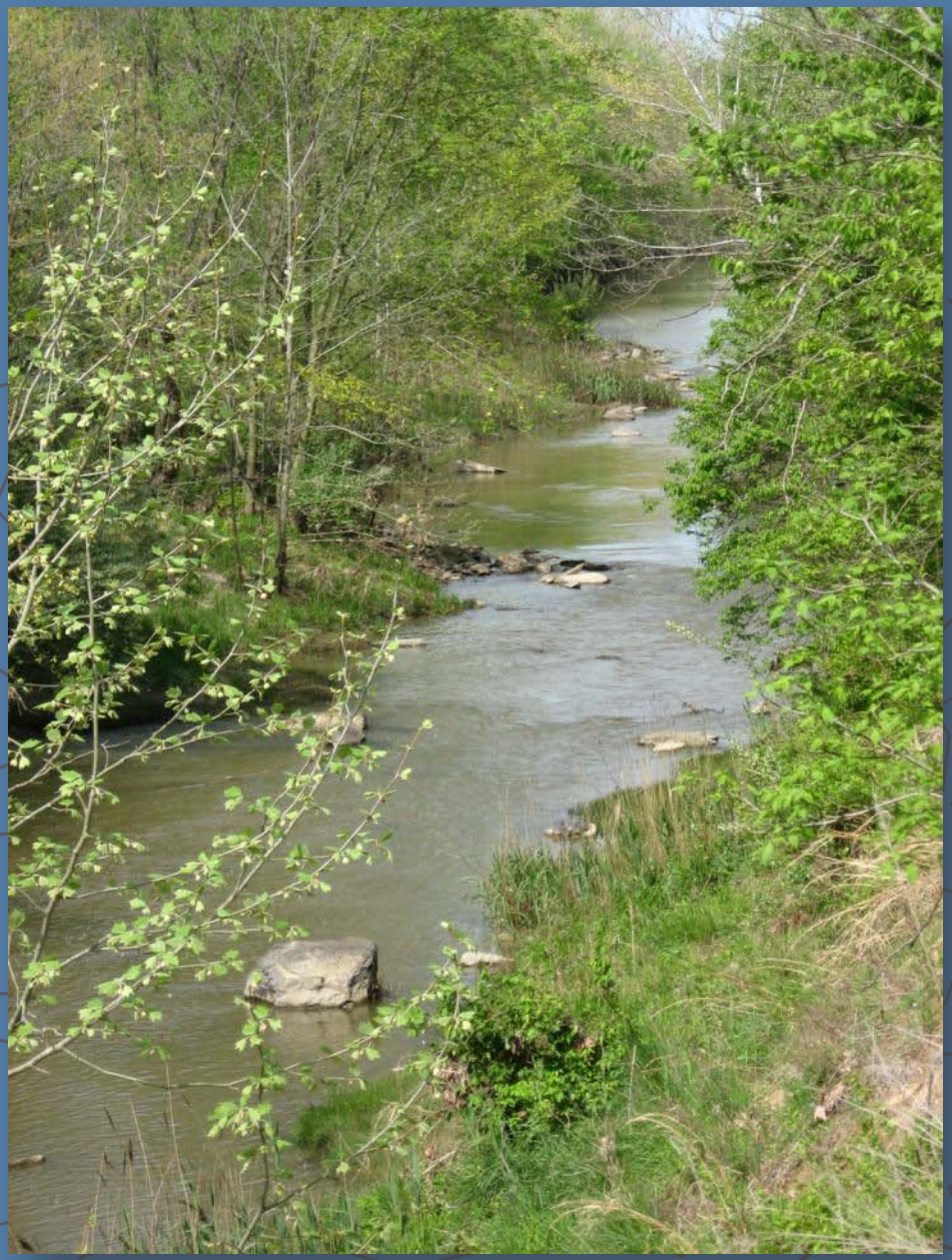
CONSOL Burning Star 4: Galum Creek

Bald Cypress
Hackberry
Box elder
Red maple
Silver maple
Swamp white oak
Beech
American Elm

Ash
Sweetgum
Sycamore
Cotttonwood
River birch
Pin Oak
Pecan
American plum

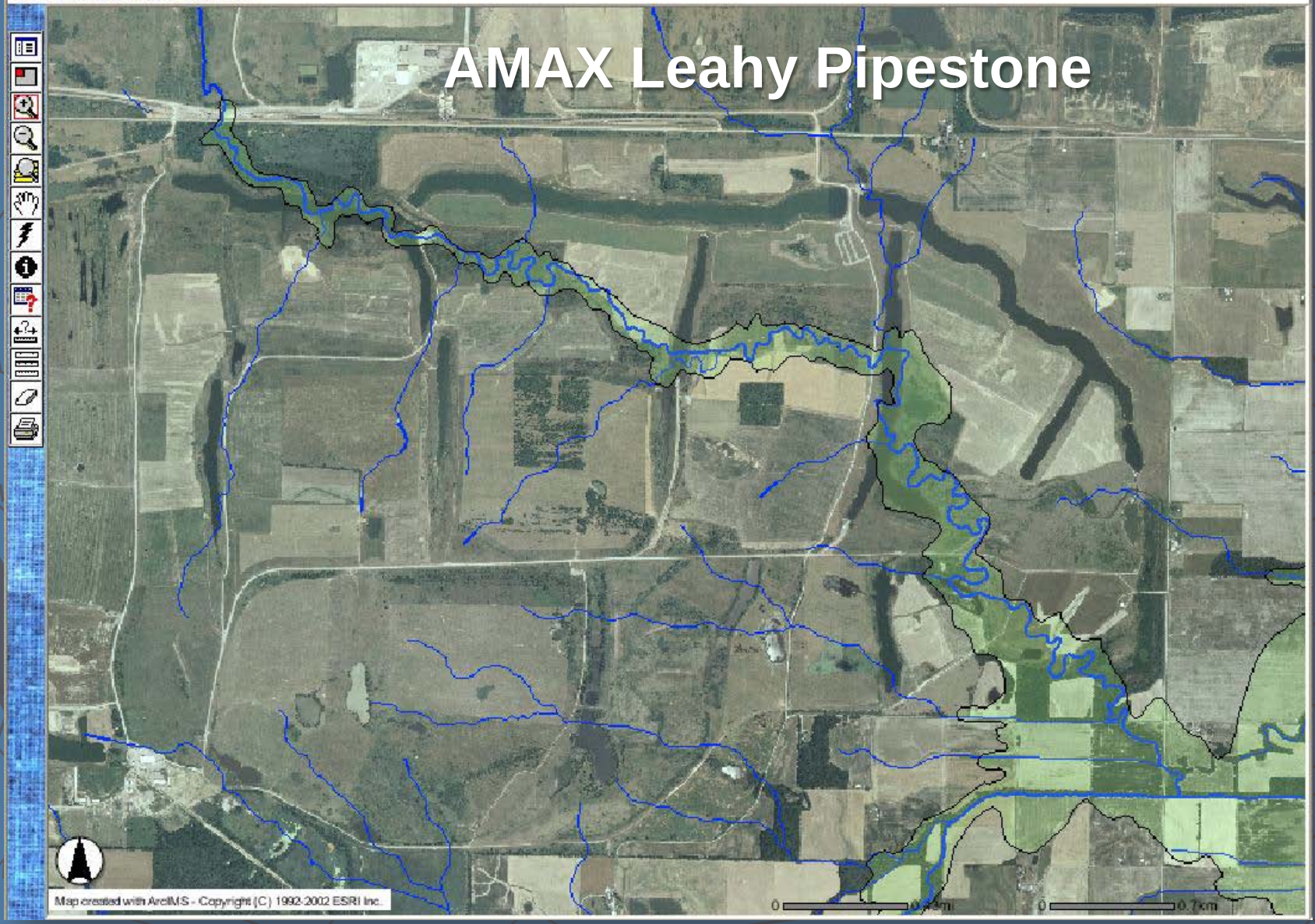


Site	Length	Meander	M r	Buffer
Galum Div.	16,400	-	-	150-250

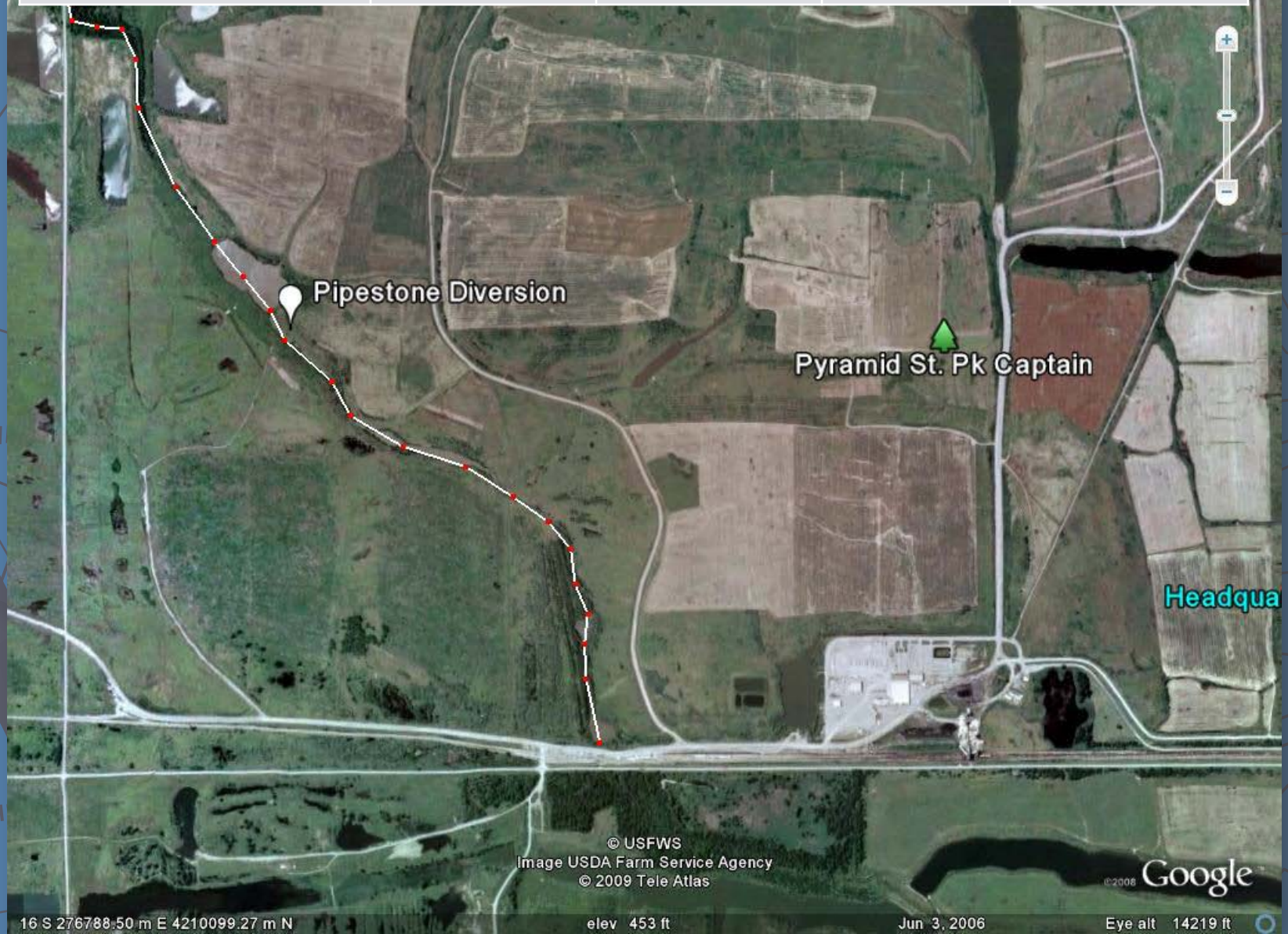


Illinois Department of Natural Resources
Office of Mines & Minerals
Land Reclamation Division

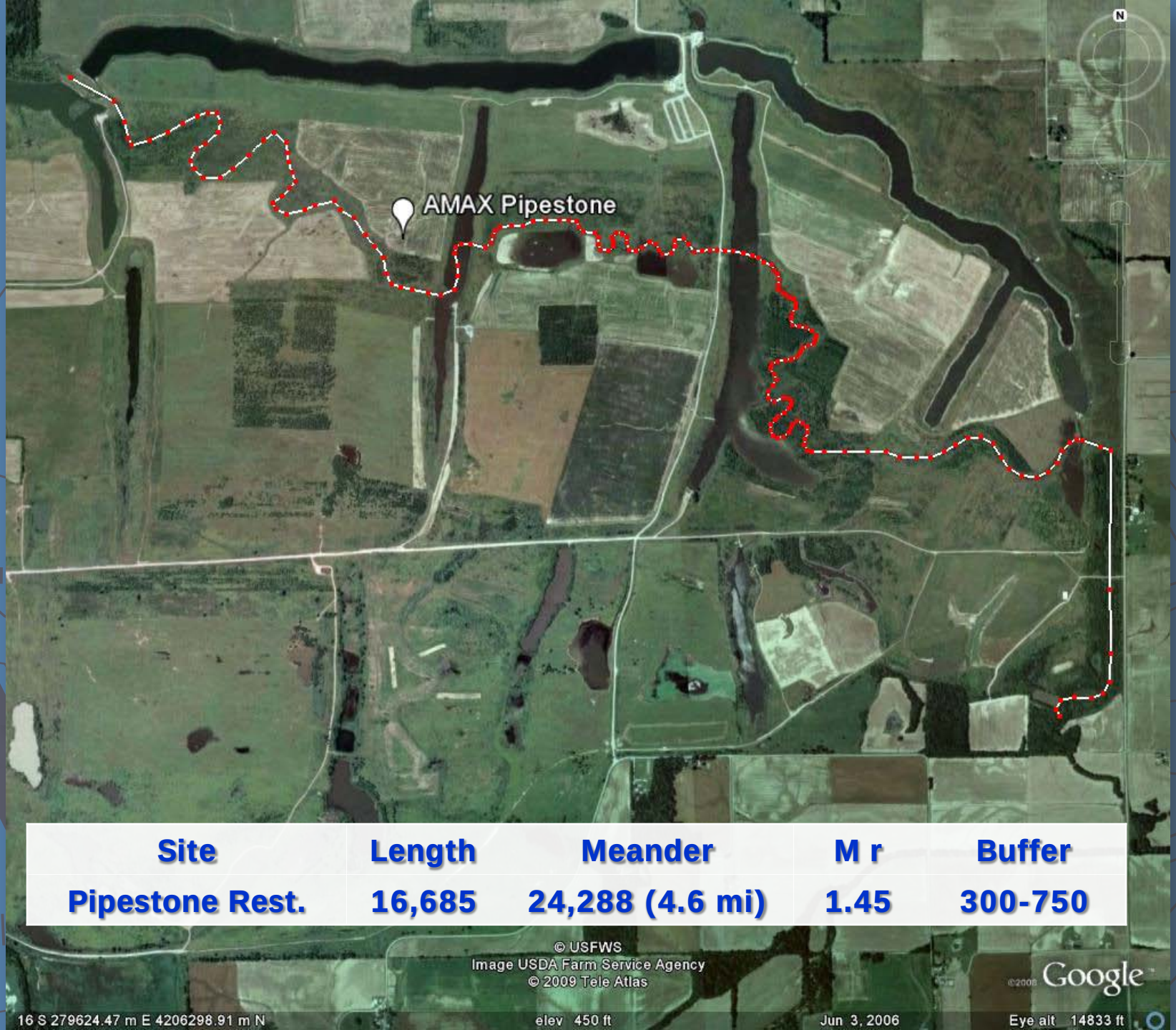
ArcIMS Illinois Coal Mine Permit Viewer



Site	Length	Meander	M r	Buffer
Pipestone Diver.	11,342	-	-	85



Site	Length	Meander	M r	Buffer
Pipestone Temp Div.	22,704	-	-	-



Site	Length	Meander	M r	Buffer
Pipestone Rest.	16,685	24,288 (4.6 mi)	1.45	300-750

Woodrail Rd
Union School Rd
Tangen Cmtry Rd
© USFWS
Image USDA Farm Service Agency
© 2009 Tele Atlas
Google
16 S 280811.26 m E 4206735.06 m N
elev 439 ft
Jun 3, 2006
Eye alt 7448 ft

AMAX Leahy

Sept 1985

April 2009
Reconnection Fall 1991

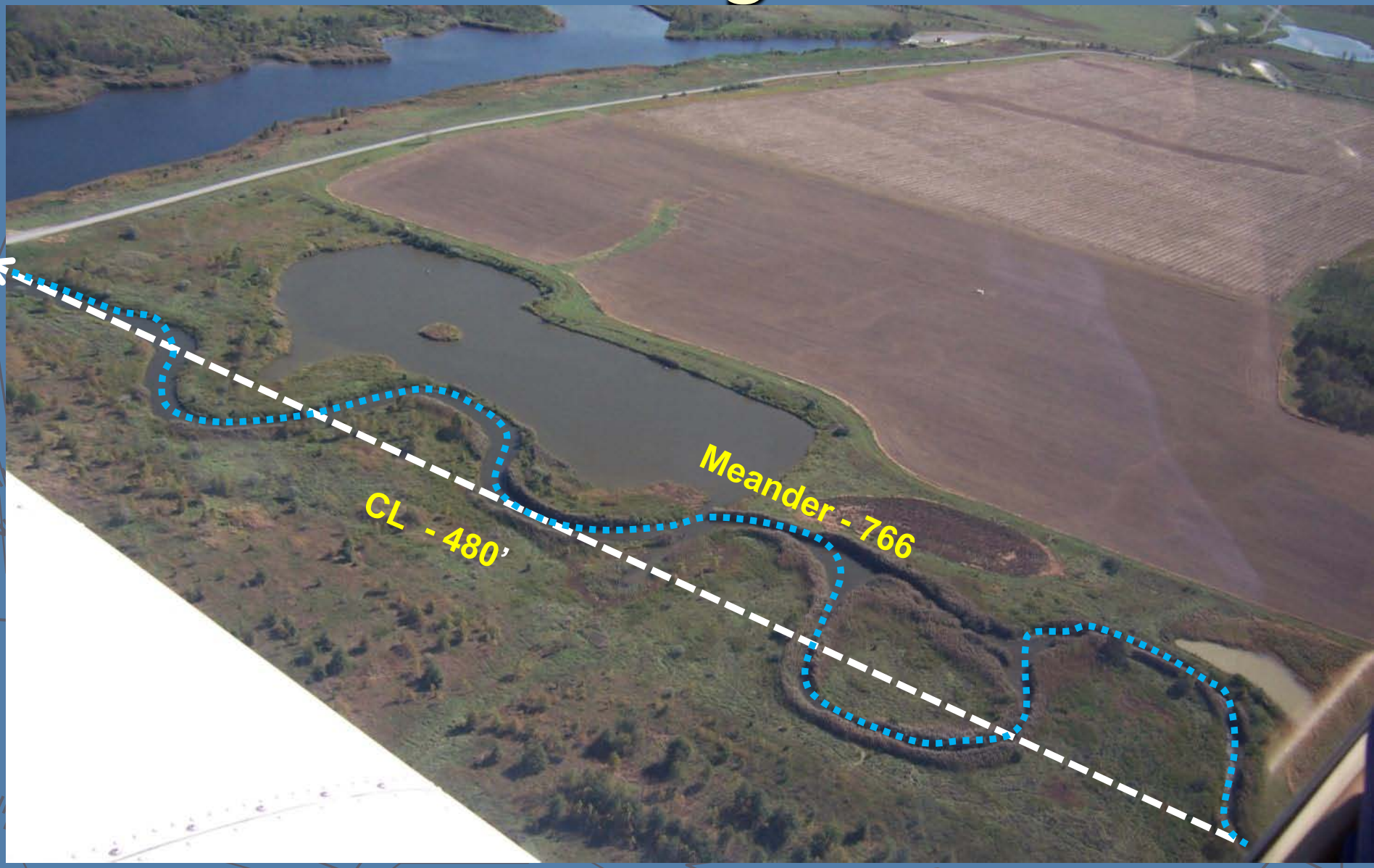
Sept 1985

June 2005

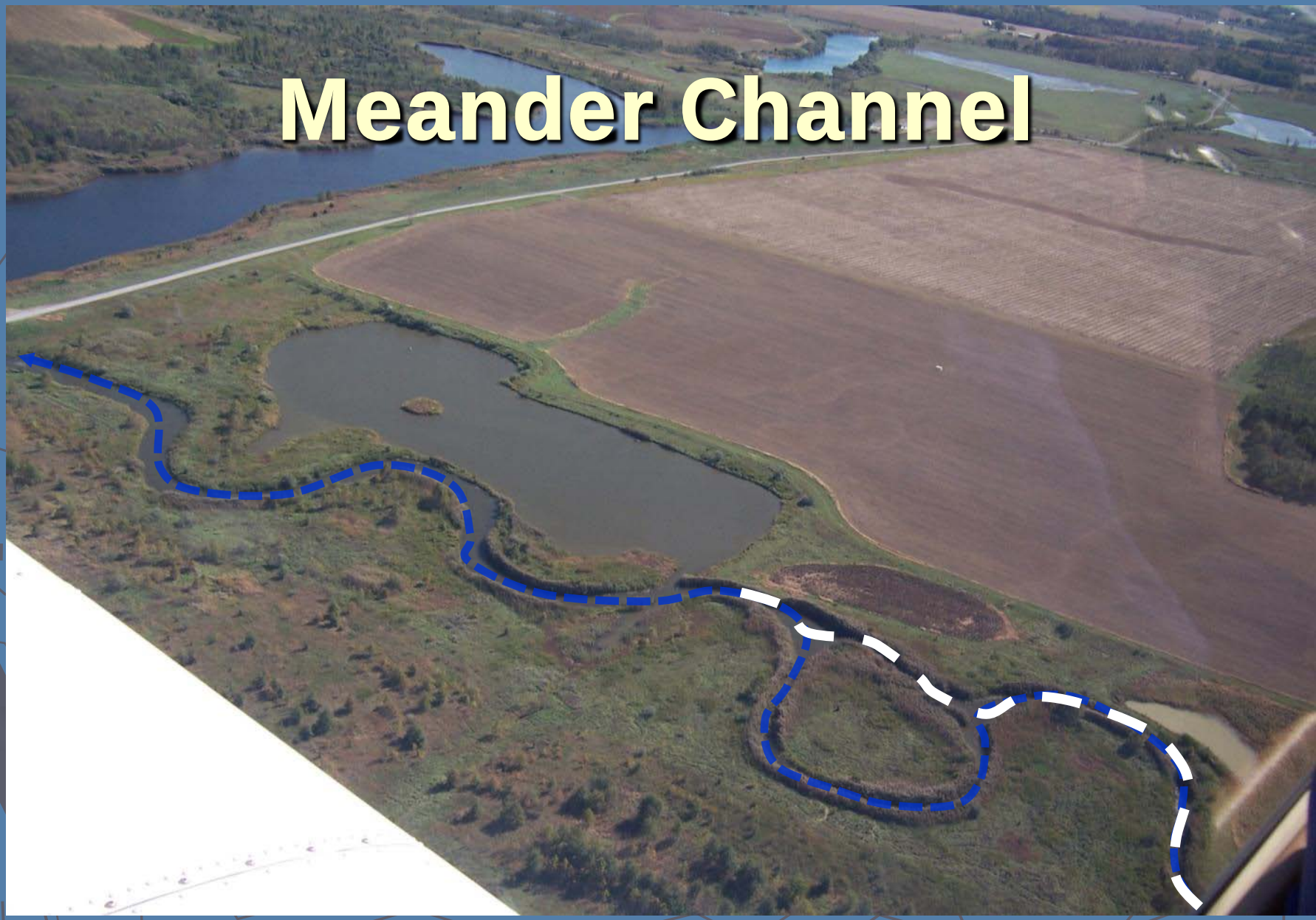
Design

Floodplain Wetland
Conservation Buffer / Corridor - 500 – 750 '
Meander

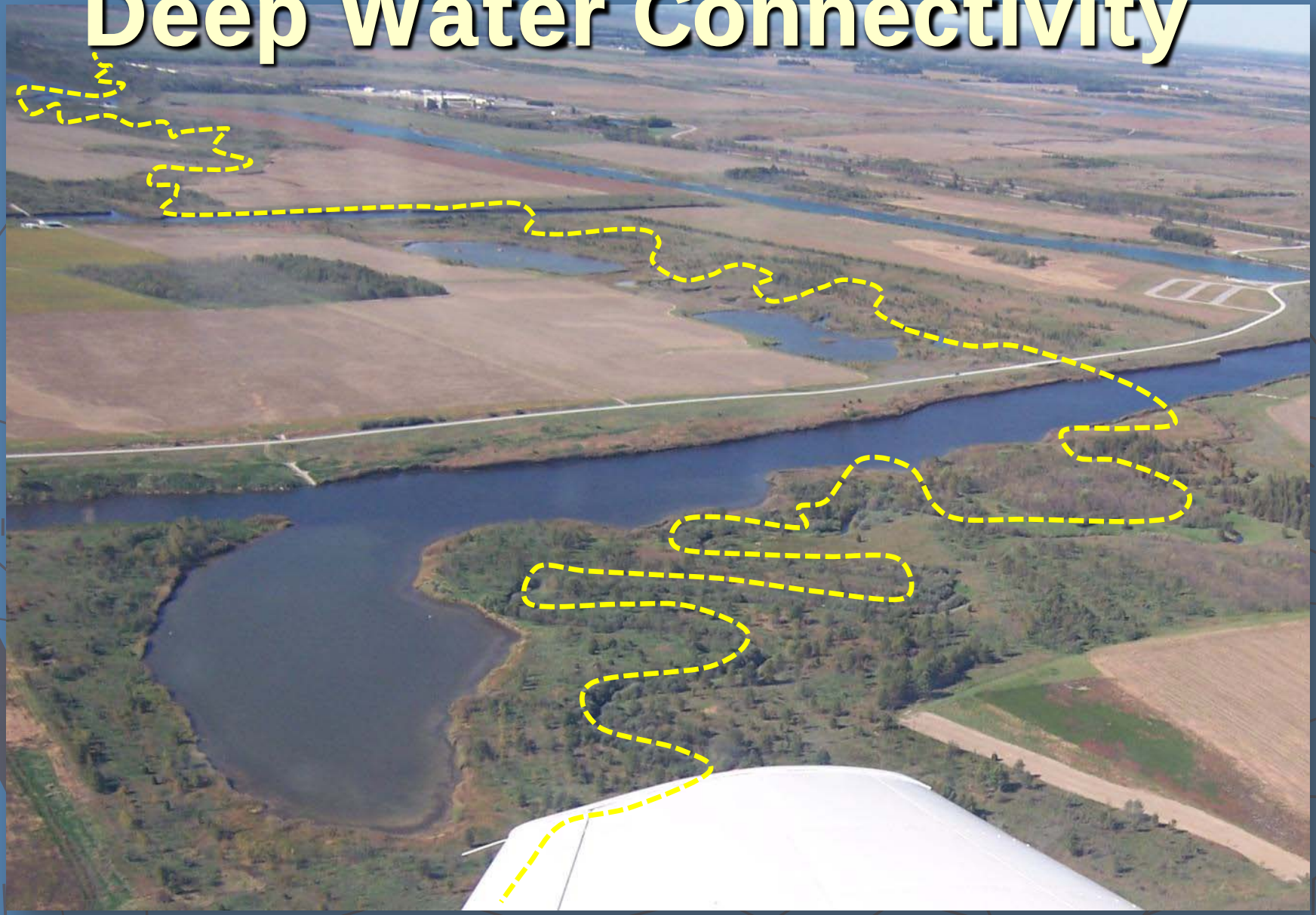
Design



Meander Channel



Deep Water Connectivity



METHODS

GEOMORHOLOGICAL

- Bank
- Channel
- Flow
- Bed Substrate

PHYSICAL- CHEMICAL

BIOLOGICAL

- Fish & Invertebrates
- Buffer Zone Canopy

Monitoring: Streamflow

Pipestone	Discharge (cfs)				
Winter (1/17 - 18/95)	L7	R1	R2	R3	L3
	-	-	9.33	6.71	7.52

* Restoration reconnection downstream of L7 prior to June 92

Sediment Reduction

Pipestone *June 92	Turbid (NTU)	SS (ppm)	Fe (total)	pH
Upstream - L7	36	34	0.98	7.2
Downstream - R3	8	3	0.23	6.8
November 93				
Upstream - L7	26	28	1.14	9.2
Downstream - R3	8	12	0.62	8.3

* Restoration reconnection downstream of L7 prior to June 92

Monitoring: “Indicator“ Species

Pipestone

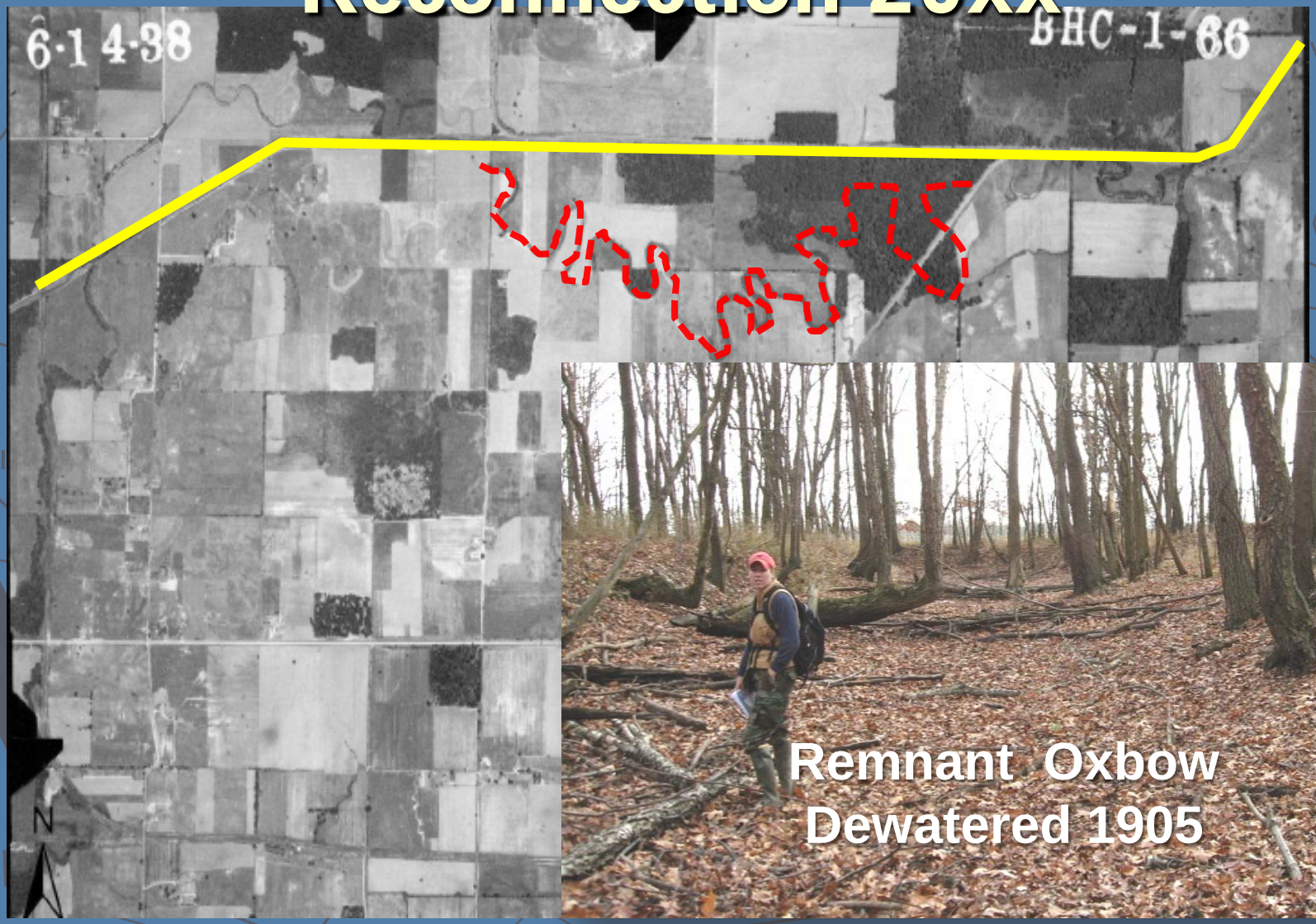
Winter 95	L7	R1	R2	R3	L3
Brook Silversides	19	>50	>50	34	-
Blackstripe Top Min.	1	0	15	4	2
Mayfly (Canidae)	-	-	P	P	-
Flies (Chironomidae)	P	P	P	P	P
Stonefly ’88 (Perlidae)					40

* Restoration reconnection downstream of L7 prior to June 92

PIPESTONE:

Remnant Oxbow
Dewatered 1905

Channelized 1905-Reconnection 20xx

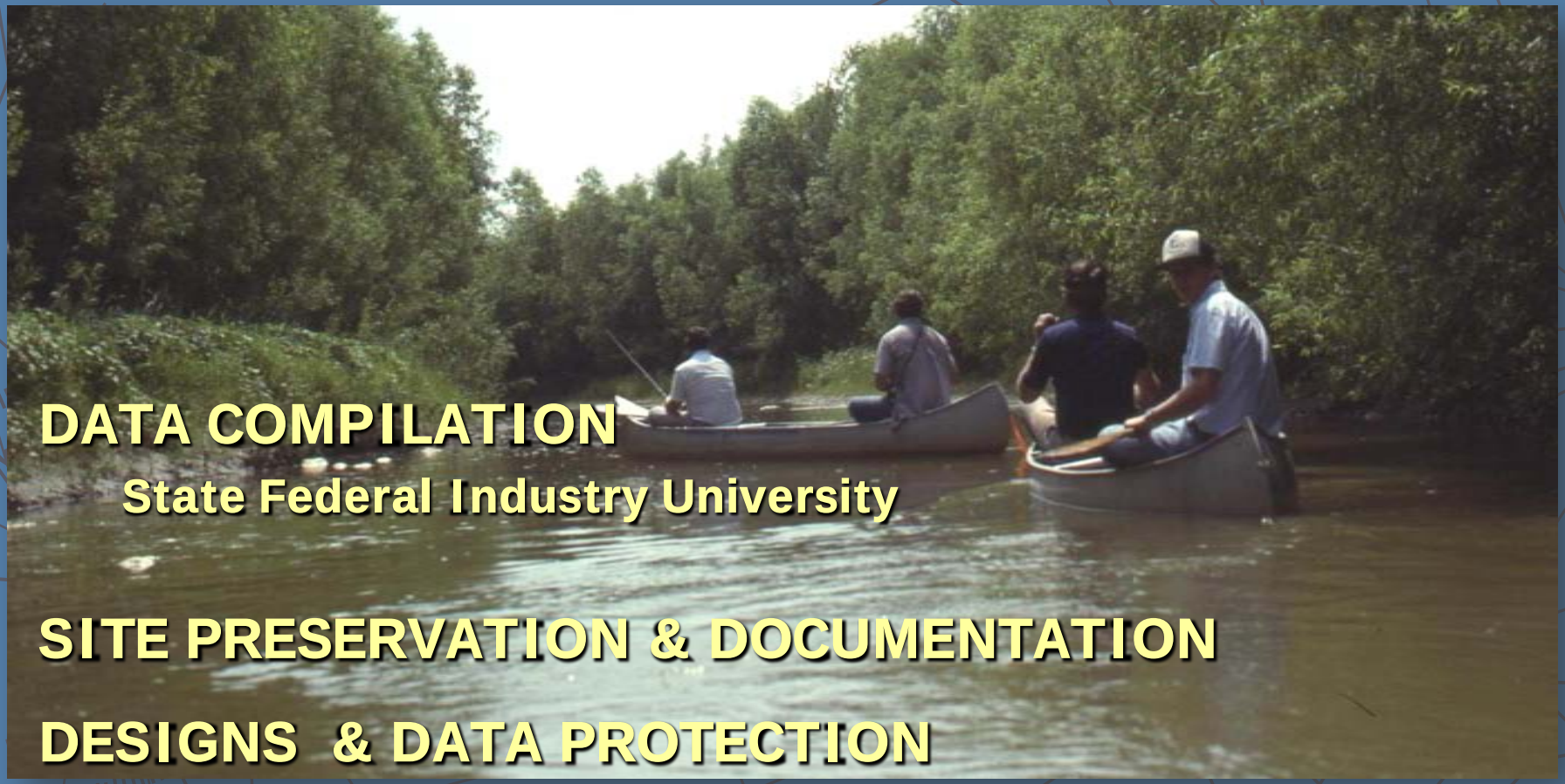


Remnant Oxbow
Dewatered 1905

30 YEAR REASSESSMENT

RESTORATION SUCCESS

Functions and Values



DATA COMPILATION

State Federal Industry University

SITE PRESERVATION & DOCUMENTATION

DESIGNS & DATA PROTECTION

PIPESTONE CREEK: FALL 1989
ARCH OF ILLINOIS - PIPESTONE CR
Aquatic Monitoring 1987
PIPESTONE CREEK 1986 SURVEY
OF ILLINOIS PIPESTONE CREEK
Diversion - Monitoring
AMAX
COAL COMPANY
1984 MINE STREAM SURVEY
LEAHY MINE
PREPARED BY
Gilbert/Commonwealth, Inc.

DATA ARCHIVE

GALUM

File Edit View Favorites Tools Help

Back Search Folders

Address C:\Documents and Settings\jnawrot\My Documents\STREAM RESTORATION\MONITOR DATA Archives OMM\GALUM Go

Folders

- Desktop
  - My Documents
    - STREAM RESTORATION
      - BACKGROUND DOCS
      - MAPS PHOTOS
      - MONITOR DATA Archives OMM
        - BONNIE
        - GALUM
        - WHITE WALNUT
      - PHOTO DOC
      - PRESENTATIONS
      - PROGRAM REGIST
      - REGULATIONS
      - TRAVEL
  - My Computer
  - My Network Places
  - Recycle Bin

Name	Size	Type	Date Mod
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Galum Creek 2002 Report Text	28 KB	Microsoft Office Word...	3/26/200
Galum Creek 2002 Table 1	24 KB	Microsoft Office Excel...	3/26/200
Galum Creek 2002 Table 2-1	21 KB	Microsoft Office Excel...	3/26/200
Galum Creek 2002 Table 2-2			3/26/200
Galum Creek 2002 Table 2-3			3/26/200
Galum Creek 2002 Table 2-4			3/26/200
Galum Creek 2002 Table 3			3/26/200
Galum Creek 2003 APPENDIX 1			3/26/200
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Galum Creek 2003 Part 2	218 KB	Microsoft Office Word...	3/26/200
Galum Creek 2003 Part 3	21 KB	Microsoft Office Excel...	3/26/200
Galum Creek 2003 Part 4	27 KB	Microsoft Office Excel...	3/26/200
Galum Creek 2003 Part 5	19 KB	Microsoft Office Excel...	3/26/200
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GALUM CREEK 2005 Part 5	13,055 KB	Microsoft Office Word...	3/26/200
Galum Creek 2006 Part 1	766 KB	Adobe Acrobat 7.0 D...	3/26/200
Galum Creek 2006 Part 2	28 KB	Adobe Acrobat 7.0 D...	3/26/200

Type: Microsoft Office Excel 97-2003 Worksheet
Author: Dale
Date Modified: 3/26/2009 4:12 PM
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start Microsoft ... Document... GALUM 10:52 PM

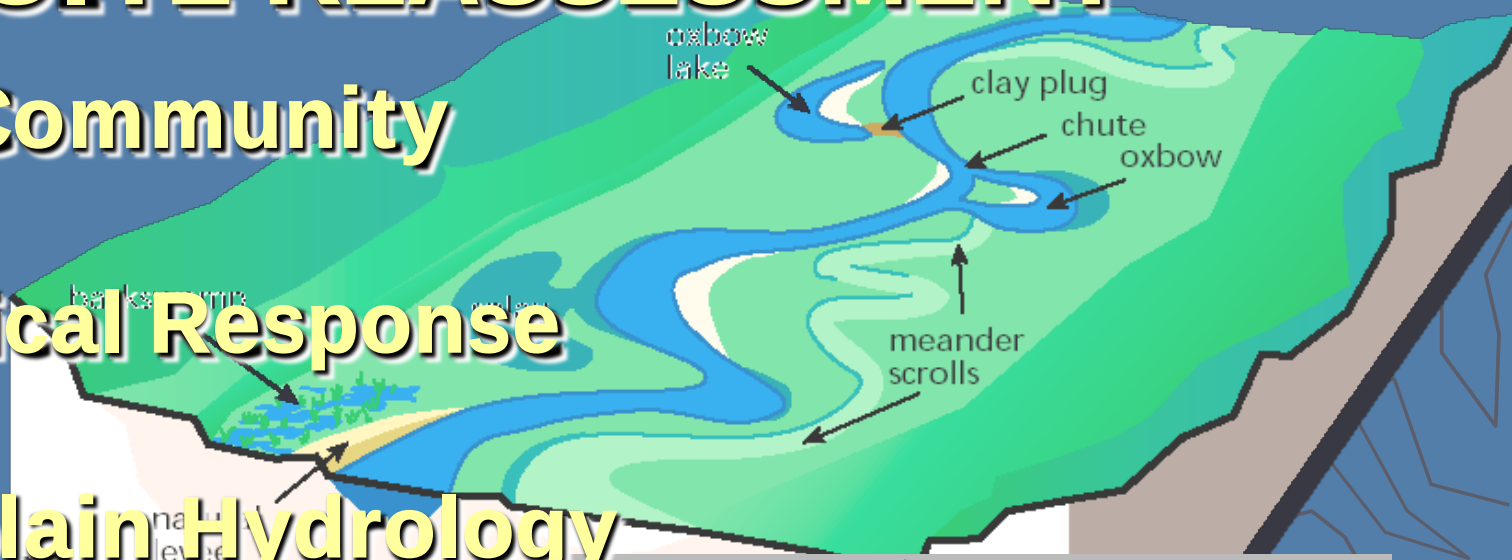
SITE REASSESSMENT

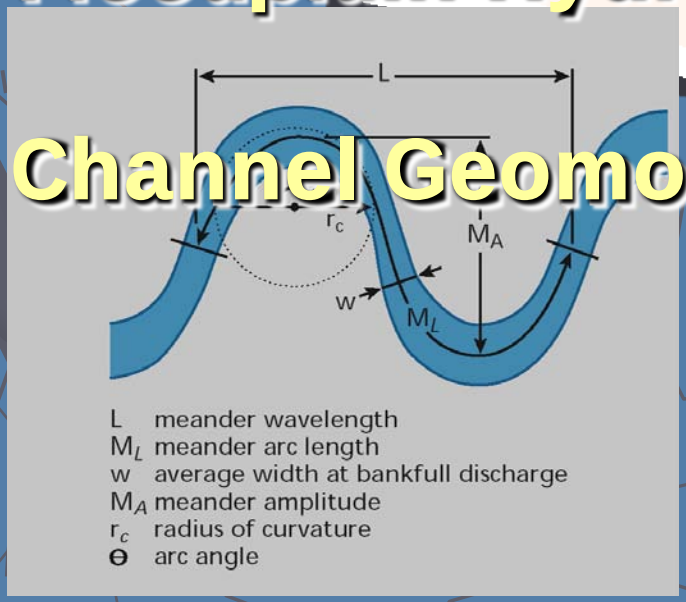
Plant Community

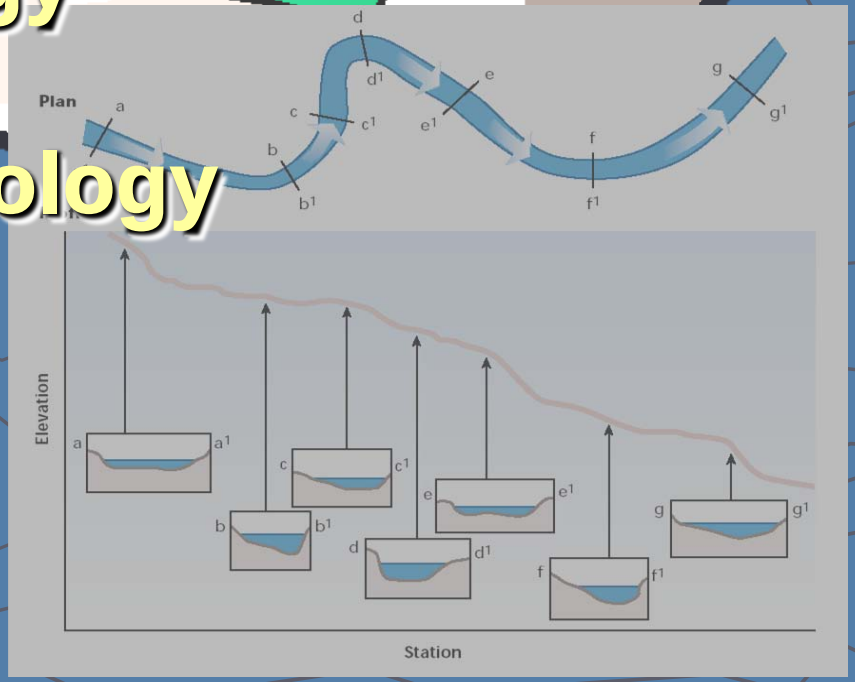
Biological Response

Floodplain Hydrology

Channel Geomorphology







“..but can you restore .....
the functions and values?”

Peabody

Peabody Energy - Midwest Operating Group

Geomorphic Reclamation in the Midwest

Industry Perspective:
Past and Current Practices, Benefits and Challenges

Scott McGarvie and Rich Williams

Geomorphic Reclamation and Natural Stream Design at Coal Mines:
A Technical Interactive Forum

Bristol, Virginia
April 28-30, 2009

Introduction

- The goal of this overview is to better understand the challenges and benefits of geomorphic reclamation at Midwest surface coal mining operations.
- What is Geomorphic Reclamation?
  - The concept has been developed over the last decade by well known geomorphologists and engineers such as Horst J. Schor and Donald H. Gray (Landforming, John Wiley and Sons, 2007).
  - In terms of mining reclamation, the technique was originally developed at active mining sites in New Mexico in 2006 (Carlson Software 'Natural Regrade').
  - Geomorphic Reclamation can be explained as *the process of restoring the earth's shape or surface to a suitable condition or use*.
  - In the context of surface coal mining, Geomorphic Reclamation can be narrowed to mean the process of restoring disrupted ground conditions and landscape to a suitable post-mining configuration and use.

Peabody

What are the Benefits and Challenges?

- The importance of geomorphic reclamation is creating topography and slope configurations that remain stable.
- Stable slopes follow natural hillside geometry more so than conventional grading designs and recreate natural drainage patterns rather than straight convex terraced slopes.
- Natural landform grading techniques and natural drainage development, if designed properly, yield a post-mining landscape that resists surficial erosion and mass wasting and increases the opportunity for more diverse vegetation.
- If geomorphic land grading is preferred for successful surface mine reclamation, why haven't more operators and regulators considered the long-term environmental and aesthetic benefits of artificial reshaping and restoration of natural topography?

Peabody

What are the issues?

- Regulations promulgated under the Surface Mining Control and Reclamation Act (SMCRA) and Sections 401, 402 and 404 of the Clean Water Act (CWA)
- Conventional mining and reclamation practices
- Methods of restoring jurisdictional waters, i.e. wetlands and streams

Peabody

The Laws, Regulations and Permits

- Surface Mining Control and Reclamation Act (SMCRA)
  - Each mining and support area will require a SMCRA permit covering both surface affected areas and underground shadow area. Permitted surface areas require reclamation bond. A SMCRA permit may take more than 12 months from submittal to issuance.

- The Clean Water Act (CWA)
  - Section 401 (Water Quality Certification)
    - Required when permitted activities may affect the water quality of a receiving stream or when fill material is placed in a jurisdictional water of the United States. A Section 401 WQC is required in conjunction with a Clean Water Act Section 404 permit. A 401 WQC typically takes 9-12 months from submittal to issuance.
  - Section 402 (NPDES Permit)
    - Required for any sedimentation basin and any other point source discharge. An NPDES permit typically takes 9-12 months from submittal to issuance.
  - Section 404 (Permit to Discharge Dredged or Fill Material)
    - Required to place fill material in jurisdictional waters of the United States when disturbing certain existing surface water drainages or wetlands. A Section 404 permit is issued by the U.S. Army Corps of Engineers and can take from 12 to more than 18 months from submittal to issuance.

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Regulatory Issues (conflict and duplicity of programs)

- Prime Farmland Requirements
  - No net loss of acreage and no net loss to property owners vs. establishment of riparian buffers and ephemeral streams
  - Proof of Productivity requirements = high target yields (requires conventional tillage practices which increase erosion)
  - Erosion control of cropland
- Balance with other land uses
- NPDES requirements
  - All drainage must pass through sedimentation basins
  - Increased sediment load without erosion control systems
- Erosion Control
  - Pre-mine illustration of ephemeral streams in crop fields; why rebuild the existing problem by putting ephemeral streams back in crop fields?

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Ephemeral Streams in Crop Fields

Why replace eroded ephemeral drainages in crop fields?

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Property Ownership Issues and In-stream Impoundments

- Landowners prefer other desirable land uses over increased riparian buffers
- Landowners prefer lakes and farmable ground
- Regulators do not allow streams to be routed through bodies of water
  - In-stream impoundments are beneficial in agricultural environments
  - Reservoirs established in streams for flood control require periodic clean-out of sediment … evidence of high sedimentation loading to streams from agricultural areas
    - Sediment to be removed from northern portion of Sullivan Lake, IN = 483,400 cubic yards (accumulated over 40 years)

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No Net Loss of Cropland

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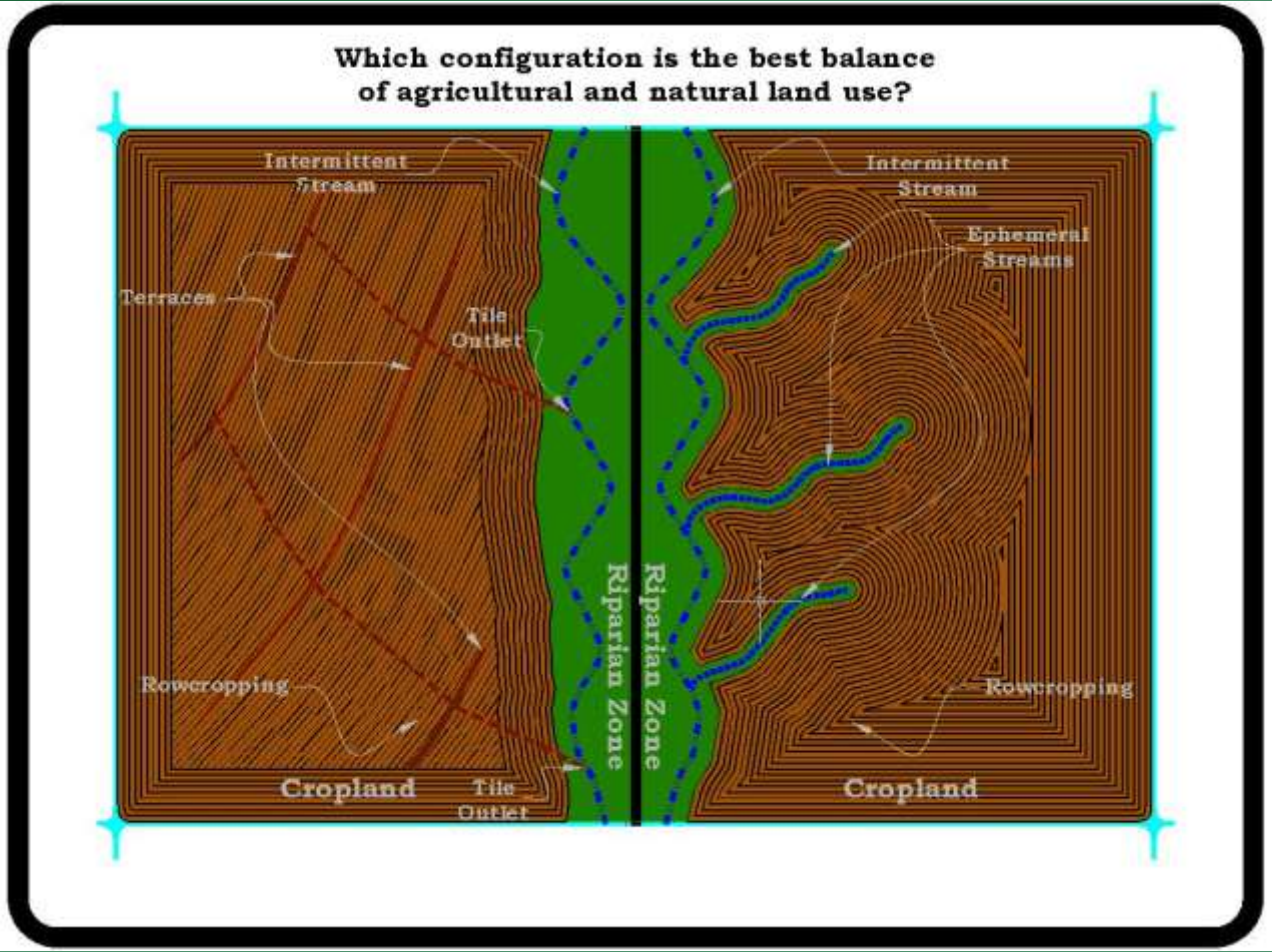
Landowners Prefer to Maximize Farmable Ground



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Properly Constructed Terraces

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Agricultural Pre-mine Land Use

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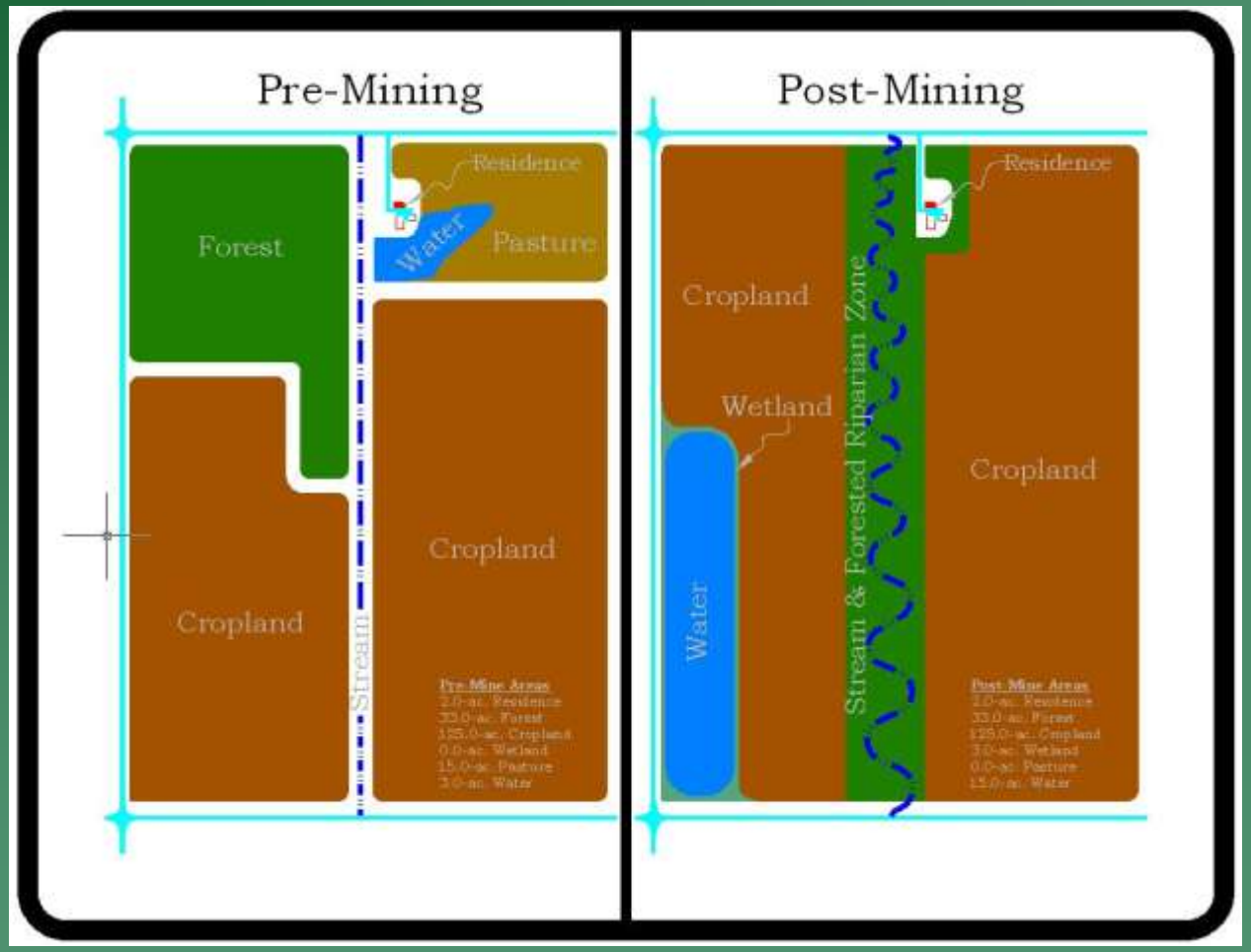
Balance and Reconfiguration of Post Mine Land Uses



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    - Sediment ends up in streams and rivers

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Stream Bypassing Open Water and Sediment Control

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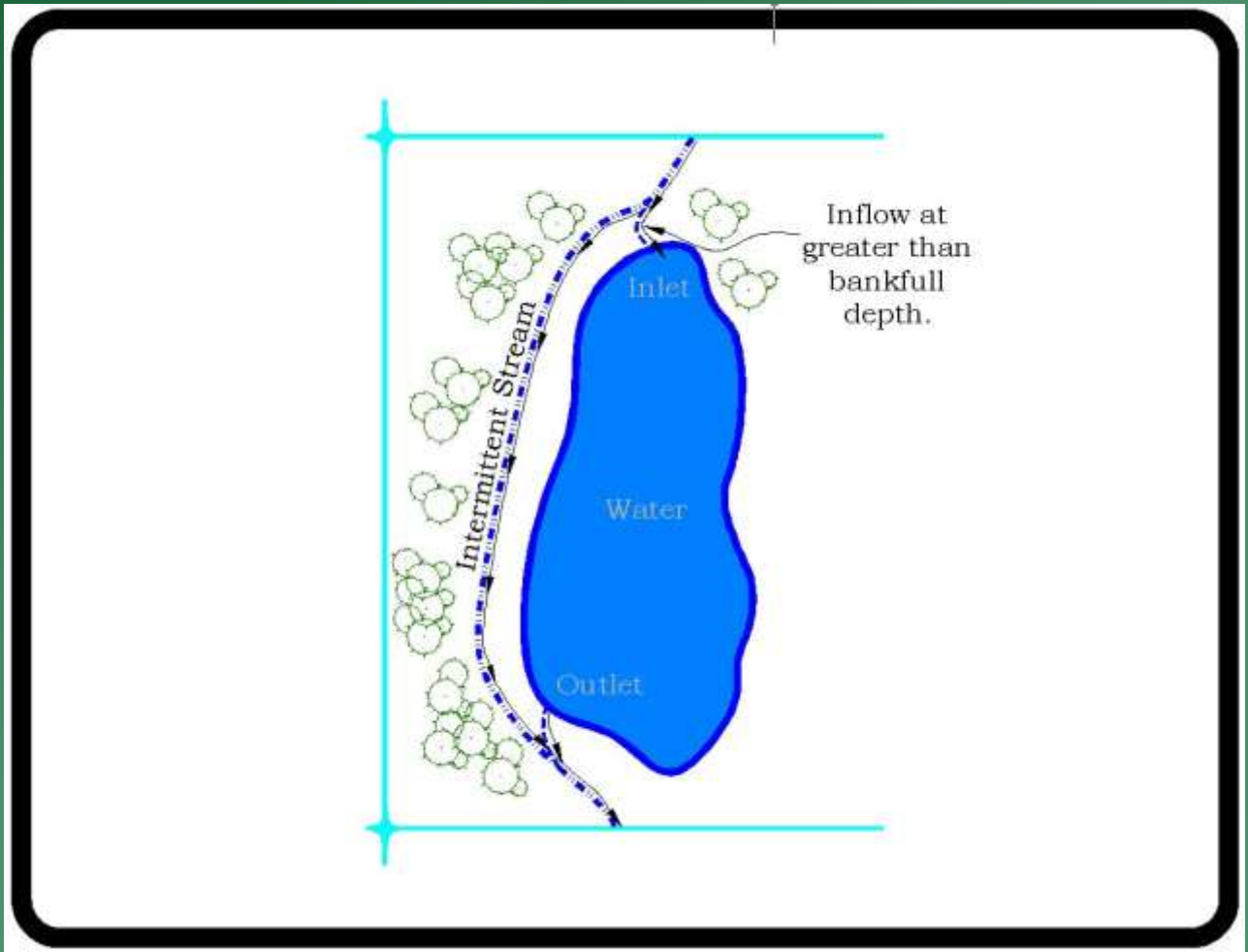
Stream Connected to Open Water with Above Bank Inflow



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Sedimentation of Reservoirs

Lake Sullivan, IN

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Sediment Loading from Runoff

Ohio River between Newburgh, IN and Owensboro, KY

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Operating Difficulties

- Contemporaneous reclamation
- Significantly longer dozer pushes result in less soil thickness (approximately 1 foot instead of 4 or more feet now typically placed) and increased compaction due to repeat tracking
- Rock grade must enable mobile soil haulage (i.e. maximum grades of 5-6% are typically used for trucks dumping soil)
- Complications of operating rubber tired equipment on uneven grades
- Advantage of trucks over scrapers for soil replacement with minimal compaction
- Safety issues
- Mechanical failure and low tire life
- Swell (different at each location)

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Opportunities

- Advance grade plan with appropriate floodplains for primary streams to be replaced.
- Plan for appropriate grades entering into floodplain area (dependent on pre-mine topography, swell, etc.).
- Truck dump single lift of soil in planned forest/wildlife areas.
- Minimal or no grading of replaced soils to reduce compaction and increase tree growth (OSM Midwest Forestry Reclamation Approach).
- Reconstruct tributaries in minimally graded soils.
- Establish enhanced riparian buffers where opportunities allow.
- Develop effective erosion control systems utilizing terraces, water and sediment control basins (WASCOBs), etc. in place of existing erosional features and ephemeral streams.
- Keep topsoil, fertilizer and pesticides in the field and out of the streams (sedimentation basins and vegetative buffers).
- Develop the reclamation plan and implement the plan for SUCCESS!

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Spoil Truck Hauling and Dozer Grading

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Final Grading

Spoil grade slope is determined by equipment capability

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Soil Replacement

Spoil and soil are direct hauled by trucks and spread by dozers to establish finished grade

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Shovel Loading End Dump Truck with Soil

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Soil Quality and Depth

Thick (often > 4 feet) soil lift establishes final grade and growth medium

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Land Uses

Flat grades are required for prime farmland (<5%) and steeper slopes and undulating topography compliment land uses like wildlife and forest

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Replacement of Water Resources

Reclaimed mining areas with lakes, wetlands and streams

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Stream Restoration

- The stream restoration methodology recently preferred by regulatory agencies is natural channel design.
- The natural stream channel design concept is based on physical channel criteria best characterized by Luna Leopold and Dave Rosgen.
- The primary criteria include:
  - Valley slope
  - Channel type
  - Meander patterns
  - Flood plain and bankfull channel dimensions
  - Bed stability

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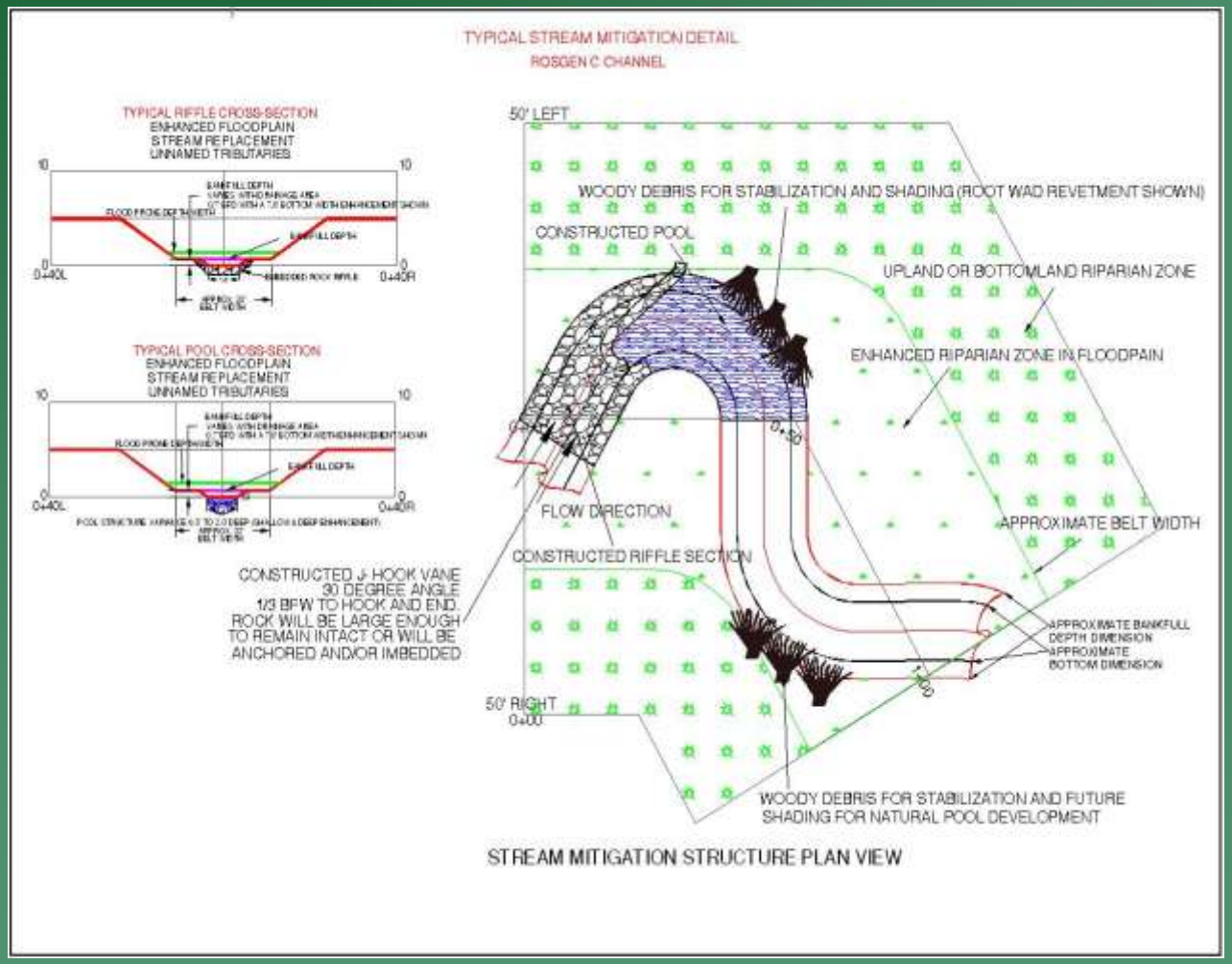
Typical Stream Design



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Reconstructed Streams

Reclaimed streams using
'Natural Stream Channel Design'
fundamentals

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Wetland Restoration

- The wetland restoration methodology preferred by regulatory agencies is bottomland hardwood plantations.
- These wetlands are created by establishing ground elevations and topography that will allow soil substrates to remain saturated and become hydric.
- The hydric soils and saturated hydrology support the growth of hydrophytic vegetation which is primarily selected hard mast tree species such as oak and hickory.

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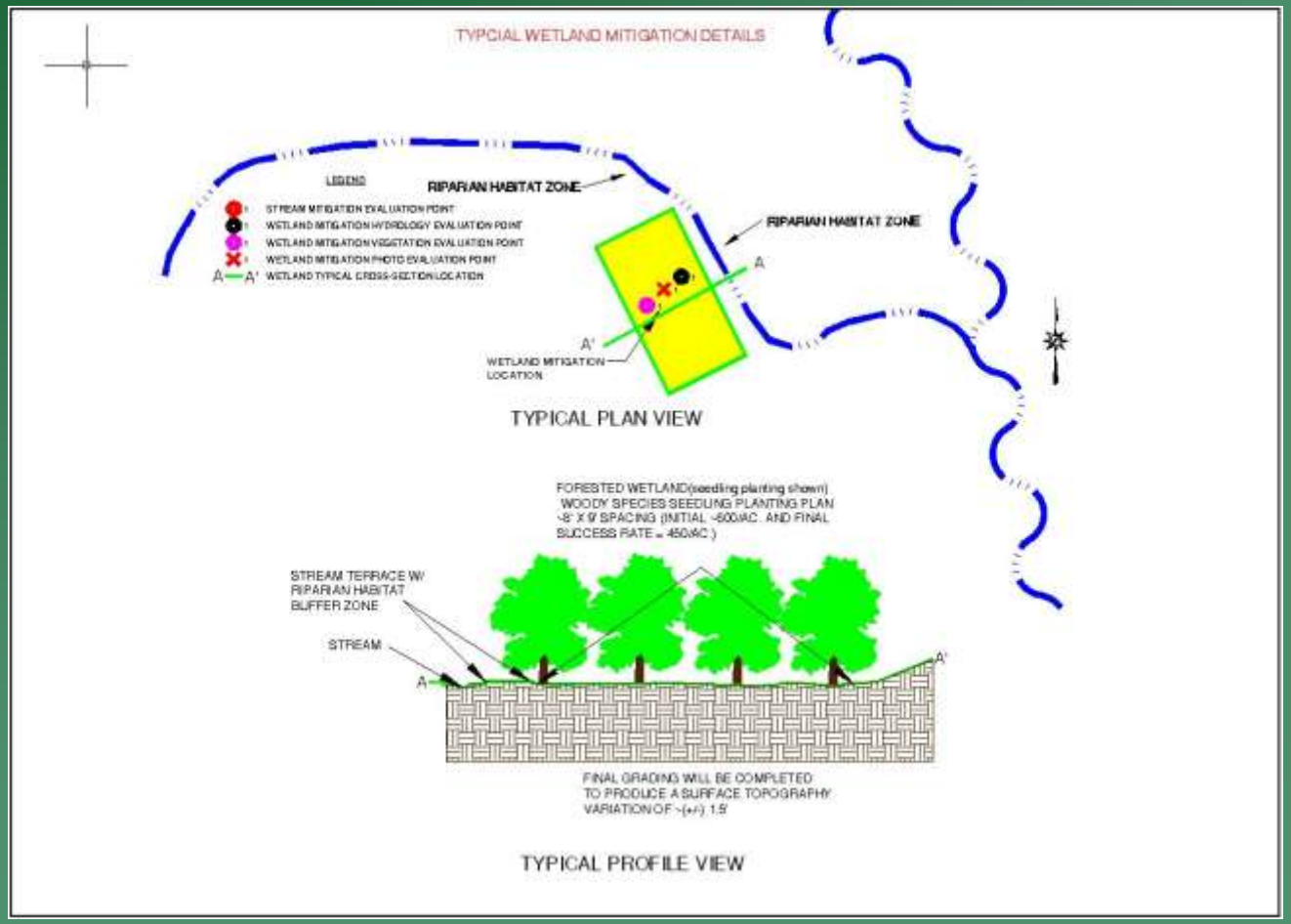
Typical Wetland Design



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Establishing Lakes and Impoundments

- Post-mining open water bodies are planned prior to and during mining.
- Private land owners recognize the value added to real estate and the added recreational opportunities lakes and impoundments provide.
- Open water bodies may be completely formed in graded spoil or as an end- or final-pit impoundment with graded highwall and spoil slopes.
- Lakes and impoundments often have wetland features incorporated around the perimeter in shallow water fringe areas or adjacent bottomland areas.

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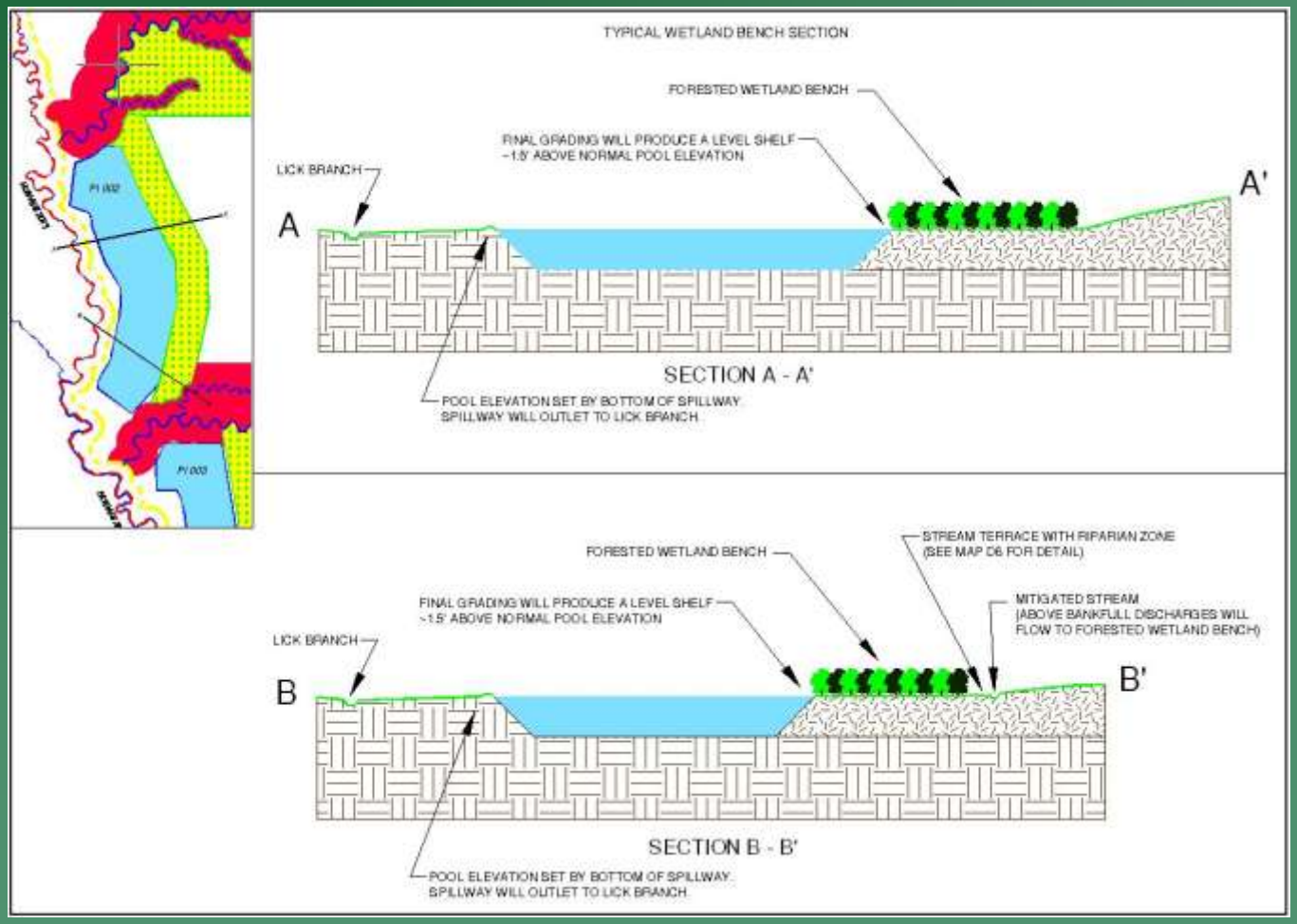
Typical Open Water Design



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Productivity

Proper landforming and soil replacement yield productive reclaimed ground

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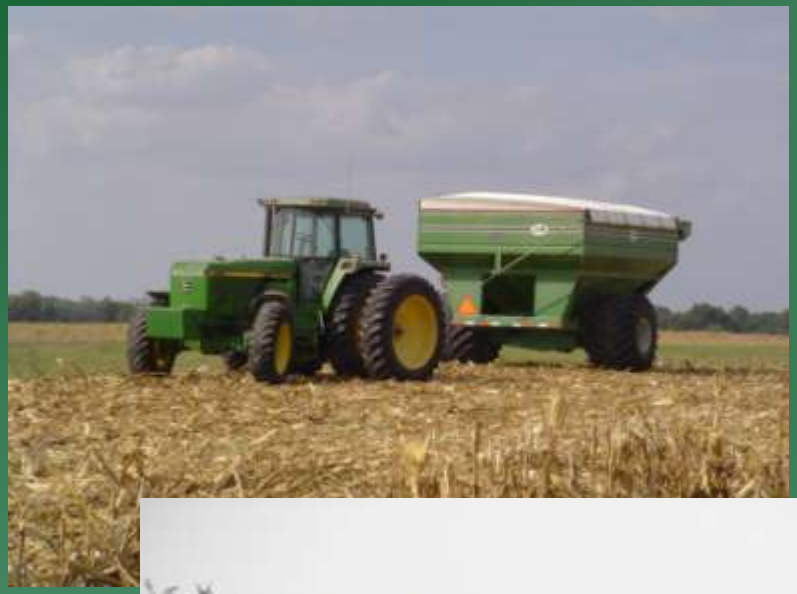
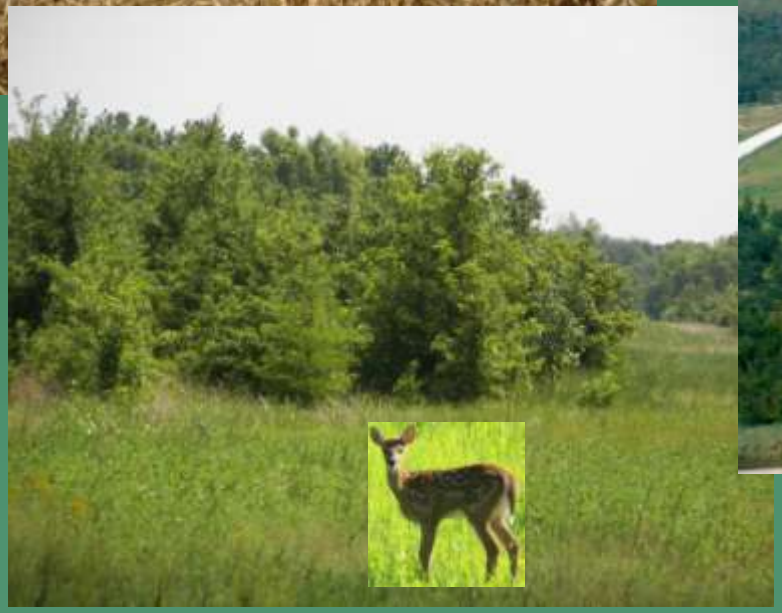
Reclamation Success = Productive Land



Productive reclaimed ground, wildlife habitat and water resources are valuable real estate



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