Influence of FRA on Water Quality and Hydrology

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APPALACHIAN REGIONAL REFORESTATION INITIATIVE ARRI

Persistent Issues

(water quality)

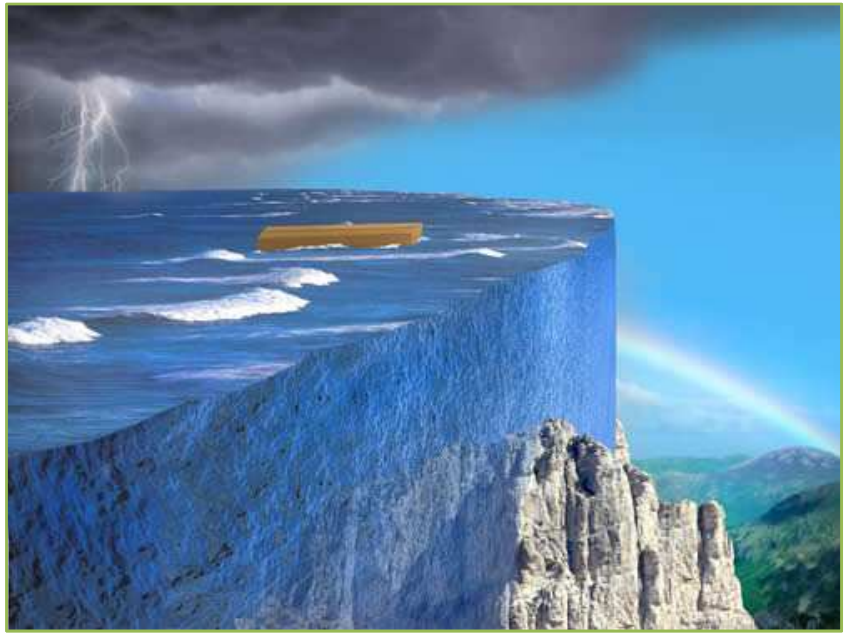
Erosion and Sedimentation

Pyrite Oxidation and AMD

Persistent Issues

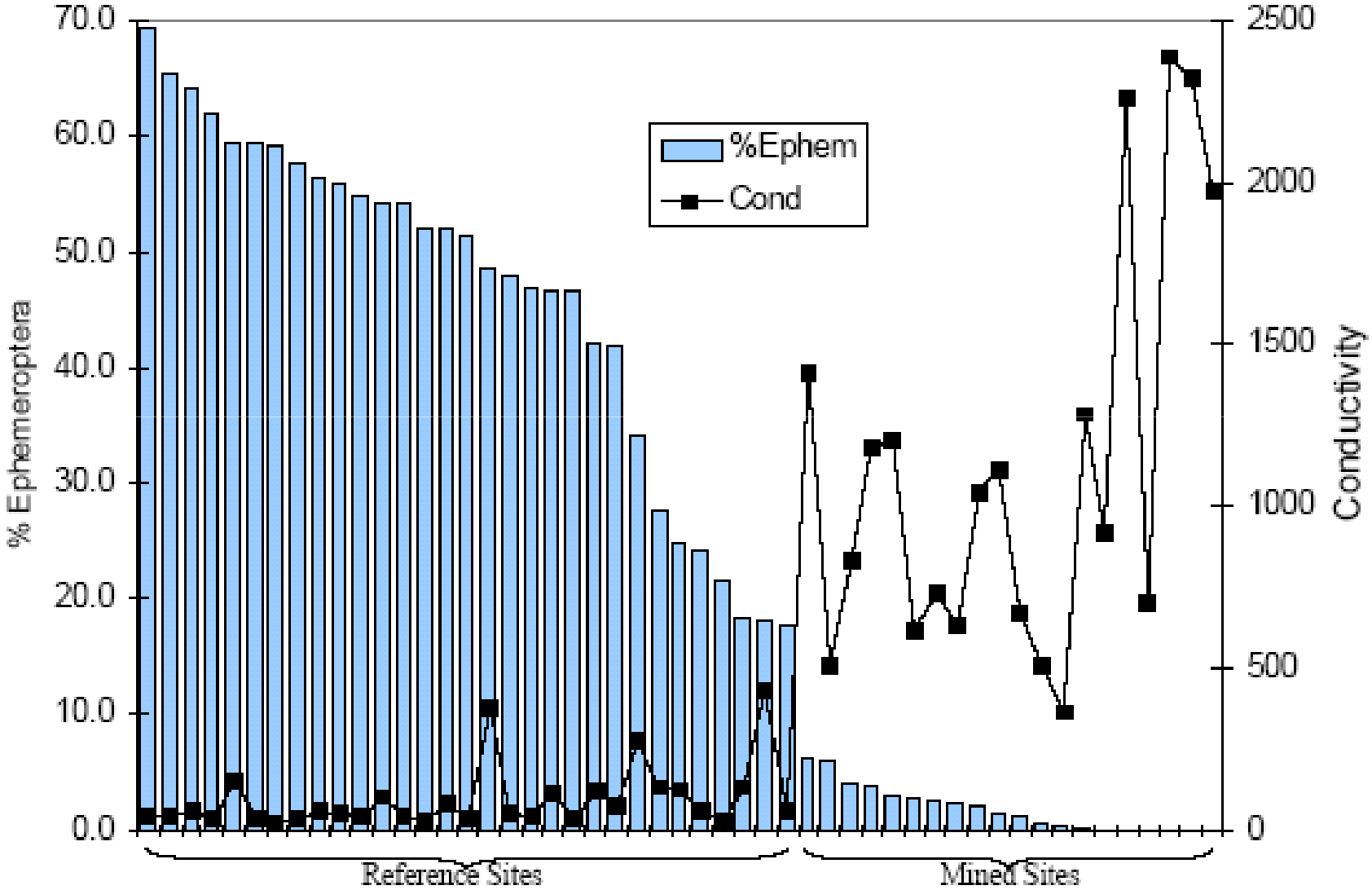
(hydrology)

Loss of Water Supply



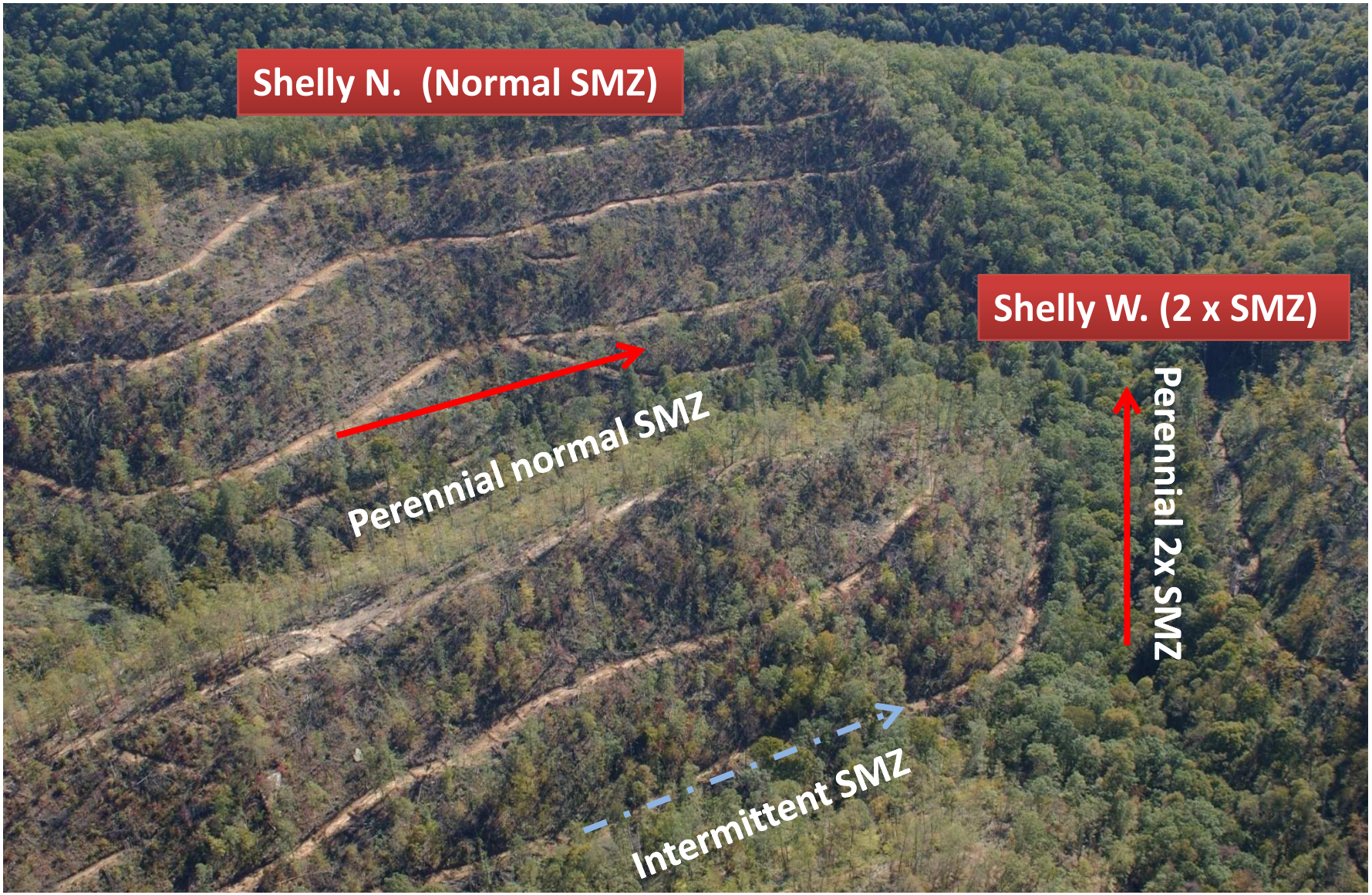
Flooding

Where Have the Mayflies Gone?



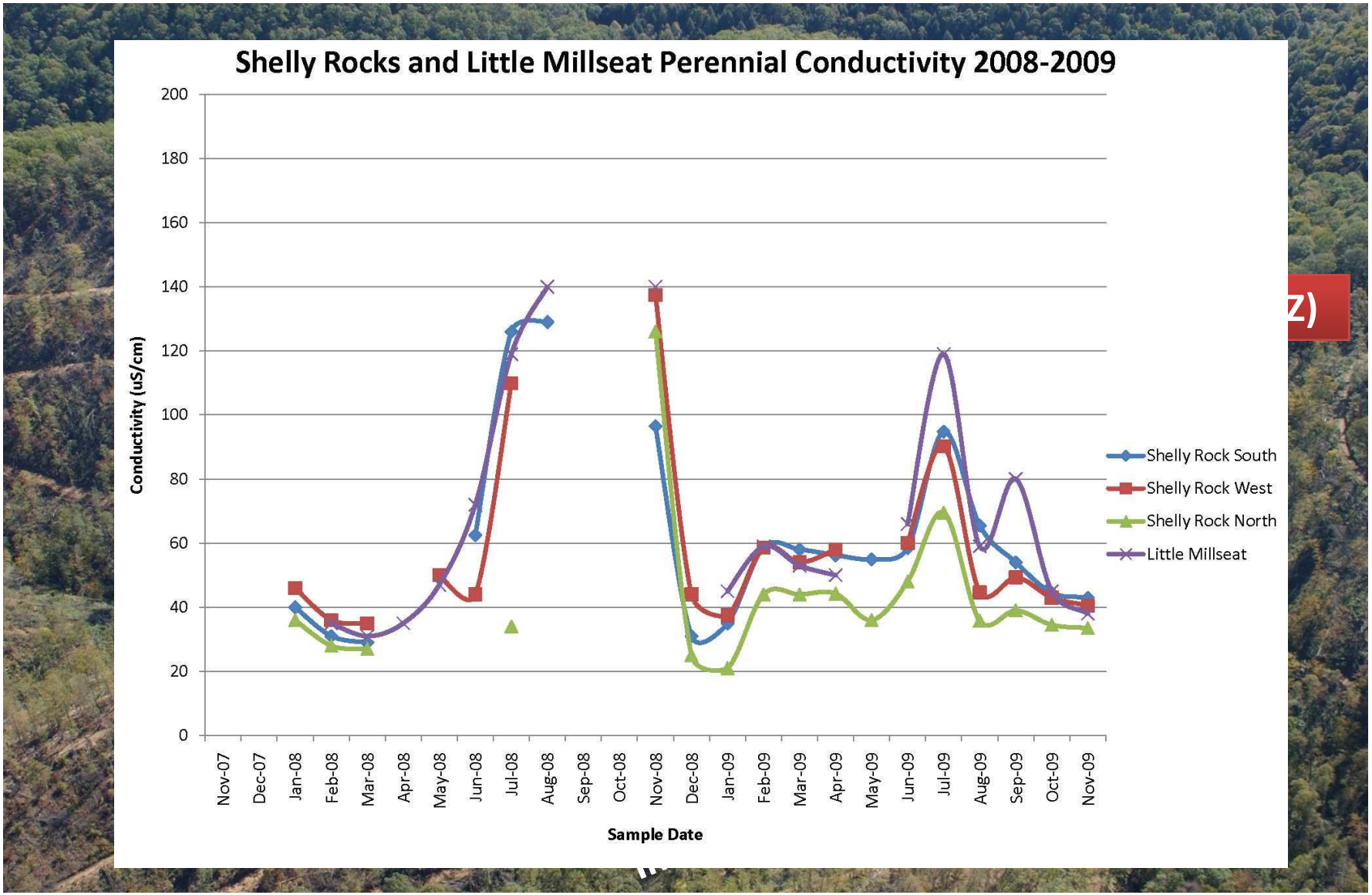
(Pond et al., 2008)

Robinson Forest SMZ Study



(Witt et al., in progress)

Robinson Forest SMZ Study



(Witt et al., in progress)

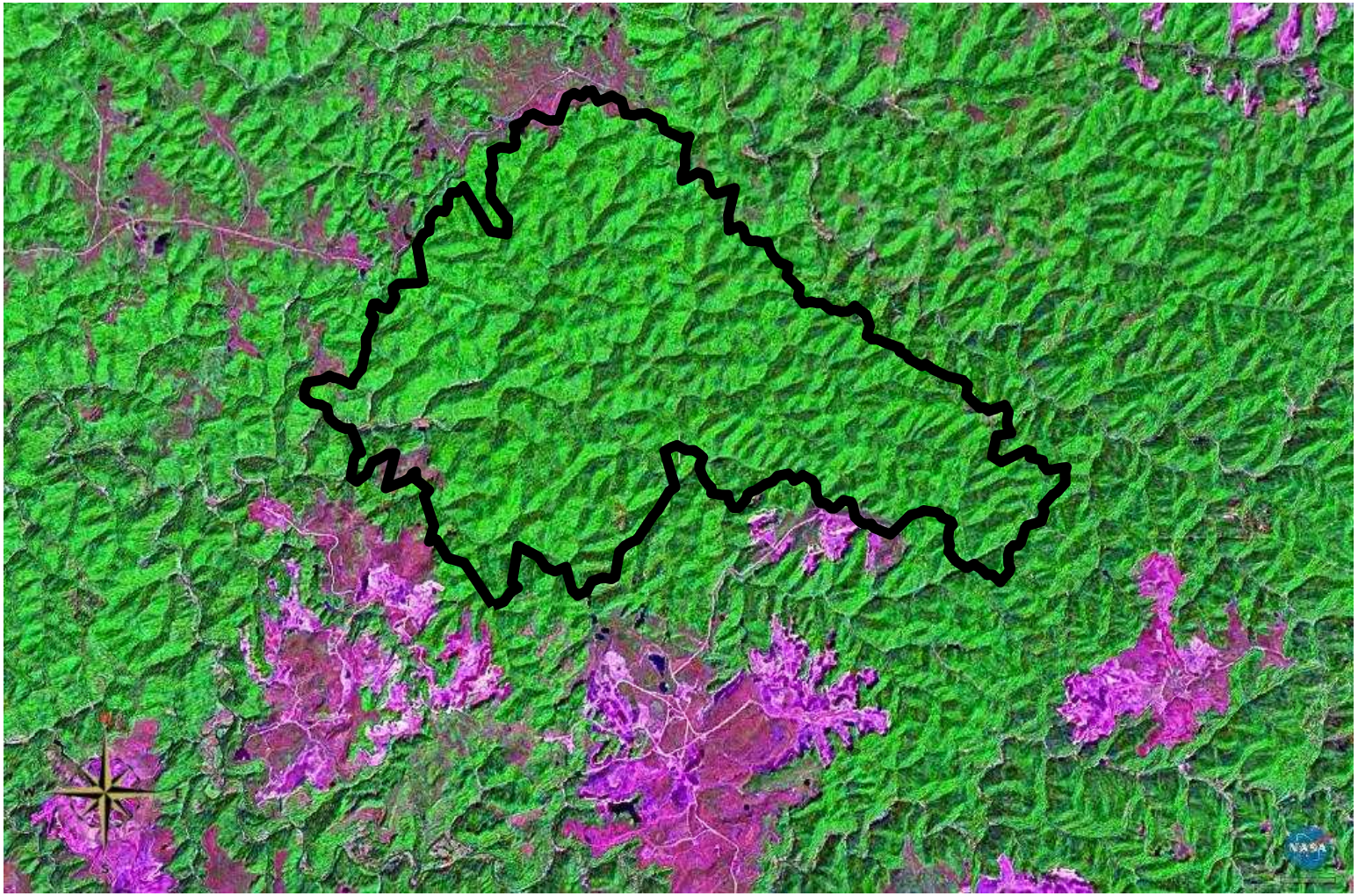
Pre SMCRA Meets Post SMCRA

Before

During

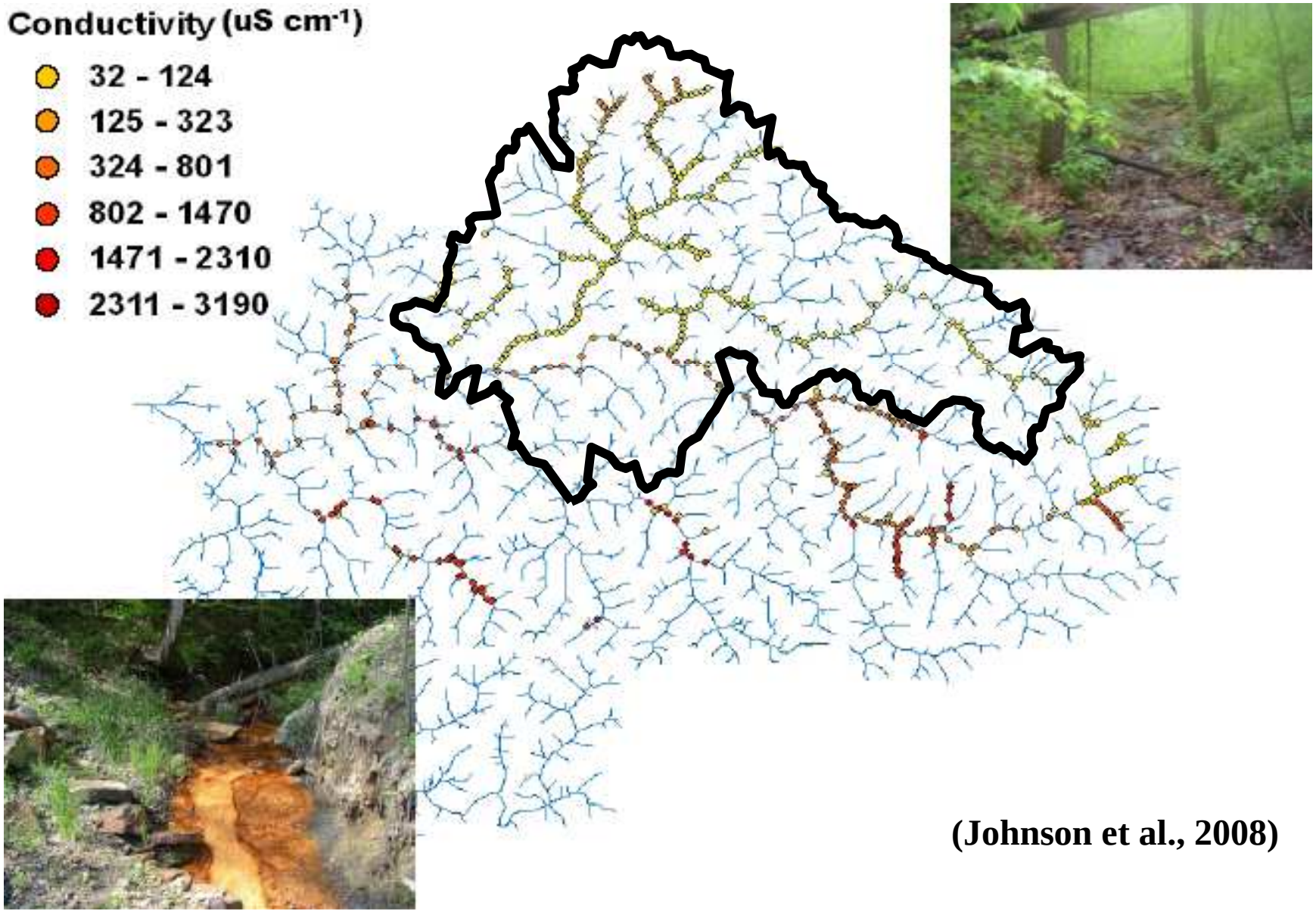
The Problems

(Water Quality/Hydrology/Habitat)



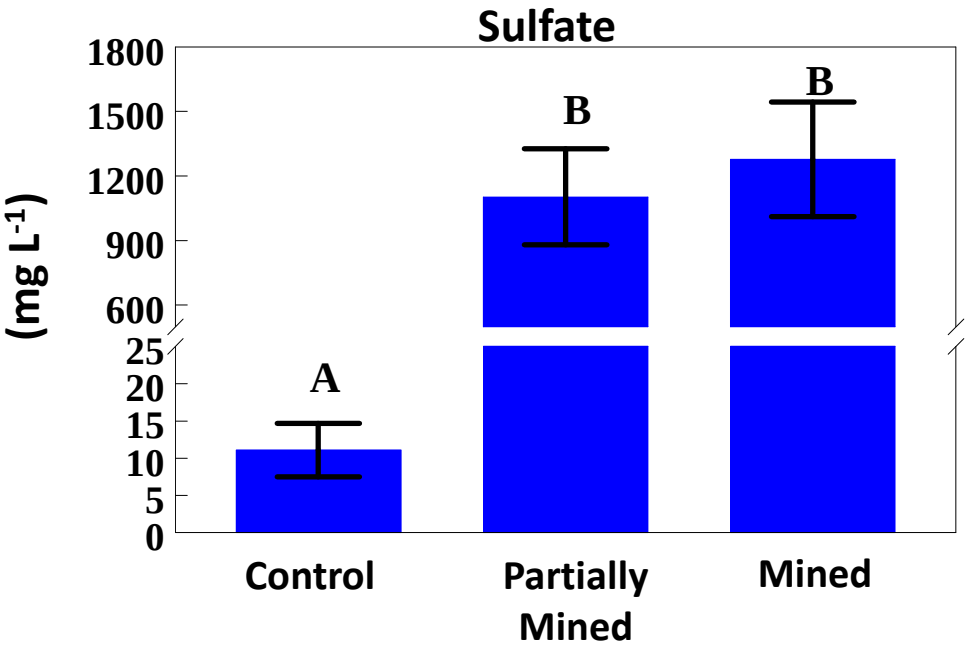
Total Dissolved Solids

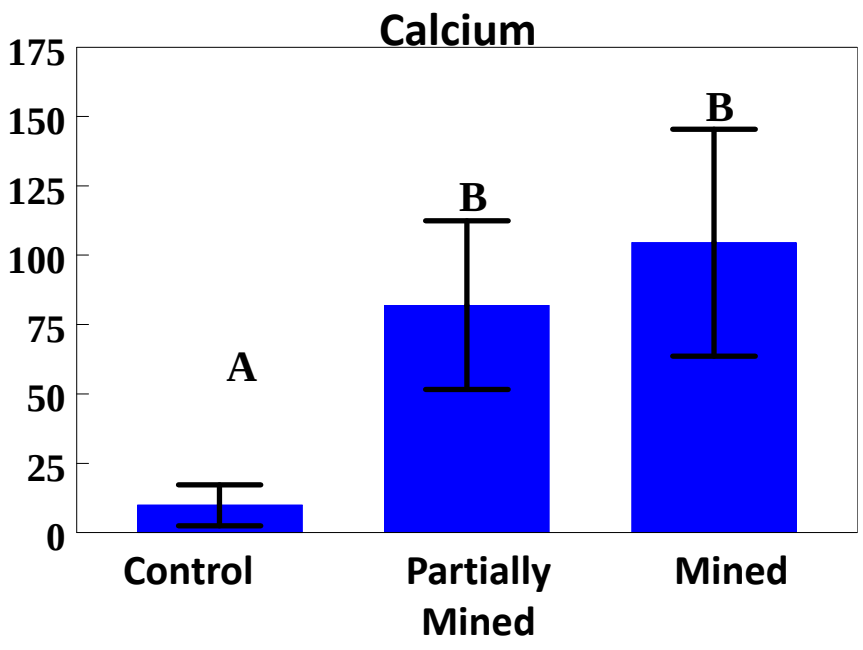
(Electrical Conductivity)



(Johnson et al., 2008)

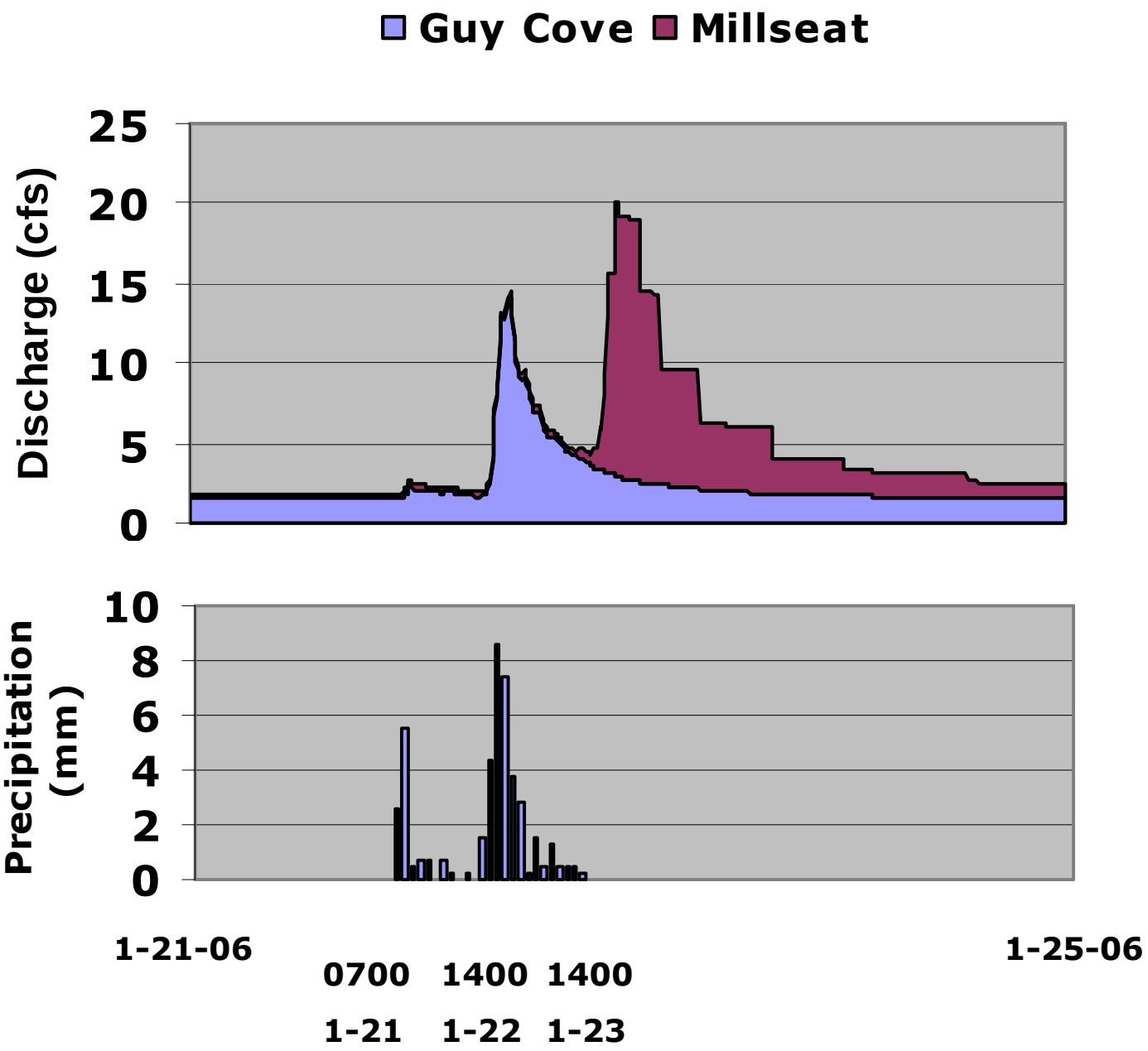
Water Chemistry





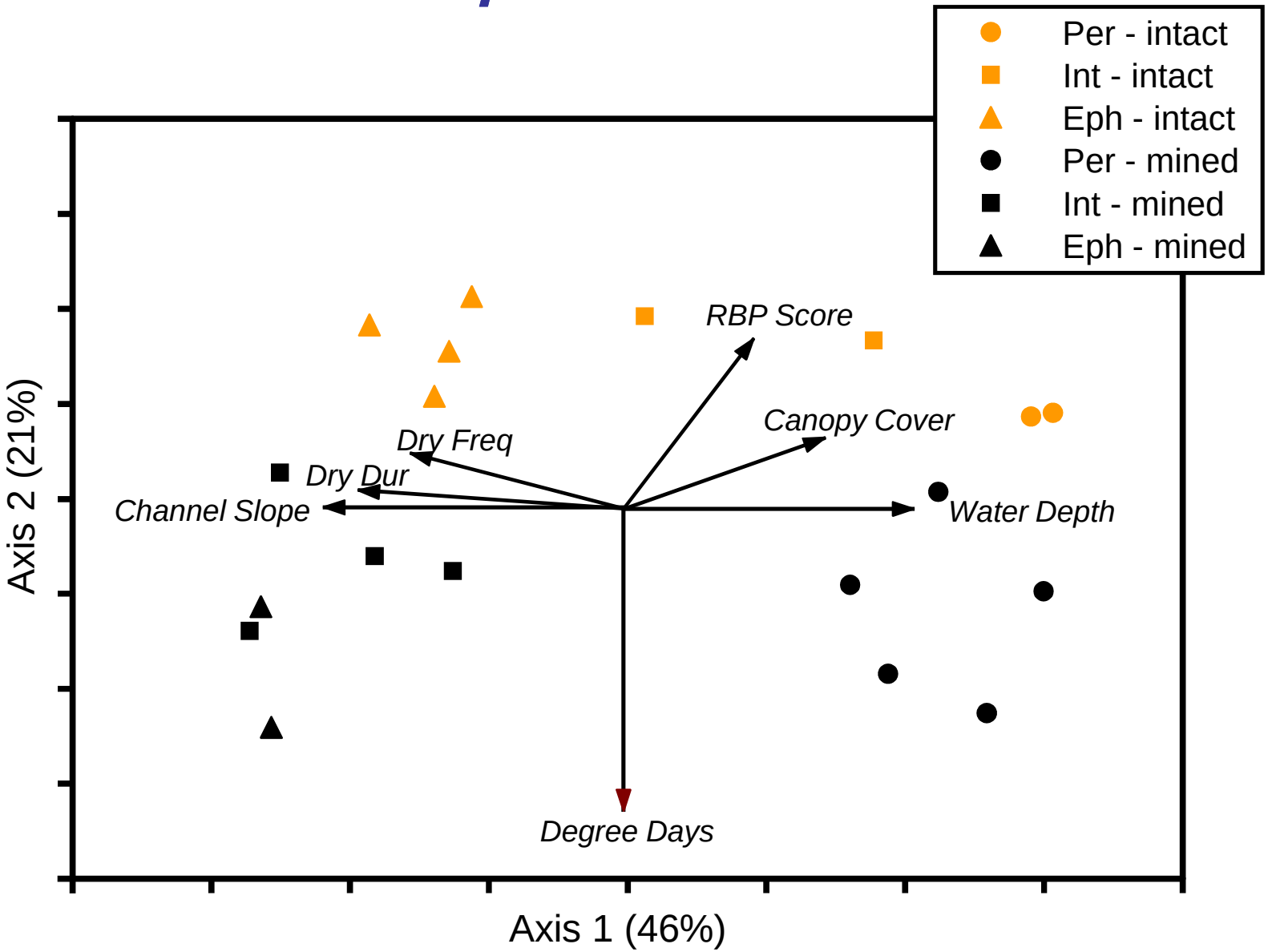
(Fritz et al., 2010)

Hydrology


Guy Cove
Millseat
Discharge (cfs)
25
20
15
10
5
0
Precipitation (mm)
10
8
6
4
2
0
1-21-06
0700
1-21
1400
1-22
1400
1-23
1-25-06

PCA – Physical Environment

PCA – Physical Environment

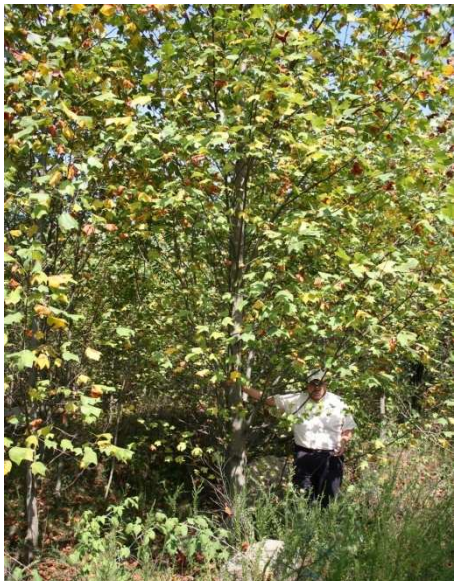


(Fritz et al., 2010)

FRA to the Rescue

1- year

3- year



11- year

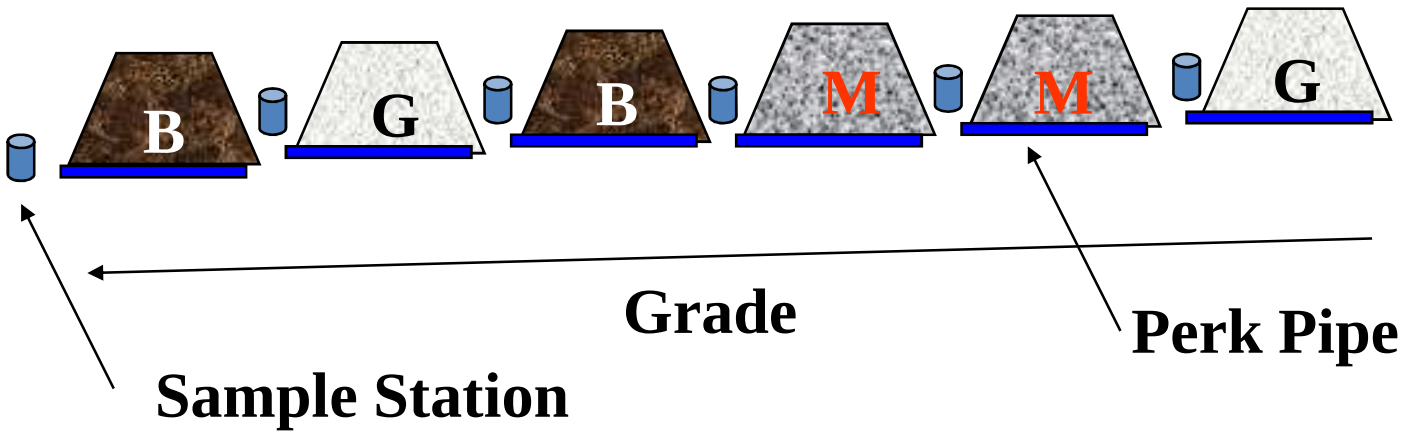
Yellow-Poplar (*Liriodendron tulipifera*) on Uncompacted Spoil

Uncompacted Spoil

(increased infiltration/decreased runoff)

Bent Mountain Experiment

- Study Site
  - Mountaintop Removal Operation
  - Alkaline Sandstones and Shale
  - Pike County, KY
- Objectives
  - Evaluate water quality and hydrology attributes from FRA spoil
  - Determine the need for spoil segregation



Bent Mountain

Compacted Subsurface

Drain Pipe Installation

Bent Mountain

Drain Pipe Installation

End Dump Spoil

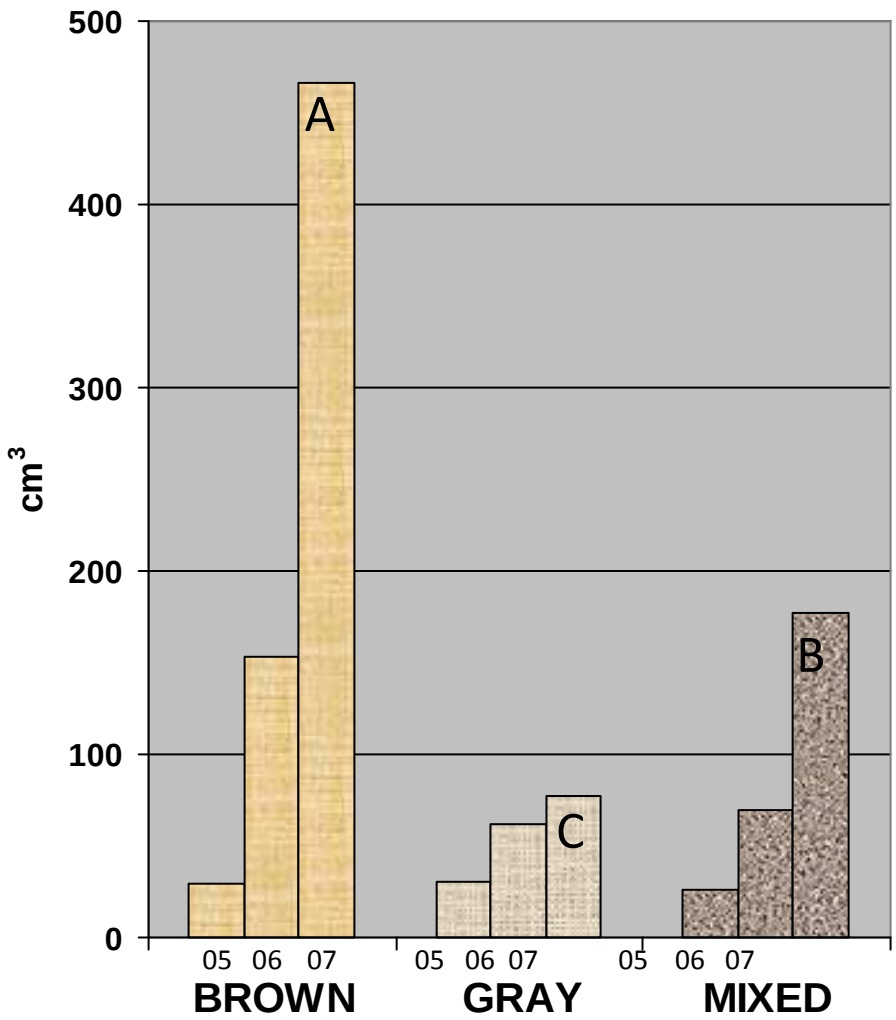
Bent Mountain

Plot Survey

Sample Station

Bent Mountain Project

(Tree Volume)

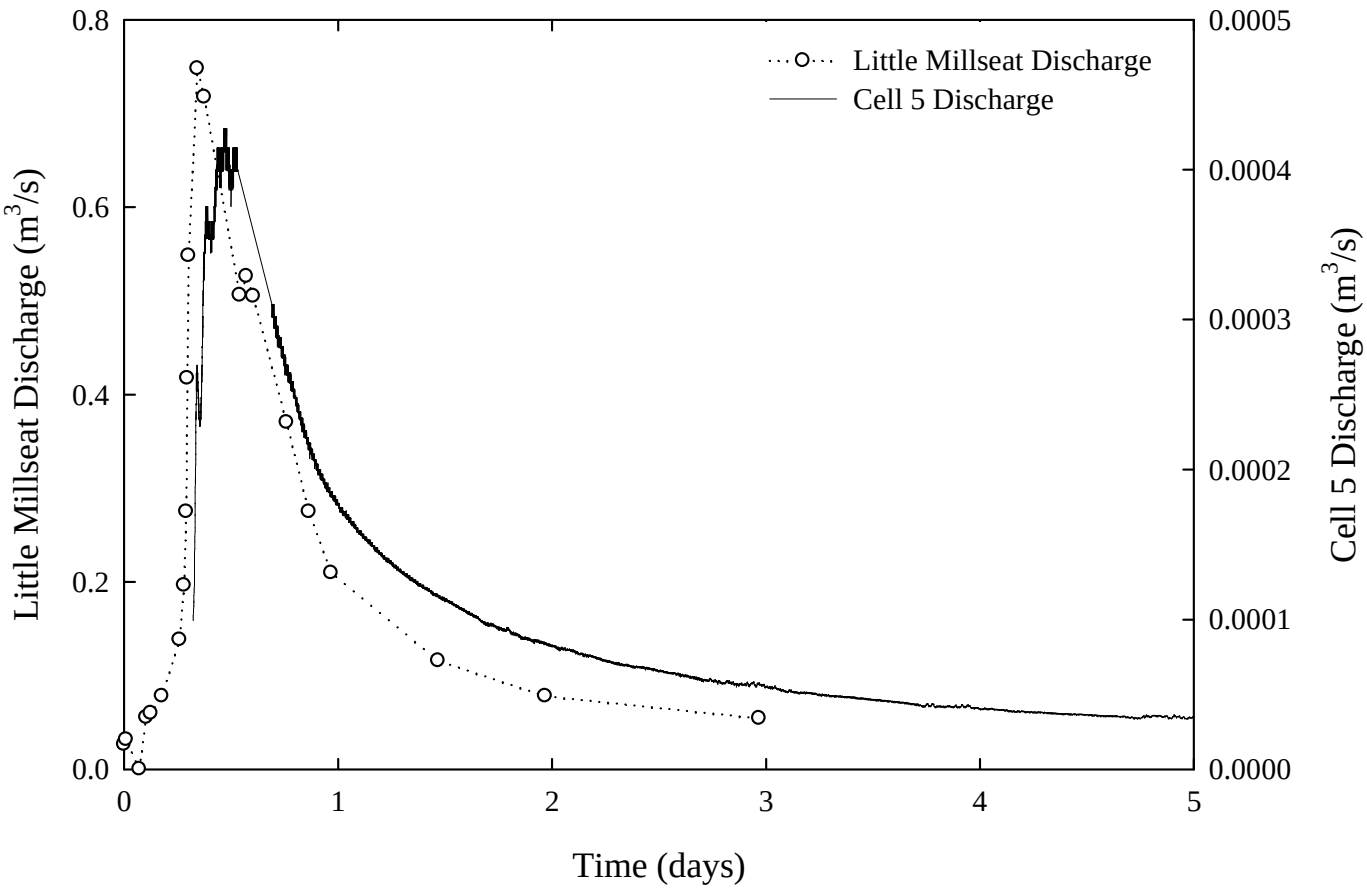


	BROWN	GRAY	MIXED
Survival	86%	88%	81%

(Angel et al., 2008)

Bent Mountain Hydrology

(unmined versus mined hydrograph)



Bent Mountain Hydrology

(runoff curve numbers)

- Un-mined Forested (Little Millseat)
  - Mean: 83 (T. Taylor et al., 2007)
- Compacted spoil (Starfire)
  - Mean: 85 (P. Taylor et al., 1995)
- Loose-dumped spoil (Bent Mountain)
  - Mean: 77 (T. Taylor et al., 2007)
  - no surface runoff

(Taylor et al., 2009)

Bent Mountain Hydrology

(Peak Flow- SEDCAD)

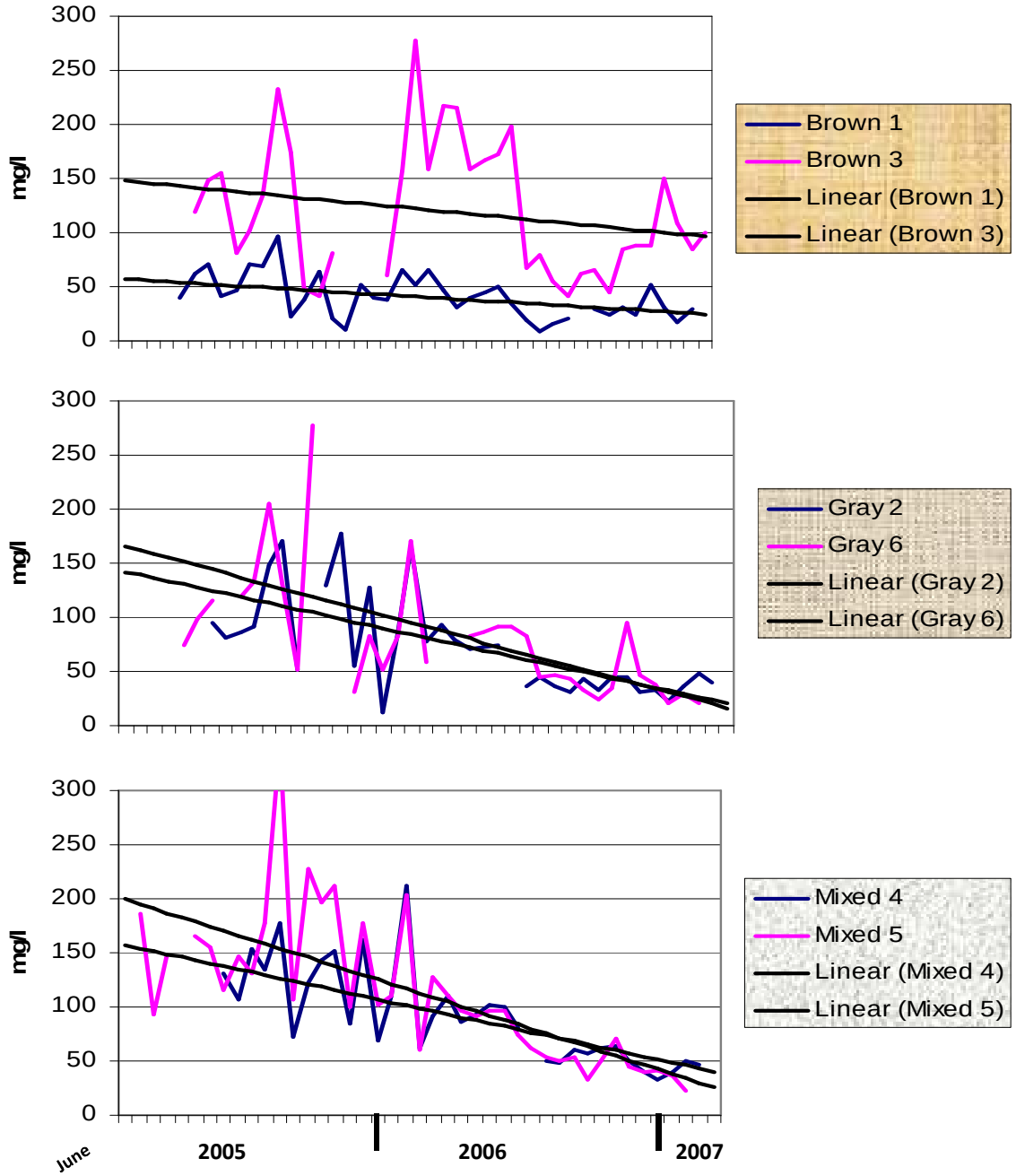
	Peak Flow (m^3/s)		
CN	**Robinson Forest**	**Traditional Reclamation**	**End-dumped Reclamation**
70	0.37	3.34	0.30
75	0.48	4.20	0.39
80	0.60	5.10	0.49
85	0.73	6.01	0.60

Area: 100 ac forest, 80 ac crown
Design storm: 2.5 in NRCS Type II -24 hour

Bent Mountain

(water quality)

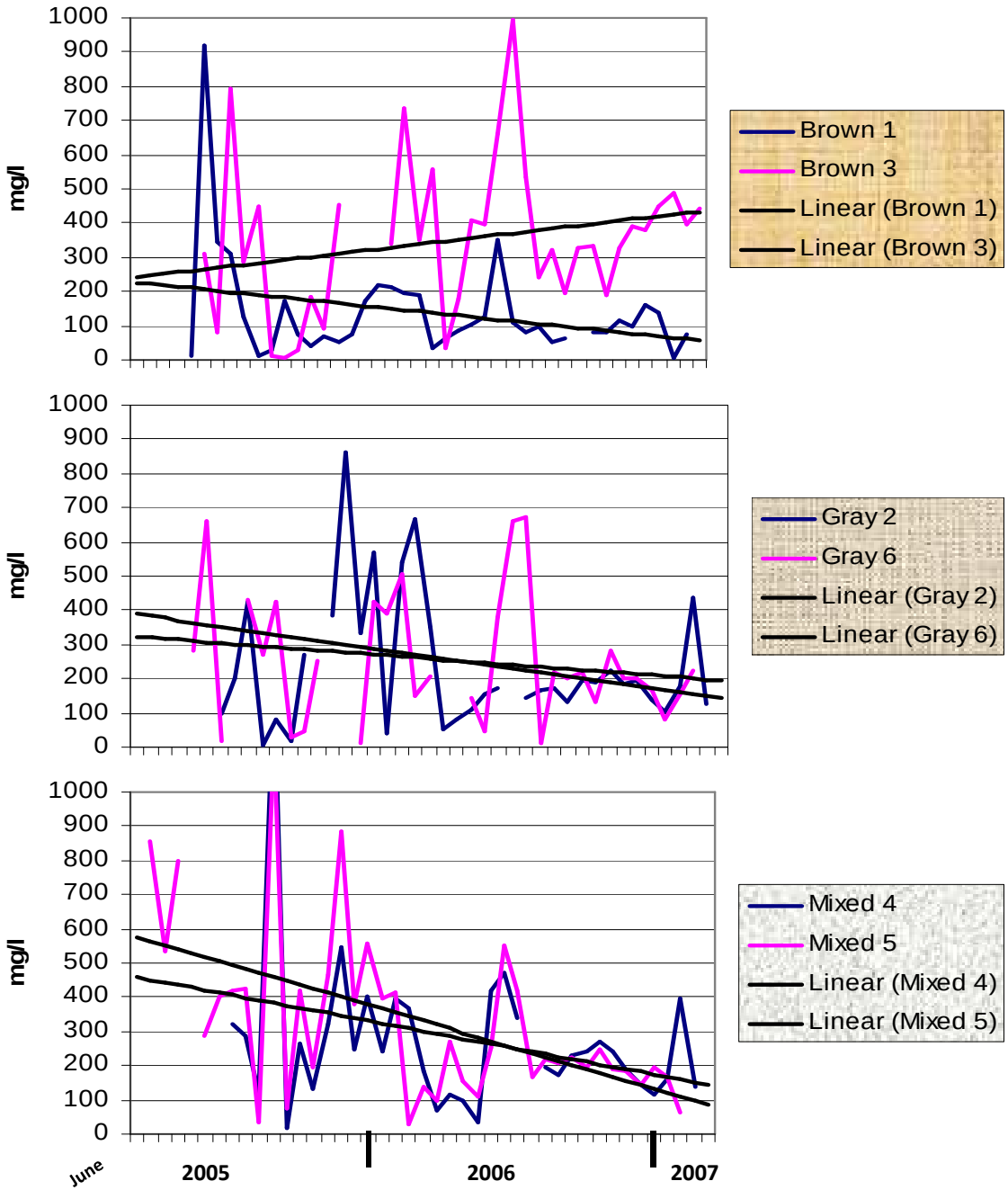
Calcium trends



Bent Mountain

(water quality)

Sulfate trends

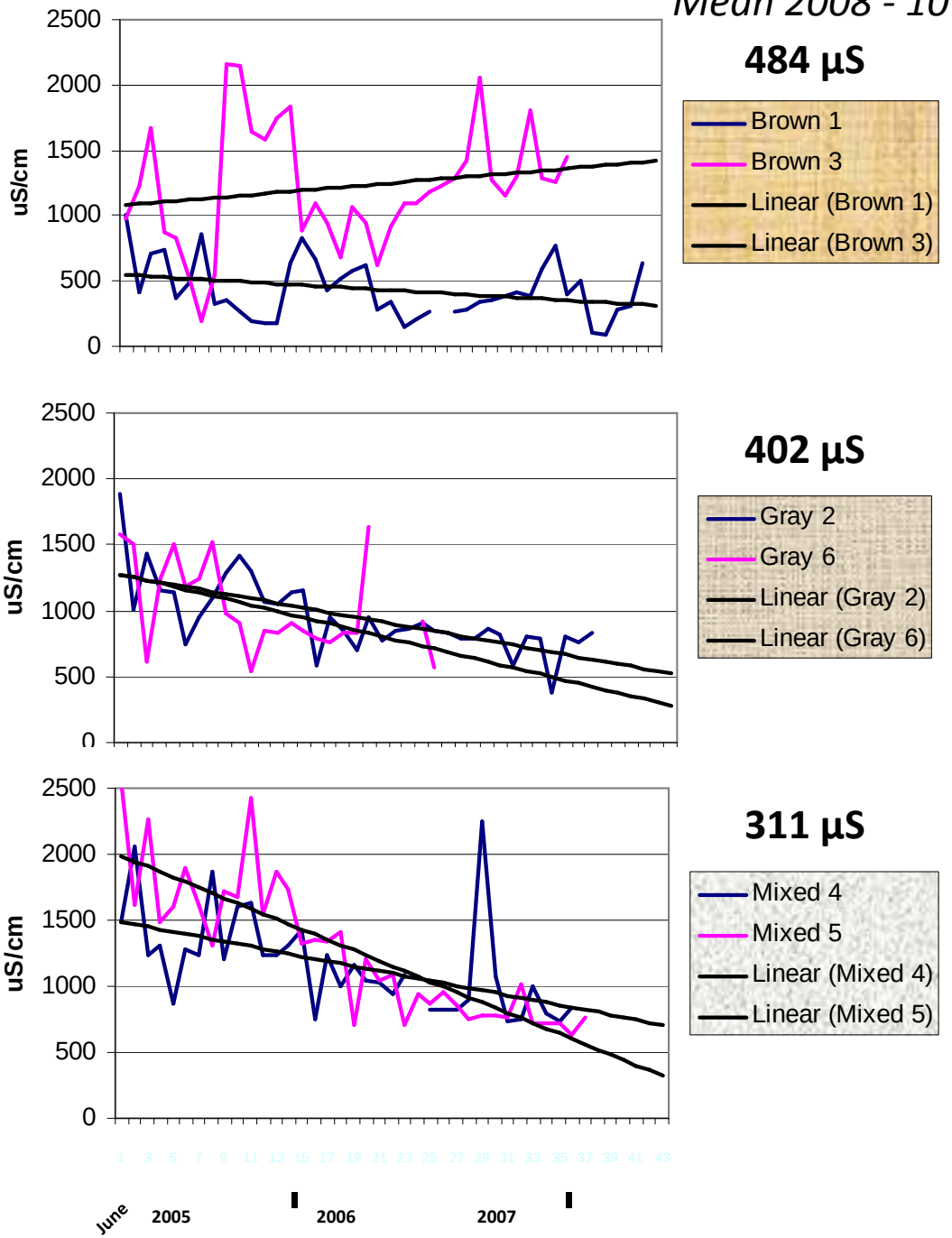


Bent Mountain

(water quality)

Electrical conductivity trends

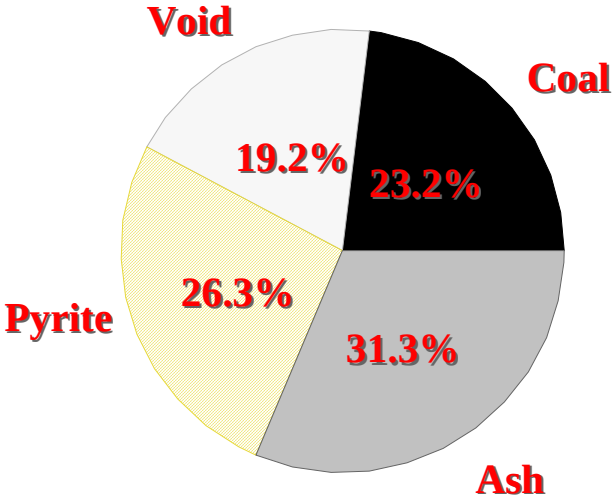
Mean 2008 - 10



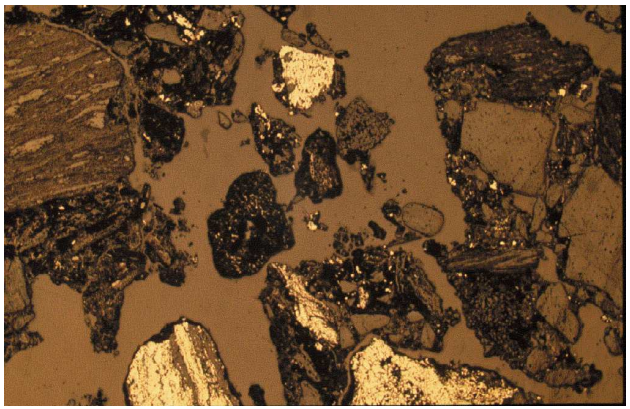
Reforestation of a Waste Coal Basin

Reject Coal Basin Material

488D Surface Layer



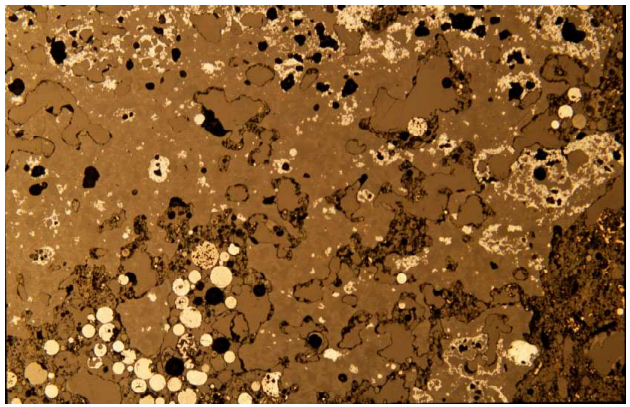
Zone A (25 cm) - 1.25x



3.6 mm

Reflected Light

Zone D (100 cm) - 10x

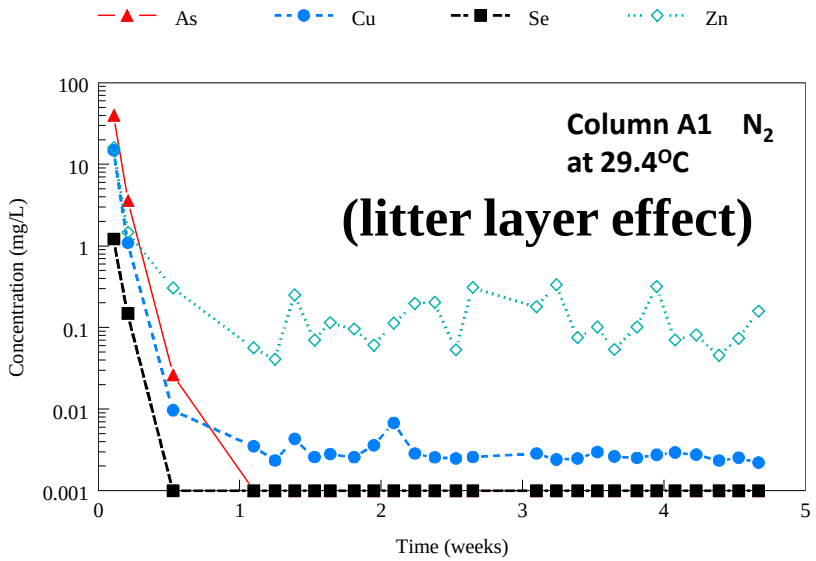


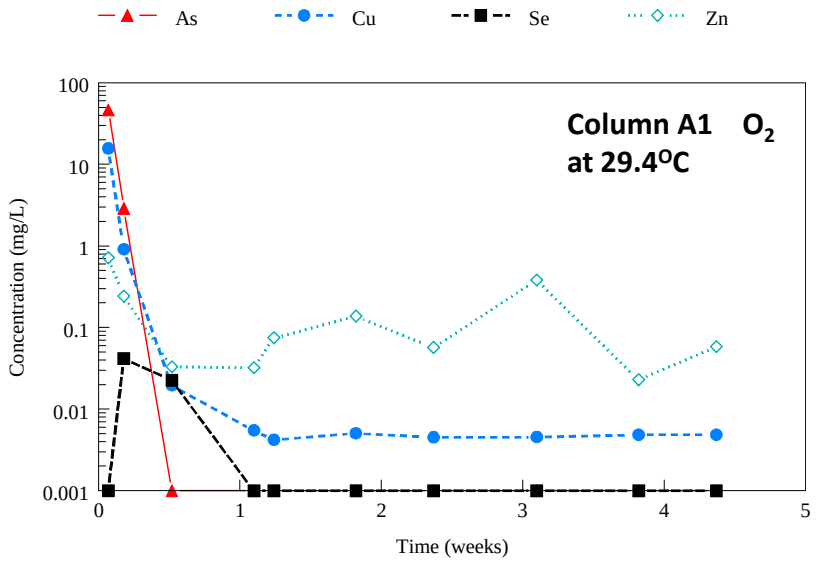
0.45 mm

Litter Effect on Water Chemistry

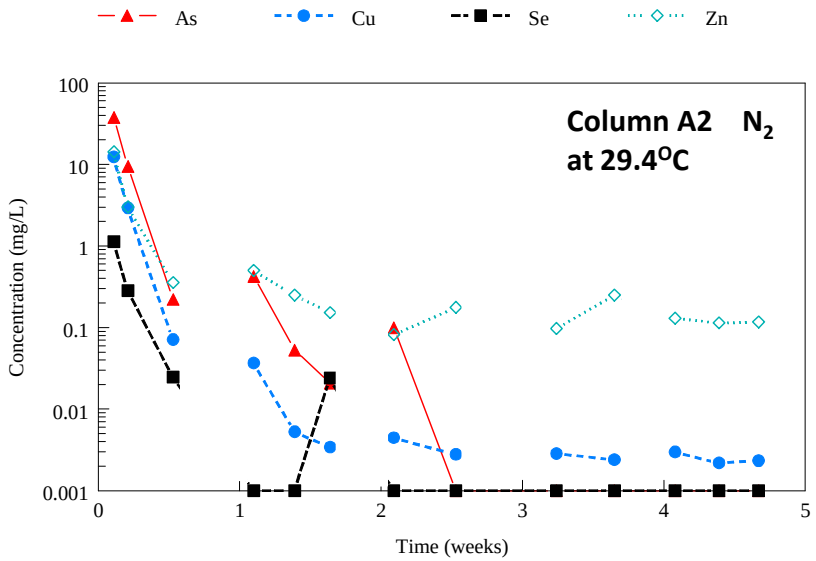
(Trace Element Mobility)

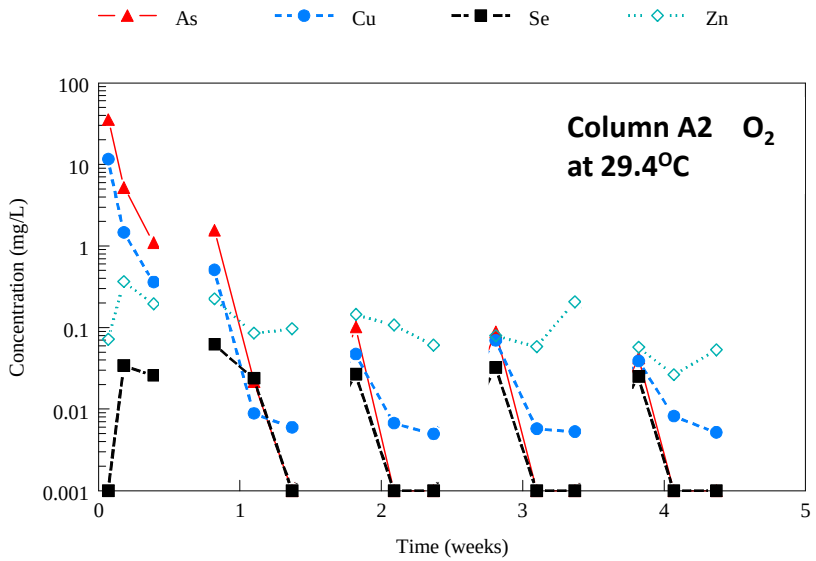
Saturated





Episodic Wetting





Litter Effect on Water Chemistry

(30 cm lysimeters)

	Forested	Control
pH	6.01	2.13
Al (mg/L)	0.6	111
Cu (mg/L)	BDL	8.4
Fe (mg/L)	1.3	882
Zn (mg/L)	0.2	12.8

Guy Cove Valley Restoration

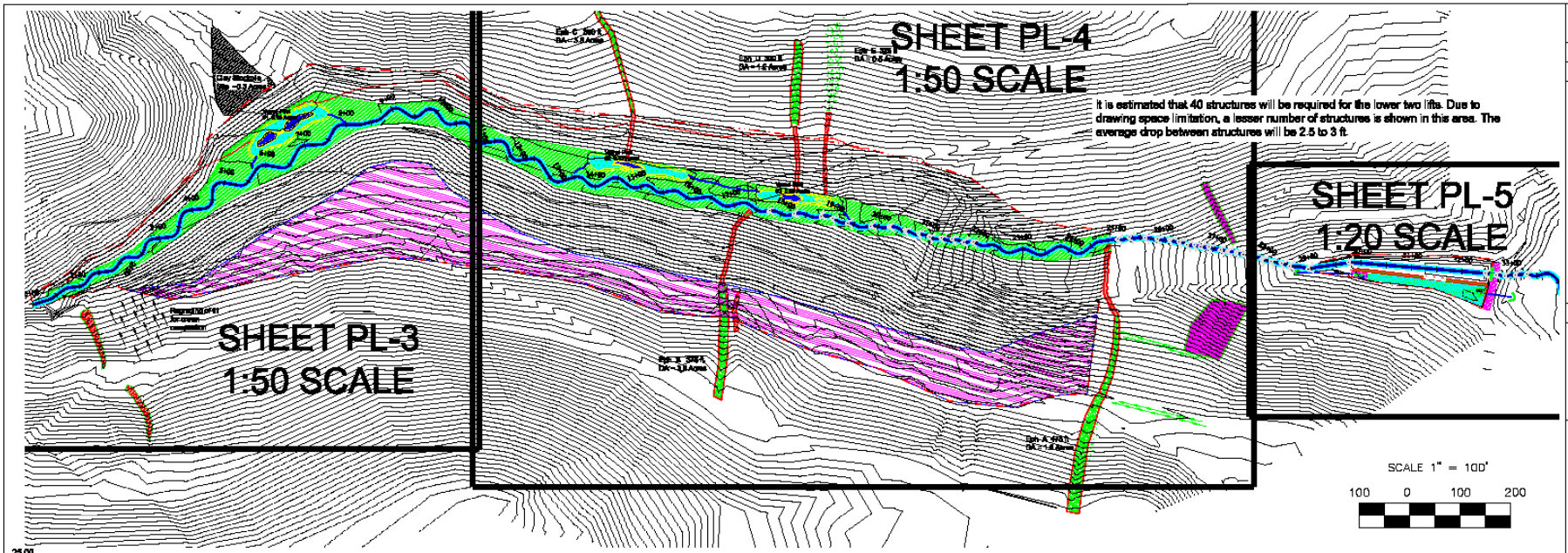
- 100 acres
- Partially Mined
- Water Quality Issues

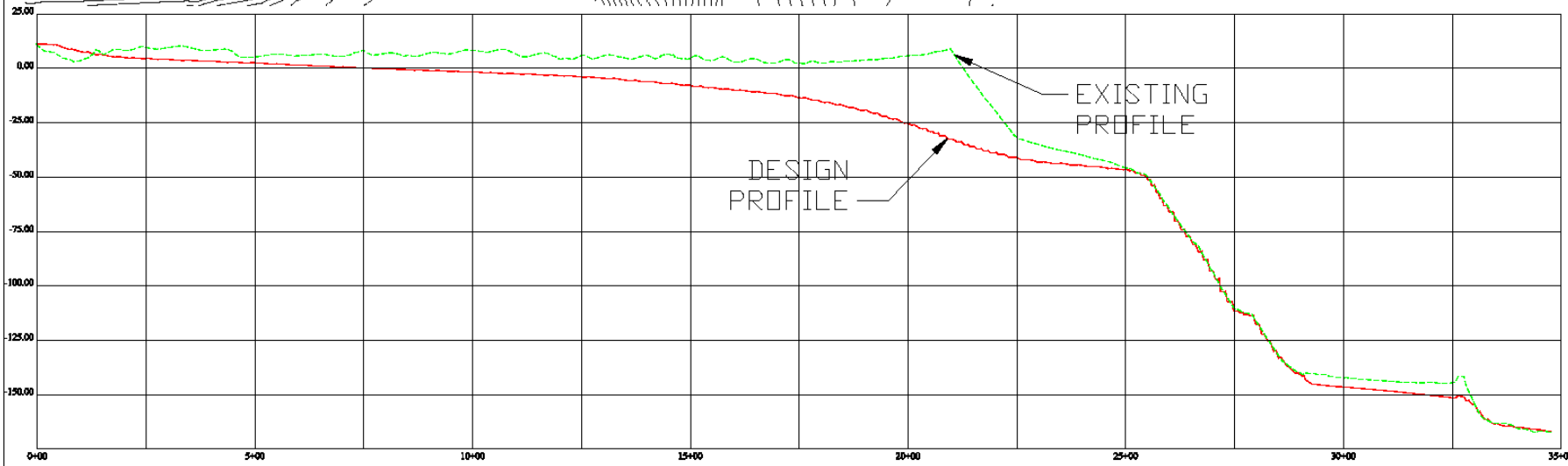
Guy Cove Valley Restoration

(objectives)

- Stream Channel Creation
- Limit Flow to Underdrain
- Restore Forest (FRA)
- Improve Water Quality
- Improve Habitat

C4 B4 B3a A2a+ C4





NO	REVISIONS	DRN	CHK	DATE
1	INITIAL DESIGN	DAB	LK	04/21/06
2	Proposed DESIGN	DAB	CA	06/16/06
3	PERMIT APPLICATION DRAWINGS AND DESIGN	DAB	CA	03/16/07

BIOSYSTEMS & AGRICULTURAL ENGINEERING
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BIOSYSTEMS AND AGRICULTURAL ENGINEERING
207 C.E. Barnhart Building
University of Kentucky
Lexington, KY 40546-0276

GLY COVE
ROBINSON FOREST
BREATHITT, KY

SITE PLAN VIEW
AND EXISTING VS. DESIGN
PROFILES

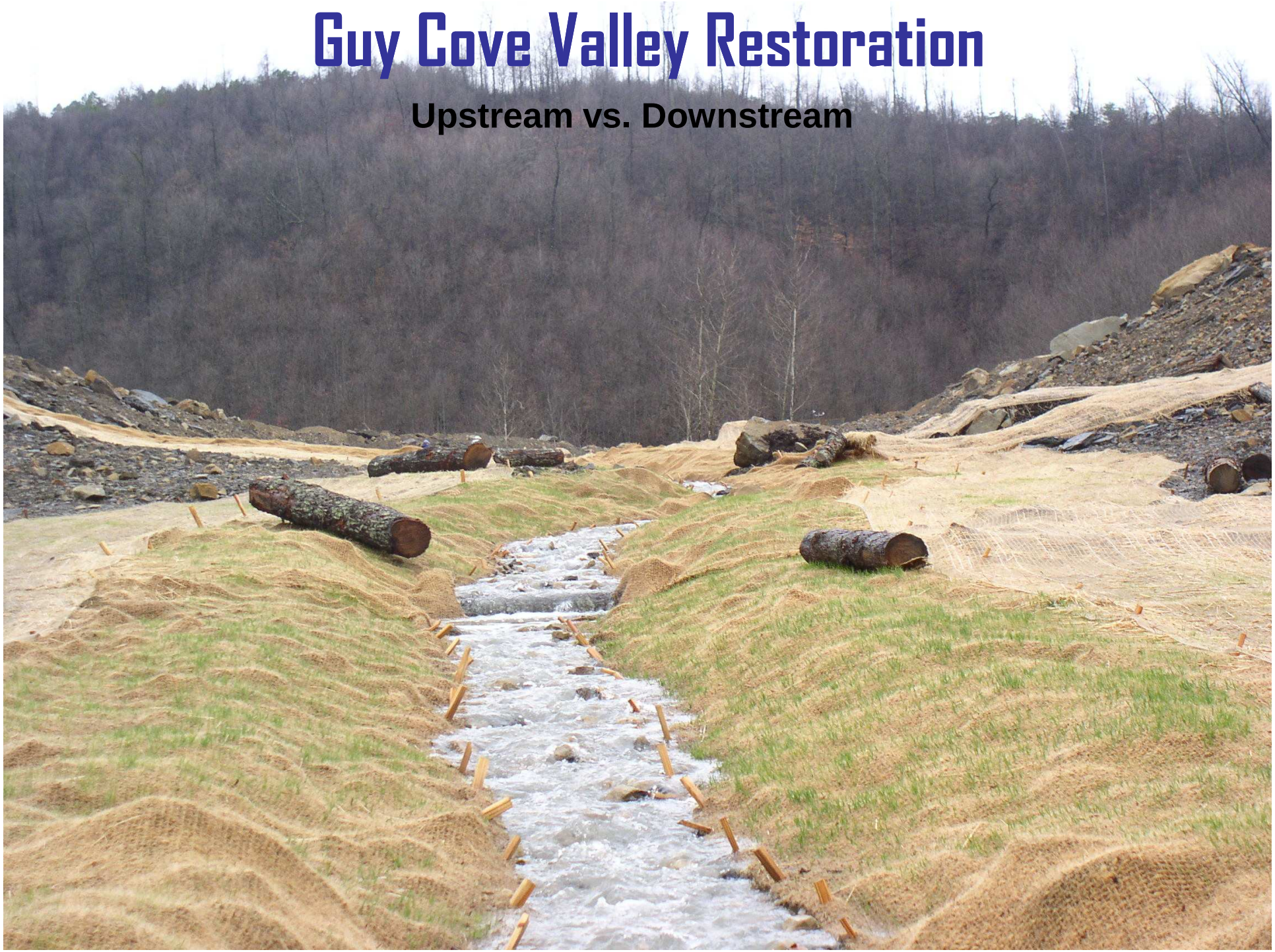
DATE 07/18/2007
PROJECT NO.
FILENAME GLYCOVE-P.DWG
SHEET NO. PL-1
DRAWING NO.

CAT

TURBO CHIEF
POWERSCREEN

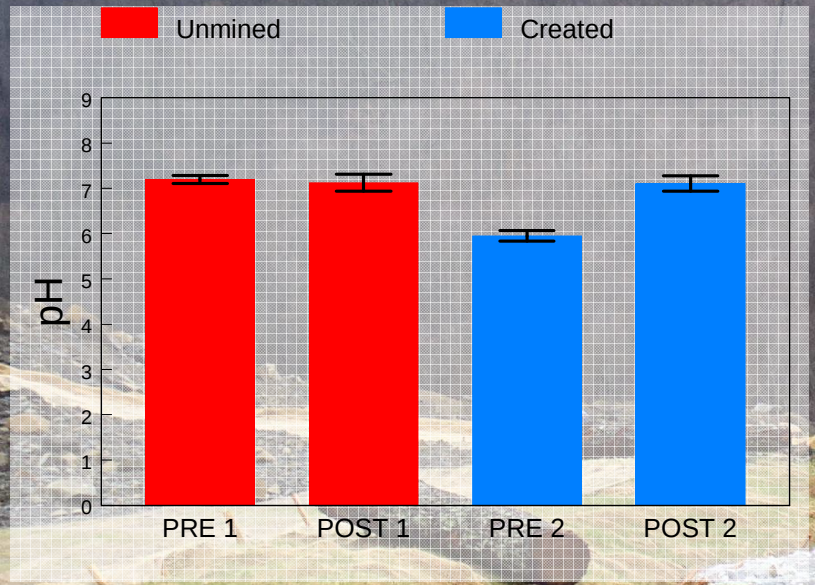
Guy Cove Valley Restoration

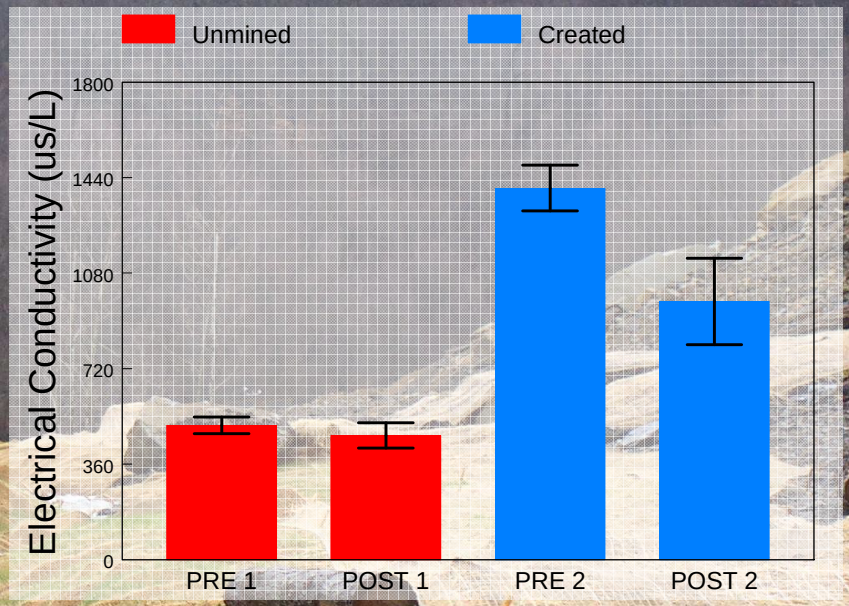
Upstream vs. Downstream

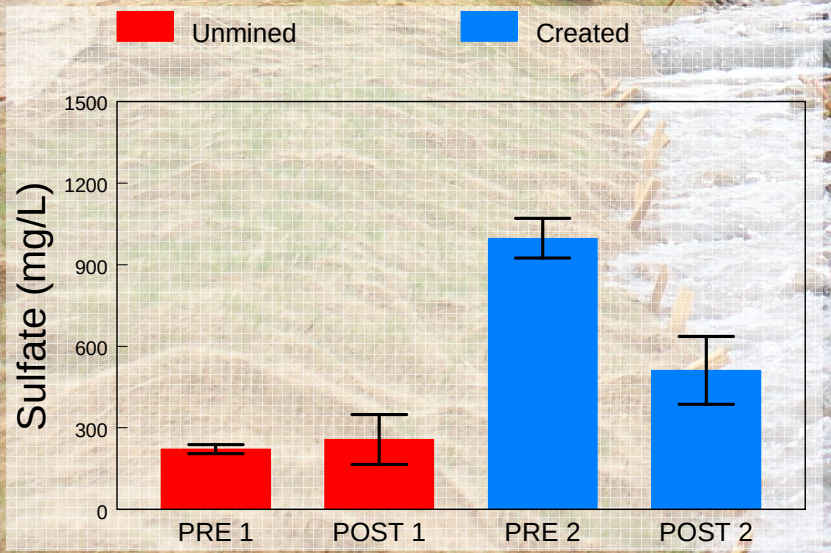


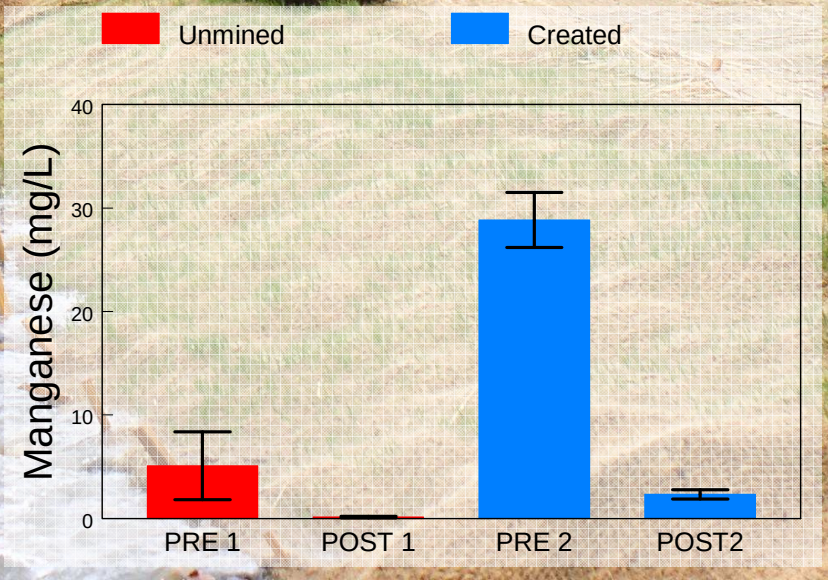
Guy Cove Valley Restoration

Upstream vs. Downstream

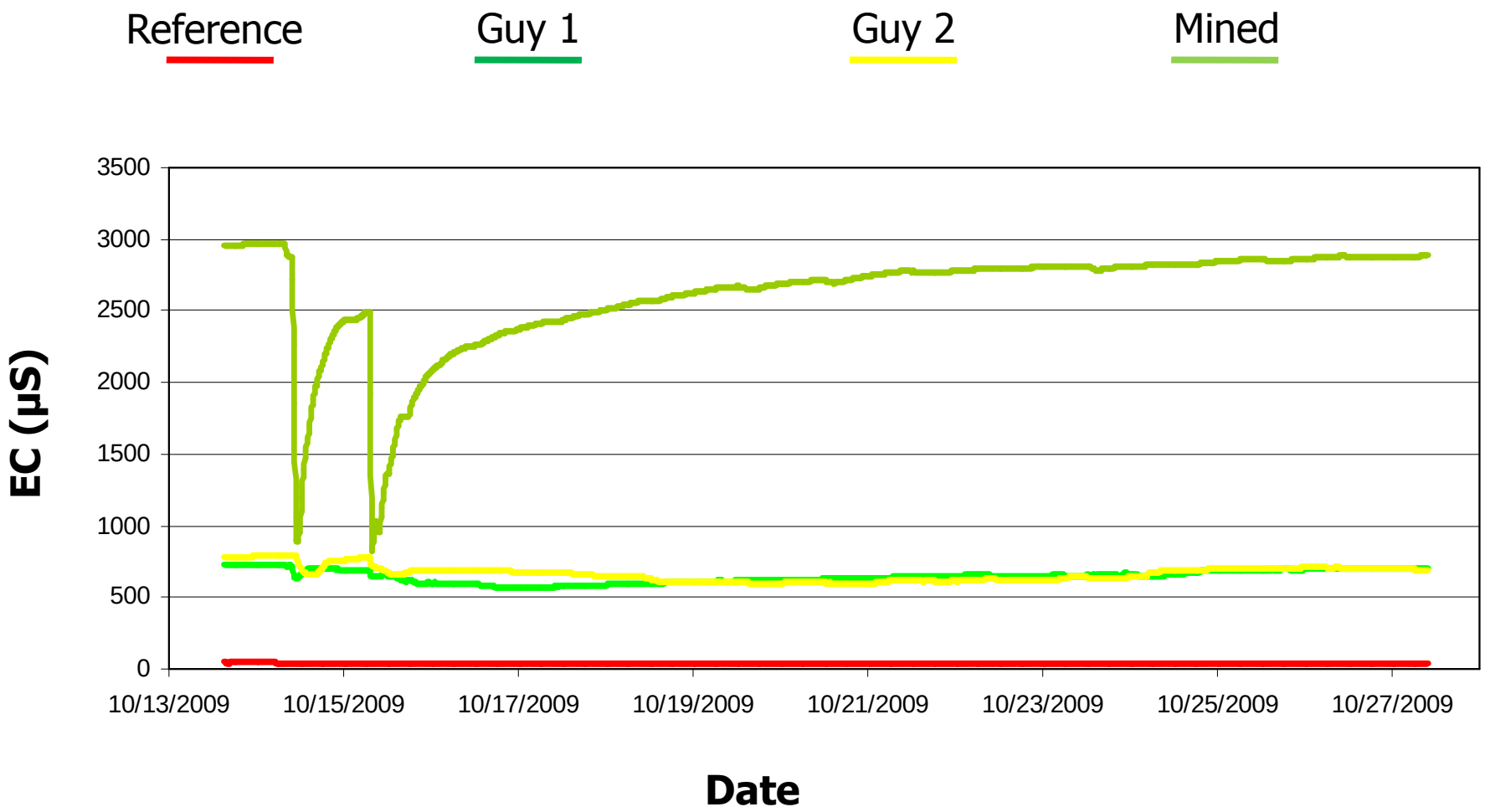








Guy Cove Valley Restoration



Guy Cove Valley Restoration
(preliminary findings)

Habitat

- Presence of salamanders and aquatic invertebrates in pools (abundant)
  - 2500 ft intermittent stream
  - 1555 ft ephemeral streams

Trees & Shrubs

- ≈30,000 trees planted
- Mixed Mesophytic:
  - American Beech, American Sycamore, Eastern Hemlock, Rhododendron, Green Ash, Swamp Chestnut Oak, Swamp White Oak, Silver Maple, River Birch, Black Willow, Flowering Dogwood Cypress, Tupelo, Buttonbush, Buckeye

Headwater Stream Recovery

(A New Direction)

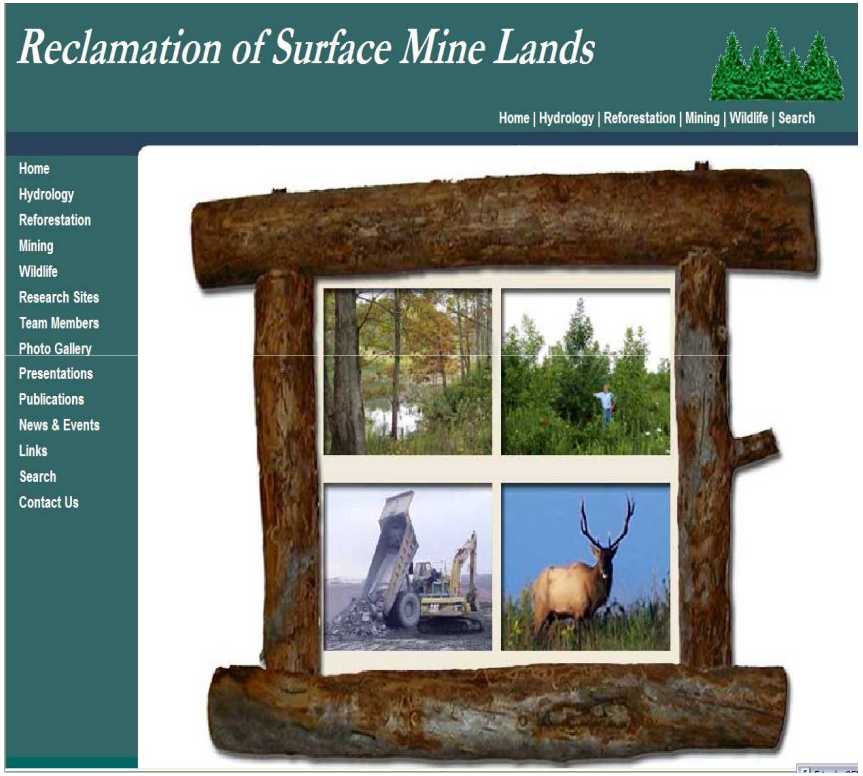
Restored Hollow Fill

(UK Laurel Fork Mine – Guy Cove)

Un-mined Headwater Stream

(UK Robinson Forest – L. Millseat)

Questions?



http://www.bae.uky.edu/UKReclamation/