WHEELING JESUIT UNIVERSITY

Coal Impoundment Program Status Report

Contract Number : DOLJ05MR20070

January 30, 2008

Project Overview

Augmentation to:

- Continue to operate and maintain the impoundment website,
- Develop a web-based Safety Information Exchange,
- Conduct mine safety technology assessments,
- Complete assessments of international mine safety technologies and regulations,
- Interface with technology developers and the mine industry,
- Conduct pilot-scale testing of impoundment and safety technologies,
- Conduct demonstration testing of safety technologies,
- Assess Current Industry Safety Practices and Plans,
- Initiate a survey of energy potential of coal waste impoundments,
- Expand the web-based emergency alerting program,
- Conduct Tabletop emergency drills, and
- Develop emergency plan update system.

Augmentation Tasks

Task 8 Impoundment Website Sustainment and Augmentation

- Impoundment Website Sustainment
- Web-based Safety Information Exchange

Task 9 Technology Assessment and Development

- Independent Impoundment & Safety Technology Assessment
- Pilot Scale Technology Development and Testing
- Technology Demonstration
- Assessment of Current Industry Safety Practices and Plans

Task 10 Waste Coal Energy Survey in West Virginia

Task 11 Emergency Alerting

- Web-based Alerting System
- Tabletop Emergency Response Drills
- Emergency Plan Updates

Task 8 Impoundment Website Sustainment and Augmentation

Website Sustainment

- Update Content
- Maintain Infrastructure
- Repair Broken Links
- Add Additional Information*

Web-based Safety Information Exchange

- Single Location for Mine Safety Information
- Technology Developer Forum
- Miner/Mine Operator Forum

* As Funding Permits

Task 9 Technology Assessment and Development

Independent Impoundment & Safety Technology Assessment

- Communication Systems
- Locator Systems
- Rescue Systems

Pilot Scale Technology Development and Testing

- Biotechnology Coal Mine Impoundment Remediation
- Wireless Impoundment Monitoring
- Coal Slurry Characterization

Technology Demonstration

- Determine Technology Readiness
- Coordinate Demonstration Participants (Developer, Mine, MSHA, etc,)
- Solicit Feedback and Report Results

Assessment of Current Industry Safety Practices and Plans

Independent Impoundment & Safety Technology Assessment

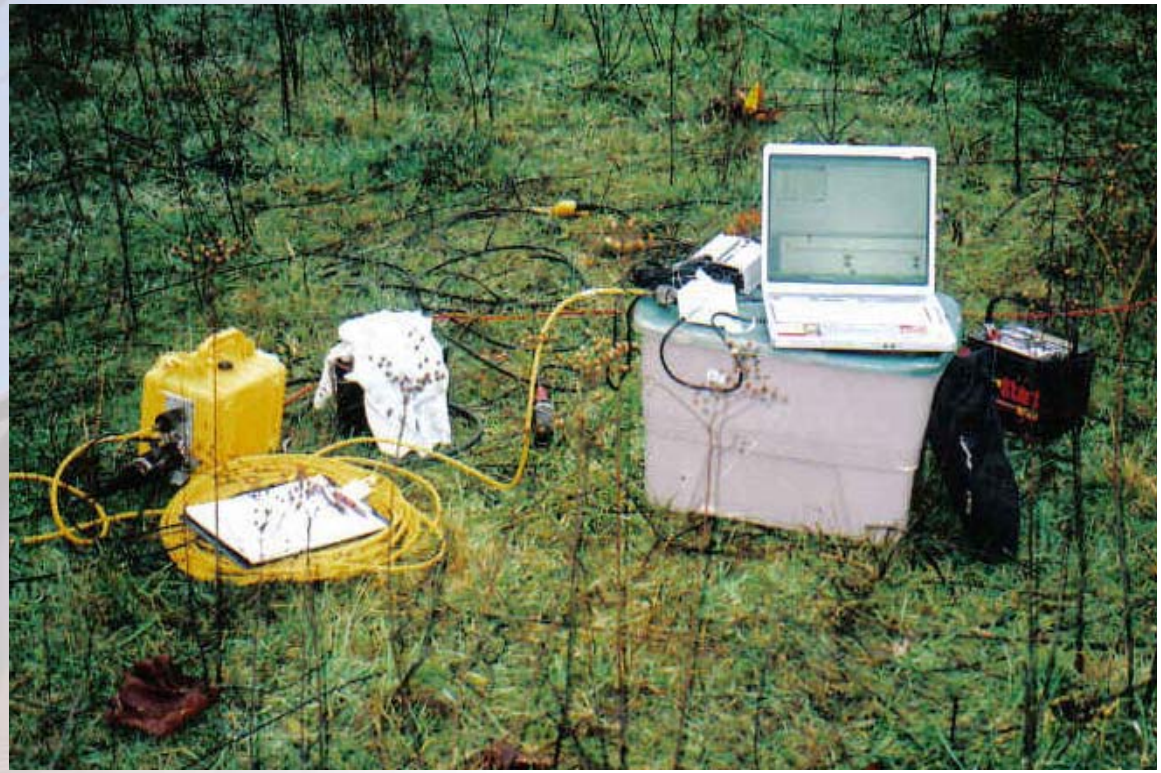
- **Through the Earth Communications**
  - Harris Technologies
- **Impoundment Stability/ Miner Locator Systems**
  - Geonano Technologies
- **Rescue Systems**
  - Robbins Company

Independent Impoundment & Safety Technology Assessment – Communications Systems

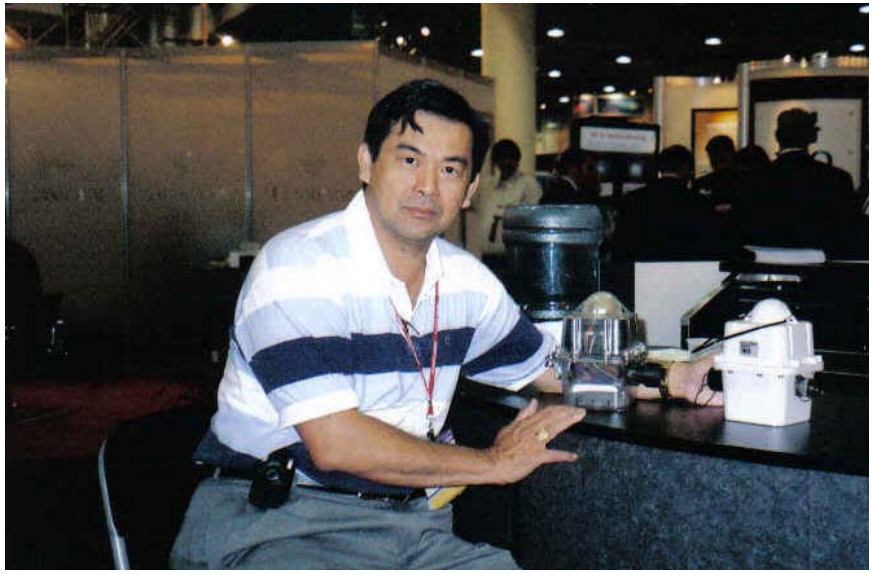
Harris Technologies, Inc.

- Hyper-Communication is an RF signal compression technology with an approximate 100:1 advantage over conventional practice.
- Data and voice communications at a high bit/sec/Hz ratio with the properties at low frequencies.
- Extension of medical imaging technologies.

Independent Impoundment & Safety Technology Assessment – Impoundment Stability Systems

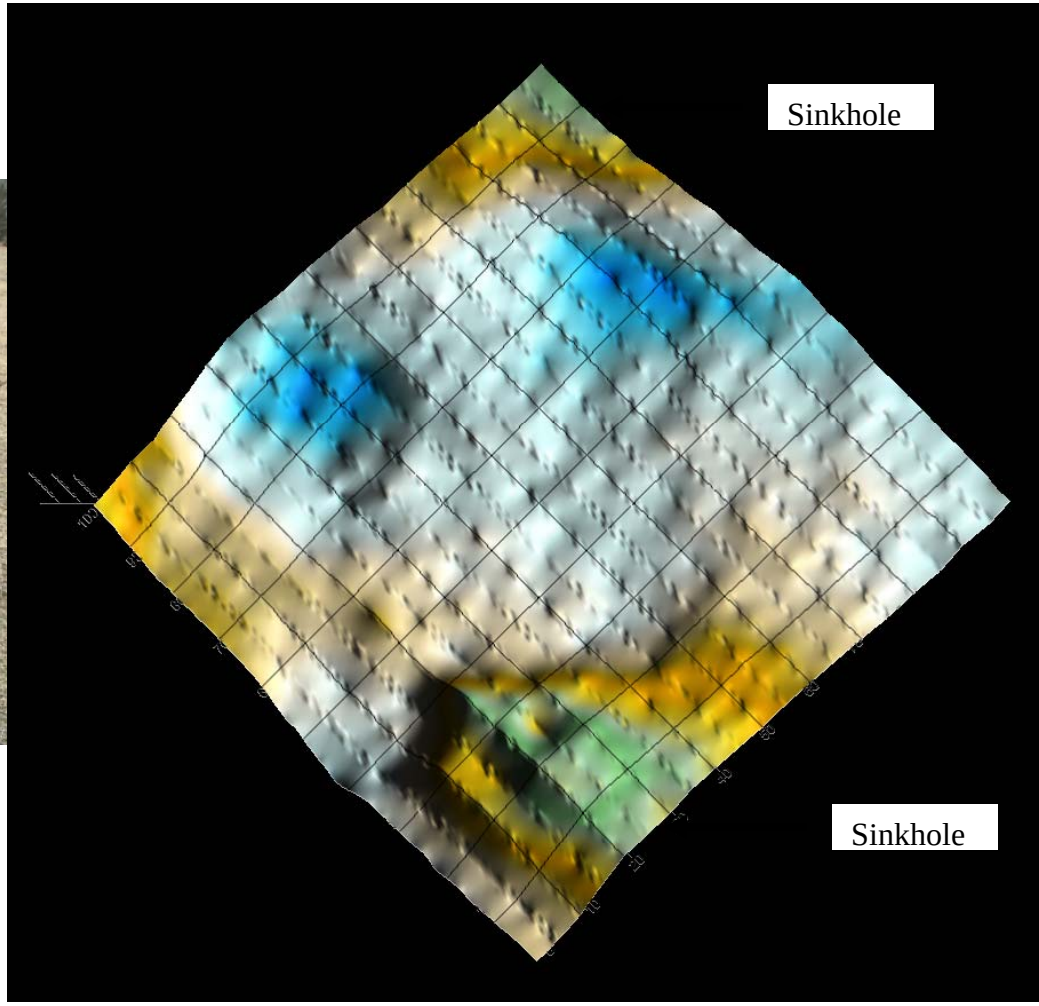


Independent Impoundment & Safety Technology Assessment – Impoundment Stability Systems



Wireless Seismic Devices

Independent Impoundment & Safety Technology Assessment – Impoundment Stability Systems



Pilot Scale Technology Development and Testing Biotechnology Impoundment Remediation

Purpose:

•Attempt to produce methane from coal slurry using an Archaea consortium found in household wells in central Appalachia near coal impoundments

•Determine viability of using Archaea for impoundment remediation

Pilot Scale Technology Development and Testing Biotechnology Impoundment Remediation

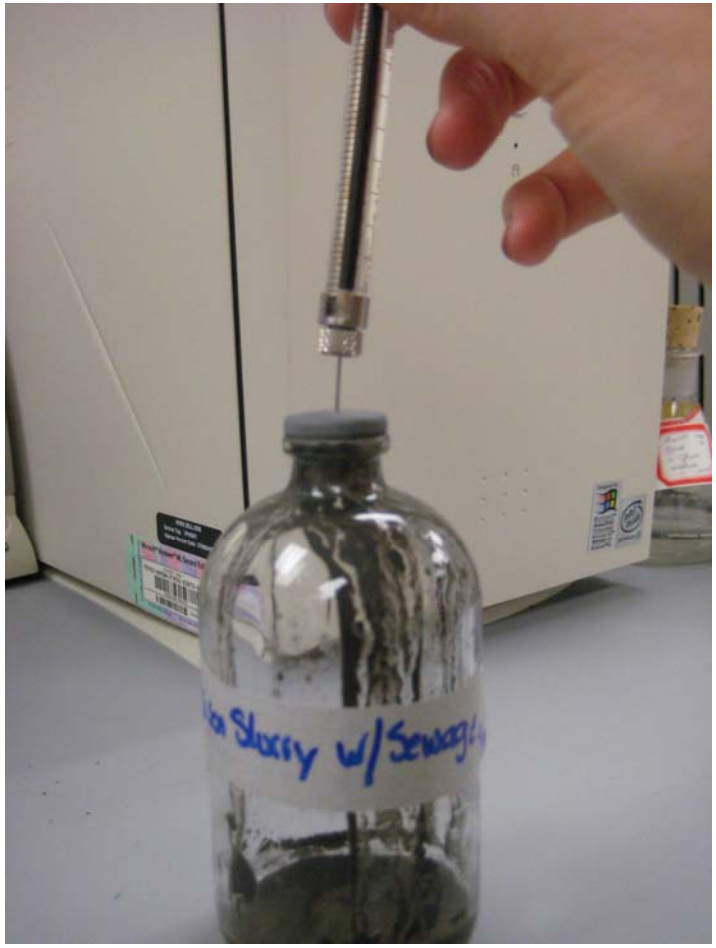
- **Archaea Consortium**
  - Moundsville Waste Treatment Plant
  - Household wells in West Virginia
  - USGS Strain (possibly)
- **Slurry Samples**
  - Captina Creek Slurry
  - John Q Slurry
  - Bison Slurry
  - Dry Slurry (50/50 water ratio by weight)

Pilot Scale Technology Development and Testing Biotechnology Impoundment Remediation

Method:

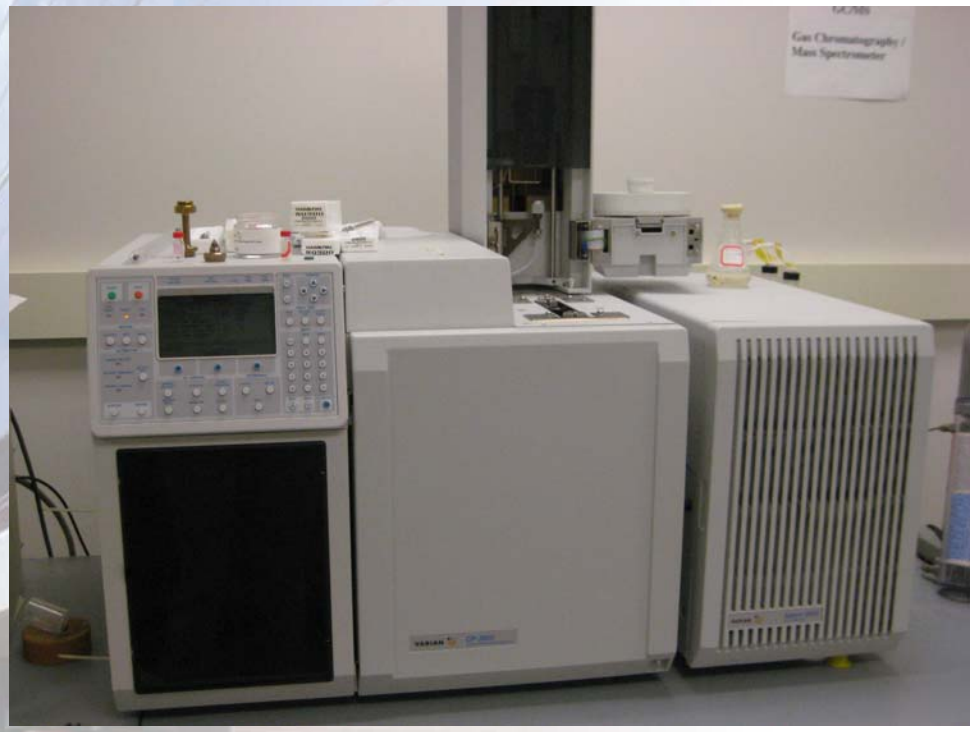
- Slurries allocated into jars in 9 cc samples
- **Treatments**
  - Formaldehyde
  - USGS media alone
  - USGS media and sewage
  - Sewage alone
  - Household well Archaea consortium
  - USGS Archaea consortium

Pilot Scale Technology Development and Testing Biotechnology Impoundment Remediation



Pilot Scale Technology Development and Testing Biotechnology Impoundment Remediation

- **Gas Chromatography**
- **Mass Spectrum**



*Dr. Michael Baird of the Wheeling Jesuit University Chemistry department is helping with the analysis.

Pilot Scale Technology Development and Testing Biotechnology Impoundment Remediation

- No direct methane detection yet
- Need a new column that is specific for small molecules such as methane (CH_4)

Pilot Scale Technology Development and Testing
Wireless Impoundment Monitoring

Research Purpose:

To develop, demonstrate, and monitor an automated and remote wireless sensor network to improve data collection and accuracy at a coal waste impoundment

Research Goals:

To introduce state-of-practice electronic instrumentation for monitoring geotechnical engineering parameters and to report that data in near real-time accuracies

Industry Partner:

Patriot Coal Corporation
Rocklick Business Unit, Greenwood, WV

Pilot Scale Technology Development and Testing
Wireless Impoundment Monitoring

Rocklick Coal Waste Impoundment

Pilot Scale Technology Development and Testing
Wireless Impoundment Monitoring

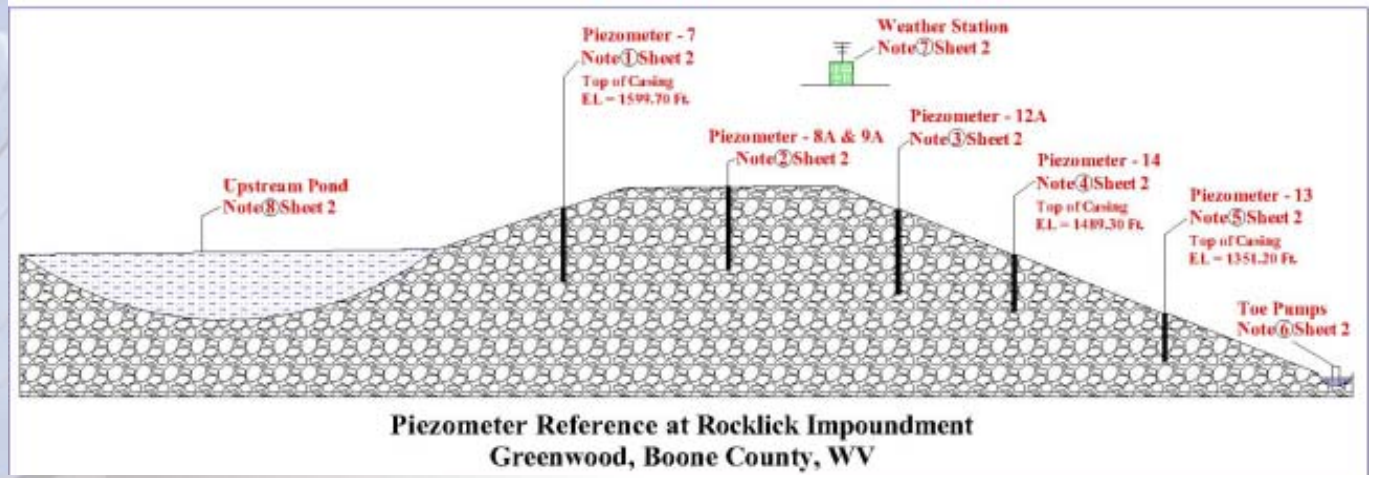
Collected Data Parameters

- Weather Conditions
- Weir Discharge Flow Rate at Toe
- Piezometric Levels
- Impoundment Pool Elevation
- Water pH (internal and discharge)
- Water Specific Conductance
  (internal and discharge)

Pilot Scale Technology Development and Testing
Wireless Impoundment Monitoring

- **Weather Station** – Installed near crest to monitor rainfall, temperature, barometric pressure and impoundment pool level.
- **Weir Outflow Measurement** – Monitors seepage flow rate.
- **Vibrating Wire Piezometers and Water Level Sensors** – Provide readings of the phreatic surface elevations. These two types of sensors will be compared for accuracy and process compatibility
- **Ancillary Sensors –** Water Temperature and Specific Conductance to monitor groundwater seepage between piezometer stations.
- **Wireless Network –** Battery powered radio modems will transmit data from sensors to radio base-station for processing.
- **Office PC –** Used to analyze data, generate reports, plot variables.

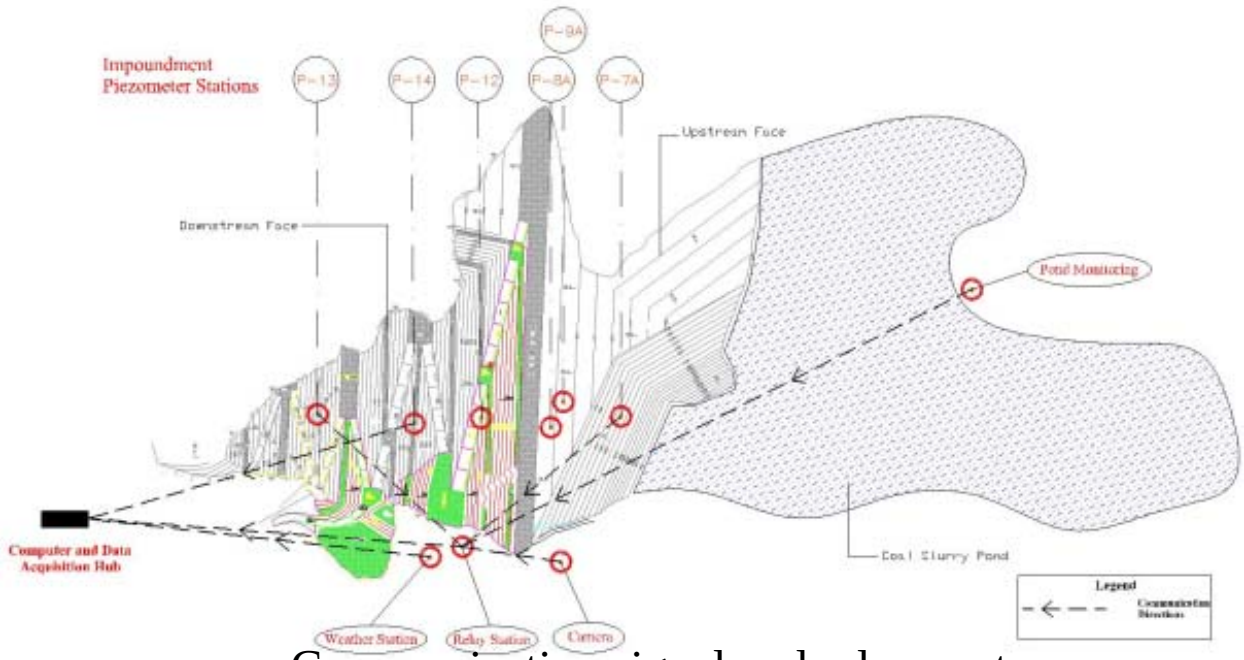
Pilot Scale Technology Development and Testing
Wireless Impoundment Monitoring



Piezometer Reference at Rocklick Impoundment
Greenwood, Boone County, WV

Piezometer/Station	Instrumentation
Toe	Wedgewood CSIM11 pH, Wedgewood CSIM11 ORP, Campbell Scientific Water Conductance
P14	Pressure Systems Hydrostatic Water Level Transducer (or VW Piezometer), Campbell Scientific Water Conductance
P13	Pressure Systems Hydrostatic Water Level Transducer (or VW Piezometer)
P7	Pressure Systems hydrostatic water Level Transducer, Wedgewood CSIM11 pH
Weather Station	HOBO Rain Gauge, HOBO Barometric Pressure, HOBO Wind Speed, HOBO Temperature
Pool	Pressure Systems Hydrostatic Water Level Transducer, Campbell Scientific Water Conductance, Wedgewood CSIM11 pH, Wedgewood CSIM11 ORP

Pilot Scale Technology Development and Testing
Wireless Impoundment Monitoring



Communication signal and relay vectors

Pilot Scale Technology Development and Testing
Wireless Impoundment Monitoring

Standard Piezometer
Data Logger and Wireless Modem

Verifying Manual Monitoring
w/Instrumentation

Weather Station – Winter Operation

Pilot Scale Technology Development and Testing
Wireless Impoundment Monitoring

Draft Output Data

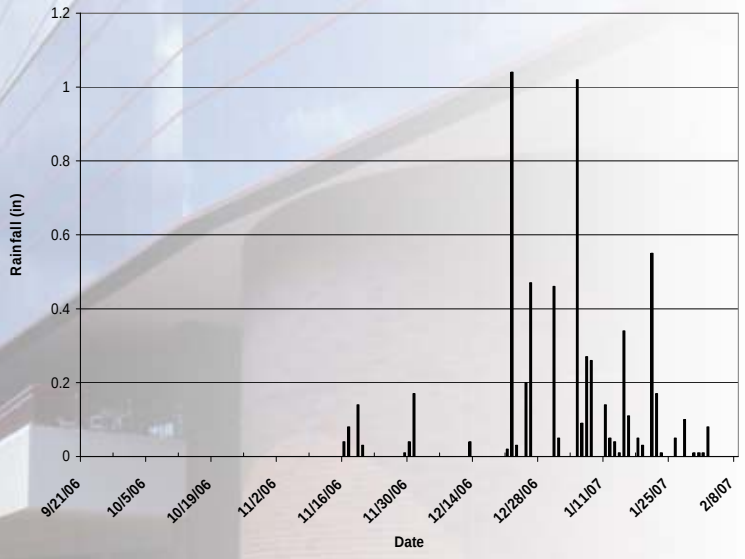


Figure 00: Daily Rainfall Amounts

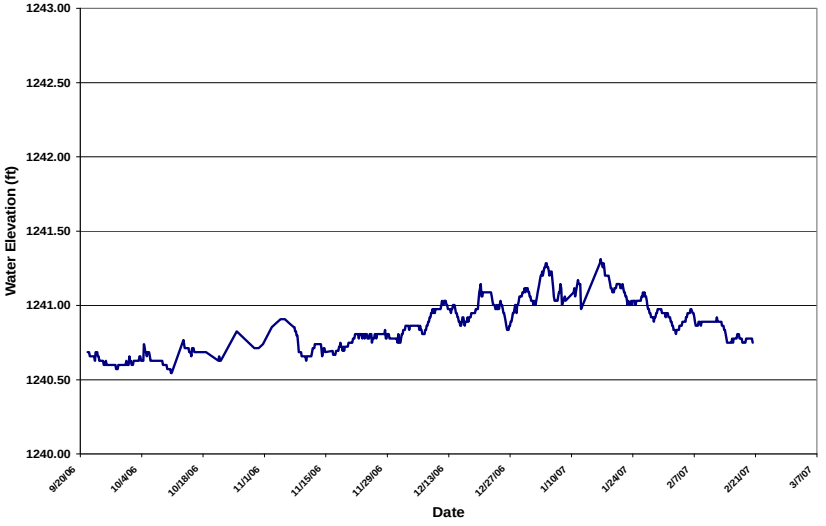


Figure 00: Water Elevation Readings at P13

Pilot Scale Technology Development and Testing
Wireless Impoundment Monitoring

Draft Output Data

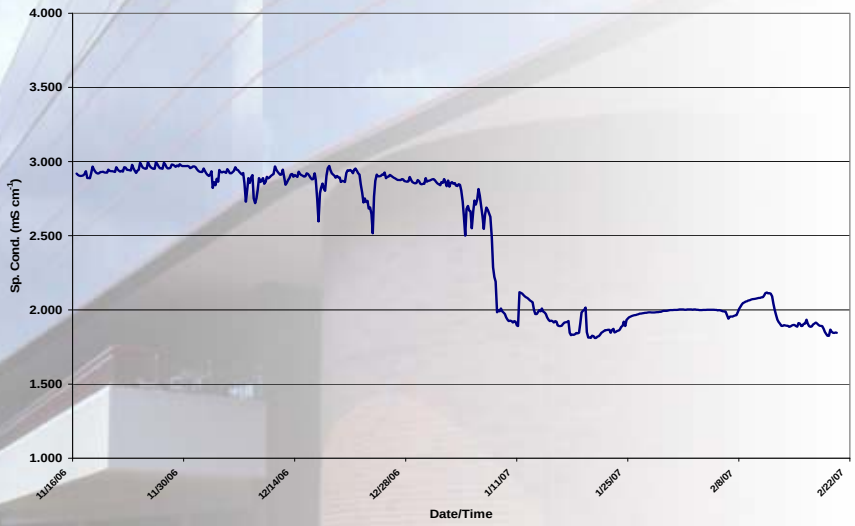


Figure 00: Specific Conductance at P14

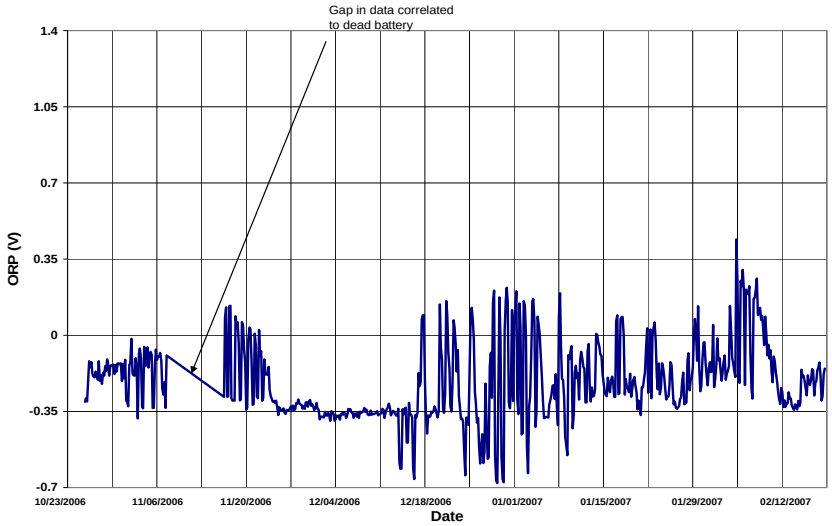


Figure 00: Oxidation Reduction Potential at Toe Pumps

Pilot Scale Technology Development and Testing
Wireless Impoundment Monitoring

Summary & Planned Activities

Research is continuing with monitoring activities including data collection and reduction.

Planned activities are to continue data collection and comparison with site's manually collected data and monitor system for both up and down-time operation.

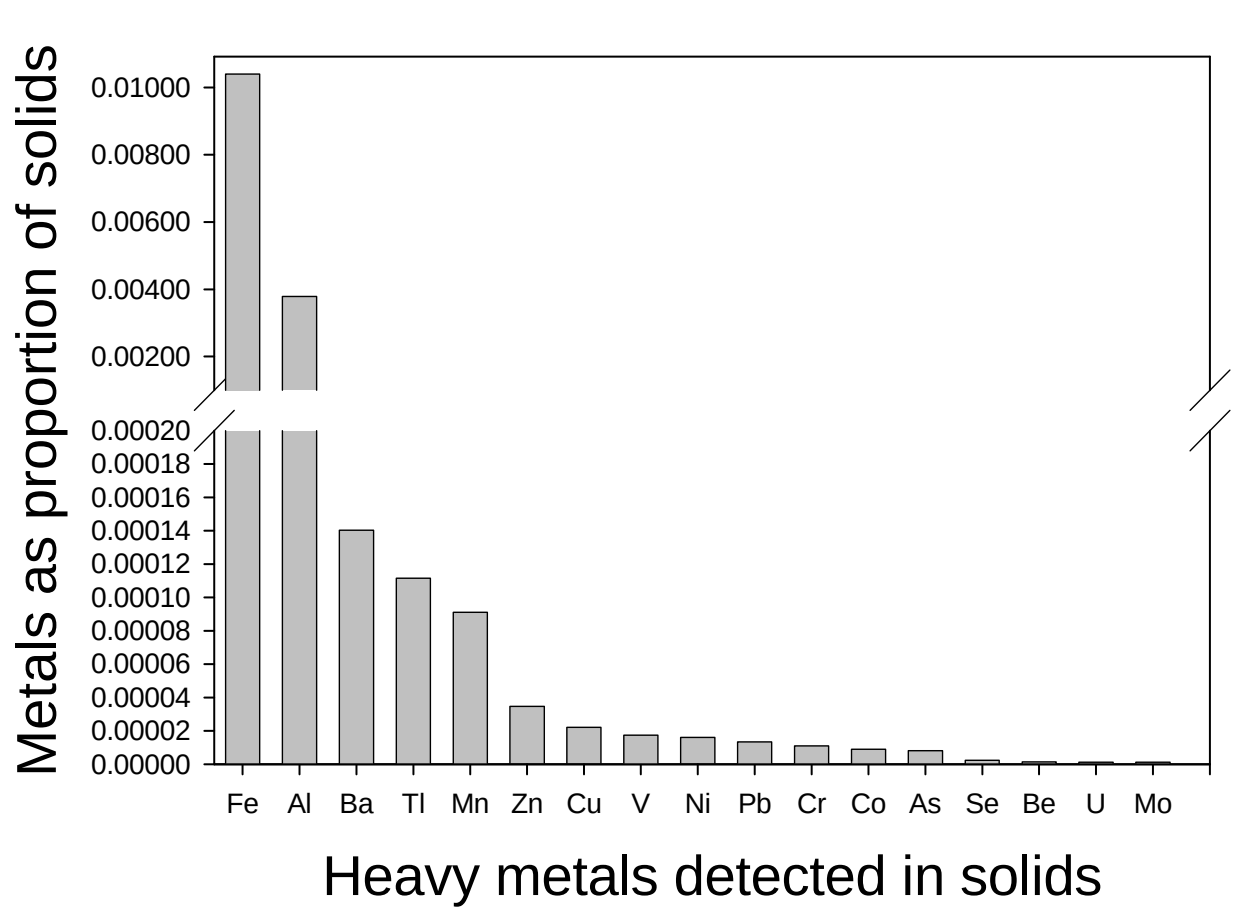
Pilot Scale Technology Development and Testing
Coal Slurry Characterization

Concentration of heavy metals in the solid fraction of 5 coal slurry samples.

Concentration (ppm)	B	L	X	C	J	AVG	Median	Min	Max	% conc.
Iron* (estimated)	8740*	7405*	2507*	6249*	27087*	10398	7405	2507	27087	0.010398
Aluminum	5948	3682	486	3127	5696	3788	3682	486	5948	0.003788
Barium	333	104	14	114	137	140	114	14	333	0.00014
Titanium	51	99	291	48	68	111	68	48	291	0.000111
Manganese	119	98	5	104	130	91	104	5	130	9.11E-05
Zinc	46	37	8	32	49	35	37	8	49	3.46E-05
Copper	28	29	3	20	31	22	28	3	31	2.21E-05
Vanadium	16	17	18	15	21	17	17	15	21	1.74E-05
Nickel	20	16	5	15	23	16	16	5	23	1.6E-05
Lead	16	18	5	9	18	13	16	5	18	1.34E-05
Chromium	12	12	9	8	13	11	12	8	13	1.09E-05
Cobalt	11	8	0	5	12	9	9	5	12	8.91E-06
Arsenic	3	7	3	6	22	8	6	3	22	8.03E-06
Selenium 78	1	3	0	0	2	2	2	1	3	2.38E-06
Selenium 82	2	4	1	0	3	2	2	1	4	2.25E-06
Beryllium	1	2	2	0	1	1	2	1	2	1.45E-06
Uranium	1	1	0	0	1	1	1	1	1	1.15E-06
Molybdenum	0	1	1	0	1	1	1	1	1	1.14E-06

*Iron concentrations were estimated because they significantly exceeded laboratory standards.

Pilot Scale Technology Development and Testing
Coal Slurry Characterization

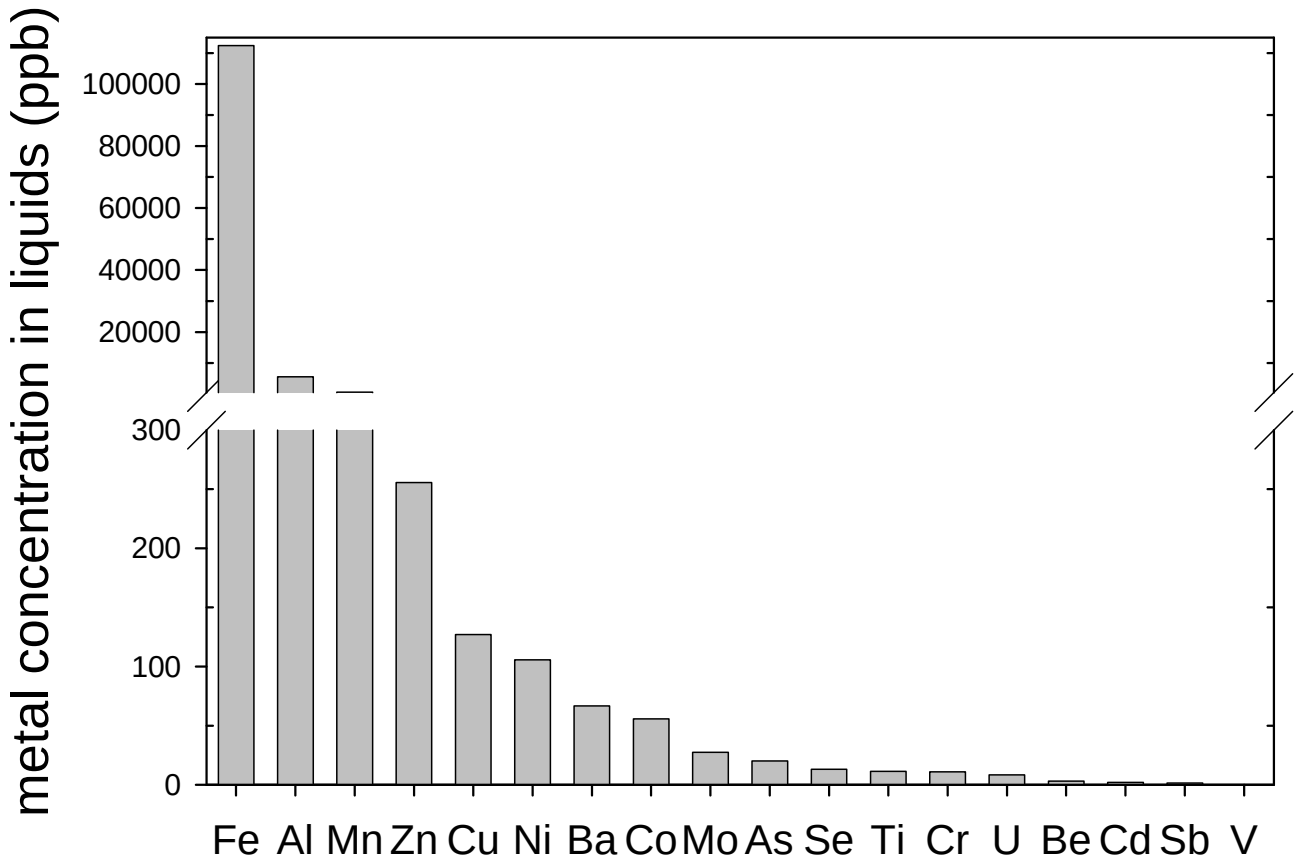


Pilot Scale Technology Development and Testing
Coal Slurry Characterization

Heavy metal concentrations (parts per billion) in liquid fraction of 5 slurry samples.

Conc. (ppb)	7085	B	L	X	hot X	Average	Median	Min	Max	Rank
Fe (ppb)	427	329	211	515105	46026	112419	427	211	515105	0.000112
Al (ppb)	149	197	187	21758	5590	5576	197	149	21758	5.58E-06
Mn (ppb)	87	100	87	2194	399	573	100	87	2194	5.73E-07
Zn (ppb)	3	7	5	1026	236	256	7	3	1026	2.56E-07
Cu (ppb)	3	3	3	367	260	127	3	3	367	1.27E-07
Ni (ppb)	4	12	4	419	90	106	12	4	419	1.06E-07
Ba 137 (ppb)	54	211	45	4	20	67	45	4	211	6.67E-08
Co 59 (ppb)	1	4	0	228	46	56	4	0	228	5.57E-08
Mo 98 (ppb)	47	36	51	0	3	27	36	0	51	2.74E-08
As (ppb)	3	2	4	76	16	20	4	2	76	2.02E-08
Se78 (ppb)	26	2	20	13	5	13	13	2	26	1.32E-08
Se82 (ppb)	27	3	11	15	6	12	11	3	27	1.21E-08
Ti (ppb)	8	7	11	24	6	11	8	6	24	1.13E-08
Cr (ppb)	0	0	0	48	7	11	0	0	48	1.09E-08
U 238 (ppb)	9	7	9	16	1	8	9	1	16	8.28E-09
Be (ppb)	0	0	0	14	1	3	0	0	14	3.04E-09
Cd (ppb)	0	0	0	10	0	2	0	0	10	1.96E-09
Sb (ppb)	0	2	5	0	0	1	0	0	5	1.46E-09
V (ppb)	0	0	0	2	0	0	0	0	2	3.6E-10

Pilot Scale Technology Development and Testing
Coal Slurry Characterization



Heavy metals detected in coal slurry liquids

Task 10 Waste Coal Energy Survey in West Virginia

Purpose:

Determine key requirements for the use of coal sites including: gob piles, reclaimed impoundments, and other reclaimed sites for use as energy sources.

Objectives:

1. Determine database fields: ownership, mapping and location, volume, infrastructure availability, environmental condition.
2. Identify existing information on sites from US Office of Surface Mining Reclamation and Enforcement, and the WV Department of Environmental Protection.
3. Populate data base from field data at ten sites in WV.

Task 11 Emergency Alerting

Web-based Alerting System

- Expand web-based Emergency pilot project to additional WV Counties
- Conduct Community Outreach

Tabletop Emergency Response Drills

- Develop Tabletop Response Drill Manual
- Conduct a Minimum of 2 Drills
- Document Drills and Outcomes

Emergency Plan Updates

- Develop a Methodology to Ensure that Emergency Plans are Updated

Web-based Alerting System

Coal Impoundment *LIS*
Location & Information System

+

ALERTS

=

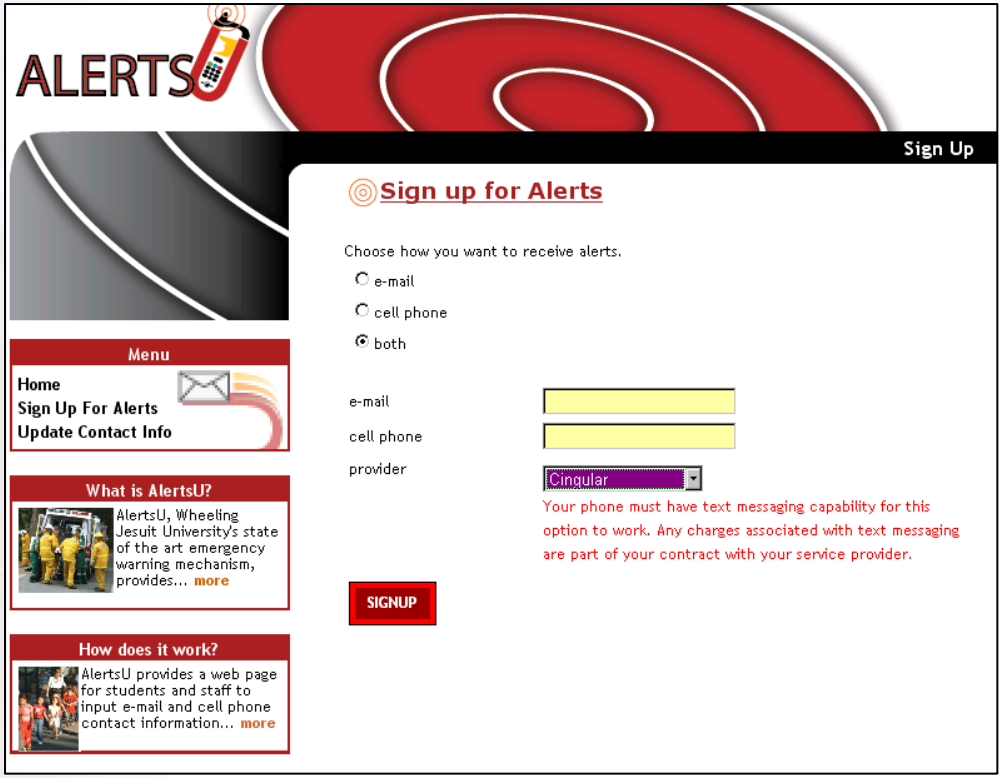
Coal Impoundment cell phone text message and email alerts for participating impoundments, companies, or counties.

Web-based Alerting System

Sign up for alerts

Community members input

e-mail and cell phone contact information to register as users.

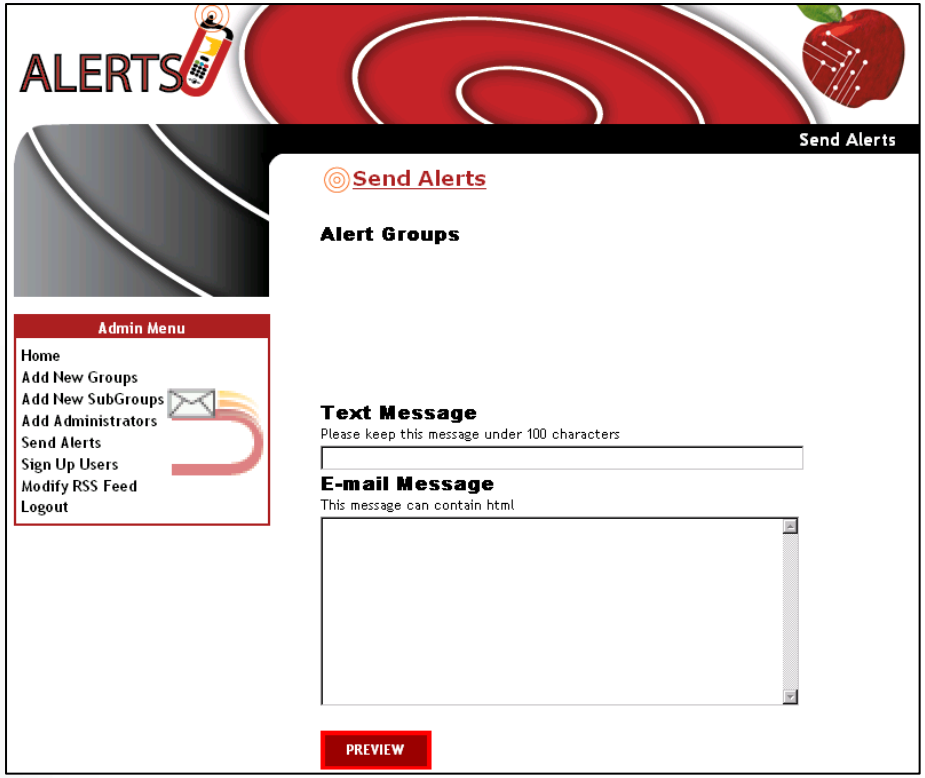


Web-based Alerting System

Send Alerts

Authorized administrators enter alerts into a password-protected website.

Server sends a cell phone text message and/or email message to each registered user.



Web-based Alerting System

Implementation Plan

- Survey alert administrators (impoundment operators and EMA's) to determine alert groups

  (by county, by impoundment, etc.)
- Interface the two web-based systems.
- Conduct outreach for additional alert administrators.
- Outreach program to inform local communities about the alert system (communities near participating impoundments).

Tabletop Emergency Response Drills

Successful exercise on August 16, 2006.

- Discussion of emergency plans for Brown's Run Slurry Impoundment, public notification, evacuation, and mass care plans for Marshall and Ohio Counties, WV.

- 16 participants
- 12 different agencies

Tabletop Emergency Response Drills

2006 Exercise

- Exercise driven by pre-scripted messages.
- Response actions and communications documented on message forms.

Tabletop Emergency Response Drills

Message Driven Exercises

Pros: Very engaging, excellent feedback from participants, met most objectives, was specific to a particular impoundment.

Cons: Significant preparation time, requires more experienced facilitators and evaluators.

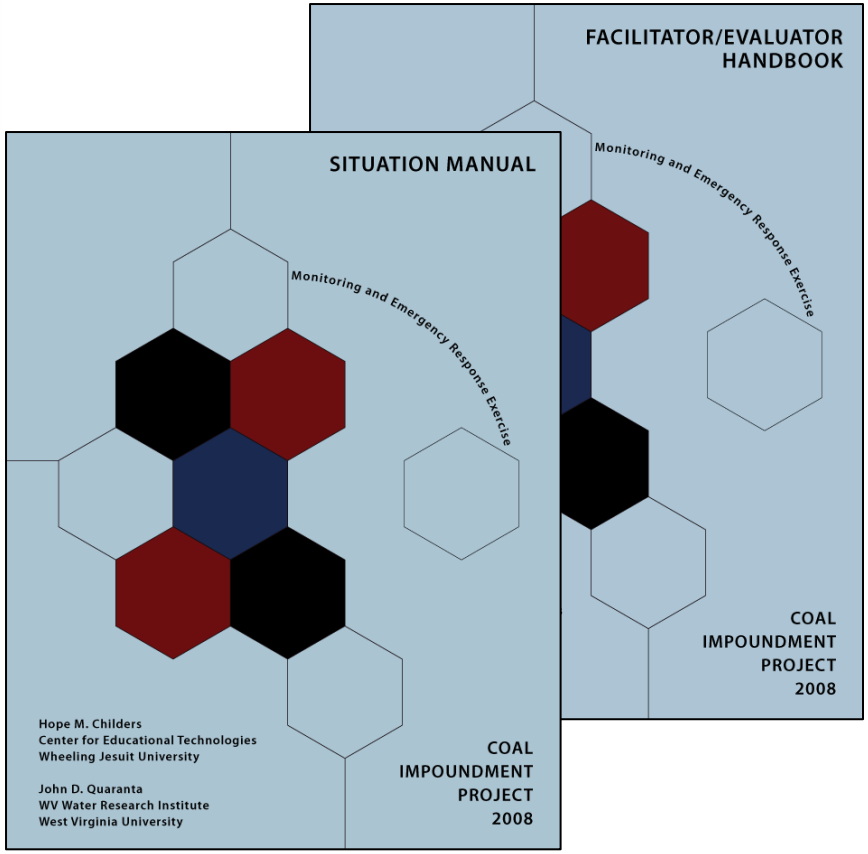
Tabletop Emergency Response Drills

Training Tools for MSHA and Industry

Facilitator/Evaluator Handbook

and participant Situation Manual

are ready for agency review.



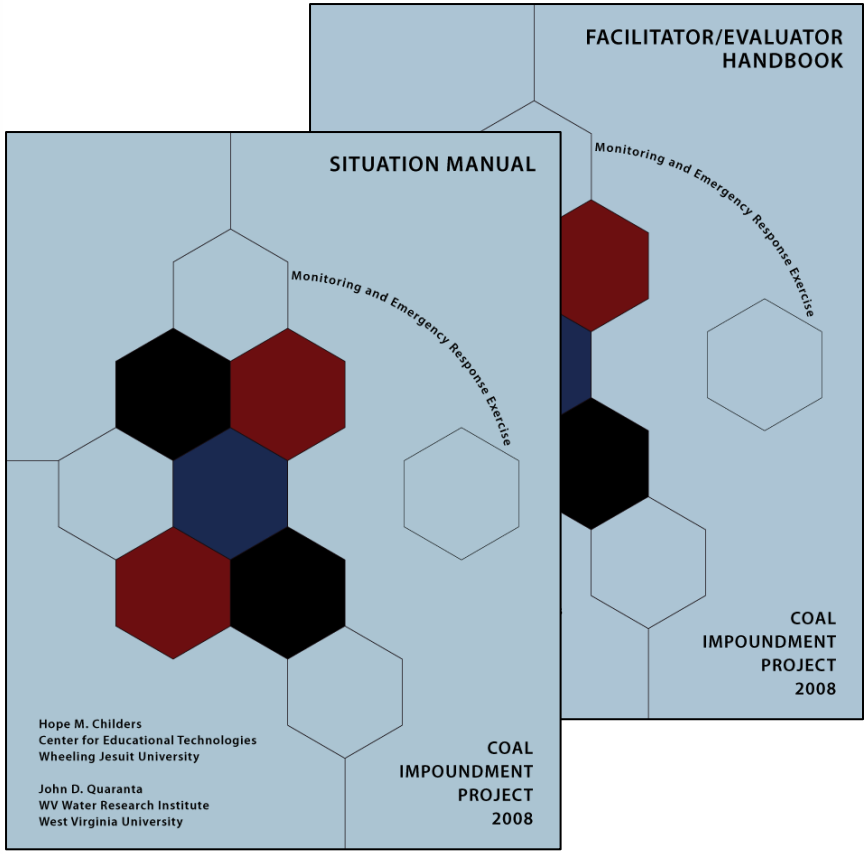
Tabletop Emergency Response Drills

Exercises are driven by written scenario updates and discussion questions.

Training materials can be used “as is” or further customized for a particular impoundment.

Little required preparation time.

Straightforward facilitation and evaluation.



Tabletop Emergency Response Drills

Facilitator/Evaluator Handbook

Introduction
- Background, Purpose, Scope, and Objectives
- Exercise Structure and Assumptions
- Sample Agenda

Exercise and Evaluation Guidelines
- Facilitating the Exercise
- Evaluating the Exercise
- What to Look for and Record
- Participant Debriefing and Evaluation Forms
- Opportunities for Improvement and Lessons Learned

Situations and Discussion Questions

Recording Sheets

Evaluator Checklists

After-action Report and Follow-up Activities

Tabletop Emergency Response Drills

Situation Manual

Introduction
- Background, Purpose, Scope, and Objectives
- Exercise Structure
- Exercise Guidelines
- Exercise Assumptions
- Sample Agenda

Situations and Discussion Questions

Debriefing and Follow-up Activities

Participant Evaluation Form

Tabletop Emergency Response Drills - Sample Exercise Overview

- Low stress, non-time-pressured discussion of the emergency plans for the Brown's Run impoundment as well as public notification, evacuation, and mass care plans for Marshall and Ohio counties.

- Wheeling Jesuit University is coordinating this exercise with assistance from the Water Research Institute from West Virginia University as part of the collaborative efforts of the Coal Impoundment Project.

Tabletop Emergency Response Drills

Sample Scenario Update and Discussion Questions

10:00 am, July 15, 2008 – Suspicious Seepage

On this beautiful sunny day, during the placement of coarse refuse, the dozer operator observes seepage around the outside of the decant pipe. The dozer operator radios the shift foreman that there appears to be seepage developing around the outside surface of the decant pipe. The shift foreman subsequently notifies the mine superintendent and they meet at the decant pipe and decide to start monitoring the flow of the seepage.

1. What physical parameters do the mine operators monitor?
2. How often are they monitoring those parameters?
3. What are some concerns relevant to the seepage condition?
4. Based on these concerns, what are the next steps of action?
5. What immediate concerns are there to the safety of the dam structure and the public?

Tabletop Emergency Response Drills

Planned Activities

- Revise handbook and manual based on agency review.
- Conduct outreach and distribute materials to agencies and operators.
- Provide exercise facilitation and evaluation assistance.

Emergency Plan Updates

- Met with Jim Pierce - West Virginia Department of Environmental Protection
- He was agreeable to our idea of bringing a scanner to his office and creating .pdfs of the EWPs there
- WVDEP is committed to all electronic permitting by January 2009
- Will probably eventually require electronic EWPs as well
- Only problems they seem to be running into with the electronic permitting are with the maps since different companies have different software tools

Enclosures

- Table Top Facilitator/Evaluator Handbook
- Table Top Situation Manual
- WVU Instrumentation Report
- Coal Slurry Chemistry Data

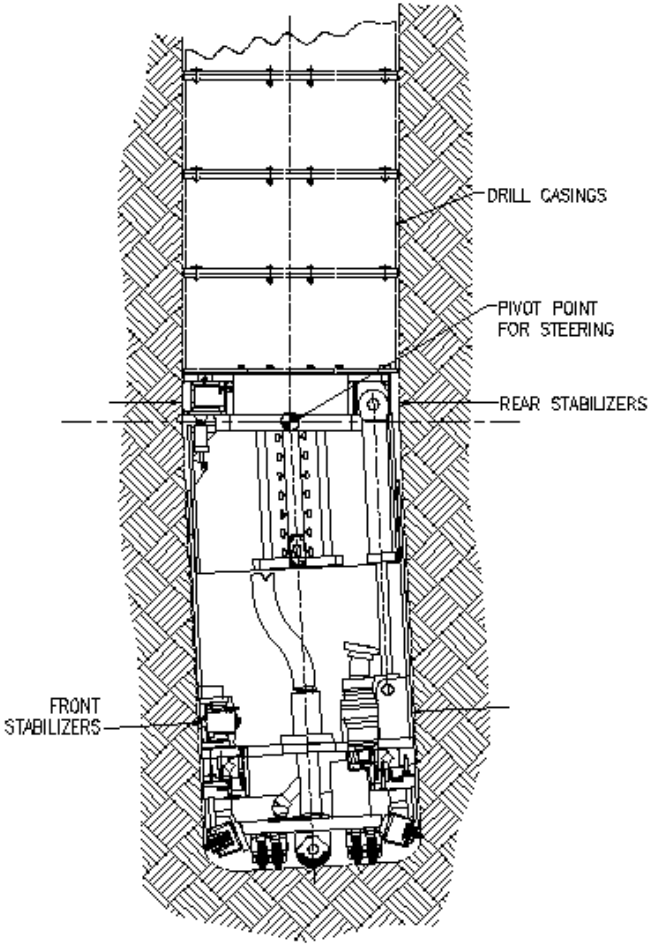
Planned Activities

- Table Top Exercises
- Website Modifications
- Methane Generation
- Coal Waste Energy Survey

Independent Impoundment & Safety Technology Assessment – Rescue Systems

- Robbins TBM Small Boring Unit

Independent Impoundment & Safety Technology Assessment – Rescue Systems



Independent Impoundment & Safety Technology Assessment – Rescue Systems