Self-Calibrating Remote Control Monitoring Systems

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Monitoring Philosophy

• Provide near real-time site performance information for management and project engineers
• Integrated multi-sensor design
• Automation of data collection, storage, and reporting
• Self-calibration of chemical sensor suite
• Remote control of data collection
• Secure web-based information accessibility
• Alarm capabilities
Quarterly Manual Monitoring Disadvantages

• Not cost effective for information gathered
• Monolithic - cannot be easily customized to fit a specific remediation system
• Does not provide a way to distribute information
• High cost per sample, it is not feasible to collect enough information to thoroughly understand the remediation system
Remote Monitoring Advantages

- Provides near real time decision making information for management and project engineers
- Economically establishes a baseline for EPA quarterly monitoring
- Multiple parameters such as temperature, chemistry, flow rate, hydrology and ion concentrations
- Reduces travel to remote sites through remote two way communications and remote calibration
- Can run on 12v DC generated by wind or solar
- Acquires information necessary to better understand the treated system
- Understand the dynamic system behavior to optimize current systems or enhance future remediation designs
Barite Hill Mine

- Located near McCormick, South Carolina
- Operated by Nevada Goldfields, Inc.
- Mined from 1989-1994 (gold, silver)
- Open pit mining effort
- Impacts a tributary to the Savannah River
- Listed as a Superfund site on the National Priorities List (NPL) April 2009
Study Motivation

• Determine if the lake treatment will remediate the waste rock repository
• Understand the treatment system and how it interacts with the lake
• Find the location of largest influx of acid
• What are the conditions that produce the influxes
Monitoring Parameters for Barite Hill

• Requirements
  – Automated data collection and system access
  – User friendly interface to data
  – Automated data management

• Pit lake Sampled at 5 foot intervals
  4 Wells Sampled at single location
  – pH
  – ORP
  – Dissolved Oxygen
  – Conductivity
  – Temperature

• Lake Level Sensor
  – Alarms at spillway

• Subsurface Monitoring
  – Resistivity
  – Temperature
  – Water levels
  – Water Chemistry

• Ground Water
  – Areal Extent
  – Flow Direction
Instrumentation  Calibration Fluids  Controllers  Pinch Valves  Pumps
Camera and Lake level sensor
Wells

• Temperature
• Water level

• Automated water pumping
• Calibrated water chemistry
Lake Sampling

- Samples every 5 feet from surface to a depth of 55 feet
- Chemical analysis of samples completed everyday
Barite Hill Results

- **Waste Rock Repository**
  - Temperature Variance is uniform in wells 26, 27 and 29
  - thermocline appears in Well 28
  - pH is 2.6 ±0.3
Barite Hill Results

- Pit Lake
  - Chemocline between 15 and 20ft
  - 45 ft to 50 ft is warmer than 30 to 35 ft
  - pH is consistent at top of lake
  - Bottom of lake is more acidic
Web Site and Control Software

- Provides a database to store the data
- Allows password protected, graduated levels of access to the system
- Provides a simple plotting tool to view the data
- Allows for remote operation of the system
- Expandable to multiple types of monitoring sites
Barite Hill Results 2010

- Will the pit lake remediation efforts affect the waste rock repository?
- Due to the close proximity of the pit lake and the waste rock, analysis of the two sources of contamination is necessary.
- The correlation of the two entities will allow for a better understanding of the dynamics of the system.
Monitoring Results
Monitoring Results

- The ability to sample daily allows time series data evaluation, enabling an understanding of the system’s dynamic behavior which allows for the optimization of the system.
- The most critical aspect to remote monitoring systems and their success is the ability to supply power, retrieving data, and calibrating the sensors.
  - The system is capable of being powered by 12V_DC generated by wind or solar power.
  - Two way communication is accomplished by either cell modem, satellite, or radio.
  - Calibrations are done weekly and data is storage securely online for easy interface.
Resistivity Results

- Resistivity is a volumetric measurement system that detects
  - Water
  - Ion concentration
  - Ion exchange capacity
  - Temperature
  - Geology
- Conductive ground
- The south waste rock repository electrical response is consistent over the entire facility however it is more conductive than the north repository
- The north waste rock repository demonstrates a different behavior
Resistivity Results

- Resistivity when teamed with point source measurements are the best technology for characterizing and monitoring chemistry, fluid flow, temperature, contaminant flow, and remediation behavior.
- Results show that wells BH 26, 27, and 29 show similar behavior.
- Well BH 28 response are similar to the pit lake.
- Current study efforts are concentrated at wells BH 28 and 29 to understand the change in system behavior at this location.
- Well BH28 behavior could be produced by a several phenomena
  - Different lake connection rates, faster REDOX reactions, higher levels of bioactivity and or larger loads of Pyrite.
Cold Weather and Remote Application

• The system can be implemented in areas without permafrost now
  – More work would have to be done to operate in that environment
• The system is designed to operate on 12 volt solar or wind
• Two way communication via cell modem, satellite, or radio
• Depending on sample and calibration frequency the system could easily run for four to six months
Summary

- Barite Hill Pit Lake is responding to treatments
- 3D resistivity shows that the North and South Waste Rock Repositories demonstrate different behavior
- The temperature, chemistry and resistivity results indicate that something is occurring around well BH28.
- The inoculation has dramatic effects on the lake only well BH28 was observed to have a difference which is the farthest from the lake.
- Pit lake has a thermo-cline that occurs near 30 feet
- Pit Lake has a weak Chemo-cline occurring near 35ft
- Well BH 28 mimics lake thermo-cline unlike the rest of the wells
- 4,275,000 temperature data points have been recorded
- 2,505 readings each of DO, Conductivity, ORP, pH
- 10,020 total chemical samples in 7 ½ months
- Total cost per sample: $0.16
Future Work for Monitoring System

• In-situ Biological Monitoring
  – Species
  – Quantity
• Replace wet chemistry sensors with a more robust method