Developing a Long-Term Monitoring Strategy of the Vadose Zone for Contaminated Waste Sites

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Long-Term Performance Monitoring of Metals and Radionuclides in the Subsurface: Strategies, Tools and Case Studies

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Outline

• Subsurface monitoring needs

• INEEL approach to subsurface monitoring

• Monitoring system example: The Gilt Edge mine site
Monitoring

• Monitoring timeframes
  – Short term (months-years) active remedial efforts
  – Medium term efforts (reactive barriers/enhanced natural attenuation)
  – Long term stewardship (compliance monitoring, predictive model development and tracking)

• Monitoring objectives drive the design of the monitoring system
**INEEL Monitoring Philosophy**

- Effective monitoring requires an integrated approach to data acquisition, data management, data processing, data analysis and result presentation.

<table>
<thead>
<tr>
<th>Monitoring – current efforts</th>
<th>Monitoring – future systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data centric</td>
<td>Information centric</td>
</tr>
<tr>
<td>Fixed product – wysiwyg</td>
<td>User controllable output</td>
</tr>
<tr>
<td>Non-existent or primitive data management (excel files)</td>
<td>Use of relational database for data and operations on data</td>
</tr>
<tr>
<td>No intrinsic QA/QC</td>
<td>Intrinsic QA/QC</td>
</tr>
<tr>
<td>Limited functionality</td>
<td>Extendable functionality</td>
</tr>
<tr>
<td>High yearly O&amp;M cost due to manual efforts</td>
<td>Low O&amp;M costs due to automation</td>
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</tbody>
</table>
INEEL LTM System Strategy

Note: Monitoring Objectives (not the sensors) drive the design of a LTM system
Landfill Cover Example

System Analysis

\( q = K(\psi) i \)

Matric Potential

mV to Pressure

Advanced Tensiometers

Information

Subsurface Water Flux

Map of Matric Potential

Decision

Compare to Maximum Allowable Flux

Action

No action

Confirmation

Remedial action

Map of Matric Potential

Compare to Maximum Allowable Flux

No action

Confirmation

Remedial action
INEEL Approach to Monitoring

- Design monitoring systems which allow end user to have user appropriate tools to access information on subsurface

- System approach
  - Autonomous, multi-sensor data acquisition
  - Automated data management
  - Automated visualization, interpretation and report delivery
Gilt Edge Mine

- Located near Deadwood, South Dakota
- Mining since 1876 (gold, copper, tungsten)
- Open pit mining effort (Brohm Mining, 1986-1998)
- Waste rock covers 64 acres, 200 foot thick
- Produces 60 GPM acidic run off
- Impacts water supply of Sturgis, SD
- Listed on Superfund site in December, 2000
- Three Operable Units
  - Focus of effort: Ruby Gulch
Operable Unit 3 - Ruby Gulch Waste Rock Dump  
2600 X 2200 feet
Monitoring Objectives

- Long-term geomembrane integrity
- Diversion liner integrity
- Acid rock drainage dynamics
Gilt Edge LTM

- Complete field data hardware and data collection system (spring - summer 2003)
- Start data collection (August 2003)
- Electrical resistivity, advanced tensiometers, suction lysimeters, temperature, flow rates
Welcome to the Gilt Edge Mine Data Access Portal

Choose the application which you want to use:

- GIS Map Server of the Gilt Edge Mine - The GIS Map Server is a GIS tool which provides a graphical interface to the Gilt Edge site.
- Time Based Well Data - Use this application to access the water level and temperature data recorded in the wells in a time based format.
- Visual Depth Based Well Data - This application provides access to well sensor data in a visual, depth based format.
- Weather Station Data Access - Use this application to access the weather station data. This information is currently updated monthly.

No News to Display

There are no news articles to display. There may be no news for this topic or your user preferences may be too restrictive for topic GiltEdge.
Data Analysis Structure

• Software structure for automated analysis
• Allows
  – Storage and documentation of analysis steps
  – Connection to external analysis programs
    • Statistical packages
    • Inversion software
    • Visualization packages
    • Models
  – Connectivity structure is flexible and can be adapted to encompass any external package
• Note: under continued development
Well Data
Analysis Example

• Statistical analysis and filtering of resistivity data

• As soon as the data are parsed in the database, the analysis can be run on the data

• Part of the analysis allows output to/invocation of inversion codes
Some Resistivity Results

- Electrodes installed in 4 wells, along 9 NS benches and 2 EW ditches
- Software can address any combination of electrodes
- Continuous data collection 24/7
- One data point every 2.5 seconds
- Currently focused on collection along 2D benches, shift to 3D patterns in early 04
- Inversion using Res2dINV
Summary

• Autonomous, automated monitoring systems are critical for obtaining data and extracting information for DOE
• Monitoring system design and implementation needs should be driven by end user needs
• LTM systems are feasible to build, and (while not cheap to build) have low O&M costs
• Information provided by LTM systems can not be obtained from any manned surveys
• Sensors must be robust and/or replaceable
• It is important to design integrated monitoring systems