The Interstate Technology and Regulatory Council

Mine Waste Treatment Technology Selection Guidance

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Overview

- Innovative Technologies
- Interstate Technology Regulatory Council (ITRC)
  - What is it?
  - Why does it exist?
  - What does it do?
- Mine waste web based guidance
  - Purpose
  - Overview
  - Example
Innovative Technology

Definition: A process that has been tested and used as a treatment, but lacks:

- a long history of full-scale use
- information about its cost
- how well it works sufficient to support prediction of its performance under a variety of operating conditions

http://www.brownfieldstsc.org/glossary.cfm?lett=l
Innovative Technologies

Or
ITRC – Interstate Technology & Regulatory Council

State led organization

ITRC State Members

Host Organization

Federal Partners

DOE  EPA  DOD

Industry, Academia, Consultants, Citizen Stakeholders

ITRC Member State
Goals

- Achieve better environmental protection through innovative technologies
- Identify and remove barriers
  - technical or regulatory
- Build confidence about using new technologies
Goals

- Increase state acceptance
- Streamline state permitting processes
ITRC Process

- Proposals
  - Technology or problem
  - Developed and ranked by states

- Teams are formed to solve the priority problems
  - State led
    - Minimum of 5 states
  - Industry
  - Federal agencies
  - Academia
  - Public stakeholders
ITRC Process

Products

- Guidance document
  - Over 40 produced
- Internet Based Training
  - Over 75,000 participants
Team is fairly diverse
(35 participants)
Mine Waste Project

- 2010 – Mine Waste Technology Selection Guidance
- 2011 – New Project Starting: Technical and Regulatory Guidance for Biochemical Reactors
Value of this Guidance

- Web-address: www.itrcweb.org/miningwaste-guidance
- Quick tool to identify appropriate technologies
- Applies to all potentially impacted media
- Access to case studies
- Reference tool for new personnel
- Describes potential regulatory constraints
Mine Waste – A Burning Issue
Mining is Important

- **Issues**
  - Mining practices
  - Lack of mined land reclamation and restoration laws

- **Needs**
  - Innovative technologies and approaches
  - Solutions for regulatory barriers
Scale of the Problem

- Large sites
- Single sites
  - Annapolis Lead Mine, MO
  - Anaconda Superfund Site, MT
- Mining districts
  - St. Francois County, MO
  - Affect large areas
  - Many small mines
Media Affected by Mining Waste

- Air
- Water
- Soil
- Vegetation
Solid Mining Waste

- Includes
  - Mine pits and workings
  - Waste rock stockpiles
  - Tailings
  - Smelter waste
  - Other

- Contain residual metals or other chemicals

- Hundreds of square miles affected
Mining-Influenced Water

- Mine drainage
  - pH
  - Contaminants

- Over 10,000 stream miles impacted

- Groundwater impacts
Objectives of the Guidance

- Select applicable technology(s)
- Provide information on technologies
- Remediate mine waste contaminated sites

Flambeau Mine, WI
During mining

Flambeau Mine, WI
After reclamation
Approach

- Problem based technology/regulatory guidance
  - Multiple technologies solve problems
  - Select appropriate technologies

- Optimize your approach
  - Clean up the source
  - Clean up the media
Advantages of Web-based Approach

- Interactive
  - Easy to navigate

- Graphics
  - Color images, photos, etc can be used for illustration

- Flexible
  - Easier to update site as new information or case studies become available
Content of Guidance

- Overview
- Decision Trees
- Technology Overviews
- Case Studies
- Regulatory Issues
- Stakeholders Concerns
- Additional Resources
Overview Page

Register for Internet based training

Print PDF versions of the page
Decision Trees – Getting Started

Mining Waste Team Decision Tree—Initial Questions

Do you need to take an action immediately or do you have a longer time period to implement your action?

>2 years

Immediate Decision Tree

<2 years

Long-term
Do you have a Solid Mining Waste or Mining-Influenced Water Problem?

Solid Mining Waste Decision Tree

Mining-Influenced Water Decision Tree
Immediate Decision Tree

- **Navigation aids**
  - Titles
  - “You are here” diagram
Technology Overviews

Focus

• Information on newer technologies
• Novel uses of conventional technologies
• Provide case studies and additional references
## Technology Overviews

1. Administrative and Engineering Controls *
2. Aeration
3. Anoxic Limestone Drains
4. Backfilling, Subaqueous Disposal
5. Biochemical Reactors
6. Capping, Covers and Grading
7. Chemical Stabilization
8. Constructed Treatment Wetlands *
9. Diversionary Structures
10. Electrokinetics
11. Electrocoagulation
12. Excavation and Disposal
13. In situ Biological Treatment
14. In situ Treatment
15. Ion Exchange
16. Microbial Mats
17. Passivation
18. Permeable Reactive Barriers *
19. Phosphate Treatment – Chemical Stabilization
20. Phytotechnologies *
21. Pressure Driven Membrane Separation
22. Reuse and Reprocess

* ITRC has guidance documents
Case Studies

- Site Information
- Remedial Actions and Technologies
- Performance
- Cost
- Regulatory challenges
- Stakeholder Challenges
- Other Challenges/Lessons Learned
- References
Case Study Distribution

Total of 59 Case Studies (as of August 2010)
Regulatory Issues

- Discuss regulatory issues and challenges related to
  - Water quality
  - Solid mine waste

Mine Waste Treatment Technology Selection

1.0 Regulatory Issues/Challenges
The ITRC Mining Waste Team searched statutes, regulations, or policies that impede or slow the use of new technologies in the reduction of threats to human health and the environment related to mining waste. During the investigative process, the team has searched for a variety of solutions to these barriers and recommend ways to overcome them. ITRC’s experience in past projects suggests that statutory and regulatory barriers often do not exist since exceptions, variances, or waivers are available. Even so, these are time-consuming, costly, uncertain, and biased toward existing or conventional technologies. This bias is part of what we are trying to overcome to allow new technologies to be tested, demonstrated, and earn an appropriate place in the toolbox of environmental professionals. The Mining Waste Team has identified the following issues.

1.1 Issue #1: Water Quality Standards
A barrier to the use of an innovative technology is the ability to consistently meet all ambient water quality standards. For example, wetland treatment systems almost always provide treatment but may not always consistently meet numeric water quality standards. To understand how a technology may address a portion of the overall water quality concerns, one must first understand that development of...
Stakeholder Concerns

- Competing values may slow the cleanup
  - Public health
  - Ecological health
  - Historical significance

- Full vs. partial cleanup
  - When is it clean enough?
  - Why not clean up to background
Section Summary

- **Web-based Guidance**
  - Assumes site is characterized
  - Help select appropriate technologies to remediate contaminated mine sites
  - May need to go through decision trees several times

- **Technology overviews** - not design manuals

- Unique site characteristics and costs must be carefully considered

- Now practical application
Case Study – Site Location

Minnesotan's Map of North America

- Possum Lake, Home of Red Green
- Great White North
- Project Site
- Mall of America
- East Coast (1 Big City)
- Las Vegas
- Texas
- California (CAL)
Case Study – Dunka Mine
Waste Rock Stockpiles
Dunka Pit Geology Cross-Section (Schematic)

- **Virginia Formation**
- **Mineralized Zone**
- **Duluth Complex**
- **Biwabik Iron Formation**
- **Giants Range Granite**
Duluth Complex, Copper-Nickel Deposit

Fresh sulfides

Oxidized sulfides
Dunka Mine Effluent

- Precipitation exceeds evapotranspiration
- Effluent from the stockpile
The Problem

- 5 major seeps
- Flow
  - Average ~ 5 – 250 gpm (19-946 L/min)
- pH
  - Generally >7
  - One site pH ~ 5
- Trace metal concentrations, mg/l
  - Nickel, ~ 1-10
  - Copper ~ 0.01 – 1
  - Cobalt ~ 0.01- 0.1
  - Zinc ~0.01 - 2
Problem – Mining-Influenced Water

- Water quality was primary driver
- Source of problem was waste rock stockpiles
Decision Trees - Getting Started

Mining Waste Team Decision Tree—Initial Questions

Do you need to take an action immediately or do you have a longer time period to implement your action?

- >2 years
  - Long-term
    - Do you have a Solid Mining Waste or Mining-Influenced Water Problem?
      - Solid Mining Waste Decision Tree
      - Mining-Influenced Water Decision Tree
  - <2 years

Immediate Decision Tree
Decision Trees - Getting Started

Mining Waste Team Decision Tree—Initial

Do you need to take an action immediately or do you have a longer time period to implement your action?

Solid Mining Waste

Long-term
Do you have a Solid Mining Waste or Mining-Influenced Water Problem?

Solid Mining Waste Decision Tree

Mining-Influenced Water Decision Tree
Mining Waste Team Decision Tree—Initial Questions

Do you need to take an action immediately or do you have a longer time period to implement your action?

Immediate Decision Tree

Long-term
Do you have a Solid Mining Waste or Mining-Influenced Water Problem?

Solid Mining Waste Decision Tree

Mining-Influenced Water Decision Tree
Mining-Influenced Water

Do you need to control water quality at the human receptor or at the source?
Mining-Influenced Water Decision Tree

Source
Can you eliminate the mining-influenced water by addressing the solid mining waste source?
Do you need to control water quality in groundwater or surface water?
Do you need a treatment technology that is more passive or can you use a more active technology?
Active vs. Passive Treatment

Global Acid Rock Drainage (GARD) Guide, 2009

► Active
  • Requires ongoing human operations, maintenance and system monitoring
  • Based on external sources of energy using infrastructure and engineered systems

► Passive
  • Processes do not require regular human intervention
  • Employs natural construction material, natural materials and promotes natural vegetation
  • Gravity flow
Mining-Influenced Water Decision Tree

Part Two

No
Do you need to control water quality in groundwater or surface water?

Groundwater
Do you want to pump water and treat it at the surface?

- No
- Yes

Surface Water
Do you need a treatment technology that is more passive or can you use a more active technology?

- Passive
- Active

Passive
- Permeable Reactive Barriers
- In-situ Treatment
- Electrokinetics
- In-situ Biological Treatment

Active
- Biochemical Reactors
- Microbial Mats
- Constructed Treatment Wetlands
- Anoxic Limestone Drain
- Aeration
- Electronic Coagulation
Why Passive?

Closure Costs, Million dollars (1986)

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Mining-Influenced Water Decision Tree
Technology Overview as part of a Web-based Technical and Regulatory Guidance

**Constructed Treatment Wetland Technologies for Mine Influenced Water**

1.0 Introduction

Click Here to view Case Study Table at the end of this document

Constructed treatment wetlands are manmade biologically active systems such as bogs, swamps, or marshes that are characterized by saturated soil conditions and at least periodic surface or near-surface water designed specifically to treat contaminants in surface water, groundwater, or waste streams. The purpose of this section is to provide an overview of technical and regulatory guidance to help regulators, industry, consultants, and technology vendors understand, evaluate, and make informed decisions about the use of constructed treatment wetland systems as they may pertain specifically to the treatment of mine influenced water (M IW).

Constructed treatment wetlands combine the abiotic and biotic functions of natural wetlands to reduce or eliminate water borne contaminants associated with mine influenced water. In some cases, constructed treatment wetlands are used as a containment option to confine solid wastes, such as process waste. Constructed treatment wetlands can be designed in a number of different ways and can include aerobic wetlands, anaerobic horizontal flow wetlands and vertical flow ponds (vertical flow wetlands). The main differences in these systems is the biological and chemical processes promoted and the design of water flow direction. Aerobic wetlands are typically designed to precipitate metals in water under aerobic conditions, usually in a horizontal flow system. Anaerobic horizontal flow wetlands treat water under anaerobic conditions through the use of a carbon substrate and typically move water horizontally. Vertical flow wetlands move the impacted water vertically through carbon substrate over a limestone bed. (Demchak, 2001). Basic design information can be found in ITRC’s guidance document *Technical and Regulatory Guidance Document for Constructed Treatment Wetlands*, (ITRC WTLND-1, 2003). Detailed design information can be found in a number of publications including Treatment Wetlands, Second Addition, Robert H. Kadlec.
Limitations

- To reduce the area required, needed to reduce input flow
- Required treating the solid mine waste

Requires appropriate land for wetlands construction
Solid Mining Waste Decision Tree

Do you have saturated sediments affected by mine waste?
No

Do you need to control exposure to mining wastes which have been transported indoors?
Solid Mining Waste Decision Tree

1. Solid Mining Waste
   - Do you have saturated sediments affected by mine waste?
     - Yes
     - No
       - No

2. ITRC Contaminated Sediments Public Page
   - Yes
   - No

3. Administrative/Engineering Controls
   - Yes
   - No

4. Administrative/Engineering Controls
   - Excavation and Disposal
   - Capping, Covers and Grading
   - Chemical Stabilization

5. Do you need to control exposure in a residential yard?
   - Yes
   - No
Solid Mining Waste Decision Tree

Is it feasible to remove the mine waste?
Solid Mining Waste Decision Tree

- Is it feasible to remove the mine waste?

  - No
  - Can you control exposure by treating the mining waste?
    - Yes
    - Passivation
      - Chemical Stabilization
      - In situ Biological Treatment
      - Electrokinetics
    - No
      - Can you control exposure with physical barriers?
        - Yes
          - Capping, Covers and Grading
          - Diversionary Structures
          - Phytostabilization
        - No
          - Administrative/Engineering Controls
Solid Mining Waste Decision Tree

- Is it feasible to remove the mine waste?
  - Yes
  - No

- Can you control exposure by treating the mining waste?
  - Yes
  - No

- Can you control exposure with physical barriers?
  - Yes
  - No

- Administrative/Engineering Controls
  - No
Solid Mining Waste Decision Tree

- Capping, Covers and Grading
- Diversionary Structures
Capping, Covers, Grading

- Classify stockpiles
- Cap accordingly
  - Soil cover
    - ~ $13,000/acre ($32,000/ha)
  - Membrane cover
    - ~ $50,000/acre ($124,000/ha)

Problem
- Could only cap flat portions
- Side slopes ~ 1.5:1
40 ml LDPE Liner
Routing Water Off Stockpile
Capping Performance

Overall Mass Reduction 94%

Flow

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Mass Release

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Nickel Concentration

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Nickel standard 0.2 mg/L

BUT . . .
Nickel concentrations still exceeded the standard
Mining-Influenced Water Conclusion

- Could not completely control problem with source control
- Still needed to treat water
- Constructed treatment wetlands
Wetland Treatment Systems
Wetland - Before and After

Wetland construction
Wetland Treatment Performance

Nickel Concentration, mg/L

Inflow

Outflow

Nickel Standard 0.2 mg/L

Nickel Concentration, mg/L

Inflow

Outflow

Nickel Standard 0.2 mg/L
Regulatory Approach

► Initially used chronic standards
  • All systems removed metals
  • Not all systems consistently met standards

► Flexibility
  • Final acute value
    ▪ Effluent cannot be toxic
    ▪ Summation of individual metal toxicities
  • Variances
  • Receiving stream monitoring
    ▪ Invertebrates, fish
    ▪ Toxicity testing
Summary

- **ITRC**
  - Who we are
  - What we do

- **Overview of Guidance**
  - Web based
  - Useful tool, but not design manual

- **Case Study**
  - Used mining influenced water decision tree to determine a group of suitable technologies
  - Technology overview described limitations
  - Used solid mine waste tree to determine additional technologies for the site
  - Regulatory flexibility was needed
Questions?

Got Mine Waste