Treatment Technologies for Mining-Influenced Water

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Overview

- Technology Assessment Branch
- Mining Website
  - www.cluin.org/mining
- Mining Webinar Series
- MIW Treatment Technologies

Technology Assessment Branch

- Demonstrates and promotes the use of new and innovative treatment technologies for more cost effective cleanups
- Assesses and communicates to site managers state-of-the-art remedy technology information
- Provides site-specific support through five Technical Support Centers and staff consultation

Mining Website: CLU-IN
Mining Sites Focus Area

www.cluin.org/mining

CLU-IN Mining Sites Focus Area

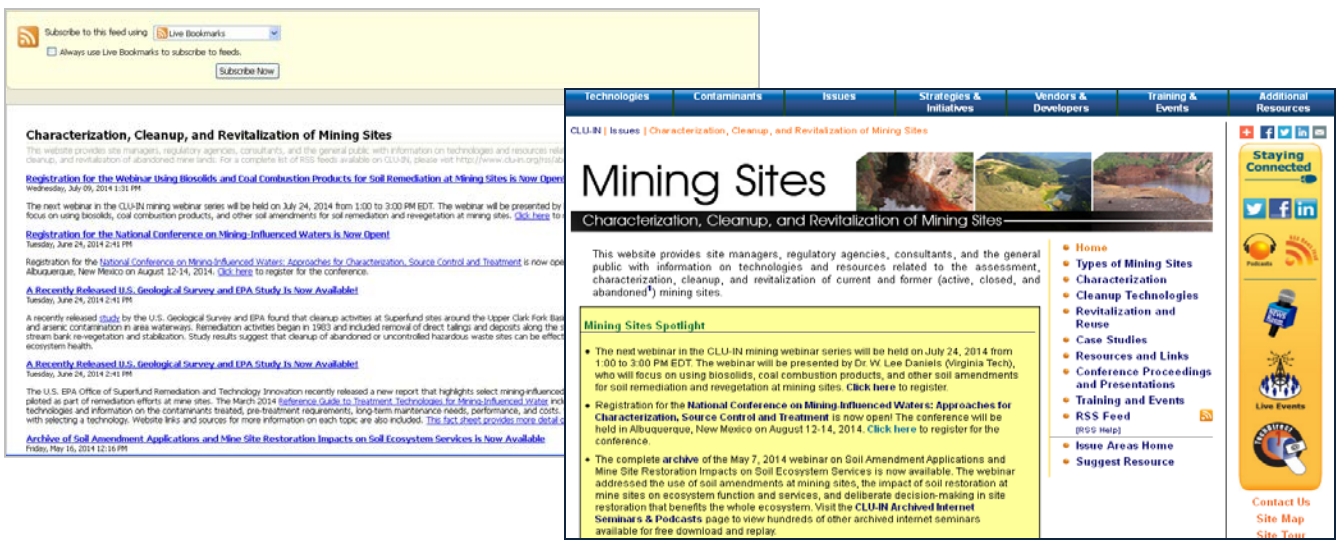
- Launched in 2012 (www.cluin.org/mining)
- Maintained on CLU-IN: Contaminated Site Cleanup Information (www.cluin.org)
- Goal: develop a source of information on site assessment, characterization, cleanup, and revitalization technologies & training opportunities
- Initial focus: abandoned mine lands
- Today: current and former (i.e., active, closed and abandoned) sites

CLU-IN Mining Sites Focus Area

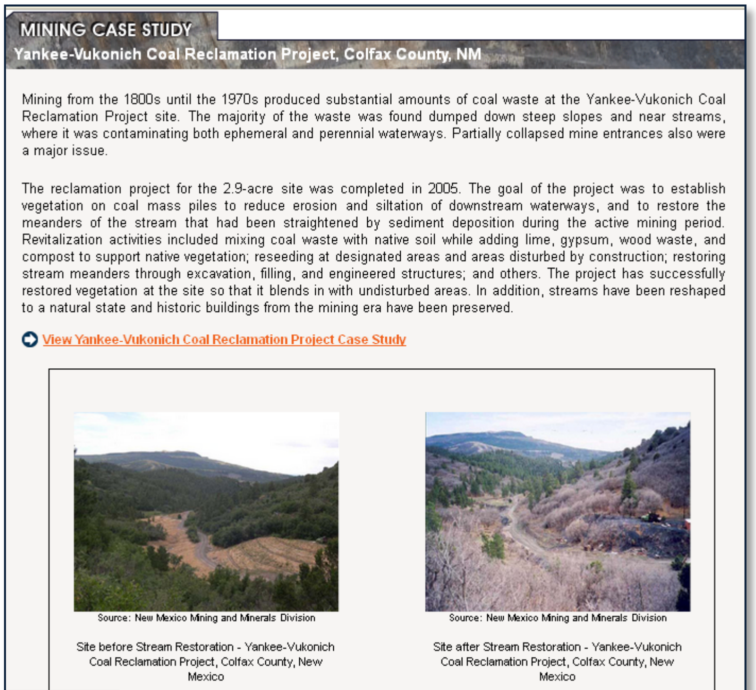
- Target audience: site managers, regulatory agencies, consultants, general public
- Spotlight, overview, and RSS feed
- Case studies
- Characterization
- Revitalization and reuse
- Resources and links
- Conference proceedings and presentations
- Training and events

CLU-IN Mining Sites Focus Area

- Spotlight and overview
- RSS feed



CLU-IN Mining Sites Focus Area


MINING CASE STUDY

Yankee-Vukonich Coal Reclamation Project, Colfax County, NM

Mining from the 1800s until the 1970s produced substantial amounts of coal waste at the Yankee-Vukonich Coal Reclamation Project site. The majority of the waste was found dumped down steep slopes and near streams, where it was contaminating both ephemeral and perennial waterways. Partially collapsed mine entrances also were a major issue.

The reclamation project for the 2.9-acre site was completed in 2005. The goal of the project was to establish vegetation on coal mass piles to reduce erosion and siltation of downstream waterways, and to restore the meanders of the stream that had been straightened by sediment deposition during the active mining period. Revitalization activities included mixing coal waste with native soil while adding lime, gypsum, wood waste, and compost to support native vegetation; reseeding at designated areas and areas disturbed by construction; restoring stream meanders through excavation, filling, and engineered structures; and others. The project has successfully restored vegetation at the site so that it blends in with undisturbed areas. In addition, streams have been reshaped to a natural state and historic buildings from the mining era have been preserved.

View Yankee-Vukonich Coal Reclamation Project Case Study

Source: New Mexico Mining and Minerals Division

Site before Stream Restoration - Yankee-Vukonich Coal Reclamation Project, Colfax County, New Mexico

Source: New Mexico Mining and Minerals Division

Site after Stream Restoration - Yankee-Vukonich Coal Reclamation Project, Colfax County, New Mexico

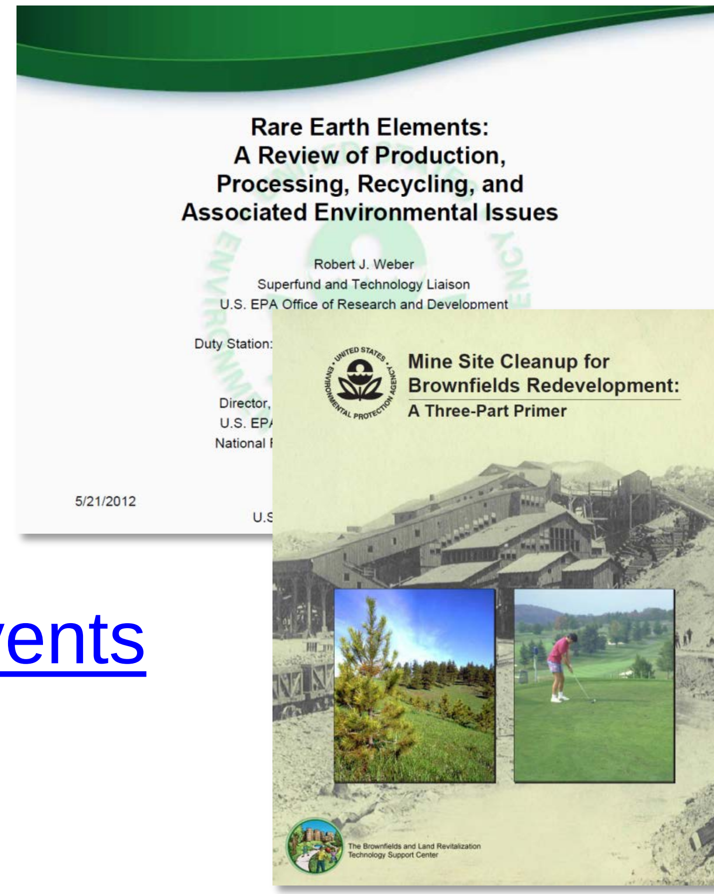
- Case studies
  - Successful remediation and revitalization efforts
  - Grouped by mining site type
    - Hardrock
    - Coal
    - Uranium

CLU-IN Mining Sites Focus Area

- Characterization
- Cleanup technologies (adapted from ITRC)
  - Mining solid waste
  - Mining-influenced water
  - Both media
- Revitalization and reuse

CLU-IN Mining Sites Focus Area

- Resources & links
- Conference proceedings and presentations
- Training & events



www.cluin.org/mining/events

CLU-IN Mining Webinar Series

www.cluin.org/mining

CLU-IN Mining Webinar Series

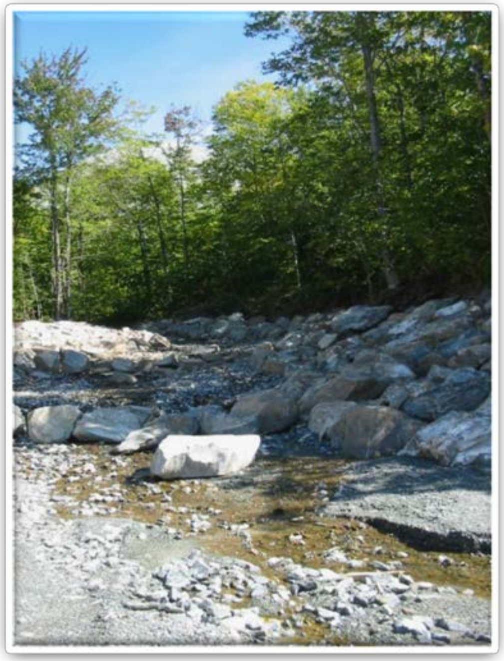
- Launched in June 2012
- Complements CLU-IN Mining Sites Focus Area
- Held quarterly
- Goal: technology transfer resource and additional information source on innovative technologies and approaches for mine waste and MIW treatment

CLU-IN Mining Webinar Series

- Six webinars held since the launch
- Example topics:
  - EPA resources and training opportunities
  - Overview of the Global Acid Rock Drainage (GARD) Guide
  - Impact of soil restoration at mine sites on ecosystem function and services
  - Using biosolids and coal combustion products for soil remediation at mining sites

CLU-IN Mining Webinar Series

- Case studies and field applications at different types of mining sites and mine waste/MIW
- 1050 attendees total (average 175 per webinar)
  - Environmental, engineering, and mining professionals – government, consulting firms, academia, natural resource exploration industries

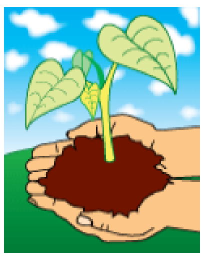


CLU-IN Mining Webinar Series

- Next webinar: Fall 2014
- Updates and archived mining webinars: www.cluin.org/mining/events

Contact: mahoney.michele@epa.gov to sign up for mailing list

EcoTools Tools for Ecological Land Reuse



Ecological reuse returns polluted or otherwise disturbed lands to a functioning and sustainable use by increasing or improving habitat for plants and animals. "Ecological land reuse" is a broad term that encompasses a number of interrelated activities including the reconstruction of antecedent physical conditions, chemical adjustment of the soil and water, and biological manipulation which includes the reintroduction of native flora and fauna.

ECOTOOLS SPOTLIGHT

[RSS Help]

- **Land Application of Municipal Biosolids**

  In June 2014, the U.S. Geological Survey created a **webpage** focused on the land application of municipal biosolids. The application of municipal biosolids on land may be a widespread source of emerging contaminants to surface and ground water. The USGS scientists and their collaborators are conducting projects including: the development of analytical methods for characterizing the potential emerging contaminants in biosolids-derived composts and other products; sampling biosolids to characterize the occurrence of emerging contaminants; an investigation to assess the ability of a range of wastewater treatment technologies to remove selected pharmaceuticals and other emerging contaminants from municipal sewage; and an investigation to determine the persistence and vertical transport in the soil zone of emerging contaminants derived from biosolids applied to the land surface.

- **ASA, CSSA, & SSSA International Annual Meeting: November 2-5, 2014 in Long Beach, CA**

  The American Society of Agronomy, Crop Science Society of America, and Soil Science Society of America will host more than 4,000 scientists, professionals, educators, and students at the 2014 International Annual Meeting, "**Grand Challenges—Great Solutions**."

- **Contaminant Uptake in Food Crops grown on Brownfield Sites: September 26,**

- Home
  - Why restore disturbed or contaminated lands?
  - Why are ecosystems important to ecological land reuse?
- EPA Presentations
- Principles for Ecological Land Reuse
- Soil Science
- Soil Amendments
- Terrestrial Carbon Sequestration
- Plants and Revegetation
- Growing Gardens in Urban Soils
- Ecosystem Services
- Act Locally
- Organizations and Resources
- Land Revitalization Assistance
- Case Study Profiles
- Publications and Resources

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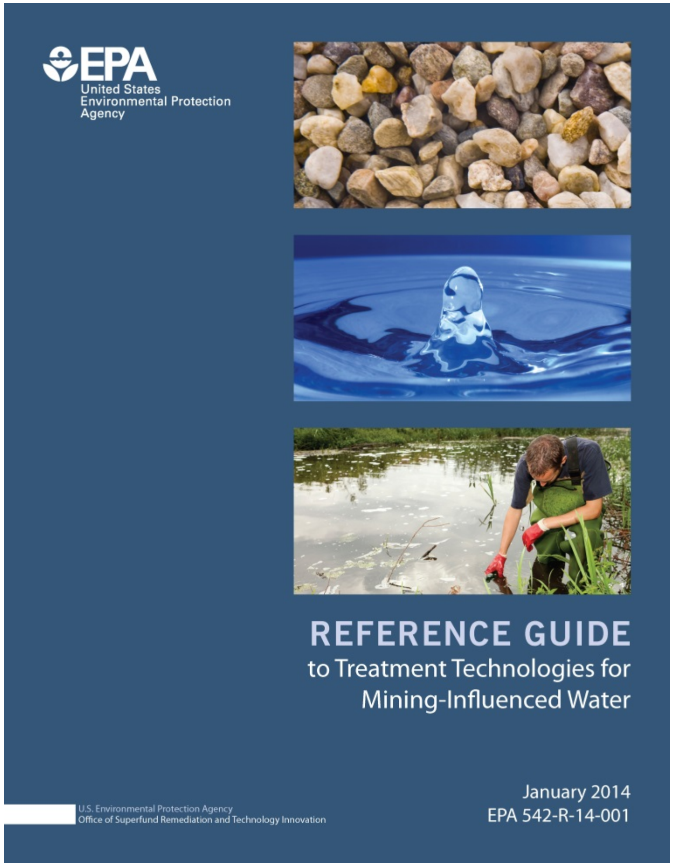
2014 EPA Reference Guide



- Compilation of MIW treatment technologies
- For regulators, site owners and operators, and other stakeholders

Document Development

- EPA National Mining Team
- External Stakeholders

Document Objectives

- Identify and describe MIW treatment technologies
- Support selection of appropriate and cost-effective treatment technologies
- Inform decision makers on up to date and available treatment technologies

Long-term Goal

- Support development of technologies
  - Low energy needs
  - Low costs
  - Low maintenance

MIW

- MIW: water whose composition has been affected by mining or mineral processing
- Includes acid rock drainage, neutral and alkaline waters, mineral processing waters and residual waters
- Affects over 10,000 miles of receiving waters in the United States

Treatment Considerations

- Available land surface and its topography
- System longevity
- Maintenance needs
- Flow rate and strength
- Site accessibility and remoteness
- Availability of power sources
- Performance criteria
- Design, capital and operation costs
- Maintenance costs
- Local climate impacts on system effectiveness

Reference Guide Content

- 16 Technology Narratives
  - 7 passive
  - 9 active
- 31 Technology Summaries

Summary Table Snapshot

Technology	Technology Description	Treated Constituents	Scale	Example Sites	Operations	Long-term Maintenance	Engineering Constraints	Costs	Effectiveness
Anoxic Limestone Drains (ALD)[5,11,21]	A limestone drain is a simple treatment method which involves the burial of limestone in air-tight trenches that intercept acidic discharge water. Keeping carbon dioxide within the drain can enhance limestone dissolution and alkalinity production. Furthermore, keeping oxygen out of contact with the discharge water minimizes the potential for oxidation of dissolved iron and the consequent precipitation of solid iron hydroxide [Fe(OH)3], which could armor the limestone and clog the drains.	Al, Fe, acidity	Full-scale	Fabius Coal Preparation Plant, AL Copper Basin Mining Site, TN Hartshorne/Whitlock-Jones: Hartshorne, OK Ohio Abandoned Bituminous Coal, SE OH Tecumseh - AML Site 262, IN Tennessee Valley Authority, AL Valzinco Mine, VA	The construction of an ALD consists of a trench containing limestone (typically 90% calcium carbonate equivalent minimum) encapsulated in a plastic liner and covered with clay or compacted soil to maintain anoxic conditions, as well as to prevent water infiltration and to keep CO2 from escaping. The width and length of the trench are based on the levels of dissolved metals present in the mine drainage, the retention time needed to raise the pH, as well as the amount of area that is available for construction. The ALD may be capped with topsoil and vegetation to control erosion. The dimensions of the drain depend upon individual on-site conditions, including topography, geology, and available area and, equipment. However, the two factors that must be considered when sizing an anoxic limestone drain are the accommodation of the maximum probable flow and the desired longevity of the drain.	Routine maintenance is typically limited to inspection of the surface for evidence of leakage in the anoxic cover material, and periodic cleaning of the discharge point to remove accumulated iron oxides. The systems are generally designed for limestone replenishment every 15–25 years, depending on the characteristic of the drainage flow. Maintenance costs for ALD's are not expected to be significant. Apart from monitoring costs which might be required to ensure the effectiveness of downstream systems, costs should be limited to periodic inspection of the site and maintenance of the vegetation cover.	ALDs are suitable to treat MIW that has low concentrations of ferric iron, dissolved oxygen and aluminum. When any of these three parameters are elevated, armoring of limestone can occur and slow the dissolution rate of limestone. When the dissolution rate slows, there is a higher buildup of ferric iron and aluminum on the limestone, which eventually clogs the open pore spaces, resulting in abnormal flow paths that can reduce both the retention time of MIW within the ALD and the reactive surface area of the limestone. With only a few exceptions, passive systems cannot handle Acidity Loads in excess of 100-150 kg of CaCO3 per day. Metal removal must occur elsewhere to prevent clogging of the bed and system failure. ALD's must be kept anoxic to prevent the oxidization of soluble ferrous iron to the insoluble ferric species. Field tests show that relatively high rates of limestone dissolution occur within the initial 15 hours of contact with mine water. After that period, the rate of dissolution is much slower. For this reason, ALD's are sized to have a 15-hr retention time at the end of its design life (25-30yrs). Although ALDs are documented to have success in raising pH, the differing chemical characteristics of the influent mine water can cause variations in alkalinity generation and retention of metals. Most ALD systems exhibit reduced effectiveness over time and eventually require maintenance or replacement. To meet effluent compliance limits, (Tennessee Valley Authority) TVA advocates the use of ALDs only as a staged portion of aerobic acid drainage wetlands systems, and does not recommend their use as stand-alone systems, or as a stage of an anaerobic wetlands system.	Passive treatment systems can provide low cost solutions unless they are used for inappropriate applications, which have resulted in many being far more costly (per ton of acid neutralized) than conventional active treatment plants The cost of installing ALDs can vary from site to site, depending largely on location and chemical makeup of the MIW. Operators of the Tennessee Valley Authority abandoned mine site in Alabama reported that their capital cost was approximately $0.25/1000 gal of water and their operation and maintenance costs were approximately $0.10/1000 gal of treated water. Passive treatment systems provide low cost solutions with low to medium capital costs (AU$5,000 -200,000) and generally very low operating costs (<AU$1,000 / year). A 'typical' ALD constructed at most locations in Canada is expected to cost in the range of $4,000 to $25,000 depending on chosen dimensions and design flow. This estimation would not apply to more remote sites, or sites where establishment of an ALD would require extensive excavation or blasting.	Alkalinity concentrations in the effluent ranged 80–320 mg/L as CaCO3 with near maximum levels being reached after approximately 15 hours of detention in the ALD. Where influent mine water contained less than 1 mg/L of both ferric iron and aluminum, the ALDs produced consistent concentrations of alkalinity for over 10 years. An ALD receiving influent mine water containing 21 mg/L of aluminum experienced rapid failure due to permeability reduction within 8 months. Although long term data is not available, the research conducted to date suggests that ALD's can be expected to be effective for 20 to 80 years (Brodie et al. 1992) and perhaps even longer (>100 years), if influent quality is within the required criteria and the system is properly designed and constructed.

Reference Guide Content

- Treatment technologies
- Contaminants treated
- Pre-treatment requirements
- Costs
- Long-term maintenance needs
- System performance

Reference Guide Content

- System costs
- Example sites
- Data gaps and research needs
- Resources for more information on each technology

Technologies

- Anoxic limestone drains
- Successive alkalinity producing systems
- Aluminator
- Constructed wetlands
- Biochemical reactors

Technologies

- Phytotechnologies (http://cluin.org/products/phyto/)
- Permeable reactive barriers
- Fluidized bed reactors
- Reverse osmosis
- Zero valent iron

Technologies

- Rotating cylinder treatment systems
- Ferrihydrite adsorption
- Electrocoagulation
- Ion exchange
- Biological reduction
- Ceramic microfiltration

Anticipated Outcomes

- Supplement and complement existing reference materials
- Identify promising technologies and best practices
- Determine data needs
- Develop pilot projects
- Present information publically

For More Information

- Reference Guide: http://www.clu-in.org/download/issues/mining/Reference_Guide_to_Treatment_Technologies_for_MIW.pdf

- Characterization, Cleanup and Revitalization of Mining Sites: http://www.cluin.org/mining

Contact

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