

Mississippi State UNIVERSITY

Overview – Technologies for the Remediation of Heavy Metals in Soil and Water
 Dr. R. Mark Bricka

What is Environmental Remediation

The removal of Contaminants from Environmental Media

- Soil
- Groundwater
- Sediment
- Surface Water

Example Remediation Project: Lead Immobilization at Small Arms Firing Ranges

Objective: To Cost Effectively remove or reduce the toxicity of Lead at SAFR

Many Approaches

Soil Formation (Order) and Small Arms Firing Ranges

SAFR

Remediation Approaches

- Dig and Haul
- Containment
- Water Treatment
- Biological Treatment
- Sorption
- Physical Treatment
- Phyto Remediation
- EK
- ETC.

Dig and Haul

- Most used technique
- Involves
 - Landfill
 - SWMU
- Only Transfer Issue
- Long Term Liability
- Relative Low \$
- Depends on Many Factors

Source:


Containment

- Landfills
- Slurry Walls
- Solidification/Stabilization
- Vitrification
- Calcination



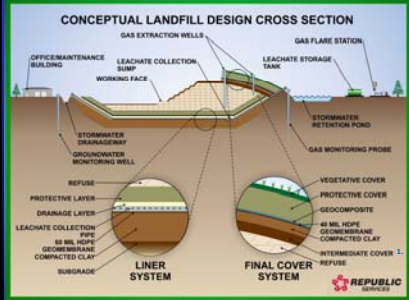
Landfills

- Types C & D
- Issues



Cherry Island Landfill

Source: <http://dava.com/wp-content/uploads/2013/04/Cherry-Island-Landfill-2-systems.jpg>





CONCEPTUAL LANDFILL DESIGN CROSS SECTION

REPUBLIC SERVICES

Source: http://republicservices.com/publishing/images/2_2_1.jpg#v=1

Slurry Walls



Source: <http://www.keller.com/in.asp?w=cont/uploads/2014/06/SlurryWall-28x3104.jpg>

Source: <http://www.mckinstry.com/Slurry%20Wall%20in%20the%20field.jpg>

Solidification/Stabilization



Source: <https://research.engineering.widavis.edu/epa/wp-content/uploads/sites/43/2015/02/Alma-IP-2-labeled.jpg>

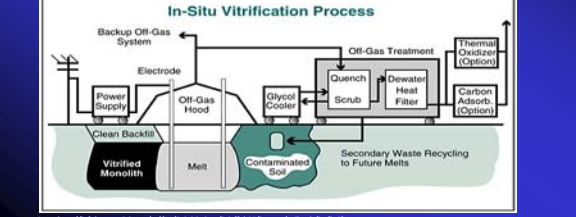
- Exsitu & Insitu
- Lime, Fly Ash, Portland, Adsorbents
- Mixing Critical



Source: http://www.rockwell.com/Content/Assets/2012/02/20120228_02.jpg

Vitrification

- Primarily Nuclear Waste
- Energy Intensive
- \$\$\$\$\$\$\$



In-Situ Vitrification Process

Source: http://infobase.ezfc.nrc.ca/1470_initiatives/inis/ibns/mazes/colimits/ivd/ef

In Situ Vitrification



Source: http://vimeo.com/video/62372553_640.jpg

Calcination

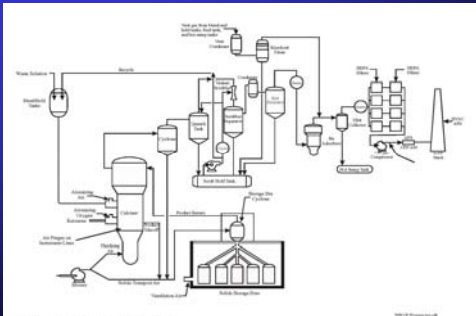



Figure 1. Schematic of the SNCT Calcination process.

Source: Neasey Z O'Brien "Summary of Waste Calcination at the Idaho Nuclear Technology and Engineering Center, INEEL/EXT-200, ID2001-05CL2000.

Water Treatment


- Water Treatment
- Neutralization
- Precipitation
- Flocculation
- Sedimentation
- Membrane Treatment
- Ion Exchange
- Electro Techniques
- Flotation
- Electro winning
- Filtration



Source: http://www.cetech.com/courses/ENVE666/ENVE666_06.htm

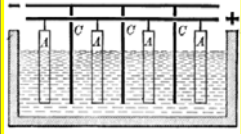
Source: <http://www.illinois.edu/~capec/cees/papers/separation.pdf>

Electrowinning



Source: <http://www.dewa.com.au/you-asked/you/asked/electrowinning/>


Source: http://www.constructiontechnology.com/news/electrowinning/2013/10/20131020131_Worker_Keeps_Copper_Cathodes_in_Electrolyte_Electro_Winning_Shed_Chief_22



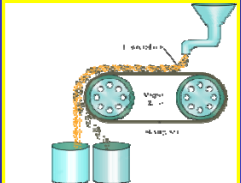
Source: <http://www.electrochemical.com/Products/Industrial/EF/EFElectrolyticCell/EFElectrolyticCell.asp>

Physical Separation

- Tabling
- Flotation
- Classification
- Trammels
- Magnetic and Electrostatic Separation
- Density segregation
- Soil Flushing/Washing



Source: <http://www.suntec.com.sg/eng/eng/Pages/Physical%20Separations.aspx>



Source: <http://www.mtw.com/products/central/central/pdfs/mtpg/pdfs04.pdf>

Other Remediation Technologies

- Heap leaching
- Phyto Remediation
- Chemical and Supercritical Water Oxidation
- Adsorption/Absorption
- Freeze Crystallization
- Electrokinetics




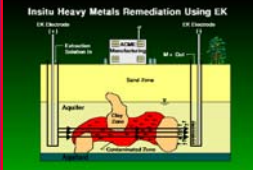

Source: <http://www.bonanza.com>



Source: <http://www.mts.com>

Application of EK

- Electromigration
- Electroosmosis
- Electrophoresis
- pH



EK Pt. Mugu NAWS EK Field Project




- DoD 6.4 Dem/Val Project
- EPA SITE Project
- ESTCP

Biological Treatment




- **Aerobic**
 - Activated Sludge
 - RBC
 - Aerated Lagoons
 - Trickling Filters
 - Composting
- **Anaerobic**
 - Anaerobic Digestion
 - Composting
 - Stabilization Ponds
 - Engineered Wet Land

Requirement for Application

- **Site assessment**
 - CoC
 - Soil Characteristics
 - Geology
- **Costs**
- **Regulations**
- **Public - NIMBY**
- **PRG**
- **Clean Closure**

Remediation Reclamation Results



Latvia - Flambeau Minerals

Source: <https://www.mine.com/2014/10/01/mining-degradation/>

Remediation Reclamation Climax Mine



Storke Yard at Climax in 2008 (left) and in 2012 after revegetation activities that included using compost produced at the site's award-winning Biosolids Composting Operation. These activities were part of a larger project to restore the Arkansas River channel and habitat at Storke Yard, both of which had been impacted by historic mining activities.

Source: http://718news1.amaonews.com/images/01061010_1.jpg

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