EPA Region 9 and Use of Biosolids for Contaminated Soils Management

PACIFIC SOUTHWEST REGION
SUPERFUND DIVISION
EMERGENCY RESPONSE PREPAREDNESS AND PREVENTION BRANCH
Emergency Response in Region 9

17 OSCs, 4 time zones

- San Francisco
  - Regional Office
  - 13 OSCs
  - Equipment Warehouse

- Carson City
  - 1 OSC

- Signal Hill, CA
  - 4 OSCs
  - Equipment Warehouse

Also responsible for:
- Guam
- Northern Mariana Islands
- Pacific Island Governments
- American Samoa
Why we need contam. soils management skills?

- Estimated 3rd of our work is on contaminated soils sites.
- Highest cost sites to remediate – often other stakeholders request assistance.
- Often high toxicity and direct exposure (residential sites).
- Interventions should preserve water quality – on-site techniques allay monetary and environmental costs.
Reconsidering Cleanup Goals

- Bioavailability in risk assessment
  - Removal objectives use Preliminary Remediation Goals (PRGs) for decision making in the “risk range” of contaminant concentrations
  - PRGs may not be an appropriate measure of risk at a mine site
    - Total metals may not be bioavailable
    - Risk assessment modeling traditionally assumes 80 to 100% absorption
- Consult your toxicologist
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<th>Test Material</th>
<th>RBA</th>
<th>LB</th>
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Ranges from 8-61% in 30 studies

Presented by B. Brattin, Summary of EPA *in-vivo* As studies
An Example: Iron King Mine Site

- Iron King Mine Site is a large mine and smelter in Humboldt, AZ
- Runoff and erosion from the mine contaminated neighboring residences with arsenic
  - Arsenic is high in the region (above state and EPA guidelines for cleanup)
EPA found that all residences in the study exceeded PRGs (22 ppm – Reg 9 PRG).
EPA found that background concentrations (35 ppm) exceeded PRGs.
EPA then considered bioavailability of arsenic as a means of reconsidering what the true protective level really is.
- Based on lines of evidence EPA selected a bioavailability default of 50% (departure from 80-100% typically used).
EPA reported a best estimate of 30% and a high end estimate of 45% for the RBA of arsenic in soil for the Ironite product (based on in-vivo & in-vitro respectively).

Based on lines of evidence EPA tweaked the risk equations to include a bioavailability factor of 50%

- Chose a cleanup goal of 80 parts per million instead of 22 ppm.
Electron Microprobe Analysis

- EPA Region 9 conducted speciation of As using an electron microprobe
  - Determined that As was present as arsenopyrite – a low bioavailability form of As
- Analysis provided confirmation that primary species in soil samples is in fact arsenopyrite.
Arsenopyrite in Soil at Iron King
Create a “Reactive Cover”

- Various substances can be used to decrease bioavailability *in-situ*
  - Biosolids and Water Treatment Residuals (other OM)
  - Amendments
    - Limestone, use for arsenic, lead, zinc, cadmium
    - Phosphate, use for lead sites
  - Basis provided by bioavailability & ecotoxicity tests
Biosolids

- Produced by all municipalities
- Use regulated under 40 CFR 503
- 70% of biosolids are now land applied
- Cost - "subsidized" by municipality

Courtesy of H. Compton, EPA & Dr. S. Brown, U. Wash.
**In-vitro** bioavailability

- Physiologically Based Extraction Test (PBET) & others
- Correlated to past *in-vivo* bioavailability studies
The McCleur Tailings Site is an abandoned mine with high arsenic and lead concentrations in soil.

- Estimated bioavailability before and after treatment with biosolids, limestone and phosphate.
- Demonstrated a reduction in bioavailability and leachability.
- Demonstrated that the site could be revegetated for erosion control.
Background

- **1863-1959**: Active gold, silver, copper, and lead mining in the historic Walker Mining District.
- **1975-6**: Partial Site restoration by University of Arizona and the U.S. Forest Service.
- **1999**: Environmental Investigation of mine sites in the Lynx Creek and Hassayampa Creek watersheds. Surface water, soil, sediment and tailings samples were collected throughout two watersheds.
Cleanup Goals

- Reduce contaminated surface runoff and impacts to groundwater.
  - Improve site drainage to route run-on around sources.
- Prevent fugitive dust emissions
  - Construct vegetative cover of natural materials (wood mulch, soil, and biosolids compost) and revegetate (hydroseed w/native plants & grasses)
- Coordinate activities with Federal and State authorities, consider National Historic Preservation Act.
### McCleur Soil Characteristics – Tailings

<table>
<thead>
<tr>
<th></th>
<th>Tailings A</th>
<th>Tailings B</th>
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<tr>
<td>Total Lead</td>
<td>3%, 30,000 ppm</td>
<td>0.2%, 2,000 ppm</td>
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<tr>
<td>Total Arsenic</td>
<td>300 ppm</td>
<td>200 ppm</td>
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<td>pH</td>
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PBET Extractable

Available Pb

Available As

Soil A

Soil B
Reduction in Lead Bioaccessability

Soil A

Soil B
McCleur Before & After
Tailings Pile
Drainage Ditch Filled with Sediment & Tailings
Acid Mine Drainage at Toe of Tailings Pile
The Problem

- Fugitive dust and direct contact result in As & Pb exposures to wildlife and the public posing risks.
- Contaminated runoff enters receiving waters and groundwater.
- Increased exposure of pyritic (high iron and sulfide) mine waste to oxygen and water.
  - Metal sulfide minerals are oxidized and dissolve into water.
  - Microbially mediated acid generation occurs resulting in increased metal mobility.
Cleanup Plan

- **Site Drainage Improvements**
  - Grading
  - French drain system with lined trenches to reroute clean surface water around mine waste

- **Vegetative Cap**
  - Barrier to direct exposure and fugitive dust
  - Reduction of storm water infiltration to minimize Acid Mine Drainage (AMD)

- **Excavation and removal of contaminated sediments in stream channel**
Evapotranspiration Covers

- Isolate and secure contaminants to prevent spread of contaminated materials
- Design a soil-plant layer or cover to slow downward movement of rainwater maximizing storage
  - Stored water will evaporate or transpire controlling
- Construct a 2- to 10-foot-thick layer of fine-grained soil over contaminated material
- Plant native grass, shrubs, small trees to form extensive root systems
- ET covers good in dry climates to cover tailings piles and may reduce acid mine drainage
The Vegetative Cap

- Organic mulch lower layer that isolates contaminated mine waste, slowly releases N and P, holds water, and helps plants grow long-term
- Upper vegetated layer that acts as a sponge
  - Use local source of borrow soil and Class A Biosolids
  - Good growth media for establishing plants
  - Plant uptake, transpiration and evaporation help prevent water infiltration into tailings
- Multiple layers work together to seal in waste, store water, prevent erosion, and stem AMD generation
Vegetative Cap

Vegetative Cap - Apply specified seed mix and erosion control measures. See attached specifications.

Class A Biosolids. Apply at 10–20% disked into top 6–12" of cap.

Detail:
Cap design typical cross section
Scale: 3/4" = 1'–0"

Surface graded to promote runoff.
Revegetation of cap reduces sheet erosion during heavy rainfall.

Install fiber rolls around culverts and across all vegetated slopes.
- Reduce loss of topsoil and sediment loading to waterways.
- Blown Straw on surface to reduce impact energy of rainfall.
Import Quantities

- Approximately 4,390 cubic yards (cys) of Borrow Soil available at no cost from USFS. Located ~6 miles from the site off of Walker Road
- Approximately 1,200 cys of composted wood mulch available at no cost from Sun Dog Ranch Road Transfer Station
- Approximately 364 cys (225 tons) of Exceptional Quality Class A sterile biosolid compost
Workers Installing Drainage
Workers Spreading Biosolids
Tractor Disking in Biosolids
Hydroseeding
Biosolids Amendment

- EPA consulted with Greg Kester, Biosolids Program Manager, CASA, and Lauren Fondahl, EPA Region 9 Biosolids Coordinator
- EPA’s cleanup contractor sent RFPs to several biosolids applicators in Arizona, but only Synagro could provide Class A Biosolids
Biosolids Amendment

- Synagro Technologies Soils Composting Facility, Vicksburg, Arizona
- Nutrient rich by-product of wastewater treatment
- Decision to use Class A EQ rather than Class B
  - Cleanup contractor concerned with worker H&S
  - Concern about odors near residential area
  - Concern about runoff impacts to nearby Lynx Creek and Lynx Lake
Biosolids Amendment

- Class A Biosolids are essentially free of pathogens prior to land application
- Exceptional Quality Biosolids have lower metals requirements than Class A or Class B Biosolids; same pathogen level as Class A Biosolids
- Synagro’s Arizona Soils Composting Facility used the windrow process and composted biosolids with green waste
Lesson Learned

- The Biosolids material was dry and powdery
- Application with tractor was not optimal due to the powdery consistency of the material
- Some material lost during the AZ monsoon season
- Deep cultivation methods should be used to mix the material into the upper 6-8 inches of topsoil – e.g., ripper blades on the back of a dozer