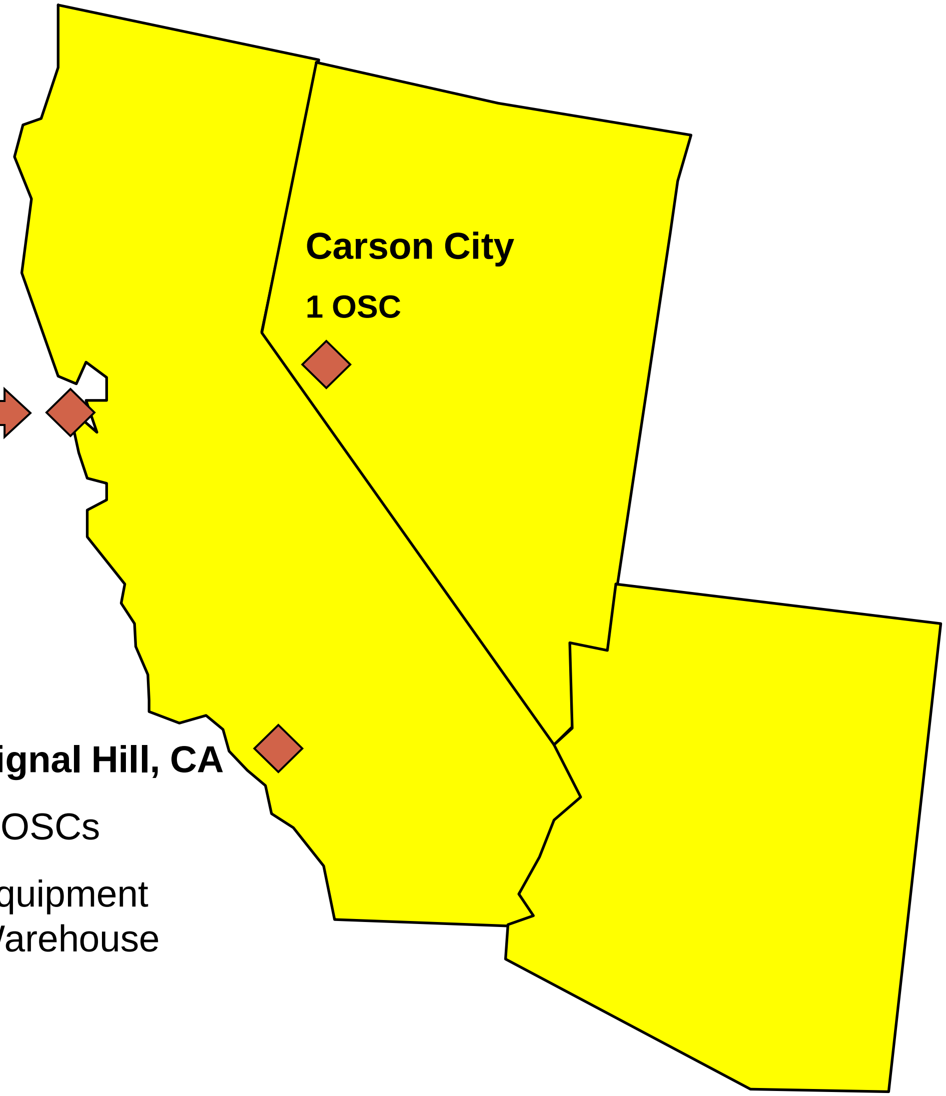
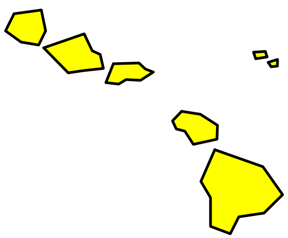
EPA Region 9 and Use of Biosolids for Contaminated Soils Management

PACIFIC SOUTHWEST REGION
SUPERFUND DIVISION
EMERGENCY RESPONSE PREPAREDNESS AND PREVENTION BRANCH

Emergency Response in Region 9

17 OSCs, 4 time zones





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

As Bioavailability Summary

Phase	Experiment	Test Material		RBA	LB	UB	SE
		Number	Description				
II	2	2	Bingham Creek Channel	0.39	0.26	0.53	0.08
II	4	1	Murray Slag	0.55	0.38	0.73	0.10
II	6	1	Midvale Slag	0.23	0.17	0.30	0.04
II	6	2	Butte Soil 1	0.09	0.04	0.14	0.03
II	7	1	California Gulch Phase I Residential	0.08	0.03	0.14	0.03
II	7	2	California Gulch FeMnPbO	0.57	0.38	0.77	0.12
II	8	1	California Gulch AV Slag	0.13	0.07	0.19	0.04
II	9	1	Palmerton Location 2	0.49	0.34	0.66	0.10
II	9	2	Palmerton Location 4	0.61	0.44	0.80	0.11
II	11	1	Murray Soil	0.33	0.25	0.42	0.05
II	10	1	California Gulch AV Slag	0.18	0.15	0.22	0.02
II	10	2	NaAs (IV)	0.41	0.33	0.54	0.06
II	15	1	Clark Fork Tailings	0.51	0.42	0.62	0.06
II	15	2	NaAs (IV)	0.47	0.38	0.59	0.06
II	15	3	NaAs (Gavage)	0.50	0.41	0.63	0.07
III	1	1	VBI70 TM1	0.40	0.35	0.47	0.04
III	1	2	VBI70 TM2	0.42	0.36	0.49	0.04
III	1	3	VBI70 TM3	0.37	0.31	0.42	0.03
III	2	4	VBI70 TM4	0.24	0.20	0.28	0.02
III	2	5	VBI70 TM5	0.21	0.18	0.25	0.02
III	2	6	VBI70 TM6	0.24	0.19	0.28	0.03
III	3	1	Butte Soil 1	0.18	0.12	0.23	0.03
III	3	2	Butte Soil 2	0.24	0.20	0.28	0.02
III	4	1	Aberjona River Sediment - High Arsenic	0.38	0.36	0.41	0.02
III	4	2	Aberjona River Sediment - Low Arsenic	0.52	0.49	0.56	0.02
III	5	1	El Paso Soil 1	0.44	0.39	0.49	0.03
III	5	2	El Paso Soil 2	0.37	0.33	0.42	0.03
III	6	1	Soil Affected by CCA-Treated Wood Utility Poles	0.47	0.42	0.52	0.03
III	7	2	Dislodgeable Arsenic from Weathered CCA-Treated Wood	0.26	0.25	0.28	0.01

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)

Bioavailability in Risk Analysis

- 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)

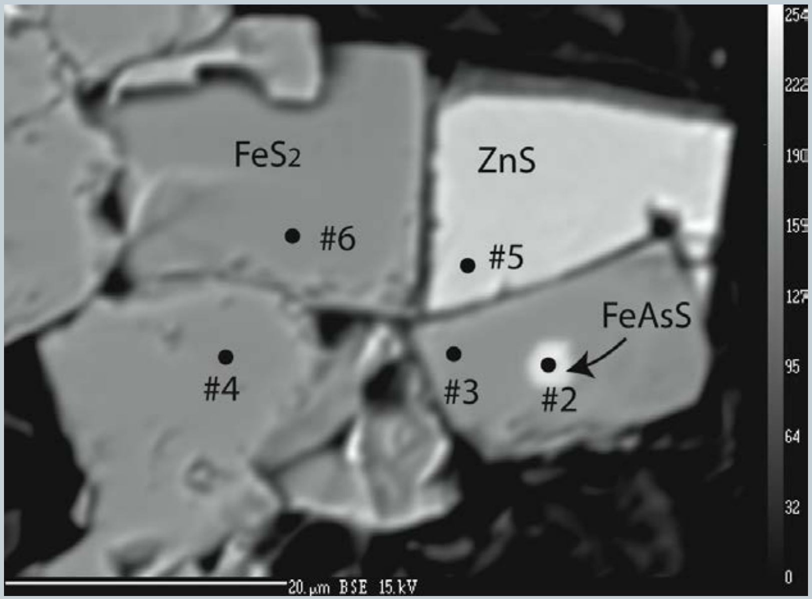
Approach

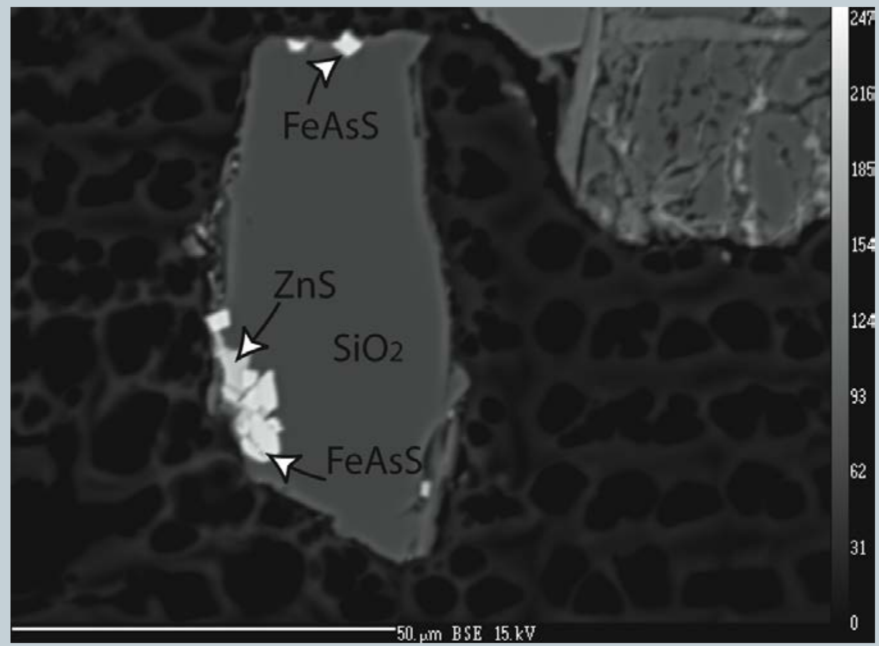
- EPA reported a best estimate of 30% and a high end estimate of 45% for the RBA of arsenic in soil for the Ironite product (based on in-vivo & in-vitro respectively).
- Based on lines of evidence EPA tweaked the risk equations to include a bioavailability factor of 50%
  - Chose a cleanup goal of 80 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

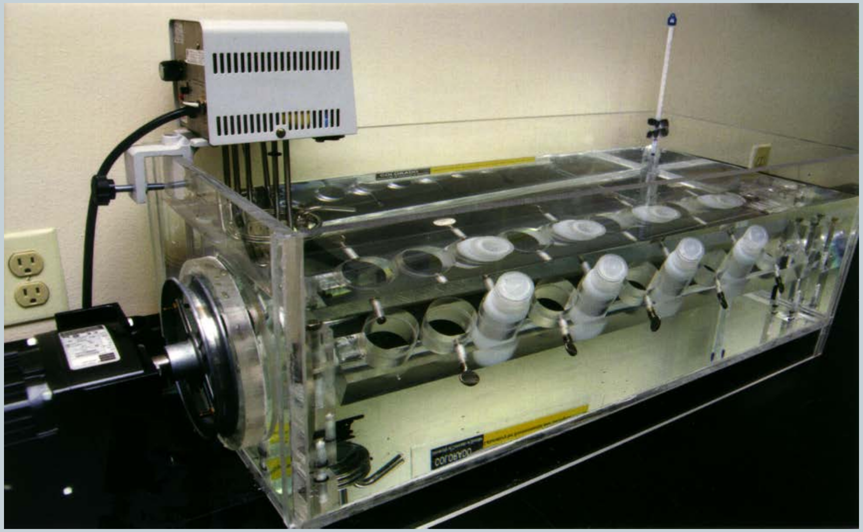
Biosolids

- 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



McCleur & Sheldon Tailings Site

- 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

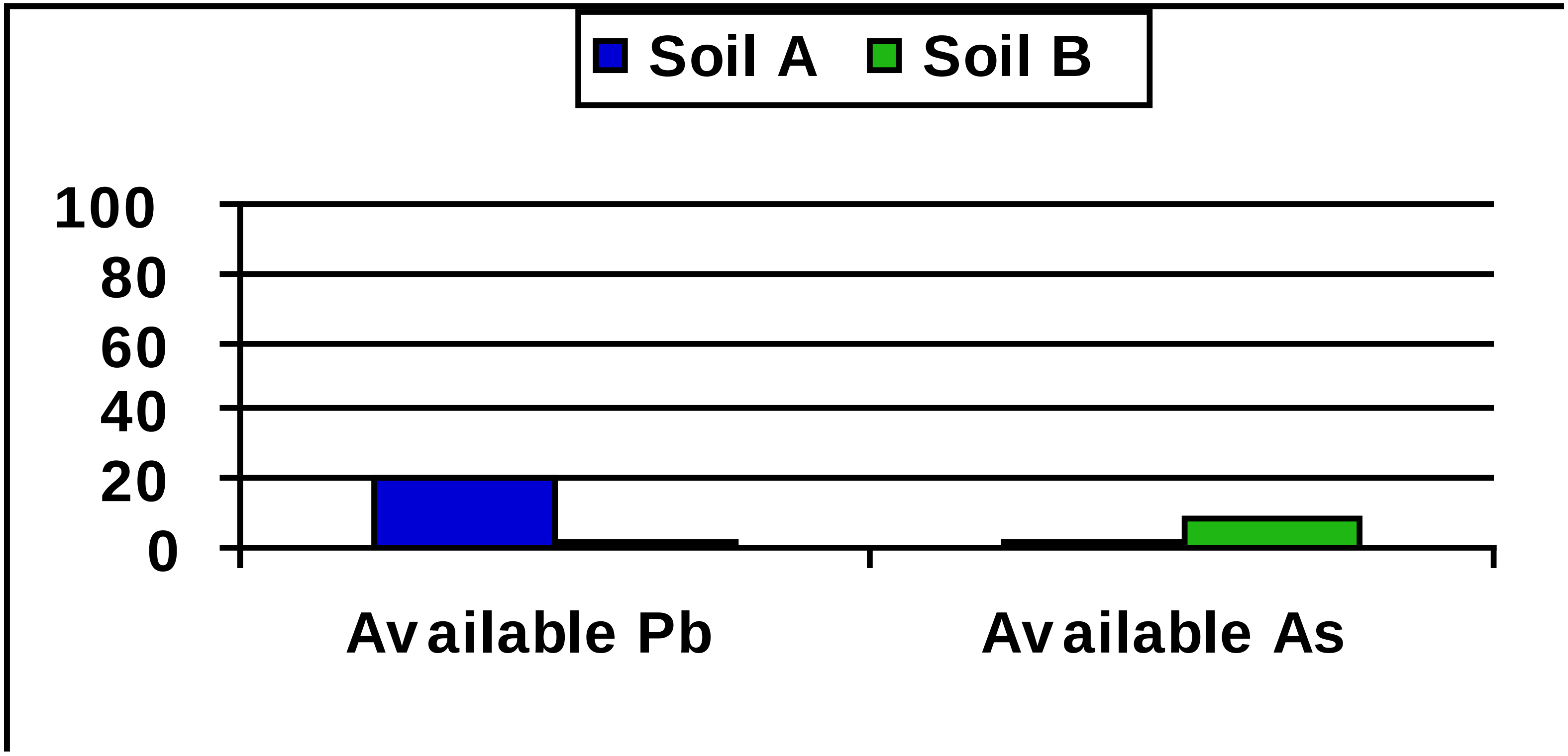
- Reduce contaminated surface runoff and impacts to groundwater.
  - Improve site drainage to route run-on around sources.
- Prevent fugitive dust emissions
  - Construct vegetative cover of natural materials (wood mulch, soil, and biosolids compost) and revegetate (hydroseed w/native plants & grasses)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

McCleur Soil Characteristics – Tailings

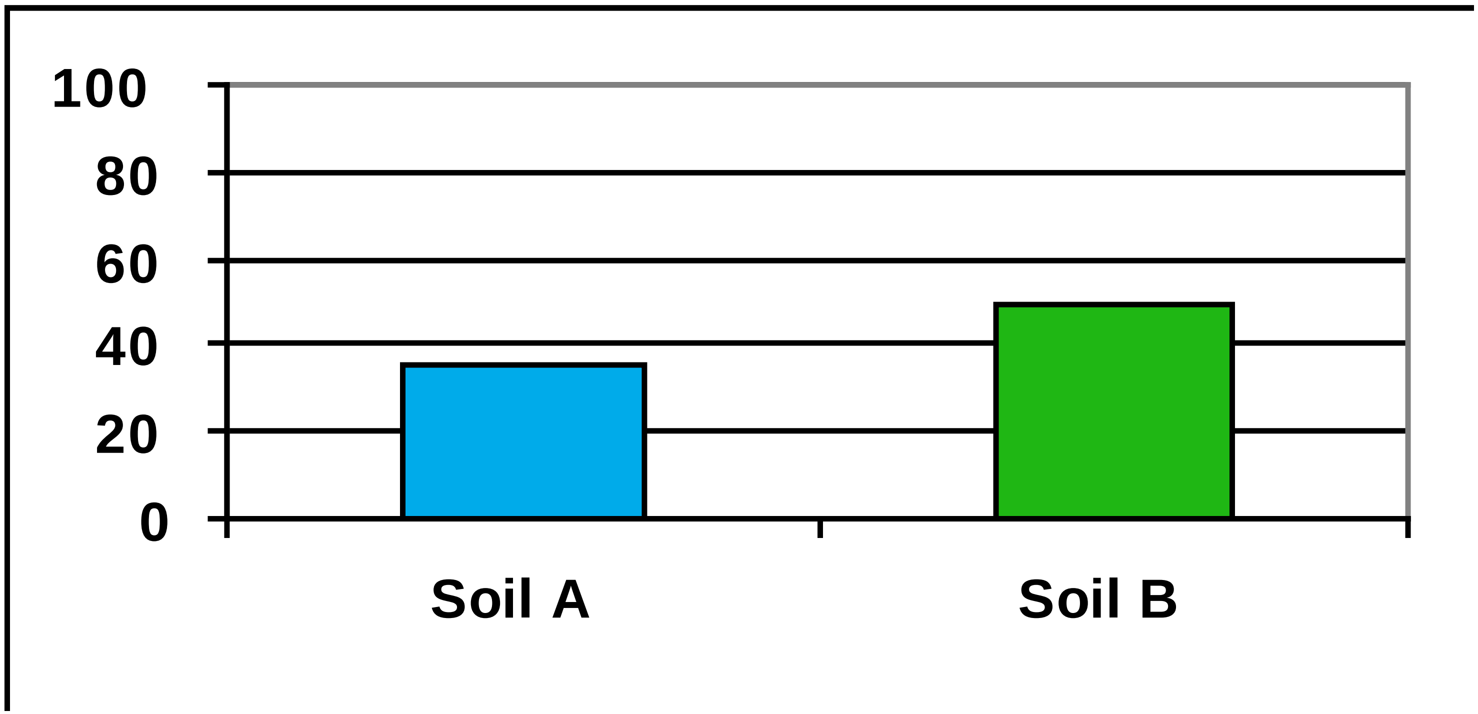
- Tailings A
- Total Lead 3%,
- 30,000 ppm
- Total Arsenic 300 ppm
- pH 2.3

- Tailings B
- Total Lead 0.2%,
- 2,000 ppm
- Total Arsenic 200 ppm
- pH 2.7

PBET Extractable



Reduction in Lead Bioaccessability




DEERE

McCleur Before & After

Project#: 002693.2179.01RA
TDD: T0-02-09-12-04-0006

Source: ESRI 2010; E&E 2011; Microsoft Virtual Earth 2011
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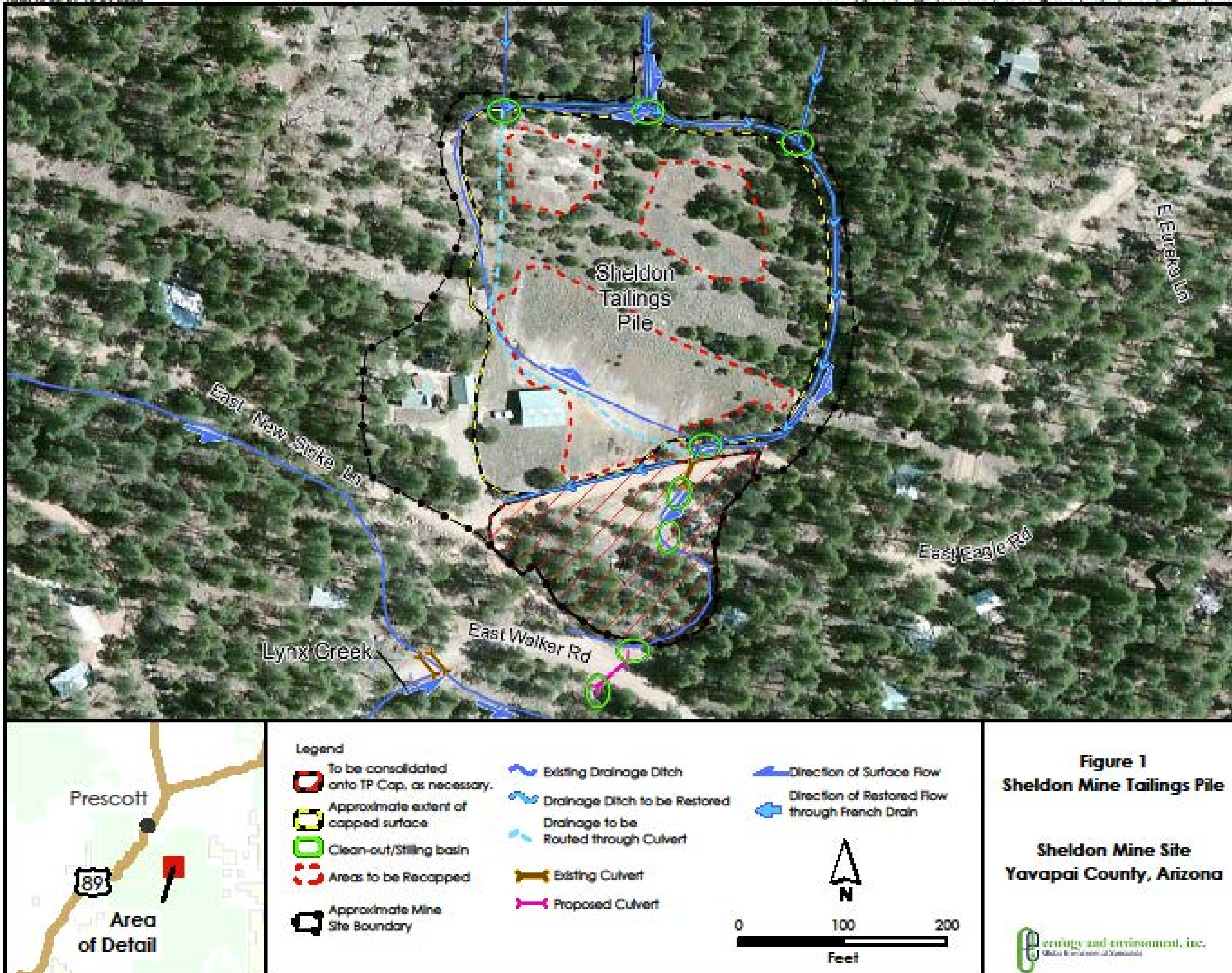


Tailings Pile

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

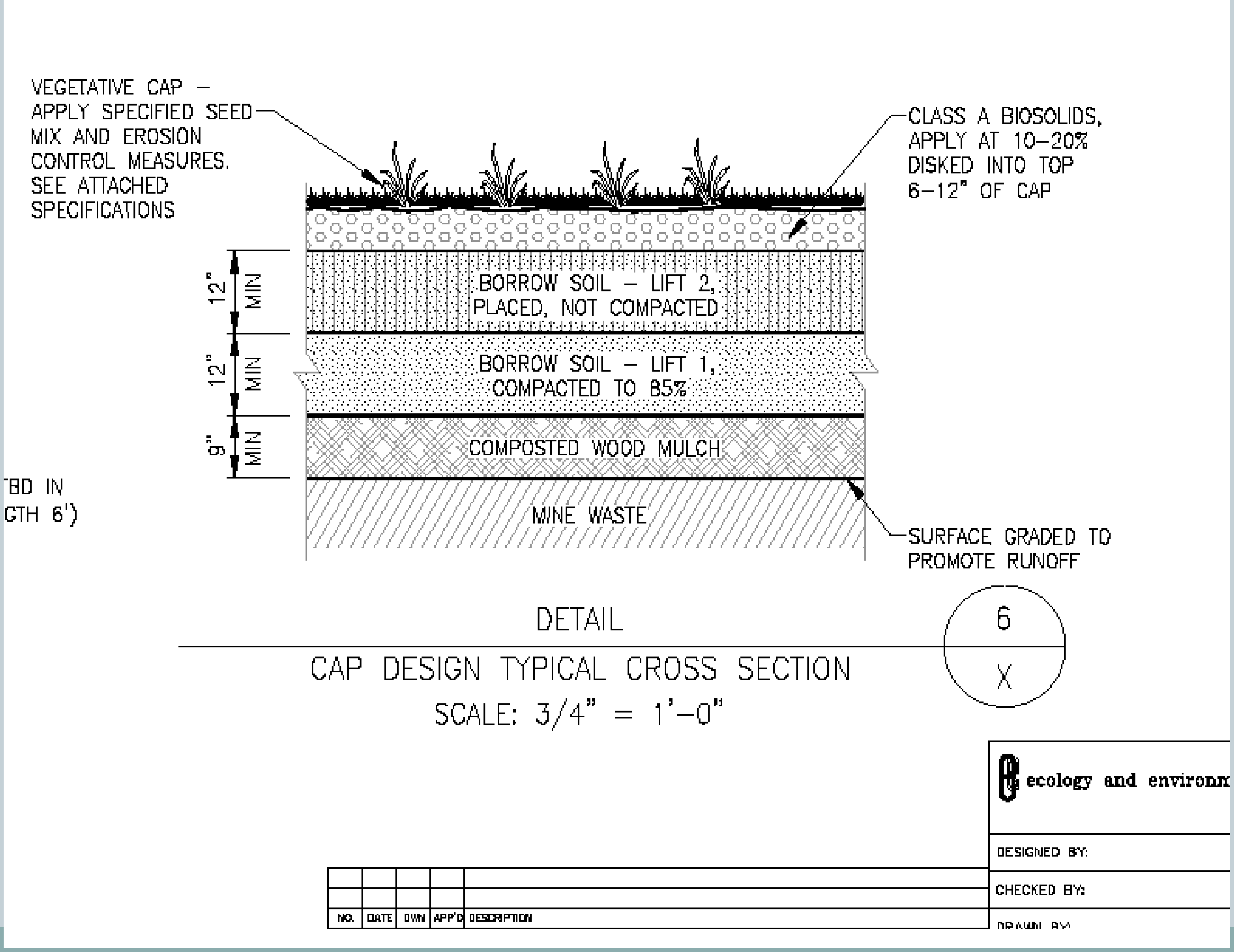
Evapotranspiration Covers

- 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, shurbs, 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



Erosion Control

- 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