Overview of U.S. EPA's ORD Technical Outreach and Support Activities on Sustainable Mining Applications

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Denver, CO
The Westin Tabor Center

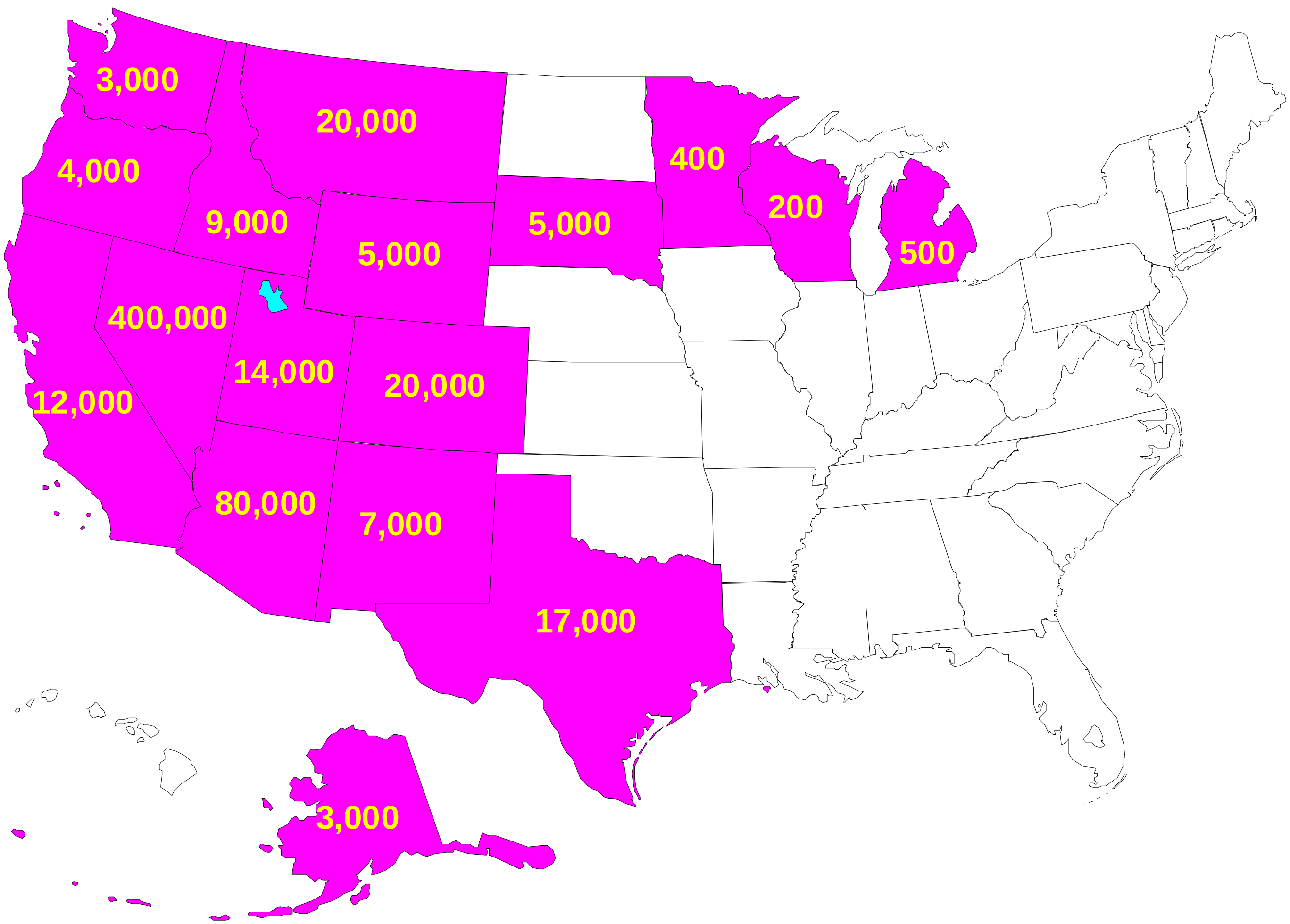
Office of Research and Development
National Risk Management Research Laboratory

Can we ***efficiently***?

- Extract and utilize resources (including by-products)
- Manage wastes
- Reclamation/restoration
- Produce socio-economic advantages

EPA United States Environmental Protection Agency

Magnitude of Ore Mine Waste Problem
Number Indicates Number of Mines

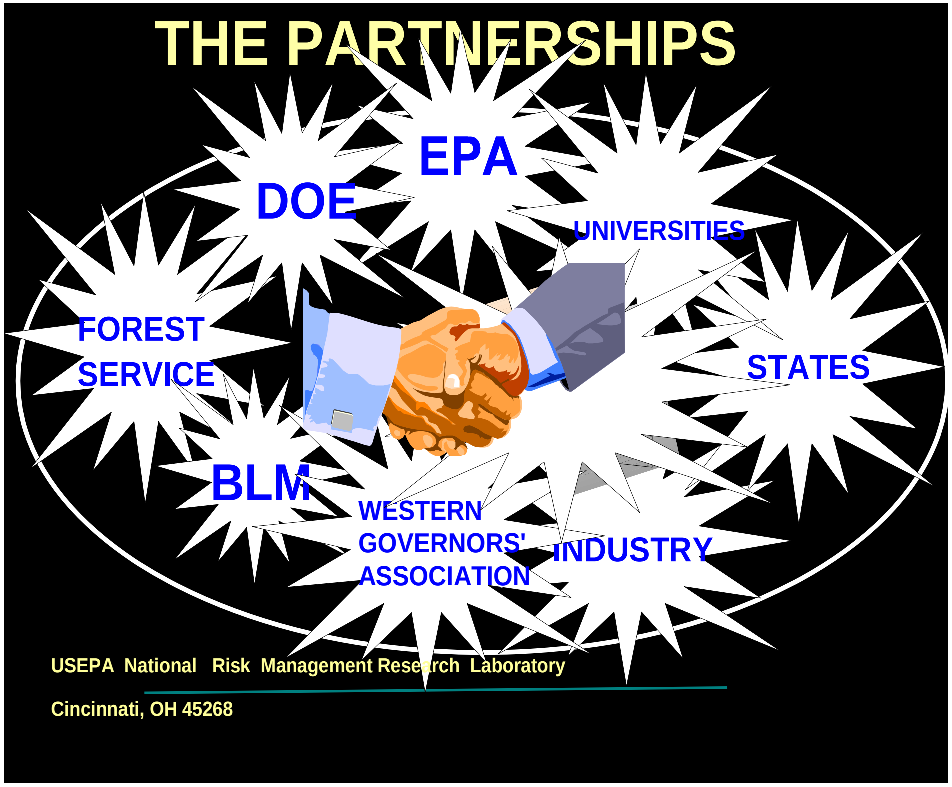


ORD’s Mining Efforts

- Mine Waste Technology Program (MWTP)
- Engineering Technical Support Center
- Technology Transfer Program

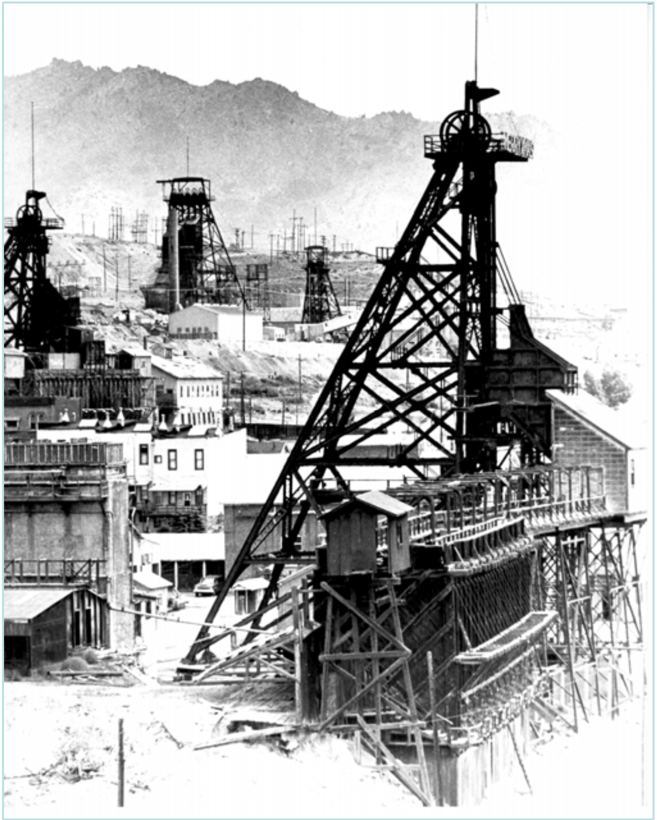
Collaboration

- EPA Region 8
- EPA Region 10
- Technology Transfer Program
- EPA Region 7
- Industry Partners
- Academia
- Western Governors Association
- BLM
- Forest Service
- DOE

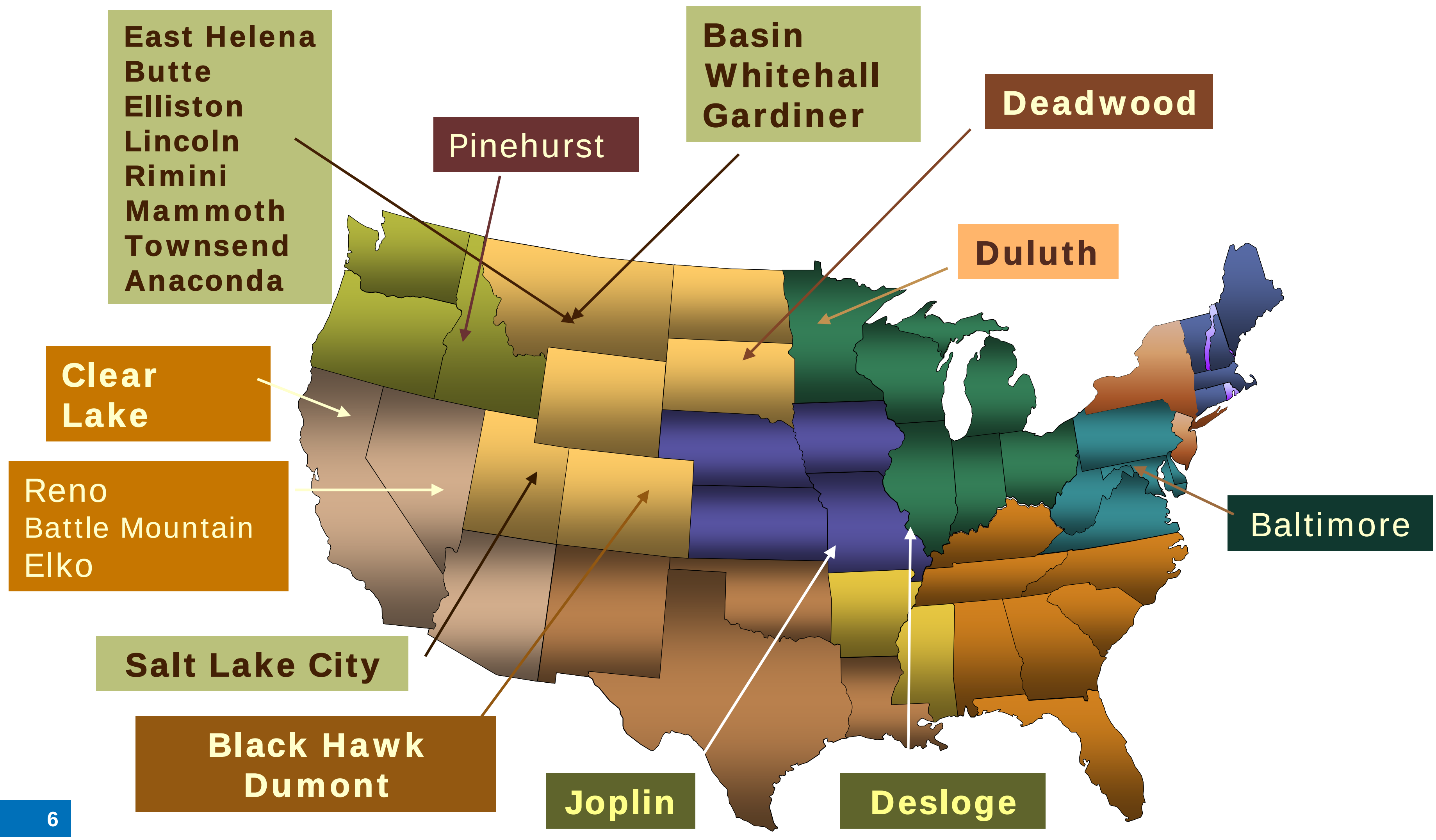


MWTP Overview

- **EPA-NRMRL**
  - Technical Direction/Oversight
  - Quality Assurance Oversight
- **DOE**
  - Administrative Oversight
- **MSE**
  - Applied Research
  - Field Demonstrations
  - Technology Implementation
- **Montana Tech**
  - Basic Research



MWTP Project Map



MWTP Projects

- Post-Mining Development Using Resources from Flooded Underground Mine Workings
- Cyanide Heap Biological Detoxification Phase II
- Design and Installation of a Modular SRB Bioreactor for Acid Rock Drainage Treatment
- Pulsed Limestone Bed Treatment of Metal Mine Drainage at the Argo Tunnel in Idaho Springs

Engineering Technical Support Center Innovative Bioreactor Studies

- Constructed Wetlands with Bioreactors
- Sulfate Reducing Bioreactors
- Biochemical Reactors

ORD Technology Transfer and Outreach

1998 Heavy Metals Contamination Workshop - 150 attendees - Carol Browner gave keynote, Sen. Baucus and Sen. Burns spoke interactively
1998 Mining Workshop - 300 attendees
1999 Heavy Metals Contamination Workshop -180 Attendees
1999 Pit Lakes Workshop -240 attendees
2000 Mercury Workshop – 275 attendees
2001 Arsenic Workshop – 70 attendees
2002 Hard Rock Mining Conference – 375 attendees
2003 Workshop on Mining Impacted Native American Lands – 275 attendees
2004 Pit Lakes – 250 attendees
2005 Abandoned Mine Lands Workshop – 100 attendees
2006 Hard Rock Mining Conference – 350 attendees
2007 Abandoned Mine Lands Workshop – Coeur d'Alene, Idaho;
1993-2006 Mine Operations, Design, and Closure Conferences;
Sponsors include: USFS, BLM, MT DEQ, MWTP

ORD Websites

U.S. EPA/U.S. DOE Mine Waste Technology Program web site:
http://www.epa.gov/minewastetechnology

EPA's Abandoned Mine Lands Program web site:
http://www.epa.gov/superfund/programs/aml

Case Study on the Belmont Mine Resource Recovery Butte, MT

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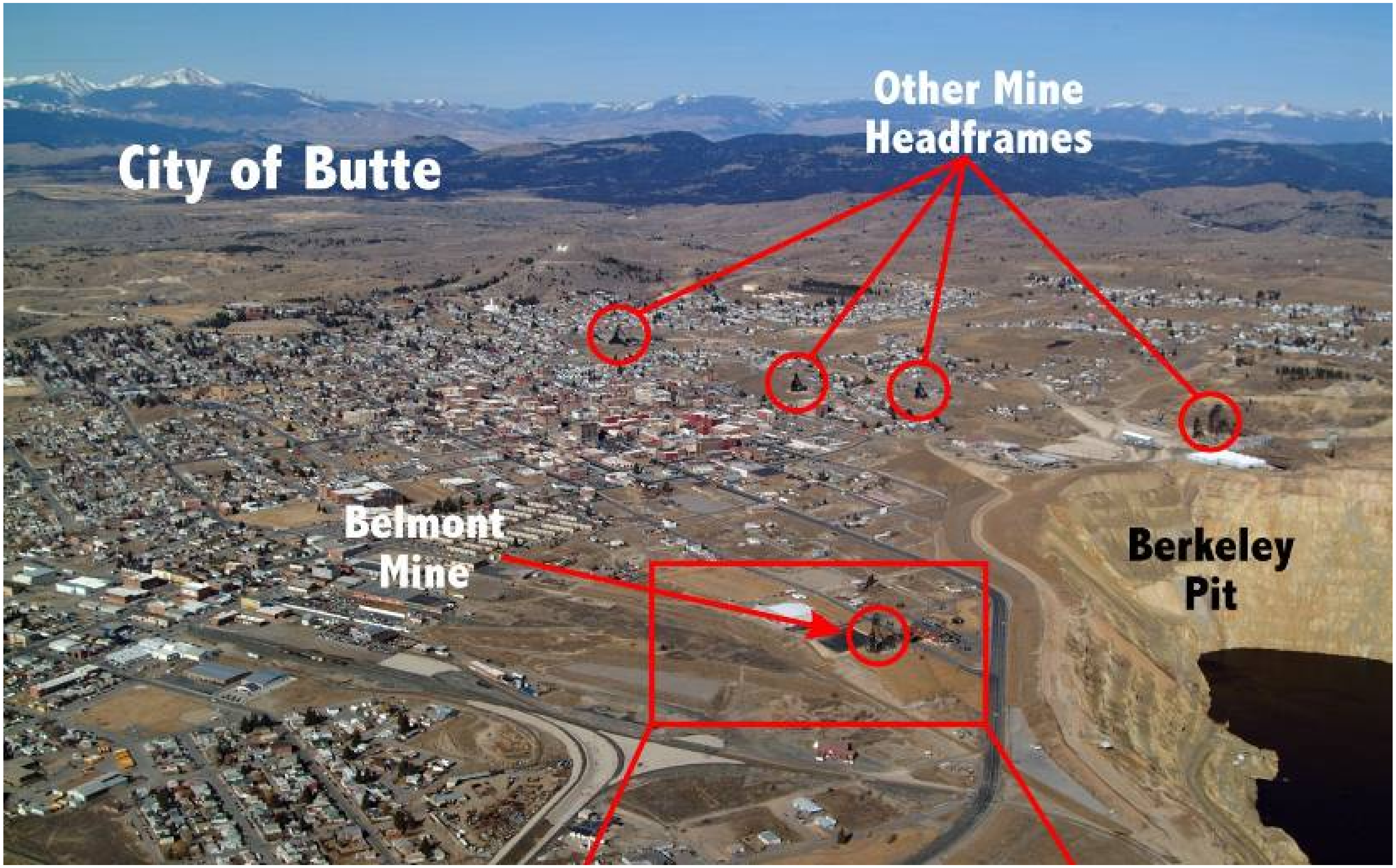

Project Purpose

- Explore feasibility of recovering additional resources for beneficial use from underground mine workings
- Characterize underground mine waters at the Belmont Mine (long-term pumping test)
- Determine feasibility of upgrading water for use as irrigation water (treatability tests)
- Determine feasibility of using naturally elevated temperature water as a heat source for nearby buildings

Belmont Mine Site

Pumping Tests

1. Step-Drawdown Test
2. Long-Term Pumping Test
3. Recovery Test
4. Test Data Analysis

Pumping Tests

Analyses for primary sampling events:

- Field parameters: pH, specific conductivity (SC), temperature, dissolved oxygen (DO), and oxidation-reduction potential (ORP)
- Major cations and anions (Ca, Mg, Na, K, SO_4^{-2}, NO_3^{-}, HCO_3^{-}, and Cl^{-})
- Total recoverable metals (Al, Sb, As, Ba, Be, Cd, Cr, Co, Cu, Fe, Pb, Mn, Hg, Ni, Se, Ag, Tl, V, U, and Zn);
- Dissolved metals (same list as above)
- Alkalinity and hardness
- Total suspended solids (TSS)
- Speciation of Fe
- Speciation of As
- Stable isotopic analysis (dD of water, d18O of water, d18O of sulfate, d32S of sulfate, d13C of dissolved inorganic carbon)
- Radionuclide analysis (dissolved radon, radium, uranium)

Pump Test Water Quality Data

Parameter	Proposed Irrigation Standard (ug/L)	Irrigation Well July 6, 2007	Irrigation Well July 24, 2007	Irrigation Well July 31, 2007	Irrigation Well August, 14 2007
Gallons Pumped	N/A	5000	1,800,000	2,700,000	4,960,000
pH (SU)	N/A	6.1	5.8	5.7	5.6
Temp (° C)	N/A	16.5	19.5	19.5	19.0
As (ug/L)	100	1190	1320	1340	1390
Cd (ug/L)	10	ND	0.3	0.3	0.8
Fe (ug/L)	20,000	28,600	182,000	188,000	160,000
Mn (ug/L)	10,000	4420	21,800	21,900	17,500
Pb (ug/L)	5000	0.8	1.7	Not analyzed	1.6
Zn (ug/L)	10,000	1990	20,900	19,300	10,100

Belmont Mine Water

- Technical Challenges:
  - Large batch flows, limited space, changing chemistry, etc.
  - Arsenic (As), iron (Fe), manganese (Mn), and zinc (Zn) concentrations exceed the guidelines for water reuse
- Oxidation/pH adjustment with solid/liquid separation is a straightforward option
- Innovative technologies were also evaluated during the treatability study

Belmont Treatability Studies

- 100 gallons of Belmont Water collected during pumping test for treatability testing stored under continuous nitrogen
- Two Phases of Testing
  - Phase 1 treatment tests were designed to incorporate oxidation and pH adjustment
    - Oxidation was accomplished using 30% H_2O_2 or air
    - 50% solution of NaOH was used for pH adjustment
  - Phase 2 tests optimized the most favorable treatment path identified in Phase 1
    - Hydrated lime ($Ca(OH)_2$) instead of NaOH was used for the pH adjustment
    - H_2O_2 was used to oxidize the water

Treatability Test Results

- Comparing the results of test runs—H_2O_2 has better contaminant removal with Fe, As, and Mn
- Oxidation first requires less pH-adjustment reagent to achieve the target pH
- Lime addition to pH 9.5 followed by H_2O_2 oxidation is the most effective treatment for removing all of the contaminants
- Settling tests were performed and flocculent was needed to settle sludge in a reasonable time

Belmont Water Quality Data

Water Needs	Cost to irrigate with groundwater from Belmont well ($/1000 gals)	Cost to irrigate with municipal water ($/1000 gals)	Cost difference that can be used for treatment of mine water for Irrigation ($/1000 gals)
1-inch/month per 10 acres for 5 months/year	$0.17	$1.72	$1.55

Treatment Technology	Cost ($/1000 gallons)
Estimated Dollar Available for Treatment of Mine Water	< $1.55
AMD Treat (DOI's Office of Surface Mining) http://amd.osmre.gov/amdtreat.asp	$0.92—1.69

Conclusions/ Recommendations

- Belmont water is moderately contaminated
- Water can be upgraded to meet irrigation standards and be utilized in a beneficial way, reducing stress on municipal water supply
- Additional feasibility/treatability testing on a larger scale is warranted
- Site owner is pursuing funding for eventual implementation of a treatment system
- MSE is finalizing conceptual design for a treatment system
- High temperature water should be investigated as potential heat source for nearby buildings

Acknowledgements

- Montana Economic Redevelopment Development Institute (MERDI)
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