

On-Site Treatment of Soils with Leachable Mercury During Mine Remediation

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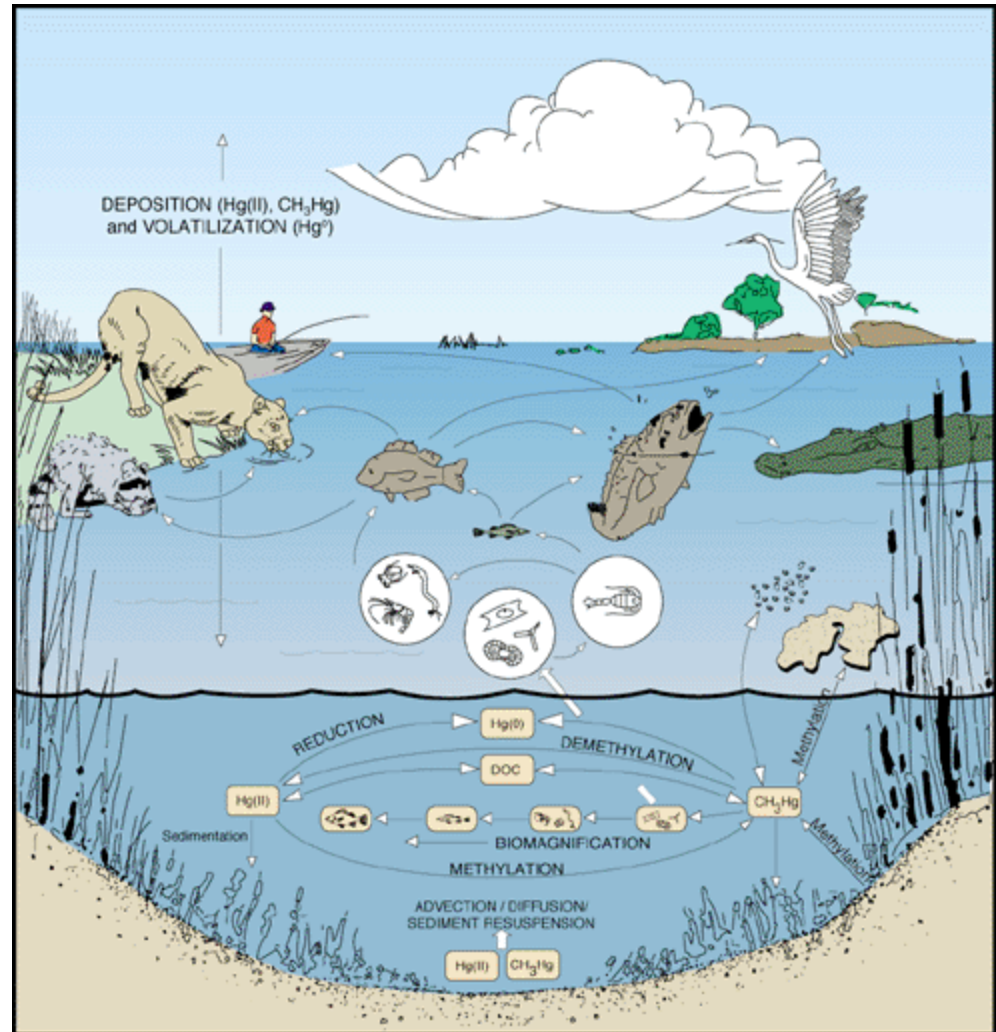


- Mercury contamination during mine reclamation
- Stabilization of mercury
- Treatability testing
- Full-scale treatment
- Conclusions



Mercury Contamination During Mine Remediation

- Historic small-scale gold and silver mining
 - Mercury used as a scavenger
- Mining and processing of cinnabar ore



From US Geological Survey

Mercury Contamination During Mine Remediation

- Leachable mercury can be found at:
 - Ore piles
 - Tailing piles
 - Soils underlying mill/ore processing areas
 - Slurry/sludge pipelines

- Materials from these areas can be determined to be hazardous waste
- May not be disposed of off-site as is
- May require treatment to chemically immobilize the mercury prior to shipment for disposal

- Chemistry, not alchemy
- Convert Hg in wastes to sparingly soluble sulfides or sulfide type products
- Encapsulate mercury sulfides or sulfide type products in cement matrix

Compound	Ksp	Compound	Ksp
CdS	7.0×10^{-27}	HgS	3.0×10^{-52}
CoS	8.0×10^{-36}	Hg ₂ S	3.0×10^{-20}
FeS	3.0×10^{-17}	NiS	2.0×10^{-22}
PbS	1.3×10^{-28}	Ag ₂ S	8.0×10^{-50}
MnS	1.1×10^{-11}	ZnS	1.6×10^{-23}

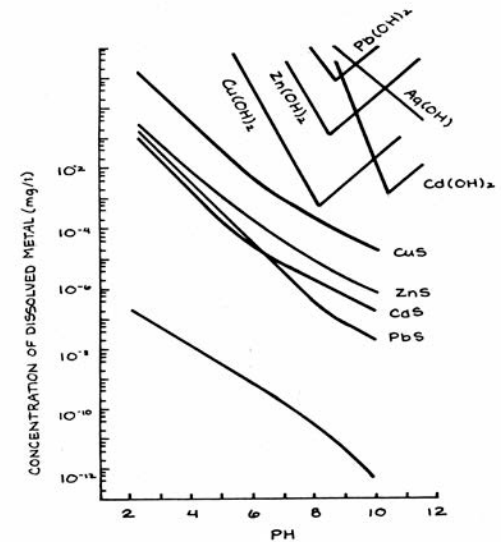


Figure 3-3 Solubilities of metal hydroxides and sulfides. (From EPA [17].)

- Sulfide reagents for mercury stabilization
 - Sodium sulfide
 - Ferrous sulfide
 - Calcium polysulfide (CPS)
 - TMT
 - Nalmet 8154
- Envirocon prefers to utilize CPS
 - Relatively inexpensive and easy to handle
 - Commonly used in water treatment and as an agricultural fungicide

- Representative samples collected and transported to a laboratory
- Sample material is homogenized and aliquots mixed with varying amounts of CPS or CPS + Portland Cement
- Treated aliquots subjected to TCLP and the leachable mercury levels compared to regulatory standards



Treatability Testing - Example

- Two samples collected
 - Soil
 - Sludge
- Mixed with varying amounts of CPS

Waste Material	Regulatory Limit	Calcium Polysulfide Mix Ratio (% by weight)					
		0	0.5	1	1.5	2	2.5
	Leachable Mercury (mg/L)						
Soil	0.1	0.079	0.316	0.419	0.533	0.518	0.525
Sludge	0.1	1.57	--	0.104	0.0729	1.01	0.704

- Inconsistent results indicate insufficient amounts of CPS were used

Treatability Testing - Example

- Additional testing with the sludge sample
 - Higher CPS addition
 - Added Portland cement addition

Waste Material	Regulatory Limit	Calcium Polysulfide Mix Ratio (% by weight)					
		4	4	5	5	6	6
		Portland Cement Mix Ratio (% by weight)					
		8	10	12	8	10	12
	Leachable Mercury (mg/L)						
Sludge	0.1	<0.002	0.0066	0.0136	0.0168	0.0098	0.0048

- Selected 4% CPS / 8% Portland Cement for full-scale treatment

- Mercury contaminated soil is excavated and placed into poly-lined and bermed cells
 - The volume of each stockpile is determined
 - Based on bulk density measured, the weight of material in stockpile is calculated
- CPS is transferred from a reagent storage tank via a chemical feed pump and added to the stockpile at the appropriate weight
- Portland Cement in supersacks is added to the stockpile at the appropriate weight

- An excavator is used to mix the amended stockpiles
 - An excavator operator lifts, turns, and folds the amended stockpile for a minimum of 90 minutes, or until the stockpile material is visually homogeneous
- Samples are collected from each treated stockpile within 24 hours of treatment
 - Grab or composite samples
- TCLP results confirm successful treatment of the stockpiles

Full Scale Treatment - Example

- Mercury contaminated soil excavated and placed into poly-lined bermed cells
- Volume of each stockpile determined
- Based on bulk density measured, the weight of material in stockpile was calculated



Full Scale Treatment - Example

- CPS was transferred from a reagent storage tank via a chemical feed pump and added to the stockpile at 4% by weight
- Portland cement in supersacks was added to the stockpile at 8% by weight



Full Scale Treatment - Example

- An excavator operator lifted, turned, and folded the amended stockpile for a minimum of 90 minutes or until the stockpile material was visually homogeneous



Full Scale Treatment - Example

- Grab samples are collected from each treated stockpile within 24 hours of treatment
- TCLP results confirm successful treatment of the stockpiles

Waste Stockpile	Regulatory Limit	Sample Result
	Leachable Mercury (mg/L)	
HW-7	0.1	0.0137
HW-4	0.1	0.0089

Full Scale Treatment - Example

- Treated material was transported off site to a landfill for disposal
 - Non-hazardous waste



- Stabilization of mercury is technically feasible
- Mercury contaminated mining wastes can be successfully treated on site
- Cost-effective as compared to off site transportation and disposal to a hazardous waste landfill



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