## Feinstein Abandoned Mine Lands Prioritization List

- **Listed on the National Priorities List (Superfund) and estimated to have high remediation costs**

  - **Decision tool used to prioritize abandoned mine lands sites or issues in each**
  - Remediation cost was used as the decision tool to identify those 117 most expensive to remediate sites and then rank them by cost tier. Listed sites are assigned to three Tiers based on past and estimated capital cost of cleanup: Tier 1 ($10M - $100M or more), Tier 2 ($1M - $10M), Tier 3 ($100K - $1M)

  - **Factor in common of highest top 1/3 or most contaminated abandoned mine sites**
  - Was presence of acid mine drainage at sites a factor in the study and site ranking, and to what extent?

  - Most Tier 1 sites had human health receptor issues. Less than half of the Tier 2 sites had high human health exposure priorities noted. The top four (most expensive to remediate) sites had AMD issues as the primary problem. 60% of Tier 1 sites and 30% of Tier 2 sites had AMD contamination.

  - **How much of a priority was AMD?**
  - High priority given ability to cause heavy metal contamination in watersheds; mercury was the 2nd most common contaminant among the 4290 sites with environmental contamination.

  - **Was presence of mercury contamination at sites a factor in the study and site ranking, and to what extent?**
  - Presence of mercury was the second most critical factor in this ranking, due to toxicity, widespread presence at CA sites, environmental persistence, and remediation expense. 44% of Tier 2 sites and 30% of Tier 3 sites had mercury contamination.

  - **How much of a priority was mercury contamination?**
  - High priority given toxicity, depositional properties, and extensive use in extraction and processing areas. Arsenic was the third most common contaminant among the 4290 sites with environmental contamination.

  - **Was presence of arsenic contamination at sites a factor in the study and site ranking, and to what extent?**
  - Presence of arsenic was the third most critical factor in this ranking, due to toxicity, threat to drinking water, natural occurrence at CA sites, and remediation expense. 36% of Tier 3 sites had arsenic contamination.

  - **How much of a priority was arsenic contamination?**
  - Qualitative, not based solely on cost

  - **Study limits/exclusions**
  - AMD has historically been the most expensive remediation issue, so AMD sites topped the list. All Tier 1 sites have AMD, arsenic, and/or mercury contamination issues, and nearly all Tier 2 and Tier 3 sites do as well.

## California’s Abandoned Mines: A Report on the Magnitude and Scope of the Issue in the State, California Department of Conservation Abandoned Mine Lands Unit, June 2000

- **Focus was on identifying the number of abandoned mine sites in CA with environmental issues (4290 or 11%) among other things**

  - Through a combination of GIS and statistical analysis, 4290 sites in CA were deemed environmental hazards. The most common hazards include AMD and heavy metals associated with 8th, mercury from sediments, other mercury forms from mercury mines, arsenic, asbestos, and chromium. Watersheds deemed most likely to contain the most mines in the 4290 group were included in this study, and this was the decision tool.

  - **Factor in common of highest top 1/3 or most contaminated abandoned mine sites**
  - Focus was on watershed protection; human health receptors were secondary as watershed users. Noted that AMD is prevalent in many areas where sulfides were mined to process silver ore and sulfides were colocated with copper deposits.

  - **How much of a priority was AMD?**
  - High priority given ability to cause heavy metal contamination in watersheds; mercury was the 2nd most common contaminant among the 4290 sites with environmental contamination.

  - **Was presence of mercury contamination at sites a factor in the study and site ranking?**
  - Noted that about 90% of mercury mined in the U.S. was mined in CA, and used extensively to process gold.

  - **How much of a priority was mercury contamination?**
  - Noted priority Qualitative

  - **Study limits/exclusions**
  - Data was collected at selected abandoned mine sites by watershed in various bioregions throughout CA; physical safety issues were also studied. The study was limited to certain pre-selected watersheds in CA where it was believed that most of the 4290 contaminated mine sites fell; other watersheds were not studied.

## California Abandoned Mine Lands Agency Group (CAMLAG) Partnership

- **Mercury, Arsenic, Sulfide deposits**

  - Decision tool will be a complex formula (still in development) that weights 16 different abandoned mine hazard inputs according to source-transport-receptor models; hazard inputs will then be added together to obtain a site score. When the formula is finalized, it will be applied to each of the 42,000 sites in order to get a site score for each and rank them in order from first priority to last.

  - Output not yet available as formula is still in development and will be applied to each of the 42,000 sites in order to get a site score for each and rank them in order from first priority to last.

  - **Factor in common of highest top 1/3 or most contaminated abandoned mine sites**
  - Formula not yet available but AMD was weighted highly in the formula input as it can cause large, expensive and regenerative contamination problems from acidifying water and releasing heavy metals; if a massive sulfide deposit is present at the site it has an additional modifier to add more weight.

  - **How much of a priority was AMD?**
  - High

  - **Was presence of mercury contamination at sites a factor in the study and site ranking?**
  - Formula not yet available but mercury was weighted highly since it degrades water quality, bioaccumulates in the food chain, methylates in aquatic environments, and can deposit far from sources.

  - **How much of a priority was mercury contamination?**
  - High

  - **Was presence of arsenic contamination at sites a factor in the study and site ranking?**
  - Formula not yet available but arsenic was weighted highly since it is persistent in the environment and poses a drinking water hazard.

  - **How much of a priority was arsenic contamination?**
  - High

  - **Study limits/exclusions**
  - Only sites involving the release of hazardous substances are included in this study; non-federal land is emphasized.
### California State Mining and Geology Board (SMGB) Information Report 2007-04: A Comparison of Regulatory Surface Mining Programs in the Western United States

| Factor in common of highest (top 1/3) or most contaminated abandoned mine sites | Decision tool used to prioritize abandoned mine lands sites or issues in each | Were human health receptor issues evident in all top 1/3 listed sites? | Was presence of acid mine drainage at sites a factor in the study and site ranking, and to what extent? | How much of a priority was AMD? | Was presence of mercury contamination at sites a factor in the study and site ranking, and to what extent? | How much of a priority was mercury contamination? | Was presence of arsenic contamination at sites a factor in the study and site ranking, and to what extent? | How much of a priority was arsenic contamination? | Qualitative or Quantitative Prioritization Scheme? | Study limits/exclusions |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Acid mine drainage, reclamation, traffic, reclamation bonds, land use/zoning | Interviews and surveys with abandoned mine professionals | Not specifically discussed | AMD was the top noted environmental concern | 1st priority | Noted heavy metals contamination potential as a result of AMD | Not specifically discussed | Noted heavy metals contamination potential as a result of AMD | Not specifically discussed | Qualitative | Limited to non-coal minerals mining in CA |


| Acid mine drainage and impacts to groundwater quality as a result | Decision tool was relative AML impact to watersheds | Not in all cases; often as secondary receptors to ecological impacts of heavy metal loadings to receiving water bodies | AMD was the top noted environmental concern | 1st priority | Heavy metals loading as a result of AMD noted as one of the most significant environmental issues for CA | 2nd priority | Heavy metals loading as a result of AMD noted as one of the most significant environmental issues for CA | 2nd priority | Qualitative |

### Prioritization of Abandoned Mine Lands in the Animas River Watershed

| Areas with copper, zinc, iron, aluminum, manganese, and sulfate concentrations were identified for their dissolved metal loading and impacts to water quality | Decision tool was relative AML impact to ecological receptors in watersheds | No; focus was on ecological receptors of the watershed | Sulfate loading, which directly relates to AMD potential, was specifically targeted in this study and used as the primary ranking tool | High priority | Not specifically discussed | Not specifically discussed | Not specifically discussed | Not specifically discussed | Qualitative | Limited to the Animas River Watershed; examined in this study for prioritization techniques |

### Hazard Ranking System (HRS)

<p>| Sites scored by HRS are going through the Site Assessment Process with EPA; sites that score 28.5 or higher (much less than the top third of all evaluated sites) are listed on the National Priorities List and become Superfund sites (8 in CA). These top listed sites have the highest toxicity values and often have high exposure risks to humans. | Decision tool is HRS site scoring system; evaluation of the following four pathways and their relative threats to human health and the environment: groundwater migration, surface water migration, soil exposure, and air migration. | Human health receptor issues factor highly into HRS | Not specifically applicable to mining contamination issues | Not specifically applicable to mining contamination issues | Not specifically applicable to mining contamination issues | Some mercury abandoned mine sites scored high enough in HRS to be placed on the NPL | Some arsenic abandoned mine sites scored high enough in HRS to be placed on the NPL | Quantitative | Only sites that are evaluated under the EPA’s Site Assessment Program are subject to HRS, as it is used to determine which sites make the NPL. Some of the HRS concepts for scoring sites are useful and can be adopted to an abandoned mine assessment and prioritization system, but overall the system does not translate well to use on its own to rank abandoned mine sites. HRS is not specifically designed for or used to score abandoned mine sites unless they enter the EPA site assessment process and NPL determination. |</p>
<table>
<thead>
<tr>
<th>USGS Mineral Resources Data System (MRDS)</th>
<th>USGS Volcanogenic Massive Sulfide Deposits list</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factor in common of highest (top 1/3) or most contaminated abandoned mine sites</td>
<td>Presence of large sulfide deposit collocated with mining activity is the decision tool.</td>
</tr>
<tr>
<td>Decision tool used to prioritize abandoned mine lands sites or issues in each</td>
<td>No; list is based on geology</td>
</tr>
<tr>
<td>Were human health receptor issues evident in all top 1/3 listed sites?</td>
<td>Listed mine sites here represent likely candidates for AMD given large sulfide deposits present where extensive geologic disturbances occurred from mining activities. A mine site making this list is an indication that it is an AMD threat, and therefore should be prioritized higher on cleanup lists due to potential for regenerative environmental contamination.</td>
</tr>
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<td>Was presence of acid mine drainage at sites a factor in the study and site ranking, and to what extent?</td>
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<tr>
<td>Study limits/exclusions</td>
<td>Study designated whether mine sites were prospects or occurrences vs. producers or past producers and identified size of mine, but environmental contamination and risk data is limited. Commodity and size of mine can be an indicator of potential environmental contamination risk, but non-toxic commodities (e.g. gold) are not accounted for correctly based on these criteria, since mercury was often used to process the gold, and naturally occurring sulfides and arsenic are often collocated with gold deposits in CA.</td>
</tr>
</tbody>
</table>

Appendix I: Evaluation of Existing Prioritization Schemes

Study limits/exclusions

USGS Mineral Resources Data System (MRDS)
- The top third of sites in this study were deemed producers or past producers of commodities; study is a large complex collection of reports describing metallic and nonmetallic mineral resources.
- Decision tool is size (small-medium-large) and commodity; large size and more toxic commodities tend to pose more of an environmental concern.
- No; list is based on mineral resources mined, not risk or receptor issues.
- Not specifically discussed
- Qualitative

USGS Volcanogenic Massive Sulfide Deposits list
- 26 CA mines listed due to naturally occurring sulfide deposits collocated with the mine site
- Presence of large sulfide deposit collocated with mining activity is the decision tool.
- No; list is based on geology
- Not specifically discussed
- Not specifically discussed
- Not specifically discussed
- Not specifically discussed
- 1st priority
- Mercury was not specifically accounted for
- Not specifically discussed, but likely high given AMD potential
- Arsenic was not specifically accounted for
- Qualitative

Study limits/exclusions
- Study identified VMS deposits around the world with grade and tonnage models; very limited scope of study based solely on this geologic occurrence.