BLM

# DRAFT ENGINEERING EVALUATION/ COST ANALYSIS REPORT

## Chicago and Research Mercury Mines

(The Chicago Research Site)

Lake County, California

BLM Order No.: L10PX04672

OCTOBER 2011

United States Department of Interior
Bureau of Land Management

Ukiah Field Office

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Prepared for:

U.S. Department of the Interior
Bureau of Land Management
2800 Cottage Way, Suite W-1834
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**October 17, 2011**

Prepared By:

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October 17, 2011
Date

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# ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| ABA | Acid-Base Accounting |
| ABP | Acid-Base Potential |
| AF | Adherence Factor |
| AGP | acid generation potential |
| amsl | above mean sea level |
| ANP | acid neutralization potential |
| ARAR | Applicable or Relevant and Appropriate Requirement |
| AT | Averaging Time |
| bgs | below ground surface |
| BLM | Bureau of Land Management |
| BW | body weight |
| Cal-EPA | California Environmental Protection Agency |
| CAM | California Administrative Manual |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| CF | conversion factor |
| CFR | Code of Federal Regulations |
| COC | contaminant of concern |
| COPEC | chemical of potential ecological concern |
| CSF | cancer slope factor |
| ED | exposure duration |
| EE/CA | Engineering Evaluation/Cost Analysis |
| EF | exposure frequency |
| EPC | exposure point concentration |
| ERA | Ecological Risk Assessment |
| ET | exposure time |
| FSP | Field Sampling Plan |
| HHRA | Human Health Risk Assessment (subsection of HHERA) |
| HHERA | Human Health and Ecological Risk Assessment |
| HI | Hazard Index |
| ILCR | Target Incremental Lifetime Cancer Risk |
| IR | Ingestion Rate |
| IRIS | Integrated Risk Information System |
| IUR | Incremental Unit Risk |
| $K_p$ | dermal permeability coefficient |
| MCLs | maximum contaminant levels |
| µg/g | microgram per gram |
| µg/L | microgram per liter |
| mg/Kg | milligrams per kilogram |
| mg/L | milligrams per liter |

| | |
|---|---|
| MRL | Minimal Risk Level |
| NCP | National Oil and Hazardous Substance Pollution Contingency Plan |
| ND | non-detect |
| PEC | probable effect concentration |
| PEF | particulate emission factor |
| PHG | Public Health Goal |
| RAO | Removal Action Objectives |
| RBSL | risk-based screening levels |
| RCRA | Resource Conservation and Recovery Act |
| RfC | Reference Concentration |
| RfD | Reference Dose |
| RWQCB | Regional Water Quality Control Board – Central Valley Region |
| RG | remediation goals |
| RMC | Risk Management Criterion |
| RSLs | Regional Screening Levels |
| SA | skin surface area |
| SVC | Tier II Secondary Chronic Value |
| STLC | soluble threshold limits concentrations |
| TCLP | toxicity characteristic leaching procedure |
| TEC | threshold effect concentration |
| TTLC | Total Threshold Limit Concentrations |
| TAL | Target Analyte List |
| U.S.C. | United States Code (Laws/Statutes) |
| USDOI | United States Department of the Interior |
| USEPA | United States Environmental Protection Agency |
| USGS | United States Geologic Survey |
| XRF | X-ray Fluorescence |
| VF | Volatilization factor |
| WET | Waste Extraction Test |

# EXECUTIVE SUMMARY

The United States Department of the Interior (USDOI) Bureau of Land Management (BLM) retained Environmental Cost Management, Inc. (ECM) to prepare a Human Health and Ecological Risk Assessment (HHERA), an Engineering Evaluation/Cost Analysis (EE/CA) and an EE/CA Report for the Chicago Mercury Mine and Research Mercury Mine (hereinafter referred to individually as "Chicago Mine" and "Research Mine" or paired as "the Chicago Research Site"). The Chicago Research Site is located approximately five miles west of Middletown in Lake County, California on the eastern slopes of the Mayacamas Mountains, facing southeast (**Figure 1**). The mines are within the headwaters of Dry Creek, with Chicago Mine on the north side of the creek and Research Mine on the south side. Dry Creek lies within the Sacramento River watershed

Mine waste materials at the Chicago Research Site are found throughout several waste piles, drainages, and other areas disturbed by mining operations. Within this EE/CA Report, waste areas and areas of contaminated materials are assigned letter designations. These areas are discussed in detail in **Section 3** of the report.

The EE/CA investigation demonstrated that the mine wastes do not generate acid mine drainage or leach appreciable concentrations of mercury or other metals to groundwater. However, stormwater run-off could potentially transport mercury-laden sediments to Dry Creek. After transport further down the watershed, that mercury could biotransform to monomethyl mercury, a potent bioaccumulative. Therefore, BLM anticipates the waste would qualify as Group C (inert) because of its low risk to groundwater and Group B with regard to surface sediment transport. Alternatives involving leaving the waste on site in a waste pile or repository would not require a bottom liner and leachate collection and removal system, but they would require a means to prevent sediment transport to Dry Creek as well as prevent direct exposure to human construction workers and recreational visitors.

The scope of removal actions evaluated in this EE/CA Report focus on:

1. Preventing or reducing human exposure to contaminants of concern (COCs) identified in waste materials;
2. Preventing or reducing ecological exposure to COCs in waste materials;
3. Preventing or reducing potential migration of COCs in waste materials via surface runoff, erosion, and wind dispersion; and
4. Preventing or reducing potential migration of COCs in waste materials to groundwater and eventual potential recharge to surface water.

The HHERA evaluated potential human health and ecological risks and indicated potential risk to ecological receptors from exposure to concentrations of metals in soil and waste that fall within the range of natural background concentrations. There is also a potential human health risk to recreational users who might access the site for extended camping or recreational use and construction workers who could potentially build trails and out-buildings in support of recreation. Surface water and groundwater are not considered a contaminant source at the Chicago Research Site, based on data collected during site investigations and leaching analysis performed as part of the EE/CA investigation. Sediment in Dry Creek was eliminated as a source because it does not appear to pose a human health or ecological risk, although sediments do pose a risk if they migrate downstream.

Eight Removal Action Technologies were reviewed to develop the following five Removal Action Alternatives:

1. Alternative 1 – No Action
2. Alternative 2 – Watershed Diversions and Institutional Controls
3. Alternative 3 – Surface Stabilization/Institutional Controls
4. Alternative 4 – On-Site Consolidation and Capping/Institutional Controls
5. Alternative 5 – Excavation and Off-Site Disposal

The five Removal Action Alternatives were evaluated based on the following overall criteria, which are further broken down in **Section 7** of the EE/CA Report:

1) Effectiveness:
   a) Protectiveness
   b) Level of Treatment/Containment
   c) Reduction or Elimination of Residual Concerns
2) Implementability:
   a) Technical Feasibility
   b) Administrative and Legal Feasibility
   c) Ease of Implementation
3) Cost:
   a) Capital Cost
   b) Post Removal Site Control Cost
   c) Present Worth Cost/Present Value
   d) Long-Term Maintenance and Monitoring Costs

Effectiveness and implementability have been evaluated in detail in the subsections presented for each alternative in **Section 7** of the EE/CA Report. The costs have been evaluated in detail and a complete break-out of costs is provided in **Appendix F**. **Table 24** provides a detailed summary of the costs based on the evaluation criteria presented above.

The following is a summary of the Present Worth Cost/Present Value for each alternative, for each mine site:

| | | **Chicago Mine Alternative** | | | | |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 |
| Years | | 0 | 30 | 30 | 30 | 5 |
| Interest (APR) | | n/a | 5% | 5% | 5% | 2% |
| Present Value | | $ - | $466,992 | $698,698 | $777,023 | $3,029,074 |
| Low Estimate | -30% | $ - | $326,895 | $489,089 | $543,916 | $ 2,120,352 |
| High Estimate | +50% | $ - | $700,488 | $1,048,048 | $1,165,535 | $4,543,611 |

| | | Research Mine Alternative | | | | |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 |
| Years | | 0 | 30 | 30 | 30 | 5 |
| Interest (APR) | | n/a | 5% | 5% | 5% | 2% |
| Present Value | | $ - | $513,261 | $924,837 | $1,017,340 | $3,132,763 |
| Low Estimate | -30% | $ - | $359,283 | $647,386 | $712,138 | $2,192,934 |
| High Estimate | +50% | $ - | $769,891 | $1,387,255 | 1,526,011 | $4,699,145 |

A detailed evaluation of each alternative accounted for the criteria outlined for effectiveness, implementability, and cost, and recommended Alternative 4. The on-site consolidation and capping of contaminated material will best meet the evaluation criteria. This alternative is illustrated on **Figure 12a** and **Figure 12b**, and discussed in detail in **Section 7.4** of the EE/CA Report.

# 1 INTRODUCTION

The United States Department of the Interior (USDOI) Bureau of Land Management (BLM) retained Environmental Cost Management, Inc. (ECM) under Purchase Order Number L10PX04672 to conduct a Human Health and Ecological Risk Assessment (HHERA), an Engineering Evaluation/Cost Analysis (EE/CA) and prepare an EE/CA Report for the Chicago Mercury Mine and Research Mercury Mine (hereinafter referred to individually as "Chicago Mine" and "Research Mine" or paired as "the Chicago Research Site"). The Chicago Mine and Research Mine, along with nearby towns, roads, and various hydrogeologic features, are depicted on the Site Location Map (**Figure 1**).

This EE/CA Report has been prepared in accordance with the criteria established under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as well as sections of the National Contingency Plan (NCP) as applicable to removal actions (40 Code of Federal Regulations [CFR] §300.415 [b][4][I]). The BLM has been delegated CERCLA lead agency authority by the President of the United States and the Secretary of the Interior, and is exercising this authority at the Chicago Research Site. The EE/CA Report is also consistent with the United States Environmental Protection Agency (USEPA) guidance document, *Guidance on Conducting Non-Time Critical Removal Actions Under CERCLA* (USEPA, 1993).

The goals of the EE/CA investigation include:

- Evaluate historic site data and determine how and where to collect additional information to fill data gaps;
- Conduct a Baseline Human Health And Ecological Risk Assessment (HHERA) to determine the potential threats posed by contamination originating from the Chicago Research Site;
- Prepare an EE/CA Report to propose removal actions and to address contamination;
- Provide a framework for the evaluation and selection of potential response actions and applicable technologies consistent with the NCP and USEPA Guidance.

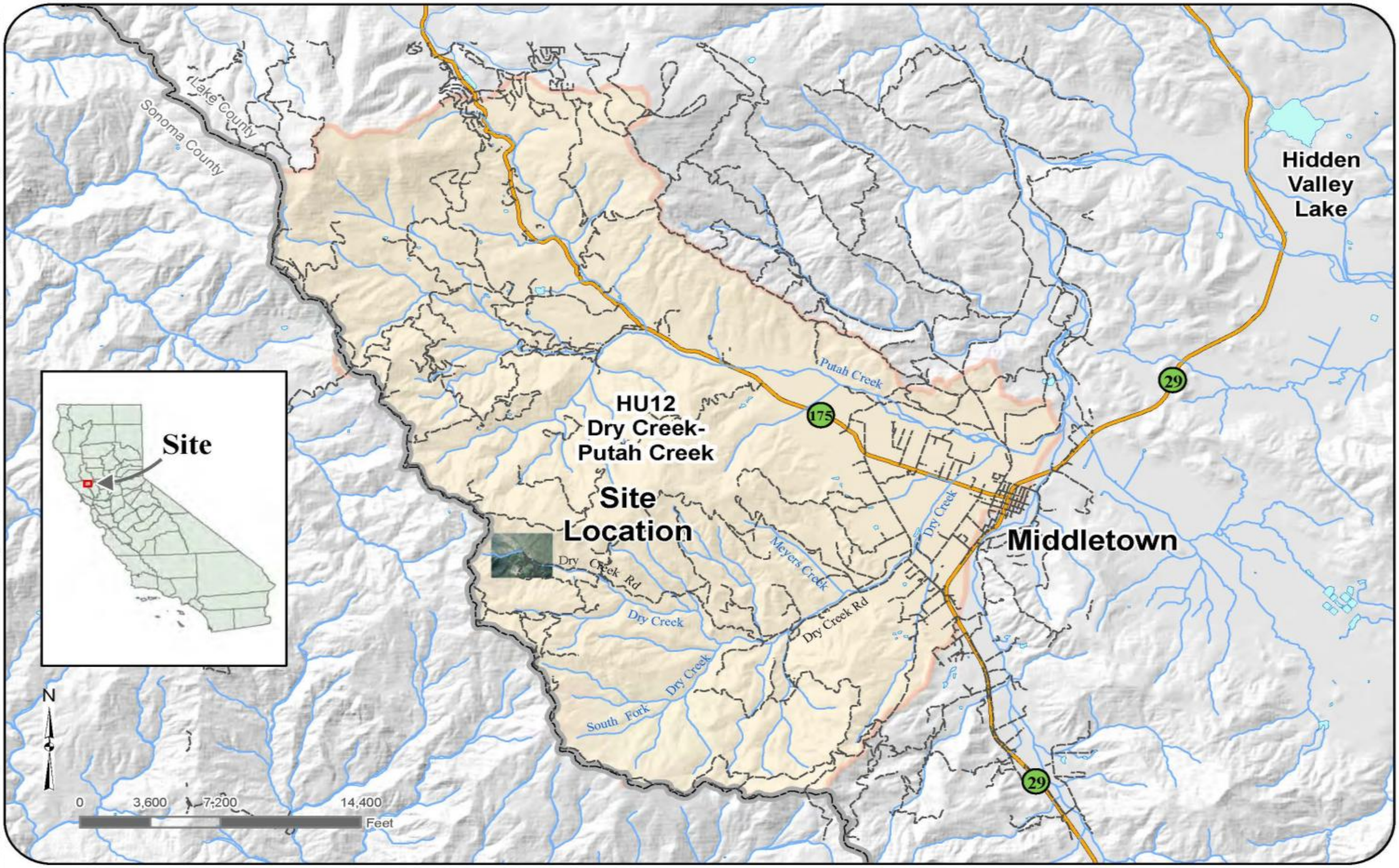
The 2010 field investigation conducted for this EE/CA is discussed in detail in **Appendix A**, with all relevant attachments and laboratory data. Photographs of site features identified in this EE/CA Report are presented in **Appendix B**. The HHERA is presented in **Appendix C**.

# 2 SITE CHARACTERIZATION

## 2.1 LOCATION

The Chicago Research Site is located approximately five miles west of Middletown in Lake County, California on the eastern slopes of the Mayacamas Mountains, facing southeast (**Figure 1**). The elevation at Chicago Mine varies from about 2,560 to 2,750 feet above mean sea level (amsl). The elevation at the Research Mine varies from about 2,560 feet to 2,680 feet amsl. The Chicago Research Site is within the headwaters of Dry Creek, with Chicago Mine on the north side of the creek and Research Mine on the south side of the creek.

Path: B:\BLM\Chicago Research\ARCGIS\MXD\Fig1-Site Location_8x11.MXD Drafter: SMK Chkd By: A. Campbell, P.E. Date Drafted: 04/26/2011 Proj Mgr: A. Campbell, P.E. Project: BLM Chicago Research Site EE/CA




| US Department of the Interior<br>Bureau of Land Management<br>California State Office<br>2800 Cottage Way, Suite W-1834<br>Sacramento CA, 95825 | ENVIRONMENTAL COST MANAGEMENT, INC.<br>*Managing Cost and Liability*<br>3525 Hyland Avenue, Suite 200 Costa Mesa CA 92626<br>Tel: (714) 662-2759 Fax: (714) 662-2758<br>www.ecostmanage.com | **Site Location Map**<br>**Chicago Research Site**<br>**Lake County, California**<br>Engineering Evaluation/Cost Analysis Report<br>The Chicago Research Site | Figure<br>**1** |
|---|---|---|---|

Path: B:\BLM\Chicago Research\ARCGIS\MXD\Fig2-SiteFeatures_11x17.MXD Drafter: SMK Chkd By: A. Campbell, P.E. Date Revised: 09/28/2011 Proj Mgr: A. Campbell, P.E. Project: BLM Chicago Research Site EE/CA


Notes:
Locations for SAIC and USGS samples based on SAIC report entitled:
Removal Site Evaluation Report, Chicago/Research Mercury Mine, July 2010.

| | | | |
|---|---|---|---|
| US Department of the Interior<br>Bureau of Land Management<br>California State Office<br>2800 Cottage Way, Suite W-1834<br>Sacramento CA, 95825 | ENVIRONMENTAL COST MANAGEMENT, INC.<br>*Managing Cost and Liability*<br>3525 Hyland Avenue, Suite 200 Costa Mesa CA 92626<br>Tel: (714) 662-2759 Fax: (714) 662-2758<br>www.ecostmanage.com | **Site Features**<br>**Chicago Research Site**<br>**Lake County, California**<br>Engineering Evaluation/Cost Analysis Report<br>The Chicago Research Site | Figure<br>**2** |

## 2.2 SITE FEATURES

A map of the general Site Features, including adits, mine entrances, and furnaces, is presented as **Figure 2**.

### 2.2.1 Chicago Mine

The abandoned Chicago Mine consists of two adits that are connected to each other, a collapsed hoist located at the creek, two former bunkhouses that are collapsed, and the remains of a furnace used to process mercury ore. Photographs of these Site features appear in Appendix A of the 2010 *Removal Site Evaluation Report-Chicago Mercury Mine* (SAIC, 2010), and are provided in **Appendix B** of this EE/CA Report. The upper adit is accessible, although parts of the stope nearest to the adit have collapsed. The lower adit has collapsed, although cool air from the opening suggests a connection to the upper adit remains open.

Mine waste materials include waste rock piles, mercury ore, waste soot from the furnace, and calcines from ore processing. Wood and metal mining debris are scattered around the site. Neither ECM personnel nor Science Applications International Corporation (SAIC) personnel observed any mine water discharge or evidence of mine water discharge near the two adits during multiple site visits conducted in 2009, 2010, and 2011.

During a March 2010 site visit, SAIC field personnel identified a third collapsed adit located about 650 feet west (upstream) of the Chicago Mine and 20 feet south of Dry Creek[1]. Rail tracks coming out of the adit extended across the creek to the north bank. SAIC personnel observed mine water discharging from the adit and flowing into Dry Creek. ECM also observed water discharging from this adit in October 2010. The presence of moss and algae along the discharge pathway implied year-round drainage.

In December 2010, ECM personnel identified a fourth adit located approximately 350 feet northwest of the Chicago Mine (**Figure 2**). ECM personnel did not observe any water draining from this adit.

### 2.2.2 Research Mine

The abandoned mine consists of two collapsed adits, three rusted fuel tanks located close to the adits, trestles at the upper adit, the remains of a brick retort, and four concrete furnaces, the easternmost of which is collapsed. Photographs of all of these Site features were provided in Appendix A of the 2010 *Removal Site Evaluation Report-Research Mercury Mine* (SAIC, 2010a), and are provided in **Appendix B** of this EE/CA Report.

As with Chicago Mine, several areas of mine waste material remain at the Research Mine. These include waste soot, waste rock piles, mercury ore, and calcines from ore processing. Miscellaneous wooden and metal mining debris were found scattered around the upper and lower adits. Neither SAIC personnel nor ECM personnel observed mine water discharge coming from the upper adit. SAIC personnel and ECM personnel observed mine water discharge emanating from the lower adit during site visits in November 2009, March, September, October, November, and December 2010, and January 2011.

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[1] Located outside of the boundaries of **Figure 2** and outside of the boundaries of the Chicago Mine investigation area.

## 2.3 HISTORY

The *Removal Site Evaluation Report* (SAIC, 2010; 2010a) for each site provides a detailed history of each. The following provides a brief synopsis of these histories.

### 2.3.1 Chicago Mine

Operations at the Chicago Mine began in 1865. Mining operations targeted a 22-foot wide opaline serpentine vein with cinnabar throughout. Historic accounts indicate the Chicago Mine initially ceased operations in 1911; however, mining occurred at various times again between 1927 and 1943. By 1943, the mine workings consisted of 1,500 feet of adits and crosscuts, and the vertical shaft was 150 feet long.

The remains of a brick retort rest on a pile of medium to coarse-grained calcines along the bank of Dry Creek. Adjacent to the calcine pile is a partially collapsed ore crib. Another pile of calcines covered by waste rock is exposed in the bank of Dry Creek just downstream from the ore crib. The underground workings are still accessible and consist of an adit and a winze[2] developed in silica-carbonate altered serpentinite.

### 2.3.2 Research Mine

The Research Mine was claimed in the early 1940s. Two adits (an upper and a lower along the hillside; **Figure 1**) were active between 1940 and 1943. The remains of a brick retort with a long brick flue formerly connected to the chimney are present on the south bank of Dry Creek. It has been estimated that the mine processed ore between 1930 and into the 1940s. The concrete furnaces found at the southeastern part of the site are were active by 1918 as part of the Chicago Mine.

By 1946 the workings at the level of the upper adit consisted of 400 feet of drifts[3] and a 55 feet of raise[4]. The lower adit, also called Bridge Tunnel, was driven 500 feet under the workings of the upper level.

The Research Mine ores were processed at two locations. One was close to the lower adit where a collapsed brick retort and three fuel tanks are located. A pile of calcines from the retort and adjacent to Dry Creek consists of coarse pebble sand. Small amounts of calcines are also present at the lower adit, between the remains of the brick retort and Dry Creek. The processing area is at the southeastern corner of the site where four concrete furnaces are located. The southeastern most of these furnaces has already collapsed. A shallow layer of soot covers the ground around the furnaces, on the slopes above the furnaces, and on the slope down towards the creek.

The underground workings are inaccessible.

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[2] A vertical or inclined chute driven downward connecting an upper drift to a lower drift. The top of a winze is located underground, as opposed to a shaft.

[3] Horizontal tunnels are called drifts.

[4] A vertical or inclined excavation that leads from one level, or drift, to another. Differs from a winze as a winze is driven downward and a raise is driven upward.

## 2.4 GEOLOGY, HYDROGEOLOGY, LAND USE, AND METEOROLOGY

### 2.4.1 Geology and Surficial Soils

The Chicago Mercury Mine and Research Mercury Mine are located in the Clear Lake Volcanic Field, a part of the Coast Ranges (**Figure 3**). The mercury deposits are among the youngest in the Coast Range Mercury Mineral Belt and occur in silica-carbonate alterations along the Big Sulfur Creek Fault Zone that separates serpentinite from Franciscan sandstone (Rytuba, et al, 2009; McLaughlin, 1978).

The ore at both Sites is found in the form of cinnabar. The silica-carbonate ledges containing the cinnabar in the area of the Chicago Research Site differs between the two mines. The ledge at the Chicago Mine, located upstream of the Research Mine, strikes west to northwest and dips to the southwest (USBM, 1965). The ledge at the Research Mine is not connected to the Chicago Mine (Bradley, 1965) and strikes northwest and dips steeply to the northeast (USBM, 1965; Rytuba, et al, 2009).

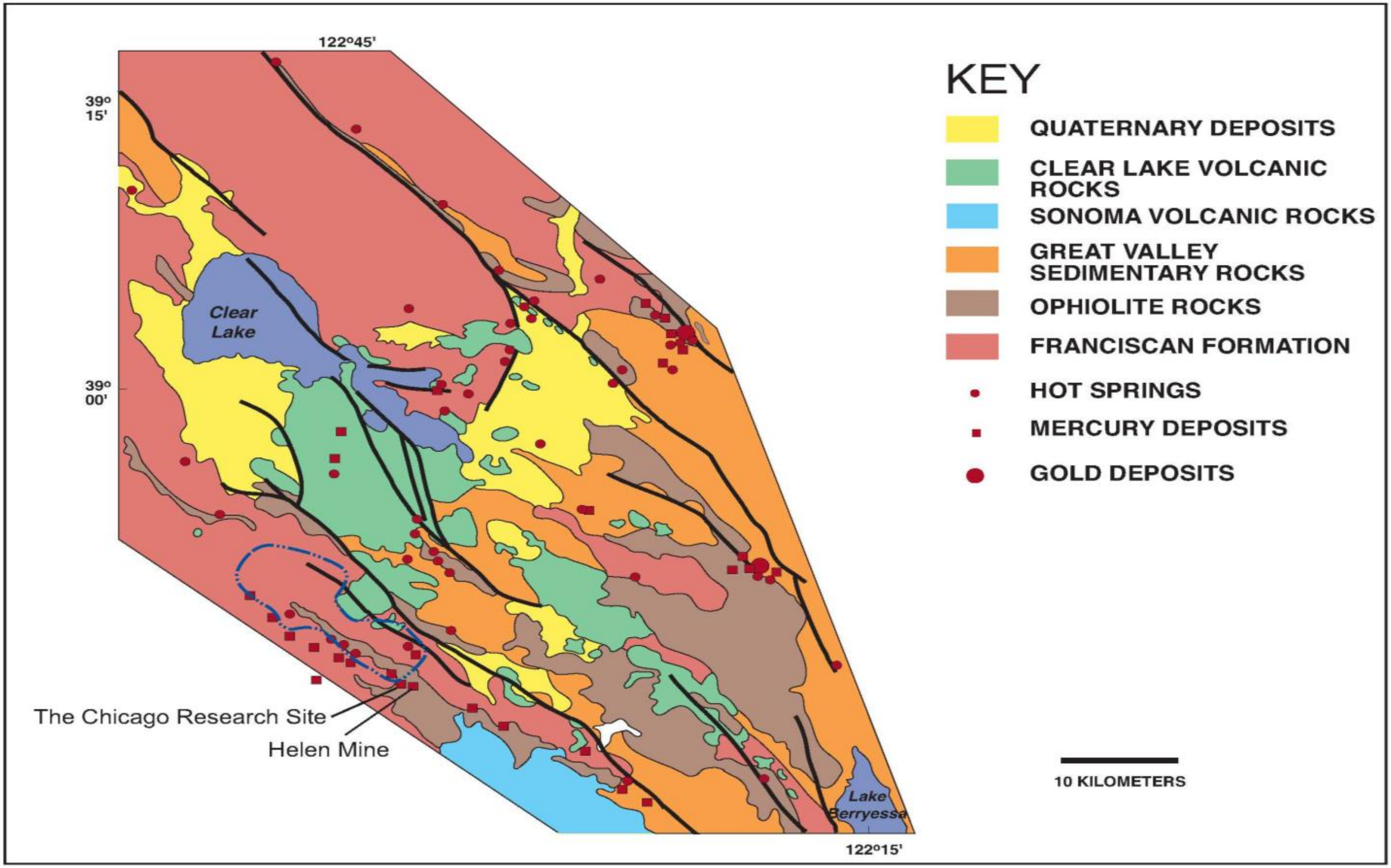
The soil at both Sites belongs to the Okiota-Henneke-Dubakella Association and are formed on material weathered from serpentinite bedrock. Okiota and Henneke soils develop on south-facing slopes, while Dubakella soils develop on north-facing slopes. All three soil types have a low permeability. Their surface runoff is rapid and the hazard of erosion is severe (Smith, 1989). Additional detailed information regarding these soils was provided in the *Removal Site Evaluation Report* (SAIC, 2010; 2010a) for both sites.

#### 2.4.2 Hydrology and Hydrogeology

##### *2.4.2.1 Surface Water*

The Chicago Research Site is located within the Dry Creek and Putah Creek Watershed. The Putah Creek watershed lies on the eastern slope of the Coast Range, south of the Cache Creek drainage and north of Napa Valley. The drainage encompasses southern Lake County, the northern half of Napa County, and small portions of Yolo and Solano Counties. The Putah Creek watershed encompasses approximately 710 square miles and extends from an elevation of 4,700 feet at Cobb Mountain in Lake County southeast for a distance of about 50 miles to the Yolo Bypass, at an elevation a one to three feet above mean sea level (amsl) (WRAYC, 2007).

The Dry Creek Watershed is depicted on **Figure 4**. Dry Creek, a tributary of the Putah Creek, is an intermittent stream at the Chicago Research Site and becomes a perennial stream less than 0.5 miles downstream of the Chicago Research Site. Groundwater discharges to the surface at the point where Dry Creek becomes a perennial stream. Dry Creek is not used as a source for drinking water, but downstream is used for irrigation and provides habitat for fish, insects, and amphibians (Burleson, 2009).




Geologic Map of the Clear Lake Volcano Field in the Dry Creek Watershed

Figure 3

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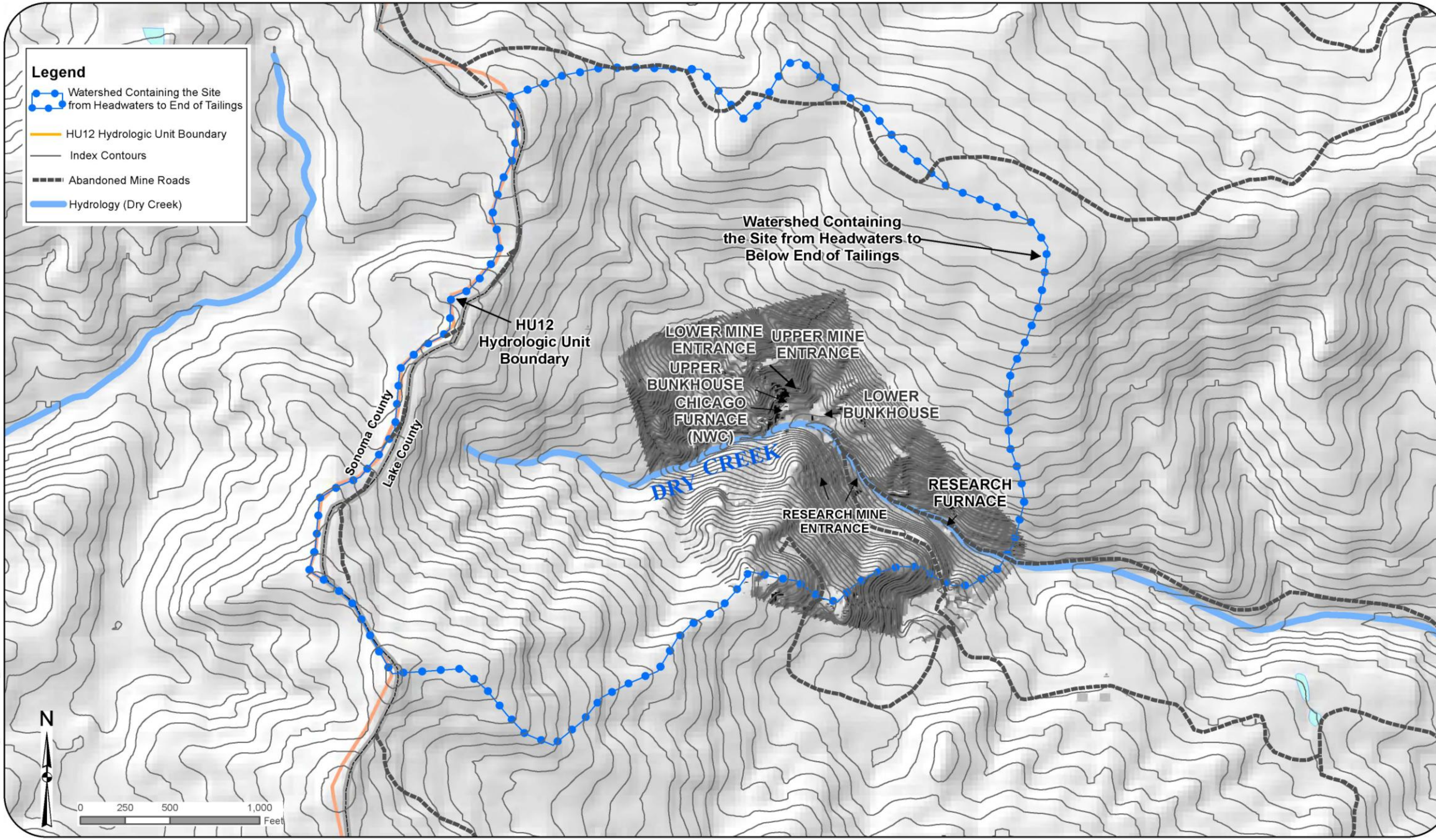


Notes:

Digital elevation model (DEM) based on USGS National Elevation Dataset (NED), 30-meter (1 arc second); and contours from site survey by SHN, 2010). Shaded relief generated using ArcGIS Spatial Analyst.

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**Watershed Delineation Map**
**Chicago Research Site**
**Lake County, California**

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The Chicago Research Site

Figure **4**

#### *2.4.2.2 Groundwater*

The Chicago Research Site is located approximately 5 miles west of the Collayomi Valley Basin, which has an approximate surface area of 6,500 acres. The Collayomi Basin includes both the Collayomi Valley and Long Valley in the headwater area of Putah Creek (E&E, 2010). Although the Chicago Research Site is located outside the Collayomi Valley Basin, the area is still part of the groundwater source area since all subsurface waters are considered groundwater for planning purposes, regardless of whether the groundwater meets the definition of an aquifer or occurs within identified groundwater basins (RWQCB, 1998).

Groundwater at the Chicago Research Site occurs in fractured bedrock and in unconsolidated deposits along the bottom of the Dry Creek valley. The groundwater table in fractured bedrock follows the surface topography with a lower slope or gradient. Groundwater flows from areas of higher elevation to lower elevation and discharges in the valley bottom to the creek. At the point downstream where Dry Creek becomes a perennial stream, groundwater discharges to the surface (CDWR, 2003).

### 2.4.3 Surrounding Land Use and Populations

The nearest city to the Chicago Research Site is Middletown, located approximately nine miles to the east/northeast. Middletown had a population of 1,126 as of July 2007 (Advameg, 2011) and is estimated to have grown to about 1,200 residents (E&E, 2010). There are several hot springs (resorts) within 10 to 15 miles of the Chicago Research Site.

Primary land uses in the vicinity of the Site are recreational, private residence, timber land, and energy development. In the immediate vicinity, the former Helen Mine is located approximately 0.5 miles to the south, the former Wall Street Mine is located approximately 0.5 miles to the east, and a private geothermal power generation plant run by Calpine Corporation (The Geysers) is located less than 0.5 miles to the west. The Geysers, comprising 45 square miles along the Sonoma and Lake County border, is the largest complex of geothermal power plants in the world (Calpine, 2011).

### 2.4.4 Meteorology

Average annual precipitation is between 35 to 45 inches and occurs mainly from October to April each year. Middletown receives an average of approximately one inch of snow per year; however, the Mayacamas Mountains receive more snow at higher elevations.

Annual precipitation records were reviewed during initial site investigations in March 2010 and reviewed again with updated information in March 2011 (WRCC, 2011; NCDC, 2011). Data obtained from the Middletown 4 SE Station, Cooperative Station Identification No. 045598-2, located approximately 8.5 miles east of the Chicago Research Site and at an elevation of 1,118 feet amsl, indicated the following:

- The average annual rainfall from January 1893 to September 2010 observed at the station was 44.06 inches.
- Over this same span of time, an average of 1.2 inches of precipitation was recorded as non-accumulated snowfall.

The Clearlake 4 SE Station, Cooperative Station Identification No. 041806, located about 15 miles northeast of the Chicago Research Site, at approximately 1,349 feet amsl, yielded the following temperature information:

- The lowest monthly average temperature from October 1954 through September 2010 was 31.3°F (December).
- Over this same span of time, the average highest monthly temperature was 93.1° F (July).

Regional weather patterns contribute to high diurnal temperature fluctuations in the area of the Chicago Research Site. Wind is generally from the south-southwest in the summer and fall, shifting to the north and east in the winter and spring months. Wind speeds average approximately 0.8 miles per hour (mph) annually. Maximum wind speeds can be up to 14 mph with a maximum wind gust recorded at 104 mph (E&E, 2010). The higher wind speeds usually occur in February through May.

## 2.5 PREVIOUS SITE INVESTIGATIONS

**Section 2.5.1** through **Section 2.5.4** summarize the four investigations conducted at the Chicago Mine and/or Research Mine prior to the November 2010 EE/CA field investigation. The November 2010 EE/CA field investigation is summarized in **Section 2.5.5**, and is discussed in detail in **Appendix A**.

**Figure 5** and **Figure 6** illustrate the sample locations from all of the previous site investigations.

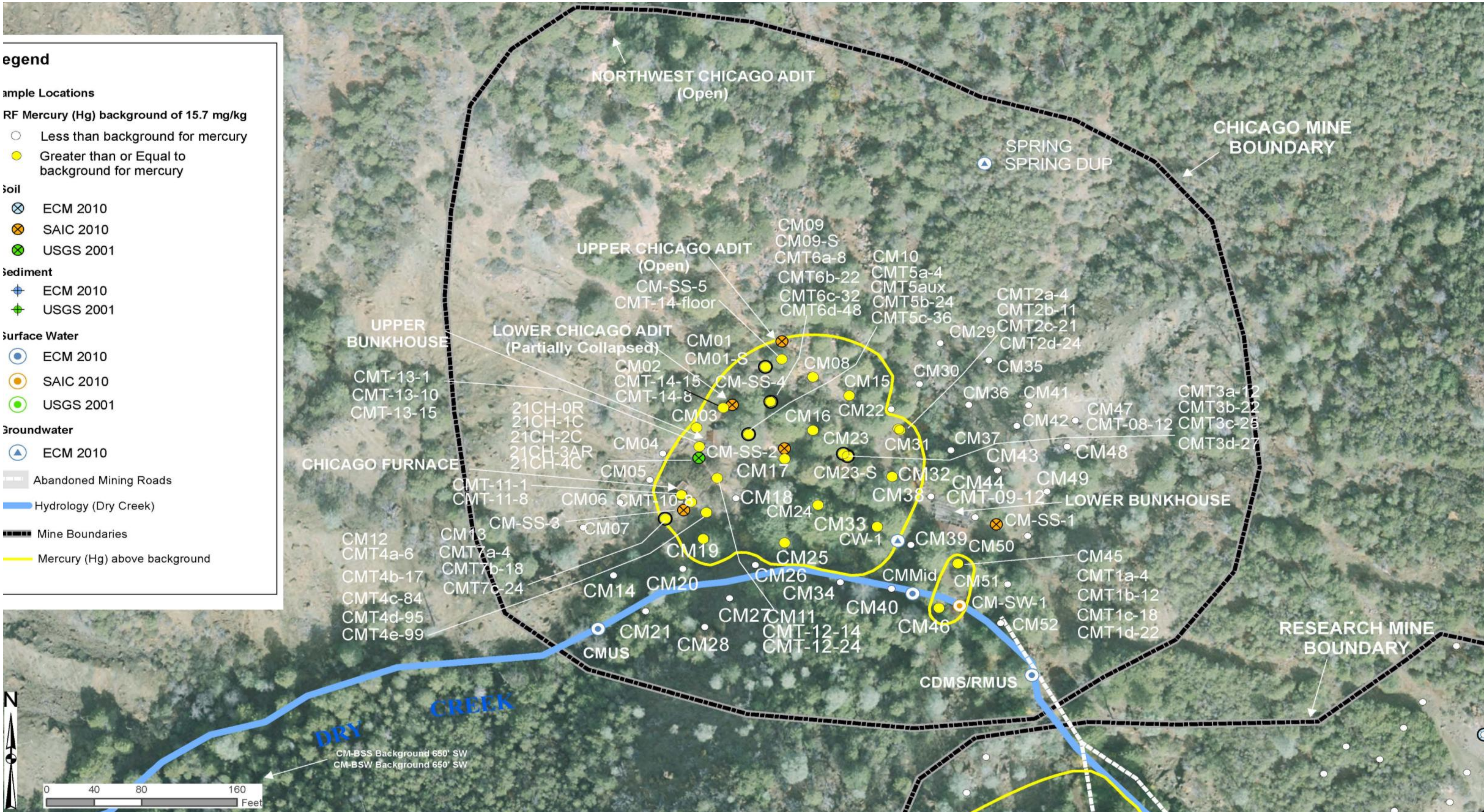
### 2.5.1 USGS Removal Site Evaluation - 2001

On April 19, 2001, the USGS conducted field sampling as part of a Removal Site Evaluation at the Chicago Mine and Research Mine (and also the nearby Helen Mine). The purpose of the Removal Site Evaluation was to assess the concentrations of mercury and biogeochemically relevant constituents in tailings and waste-rock piles at the mines.

The analytical results from this USGS Removal Site Evaluation were detailed in the USGS *Environmental Impact of the Helen, Research and Chicago Mercury Mines on Water, Sediment, and Biota in the Upper Dry Creek Watershed, Lake County, California* (Rytuba, et al, 2009) also in the *Removal Site Evaluation Report* for Chicago Mine (SAIC, 2010) and Research Mine (SAIC, 2010a). The following sections provide a summary of the sampling conducted at the mines and the analytical results for samples collected during the USGS Removal Site Evaluation.

***Chicago Mine***

The USGS collected five soil samples from bedrock material (silica-carbonate alteration and quartz veins) and mine waste materials (high grade ore, calcines, and soot) near the Chicago Mine. The analytical results from these samples are summarized on **Table 1**. There were no surface water samples or background soil samples collected during the April 2001 investigation.




otes:
ocations for SAIC and USGS samples based on SAIC report entitled:
emoval Site Evaluation Report, Chicago/Research Mercury Mine, July 2010.
ackground value (15.7 mg/kg) is used for Mercury.

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**All Investigation Sample Results**
**Chicago Mine**
**Lake County, California**

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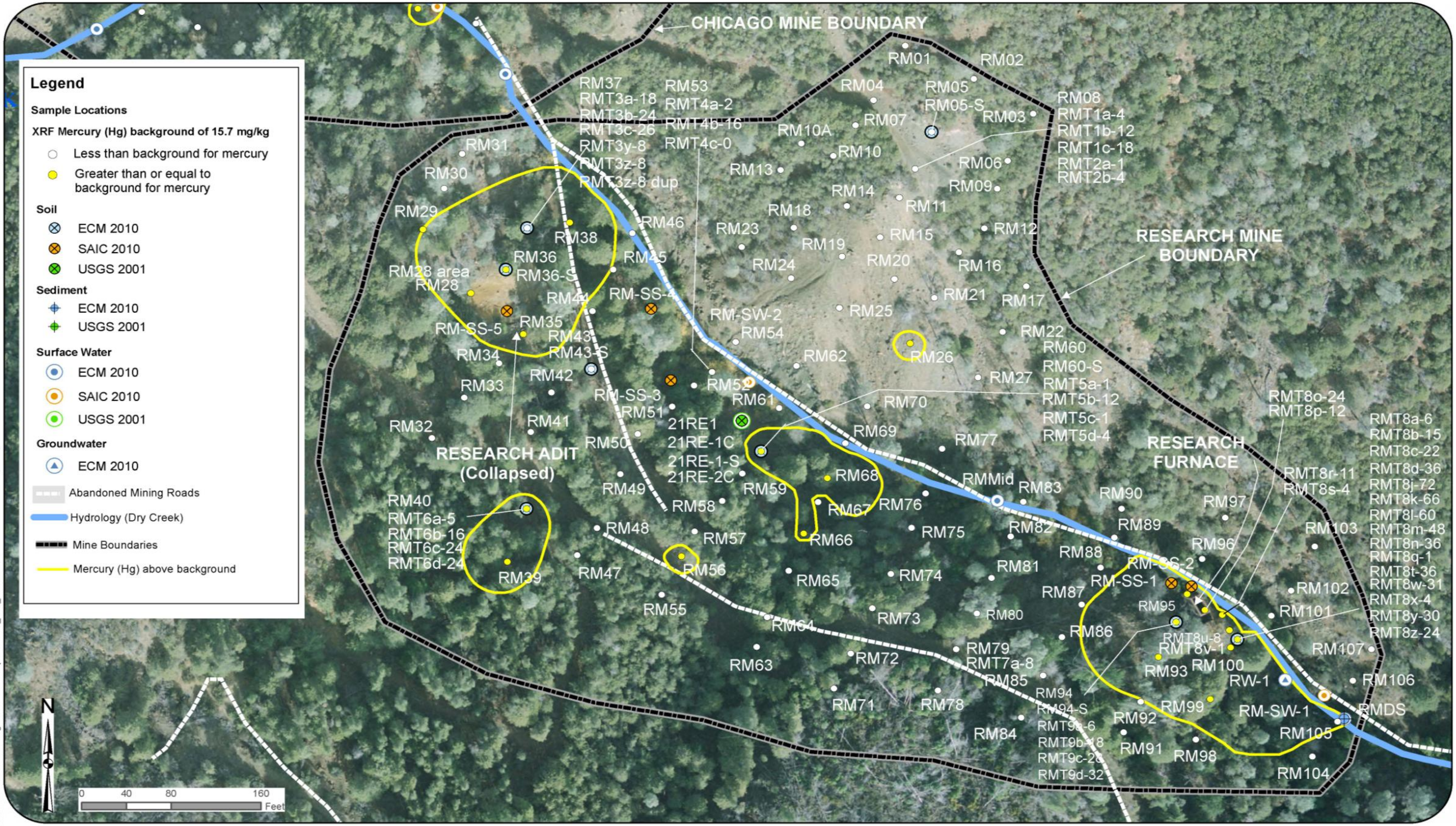
The Chicago Research Site

Figure **5**




Project: BLM Chicago Research Site EE/CA Proj Mgr: A. Campbell, P.E. Date Revised: 09/28/2011 Chkd By: Joey Pace

Path: B:\BLM\Chicago Research\ARCGIS\MXD\Fig6-All Invest Sample Results_Res_11x17.MXD

Notes:
Locations for SAIC and USGS samples based on SAIC report entitled:
Removal Site Evaluation Report, Chicago/Research Mercury Mine, July 2010.
Background value (15.7 mg/kg) is used for Mercury.

| | | | |
|---|---|---|---|
| US Department of the Interior<br>Bureau of Land Management<br>California State Office<br>2800 Cottage Way, Suite W-1834<br>Sacramento CA, 95825 | ENVIRONMENTAL COST MANAGEMENT, INC.<br>*Managing Cost and Liability*<br>3525 Hyland Avenue, Suite 200 Costa Mesa CA 92626<br>Tel: (714) 662-2759 Fax: (714) 662-2758<br>www.ecostmanage.com | **All Investigation Sample Results**<br>**Research Mine**<br>**Lake County, California**<br>Engineering Evaluation/Cost Analysis Report<br>The Chicago Research Site | Figure<br>**6** |

**Table 1**
**Soil Analytical Results from the USGS and SAIC Chicago Mine Removal Site Evaluations**

*Engineering Evaluation/Cost Analysis Report*
The Chicago Research Site

| Sample Location ID | Sample Date | Collected By | Sample Description | Hg | Ag | As | Cd | Cr | Cu | Fe | Mn | Ni | Pb | Sb | Se | Zn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 21CH-0R | 4/19/2001 | USGS | High Grade Ore | 17,700 | 0.08 | 2 | 0.12 | 1805 | 8.6 | 49,000 | 540 | 2,300 | 11.5 | 5.2 | <1 | 38 |
| 21CH-1C | 4/19/2001 | USGS | Fine sand size calcine adjacent to retort | 77 | 0.08 | 1 | 0.06 | 1670 | 11.8 | 79,000 | 1255 | 3,490 | 6.5 | 1.3 | <1 | 50 |
| 21CH-2C | 4/19/2001 | USGS | Coarse Calcine redblack | 8.4 | 0.12 | 2 | 0.02 | 745 | 7.2 | 52,000 | 780 | 2,470 | 1.5 | 0.6 | 1 | 34 |
| 21CH-3AR | 4/19/2001 | USGS | Silica-carbonate alteration and quartz veins | 57 | 0.06 | 0.6 | 0.02 | 730 | 4.4 | 37,000 | 590 | 1,455 | 0.5 | 0.1 | <1 | 26 |
| 21CH-4C | 4/19/2001 | USGS | Condenser soot below waste rock at ore crib | 430 | 0.14 | 3.8 | 0.1 | 4350 | 27.6 | 154,000 | 2670 | 4,920 | 6 | 2.5 | <1 | 116 |
| CM-SS-1 | 3/4/2010 | SAIC | Soot and Calcines | 1.80 | <2.5 | <2.5 | <2.5 | 610 | 6.5 | 49,000 | 730 | 1,900 | 11 | <5.0 | <5.0 | <50 |
| CM-SS-2 | 3/4/2010 | SAIC | Soot and Calcines | 1,400 | <2.5 | <2.5 | <2.5 | 650 | 6.9 | 53,000 | 940 | 2,200 | 33 | <5.0 | <5.0 | <50 |
| CM-SS-3 | 3/4/2010 | SAIC | Soot and Calcines | 13,000 | <2.5 | <2.5 | <2.5 | 830 | 8.0 | 63,000 | 990 | 2,400 | 16 | <5.0 | <5.0 | <50 |
| CM-SS-4 | 3/4/2010 | SAIC | Soot and Calcines | 8.30 | <2.5 | <2.5 | <2.5 | 810 | 8.3 | 63,000 | 880 | 2,000 | <10 | <5.0 | <5.0 | <50 |
| CM-SS-5 | 3/4/2010 | SAIC | Soot and Calcines | 260 | <2.5 | <2.5 | <2.5 | 1,200 | 11 | 80,000 | 1,400 | 2,500 | <10 | <5.0 | <5.0 | <50 |
| CM-BSS (background) | 3/4/2010 | SAIC | Surface soil | 0.06 | <2.5 | 3.1 | <2.5 | 100 | 22 | 26,000 | 480 | 170 | 8 | <5.0 | <5.0 | 54 |
| | | | | *All results in milligrams per kilogram (mg/kg)* | | | | | | | | | | | | |

**NOTES:**
All Results with "<" are non-detects at the Laboratory Reporting Limit

| | | | |
|---|---|---|---|
| | Ca = Calcium | Mg = Magnesium | Sb = Antimony |
| Hg = Mercury | Cd = Cadmium | Mn=Manganese | Se = Selenium |
| Ag = Silver | Cr = Chromium | Ni = Nickel | Zn = Zinc |
| As = Arsenic | Cu = Copper | Pb = Lead | CaCO3 = Calcium Carbonate |

Source for USGS Data and SAIC Data:
Science Applications International Corporation. 2010. *Removal Site Evaluation Report -Chicago Mercury Mine, Lake County, California*. Forest Service Contract No.: AG-91S8-C-07-0001; July 2.

## Table 2
## BLM Human Risk Management Criteria for Metals in Soils at Mining Sites

*Engineering Evaluation/Cost Analysis Report*
The Chicago Research Site

| Metal | Resident | Camper | ATV Driver | Worker | Surveyor |
|---|---|---|---|---|---|
| Antimony | 3 | 50 | 750 | 100 | 6,000 |
| Arsenic | 1 | 20 | 300 | 12 | 100 |
| Cadmium | 3 | 70 | 950 | 100 | 800 |
| Chromium | NE | NE | NE | NE | NE |
| Copper | 250 | 5,000 | 70,000 | 7,400 | 59,000 |
| Iron | NE | NE | NE | NE | NE |
| Lead | 400 | 1,000 | 1,000 | 2,000 | 2,000 |
| Manganese | 960 | 19,000 | 250,000 | 28,000 | 220,000 |
| Mercury | 2 | 40 | 550 | 60 | 480 |
| Nickel | 135 | 2,700 | 38,000 | 4,000 | 32,000 |
| Selenium | 35 | 700 | 9,600 | 100 | 8,000 |
| Silver | 35 | 700 | 9,600 | 1,000 | 100 |
| Zinc | 2,000 | 40,000 | 550,000 | 60,000 | 480,000 |
| *Data provided in milligrams per kilogram(mg/kg)* | | | | | |

**Notes:**
NE: Not Established
Source: United States Department of the Interior, Bureau of Land Management. 2004.
*Risk Management Criteria for Metals at BLM Mining Sites.*

- Soil Results:
  - Soil sample results for mercury were detected at concentrations up to 17,700 milligrams per kilogram (mg/kg), exceeding the BLM Human Risk Management Criteria (**Table 2**) for mercury in soil for residents (2 mg/kg) and campers (40 mg/kg).
  - Soil sample results for nickel were detected at concentrations up to 4,920 mg/kg, exceeding the BLM Human Risk Management Criteria for nickel in soil residents (135 mg/kg) and campers (2,700 mg/kg).
  - Soil sample results for arsenic were detected at concentrations up to 3.8 mg/kg, exceeding the BLM Human Risk Management Criteria for arsenic in soil residents (1 mg/kg).
  - Soil sample results for manganese were detected at concentrations up to 2,670 mg/kg, exceeding the BLM Human Risk Management Criteria for manganese in soil residents (960 mg/kg).
  - Soil sample results for copper were detected at concentrations up to 27.6 mg/kg;
  - Soil sample results for zinc were detected at concentrations up to 116 mg/kg;

The USGS did not make any recommendations for the Chicago Mine.

***Research Mine***

During the April 2001 investigation, the USGS collected two soil samples and one sediment sample (**Table 3**) and one mine drainage sample (**Table 4**) at the Research Mine. No background soil samples outside the mine area were collected during the USGS investigation.

- Soil Results:
  - Soil sample results for mercury were detected at concentrations up to 15.7 mg/kg, exceeding the BLM Human Risk Management Criteria (**Table 2**) for mercury in soil for residents (2 mg/kg).
  - Soil sample results for nickel were detected at concentrations up to 3,450 mg/kg, exceeding the BLM Human Risk Management Criteria for nickel in soil residents (135 mg/kg) and campers (2,700 mg/kg).
  - Soil sample results for arsenic were detected at concentrations up to 7.8 mg/kg, exceeding the BLM Human Risk Management Criteria for arsenic in soil residents (1 mg/kg).
  - Soil sample results for manganese were detected at concentrations up to 1,345 mg/kg, exceeding the BLM Human Risk Management Criteria for manganese in soil residents (960 mg/kg).
- Sediment Results:
  - The sediment sample collected at the collapsed adit drainage area had a mercury concentration of 3.4 mg/kg.

**Table 3**
**Soil Analytical Results from the USGS and SAIC Research Mine Removal Site Evaluations**

*Engineering Evaluation/Cost Analysis Report*
The Chicago Research Site

| Sample Location ID | Sample Date | Collected By | Sample Description | Hg | Ag | As | Cd | Cr | Cu | Fe | Mn | Ni | Pb | Sb | Se | Zn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 21RE-1C | 4/19/2001 | USGS | Coarse sand to gravel next to Dry Creek | 3.37 | 0.12 | 1.2 | 0.08 | 949 | 10 | 60,000 | 970 | 2,680 | 6.5 | 2.8 | <1 | 38 |
| 21RE-1-S | 4/19/2001 | USGS | Sediment at collapsed adit drainage | 3.37 | 0.12 | <0.2 | 0.02 | 784 | 16.8 | 52,000 | 710 | 2,420 | 2 | 0.4 | <1 | 36 |
| 21RE-2-C | 4/19/2001 | USGS | Fine sand calcine found at the adit | 15.7 | 0.2 | 7.8 | 0.22 | 1,530 | 17.4 | 83,000 | 1345 | 3,450 | 24.5 | 10.4 | <1 | 60 |
| RM-SS-1 | 3/4/2010 | SAIC | Soot and calcines | 14 | <2.5 | <2.5 | <2.5 | 320 | 12 | 40,000 | 420 | 980 | 22 | <5.0 | <5.0 | <50 |
| RM-SS-2 | 3/4/2010 | SAIC | Soot and calcines | 150 | <2.5 | <2.5 | <2.5 | 490 | 31 | 37,000 | 520 | 1,300 | 11 | <5.0 | <5.0 | <50 |
| RM-SS-3 | 3/4/2010 | SAIC | Soot and calcines | 6.6 | <2.5 | <2.5 | <2.5 | 470 | 6.3 | 40,000 | 660 | 1,800 | <4 | <5.0 | <5.0 | <50 |
| RM-SS-4 | 3/4/2010 | SAIC | Soot and calcines | 130 | <2.5 | <2.5 | <2.5 | 240 | <5.0 | 26,000 | 230 | 810 | <4 | <5.0 | <5.0 | <50 |
| RM-SS-5 | 3/4/2010 | SAIC | Soot and calcines | 2.1 | <2.5 | <2.5 | <2.5 | 820 | 11 | 82,000 | 1,300 | 2,600 | <10 | <5.0 | <5.0 | <50 |
| CM-BSS (background) | 3/4/2010 | SAIC | Surface soil | 0.06 | <2.5 | 3.1 | <2.5 | 100 | 22 | 26,000 | 480 | 170 | 8 | <5.0 | <5.0 | 54 |

*All results in milligrams per kilogram (mg/kg)*

**NOTES:**
All Results with "<" are non-detects at the Laboratory Reporting Limit

Ca = Calcium
Hg = Mercury
Ag = Silver
As = Arsenic
Cd = Cadmium
Cr = Chromium
Cu = Copper
Mg = Magnesium
Mn=Manganese
Ni = Nickel
Pb = Lead
Sb = Antimony
Se = Selenium
Zn = Zinc
CaCO3 = Calcium Carbonate

Source for USGS Data and SAIC Data:
Science Applications International Corporation. 2010. *Removal Site Evaluation Report - Research Mercury Mine, Lake County, California*. Forest Service Contract No.: AG-91S8-C-07-0001; July 2.

**Table 4**
**Surface Water Results from the USGS and SAIC Research Mine Removal Site Evaluations**

*Engineering Evaluation/Cost Analysis Report*
The Chicago Research Site

| Location ID | Sample Date | Sample Description | Hg (total) | Ag | As | Cd | Cr | Cu | Mn | Ni | Pb | Sb | Se | Zn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 21RE1 (USGS) | 4/19/2001 | Mine drainage from collapsed adit | 0.0328 | - | - | - | - | - | <0.02 | - | - | - | - | - |
| RM-SW-1 | 3/4/2010 | Mine drainage from the lower adit | 5.5 | <2.0 | <1.0 | <1.0 | 6.8 | <2.0 | <1.0 | 3.3 | <5 | <2.0 | <20 | <2.0 |
| RM-SW-2 | 3/4/2010 | Downstream of the mine site, southeast of the concrete furnaces | 5.2 | <2.0 | <1.0 | <1.0 | 6.4 | <2.0 | <1.0 | 3.1 | <5 | <2.0 | <20 | <2.0 |
| CM-BSW Background | 3/4/2010 | 1,400 feet upstream of the mine | <0.2 | <2.0 | <1.0 | <1.0 | <2.0 | <2.0 | <1.0 | <2.0 | <5 | <2.0 | <20 | **<2.0 |

*results in micrograms per liter (ug/L)*

| Location ID | Sample Date | Sample Description | Fe | CaCO3 | Ca | Mg |
|---|---|---|---|---|---|---|
| 21RE1 (USGS) | 4/19/2001 | Mine drainage from collapsed adit | <0.02 | 340 | 4.00 | - |
| RM-SW-1 | 3/4/2010 | Mine drainage from the lower adit | <40 | 150 | 8.2 | - |
| RM-SW-2 | 3/4/2010 | Downstream of the mine site, southeast of the concrete furnaces | <40 | 150 | 8.2 | - |
| CM-BSW Background | 3/4/2010 | 1,400 feet upstream of the mine | <40 | 62 | 14 | - |

*results in millgrams per liter (mg/L)*

**NOTES:**
All Results with "<" are non-detects at the Laboratory Reporting Limit

Hg = Mercury
Ag = Silver
As = Arsenic
Ca = Calcium
Cd = Cadmium
Cr = Chromium
Cu = Copper
CaCO3 = Calcium Carbonate
Mg = Magnesium
Mn=Manganese
Ni = Nickel
Pb = Lead
Sb = Antimony
Se = Selenium
Zn = Zinc

Source for USGS Data and SAIC Data:
Science Applications International Corporation. 2010. *Removal Site Evaluation Report -Research Mercury Mine, Lake County, California*. Forest Service Contract No.: AG-91S8-C-07-0001; July 2.

- Surface Water Results:
  - Mercury was detected at 0.328 micrograms per liter (µg/L) in the mine drainage sample. The BLM Human Risk Management Criteria for mercury in surface water at mine sites (**Table 5**) is 46 milligrams per liter (mg/L) for a camper (which is equivalent to 46,000 µg/L) and is higher for a swimmer (72 mg/L) or boater (166 mg/L).
  - Elevated concentrations of sulfate (78 mg/L) were detected in the mine drainage that flows directly into Dry Creek.

***USGS Conclusions and Determinations***

Based on the analytical results presented above and in the tables, plus additional data collected at the Helen Mercury Mine and in the areas surrounding the Helen Mercury Mine, the USGS made the following conclusions and determinations:

- Tailings:
  - The concentrations of mercury in waste materials at the Chicago Mine Site varied depending on material type and furnace used.
  - The Research Mine ores were processed in a brick retort, and the calcines were disposed of in a pile adjacent to Dry Creek. The calcines were poorly sorted and consisted of coarse pebble sand with very low mercury concentrations.
  - At the Research Mine adit, small amounts of calcines were present, and the mercury concentrations were low
  - The Chicago Mine ores were processed in a brick retort and the calcines and waste rock were disposed of at the site of the retort on the bank of Dry Creek. The mercury concentrations in the calcines at the retort were low to moderate (up to 76.9 mg/kg). Another pile of calcines was found exposed in the bank of Dry Creek downstream from the remains of the Chicago Mine ore crib. These calcines were fine grained with very high mercury concentrations (up to 430 mg/kg).
- Mine Drainage:
  - At the Chicago Mine, there was no mine drainage observed.
  - Mercury and other metals associated with the mining activities at the Research Mine were found in mine drainage, though at a lesser degree than mine drainage sourced from the Helen Mine.

# Table 5
# BLM Human Risk Management Criteria for Metals in Surface Water at Mining Sites

*Engineering Evaluation/Cost Analysis Report*
The Chicago Research Site

| | Resident | Camper | Driver | Worker | Surveyor | Boater | Swimmer |
|---|---|---|---|---|---|---|---|
| Antimony | NE | 124 | NE | NE | NE | 442 | 192 |
| Arsenic | NE | 93 | NE | NE | NE | 81 | 144 |
| Cadmium | NE | 155 | NE | NE | NE | 553 | 239 |
| Copper | NE | 11,490 | NE | NE | NE | 41,035 | 17,768 |
| Lead | NE | 50 | NE | NE | NE | 50 | 50 |
| Manganese | NE | 1,548 | NE | NE | NE | 5,530 | 2,395 |
| Mercury | NE | 93 | NE | NE | NE | 332 | 144 |
| Nickel | NE | 6,194 | NE | NE | NE | 22,121 | 9,578 |
| Selenium | NE | 1,548 | NE | NE | NE | 5,530 | 2,395 |
| Silver | NE | 1,548 | NE | NE | NE | 5,530 | 2,395 |
| Zinc | NE | 92,909 | NE | NE | NE | 331,818 | 143,677 |
| *Data provided in micrograms per liter (μg/L)* | | | | | | | |

**Notes:**
NE: Not Established
Source: United States Department of the Interior, Bureau of Land Management. 2004. Risk Management Criteria for Metals at BLM Mining Sites.

    - At the Research Mine, drainage from the collapsed adit had elevated mercury concentrations. The pH of the water was alkaline (8.3) because of buffering by serpentinite. Sulfate concentrations were elevated (up to 78 mg/L).
    - At the Research Mine, both calcines and mine drainage contributed to mercury-enriched sediment and waters[5] into Dry Creek. The volume of calcines was relatively small, and the flow from the collapsed adit was low. Elevated concentrations of sulfate were present in the mine drainage that flowed directly into Dry Creek.
  - Dry Creek Sediments:
    - At the Chicago Mine, calcines with very high concentrations of mercury eroded and contributed mercury-enriched sediment to Dry Creek
    - At the Research Mine, the concentration of mercury in active channel sediment was relatively low (3.37 mg/kg). [Sediment samples collected from the Helen Mine tributary showed an increase in the mercury concentrations in Dry Creek sediment to a range of 3.7 to 5.9 mg/kg.]
    - Mercury concentrations in sediment in the active channel of Dry Creek increased with increasing distance from the mine areas.
    - Pre-mining sediments exposed in the bank deposits of Dry Creek had elevated mercury concentrations. The relatively high levels of mercury indicate that the deposits were from a natural source of mercury to the watershed prior to mining.
    - At all sample sites, the mercury concentration of sediment in the active channel was higher than pre-mining sediment at the same site.
- Biota Investigation Results (investigation analytical results not summarized above):
    - Biota samples collected by the USGS indicated that release of mercury from mining increased the mercury concentration in both invertebrates and fish.
    - Biota composite samples of invertebrates from Dry Creek were all higher, with one exception (stoneflies) than reference samples from a site on the Bear River Watershed.
    - Higher values of monomethylmercury (MMeHg) were observed in both Dobsonflies and Stoneflies collected above the Helen Mine tributary compared with the values for samples collected below the tributary. This indicated the presence of a significant source of bioavailable mercury from the Research Mine and/or Chicago Mine.

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[5] The term "mercury-enriched sediment and waters" is used frequently in the USGS Environmental Impact of the Helen, Research and Chicago Mercury Mines on Water, Sediment, and Biota in the Upper Dry Creek Watershed, Lake County, California. Although the term is never directly defined, it has been inferred that this term refers to any sediment or waters which contain mercury-laden sediments which can be transported downstream and methylated.

The USGS did not make any recommendations in this report.

### 2.5.2 Research Mine Cultural Resource Inventory Report

In August 2009, the BLM completed a *Cultural Resource Inventory Report* (BLM, 2009) for the Research Mine. In attendance during the June 2009 survey of the Research Mine were a BLM biologist, a soil conservationist, and an archaeologist.

The results of the survey identified the three standing concrete furnaces located adjacent to Dry Creek as eligible for the National Register of Historic Places. The document states that "*[f]ew furnaces at abandoned mercury mines are still standing. These 3 examples provide an excellent example of what such furnaces may have looked like. In addition, the furnaces are in better shape than any located within the BLM Ukiah Field Office*."

Based on this assessment, these historic structures will need to be considered when evaluating the federal and State of California Applicable or Relevant and Appropriate Requirements (ARARs) that pertain to CERCLA removal actions. These cultural findings are governed by acts, laws, and/or orders, and are therefore "Applicable" requirements for the Chicago Research Site. ARARs are discussed in detail in the main body of the EE/CA Report.

Based on this assessment, these historic structures will need to be considered when evaluating the federal and State of California Applicable or Relevant and Appropriate Requirements (ARARs) that pertain to CERCLA removal actions. These cultural findings are governed by acts, laws, and/or orders, and are therefore "Applicable" requirements for the Chicago Research Site. **Section 4.1.2** explains the ARARs in detail.

### 2.5.3 Removal Site Evaluation Report, Chicago Mine

Science Applications International Corporation (SAIC) conducted a Removal Site Evaluation in March 2010 to evaluate the potential need for CERCLA response at the Chicago Mine. The basis for the evaluation was the potential release of mine wastes at the Site. SAIC was to determine if a release occurred and if it did, if the release presented a substantial threat to the public health or welfare.

On March 4, 2010 SAIC personnel collected six surface samples which included five soil samples from within the mine area and one soil sample collected approximately 900 feet upstream (background). Surface soil samples were collected at a maximum depth of 4.5 inches bgs. Upon completion of sampling, samples were submitted to TestAmerica for the following analyses:

- Lead by USEPA Method 6010B; and
- Nickel, arsenic, copper, zinc, silver, cadmium, chromium, antimony, selenium, iron, and manganese by USEPA Method 6020.

Two surface water samples were collected from Dry Creek. One sample was collected at the southeastern corner of the mine, downstream of the historical mining activities, and one samples was collected approximately 900 feet upstream of the mine (background). Samples were submitted to TestAmerica for the following analyses:

- Mercury by USEPA Method 7470A;

- Lead by USEPA Method 6010B;
- Nickel, arsenic, copper, zinc, silver, cadmium, chromium, antimony, selenium, iron, and manganese by USEPA Method 6020; and
- Hardness by Standard Method (SM)2340B.

The results from the March 4, 2010 investigation are presented in **Table 1** and are summarized as follows with a comparison to the background samples collected during the same investigation:

- Soil Results:
  - Copper concentrations ranged from 6.5 mg/kg to 11 mg/kg. These results were below the background sample concentration of 22 mg/kg.
  - Mercury concentrations ranged from 1.8 mg/kg to 13,000 mg/kg and were above the background mercury concentration of 0.06 mg/kg.
  - Chromium concentrations ranged from 610 mg/kg to 1,200 mg/kg and were above the background concentration of 100 mg/kg.
  - Nickel concentrations ranged from 1,900 mg/kg to 2,500 mg/kg and were above the background concentration of 170 mg/kg.
  - Lead concentrations ranged from <10 mg/kg to 33 mg/kg and were above the background concentration of 8 mg/kg.
- Surface Water Results (**Table 6**):
  - Mercury was not detected in the mine surface water sample (the sample collected at the southeastern corner of the mine).
  - Nickel was detected at 30 micrograms per liter (µg/L) in the mine surface water sample.
  - Chromium and manganese were detected at 13 µg/L in the mine surface water sample.
- Determinations made by SAIC:
  - The highest mercury concentration in soil (CM-SS-3) was similar to mercury concentrations in high grade ore. Sample CM-SS-3 was collected below the furnace.
  - Chromium and nickel concentrations identified in soil were deemed typical of those generally found in serpentine soil.
  - The lead concentrations identified in soil were deemed slightly higher than those generally found in serpentine soil.
  - The surface water concentrations were determined by SAIC to show a typical footprint of serpentine soils. They were deemed different source concentrations than those in the background sample, which came from Franciscan Sandstone as a substrate.

**Table 6**
**Surface Water Analytical Results from the SAIC Chicago Mine Removal Site Evaluation**

*Engineering Evaluation/Cost Analysis Report*
The Chicago Research Site

| Location ID | Sample Date | Sample Description | Hg (total) | Ag | As | Cd | Cr | Cu | Mn | Ni | Pb | Sb | Se | Zn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CM-SW-1 | 3/4/2010 | Surface Water (from SE corner of the mine) | <0.2 | <2.0 | <1.0 | <1.0 | 13 | <2.0 | 13 | 30 | <5 | <2.0 | <2.0 | <20 |
| CM-BSW | 3/4/2010 | Background Surface Water | <0.2 | <2.0 | <1.0 | <1.0 | <2.0 | <2.0 | <1.0 | <2.0 | <5 | <2.0 | <2.0 | <20 |
| | | | *results in micrograms per liter (ug/L)* | | | | | | | | | | | |

| Location ID | Sample Date | Sample Description | Fe | CaCO3 | Ca | Mg |
|---|---|---|---|---|---|---|
| CM-SW-1 | 3/4/2010 | Surface Water (from SE corner of the mine) | 54 | 140 | 8.8 | 28 |
| CM-BSW | 3/4/2010 | Background Surface Water | <40 | 62 | 14 | 6.4 |
| | | | *results in millgrams per liter (mg/L)* | | | |

**NOTES:**
All Results with "<" are non-detects at the Laboratory Reporting Limit

Hg = Mercury
Ag = Silver
As = Arsenic
Ca = Calcium
Cd = Cadmium
Cr = Chromium
Cu = Copper
CaCO3 = Calcium Carbonate
Mg = Magnesium
Mn=Manganese
Ni = Nickel
Pb = Lead
Sb = Antimony
Se = Selenium
Zn = Zinc

Source for USGS Data and SAIC Data:
Science Applications International Corporation. 2010. *Removal Site Evaluation Report -Chicago Mercury Mine, Lake County, California*. Forest Service Contract No.: AG-91S8-C-07-0001; July 2.

- Based upon the analytical results, SAIC used the following screening criteria to evaluate the data:
    - BLM Wildlife and Livestock Risk Management Criteria for Metals in Soils (presented on **Table 7**);
    - Soil Ecotox Screening Criteria (**Table 8**);
    - USEPA Regional Screening Levels for Soil (**Table 9**);
    - California Human Health Screening Levels for Soils (**Table 10**);
    - USEPA Ambient Water Quality Criteria for Metals in Surface Water (**Table 11**);
    - California Environmental Protection Agency (Cal-EPA) Regional Water Quality Control Board – Central Valley Region (RWQCB – CVR) Water Quality Goals Screening Criteria (**Table 12**);
- Conclusions drawn by SAIC based on the screening evaluation:
    - Antimony, arsenic, chromium, iron, manganese, mercury, and nickel in soils at the Chicago Mine pose a threat to human health.
    - Chromium, copper, iron, lead, manganese, mercury, nickel, and zinc in soils pose a threat to ecological receptors.
    - The following factors were cited to support these conclusions:
        - Humans and ecological life could potentially be exposed to antimony, arsenic, chromium, iron, manganese, mercury, nickel, and zinc, in soils at the Chicago Mercury Mine. Mercury in soil sampled at the site exceeds screening levels for protection of human health and presents an extremely high risk to potential ecological receptors. Arsenic and chromium are also encountered at elevated levels and exceed some screening levels for protection of human health and ecological receptors.
        - Mercury exceeding residential, recreational, and ecological screening criteria have been detected in mine waste at the Chicago Mine. Arsenic, chromium, and mercury exceed the residential standards for the USEPA's Regional Screening Levels (**Table 9**) and Cal-EPA's Human Health Screening Levels (**Table 10**). In addition, nickel exceeds the residential land use standard for Cal-EPA's Human Health Screening Levels.
        - Rainfall can cause runoff that could erode and transport mercury containing mine waste from the Chicago Mine to Dry Creek.

The Chicago Mine Removal Site Evaluation Report (SAIC, 2010) concluded by stating that *"[b]ased on the results of the* [Removal Site Evaluation]*, BLM will pursue a non-time critical removal action* [at] *the site*."

**Table 7**
**BLM Wildlife and Livestock Risk**
**Management Criteria for Metals in Soils**

*Engineering Evaluation/Cost Analysis Report*
The Chicago Research Site

| BLM Wildlife and Livestock Risk Management Criteria for Metals in Soils | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Metal** | **Median** | **Deer Mouse** | **Bighorn Sheep** | **Cottontail** | **White-Tailed Deer** | **Trumpeter Swan** | **Elk** | **Cattle** | **Sheep** | **Mallard** | **Canada Goose** | **Mule Deer** | **Robin** |
| **Antimony** | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE |
| **Arsenic** | 275 | 230 | 387 | 438 | 319 | 76 | 328 | 419 | 352 | 116 | 61 | 200 | 4 |
| **Cadmium** | 3 | 7 | 9 | 6 | 3 | 2 | 3 | 15 | 12 | 1 | 2 | 3 | 0.3 |
| **Chromium** | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE |
| **Copper** | 136 | 640 | 64 | 358 | 128 | 201 | 131 | 413 | 86 | 141 | 161 | 102 | 7 |
| **Iron** | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE |
| **Lead** | 125 | 142 | 152 | 172 | 124 | 43 | 127 | 244 | 203 | 59 | 34 | 106 | 6 |
| **Manganese** | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE |
| **Mercury** | 8 | 2 | 6 | 15 | 11 | 7 | 11 | 45 | 38 | 4 | 6 | 9 | 1 |
| **Nickel** | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE |
| **Selenium** | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE |
| **Silver** | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE |
| **Zinc** | 307 | 419 | 369 | 373 | 267 | 340 | 275 | 1082 | 545 | 196 | 271 | 222 | 43 |
| | *All criteria are in milligrams per kilogram (mg/kg)* | | | | | | | | | | | | |

**NOTES:**
NE = Not Established

BLM Wildlife and Livestock Risk Management Criteria for Metals in Soils Source: US Department of the Interior, Bureau of Land Management. 2004. Risk Management Criteria for Metals at BLM Mining Sites.

**Table 8**
**Soil Ecotox Screening Criteria**

*Engineering Evaluation/Cost Analysis Report*
The Chicago Research Site

| Soil Ecotox Screening Criteria | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Hg** | **Ag** | **As** | **Cd** | **Cr** | **Cu** | **Fe** | **Mn** | **Ni** | **Pb** | **Sb** | **Se** | **Zn** |
| **USEPA Ecotox Threshold** | 0.15 | NE | 8.2 | 1.2 | 81 | 34 | NE | NE | 21 | 47 | NE | NE | 150 |
| **Apparent Effects Threshold-Low** | 0.59 | 6.1 | 57 | 5.1 | 260 | 290 | NE | NE | NE | 450 | 150 | NE | 410 |
| **Apparent Effects Threshold-High** | 2.1 | 6.1 | 700 | 9.6 | 270 | 1300 | NE | NE | NE | 660 | 200 | NE | 1,600 |
| **Lowest Effects Level** | 0.2 | NE | 6 | 0.6 | 26 | 16 | 20,000 | 460 | 16 | 31 | NE | NE | 120 |
| **Severe Effects Level** | 2 | NE | 33 | 10 | 110 | 110 | 40,000 | 1100 | 75 | 250 | NE | NE | 820 |
| **Minimum Effect Level** | 0.2 | NE | 7 | 0.9 | 55 | 28 | NE | NE | 35 | 42 | NE | NE | 150 |
| **Toxic Effect Level** | 1 | NE | 17 | 3 | 100 | 86 | NE | NE | 61 | 170 | NE | NE | 540 |
| **Threshold Effects Level - Canada** | 0.174 | NE | 5.9 | 0.596 | 37.3 | 35.7 | NE | NE | 18 | 35 | NE | NE | 123 |
| **Probable Effects Levels - Canada** | 0.486 | NE | 17 | 3.53 | 90 | 197 | NE | NE | 36 | 91.3 | NE | NE | 315 |
| *All criteria are in milligrams per kilogram (mg/kg)* | | | | | | | | | | | | | |

**NOTES:**
NE = Not Established

| | |
|---|---|
| Hg = Mercury | Mn=Manganese |
| Ag = Silver | Ni = Nickel |
| As = Arsenic | Pb = Lead |
| Cd = Cadmium | Sb = Antimony |
| Cr = Chromium | Se = Selenium |
| Cu = Copper | Zn = Zinc |

Sources for Ecotox Data: Hazardous Substance Research Centers/South & Southwest, Georgia Tech Research Corporation, 2003

US EPA Ecotox Threshold (1996)
Apparent Effects Threshold-Low (Barrick et al. 1988)
Apparent Effects Threshold-High (Barrick et al. 1988)
Lowest Effects Level (Jaagumagi et al., 1995)
Severe Effects Level (Jaagumagi et al., 1995)
Minimum Effect Level (MENVIQ/EC, 1992)
Toxic Effect Level (MENVIQ/EC, 1992)
Threshold Effects Level - Canada (Smith et al., 1996)
Probable Effects Levels - Canada (Smith et al., 1996)

**Table 9**
**USEPA Regional Screening Levels for Soil**

*Engineering Evaluation/Cost Analysis Report*
The Chicago Research Site

| USEPA Regional Screening Levels for Soil | | |
|---|---|---|
| **Metal** | **Residential** | **Industrial** |
| **Antimony** | 31 | 410 |
| **Arsenic** | 0.39 | 1.6 |
| **Cadmium** | 70 | 800 |
| **Chromium** | 280 | 1,400 |
| **Copper** | 3,100 | 41,000 |
| **Iron** | 55,000 | 720,000 |
| **Lead** | 400 | 800 |
| **Manganese** | 1,800 | 23,000 |
| **Mercury** | 4.3 | 24 |
| **Nickel** | 14,000 | 69,000 |
| **Selenium** | 3,900 | 5,100 |
| **Silver** | 390 | 5,100 |
| **Zinc** | 23,000 | 310,000 |
| *milligrams per kilogram (mg/kg)* | | |

NOTES:

USEPA Regional Screening Levels for Soil Source: US EPA Region 9. 2009. Regional Screening Levels (RSL) for Chemical Contaminants at Superfund Sites.

**Table 10**
**California Human Health Screening Levels for Soils and Other Potential Concerns**

*Engineering Evaluation/Cost Analysis Report*
The Chicago Research Site

| California Human Health Screening Levels for Soils and Other Potential Environmental Concerns | | |
|---|---|---|
| **Metal** | **Residential Land Use** | **Commercial / Industrial Land Use Only** |
| **Antimony** | 30 | 38 |
| **Arsenic** | 0.07 | 0.24 |
| **Cadmium** | 1.7 | 7.5 |
| **Chromium (VI)** | 17 | 37 |
| **Copper** | 660 | 3,200 |
| **Iron** | NE | NE |
| **Lead** | 150 | 3,500 |
| **Manganese** | NE | NE |
| **Mercury** | 18 | 180 |
| **Nickel** | 1,600 | 16,000 |
| **Selenium** | 380 | 4,800 |
| **Silver** | 380 | 4,800 |
| **Zinc** | 23,000 | 100,000 |
| *milligrams per kilogram (mg/kg)* | | |

NOTES:
NE = Not Established

California Human Health Screening Levels for Soils and Other Potential Environmental Concerns Source: California Environmental Protection Agency (Cal EPA). 2005. Use of California Health Screening Levels (CHHSLs).

**Table 11**
**USEPA Ambient Water Quality**
**Criteria for Metals in Surface Water**

*Engineering Evaluation/Cost Analysis Report*
The Chicago Research Site

| USEPA Ambient Water Quality Criteria for Metals in Surface Water | | | |
|---|---|---|---|
| **Metal** | **Freshwater Aquatic Life Acute Exposure** | **Freshwater Aquatic Life Chronic Exposure** | **Human Water + Fish Ingestion** |
| **Antimony** | NE | NE | 5.6 |
| **Arsenic** | 340 | 150 | 0.018 |
| **Cadmium** | 2 | 0.25 | NE |
| **Chromium (III)** | 570 | 74 | NE |
| **Copper** | 13 | 9 | NE |
| **Iron** | NE | 1,000 | 300 |
| **Lead** | 65 | 2.5 | NE |
| **Manganese** | NE | NE | 50 |
| **Mercury** | 1.4 | 0.77 | 0.3 |
| **Nickel** | 470 | 52 | 610 |
| **Selenium** | NE | 5 | 170 |
| **Silver** | 3.2 | NE | NE |
| **Zinc** | 120 | 120 | 7,400 |
| *All criteria are in micrograms per liter (µg/L)* | | | |

NOTES:
NE = Not Established

Source: US Department of the Interior, Bureau of Land Management. 2004. Risk Management Criteria for Metals at BLM Sites.

# Table 12
## Cal-EPA RWQCB-CVR Water Quality Goals Screening Criteria

*Engineering Evaluation/Cost Analysis Report*
The Chicago Research Site

| California Environmental Protection Agency<br>Regional Water Quality Control Board - Central Valley Region<br>Water Quality Goals Screening Criteria | | | |
|---|---|---|---|
| **Metal** | **California/ Federal MCL** | **California PHG** | **California Toxic Rule Criteria - Inland Surface Waters Non-Drinking Water Sources** |
| **Antimony** | 6 | 20 | NE |
| **Arsenic** | 10 | 0.004 | NE |
| **Cadmium** | 5 | 0.04 | NE |
| **Chromium** | 100 | 100 | 100 |
| **Copper** | 1,300 | 300 | NE |
| **Iron** | NE | NE | NE |
| **Lead** | 15 | 2 (0.2) | NE |
| **Manganese** | NE | NE | NE |
| **Mercury** | 2 | 1.2 | NE |
| **Nickel** | 100 | 12 | NE |
| **Selenium** | 50 | NE | NE |
| **Silver** | 100 | NE | NE |
| **Zinc** | 5,000 | NE | NE |
| *All criteria are in milligrams per kilogram (mg/L)* | | | |

NOTES:
Cal-EPA = California Environmental Protection Agency
RWQCB-CVR = Regional Water Quality Control Board - Central Valley Region
NE = Not Established
PHG = Public Health Goal
MCL - Maximum Contaminant Limit

Source: US Department of the Interior, Bureau of Land Management. 2004. Risk Management Criteria for Metals at BLM Sites.

### 2.5.4 Removal Site Evaluation Report, Research Mine

As with the Chicago Mine, SAIC completed a Removal Site Evaluation at the Research Mine. On March 4, 2010, SAIC personnel collected six surface samples which included five soil samples from within the mine area and one soil sample collected approximately 900 feet upstream (background). Surface soil samples were collected at a maximum depth of 3 inches bgs. Upon completion of sampling, samples were submitted to TestAmerica for the following analyses:

- Lead by USEPA Method 6010B; and
- Nickel, arsenic, copper, zinc, silver, cadmium, chromium, antimony, selenium, iron, and manganese by USEPA Method 6020.

Three surface water samples were collected from Dry Creek. One sample was collected at the southeastern corner of the mine, downstream of the historical mining activities, and one sample was collected approximately 900 feet upstream of the mine (background; same sample used in Chicago Mine evaluation). Samples were submitted to TestAmerica for the following analyses:

- Mercury by USEPA Method 7470A;
- Lead by USEPA Method 6010B;
- Nickel, arsenic, copper, zinc, silver, cadmium, chromium, selenium, iron, antimony[6], and manganese by USEPA Method 6020; and
- Hardness by Standard Method (SM)2340B.

The results from the March 4, 2010 investigation at Research Mine are presented in **Table 5** and are summarized as follows with a comparison to the background samples collected during the same investigation:

- Soil Results:
    - Copper concentrations ranged from 6.3 mg/kg to 31 mg/kg. These results were below the background sample concentration of 22 mg/kg except for the sample collected in soot just to the west of the furnace.
    - Mercury concentrations ranged from 2.1 mg/kg to 150 mg/kg and were above the background mercury concentration of 0.06 mg/kg.
    - Chromium concentrations ranged from 240 mg/kg to 820 mg/kg and were above the background concentration of 100 mg/kg.

[6] The *Removal Site Evaluation Report -Research Mercury Mine* indicates in the text that these surface water samples were analyzed for antimony, though antimony is not documented in Table 3 of the report. However, antimony appears in the laboratory results for the two surface water samples and has therefore been included on **Table 5**. The background lab data for CM-BSW was not provided in the Research Mine Report and was therefore obtained from the *Removal Site Evaluation Report -Chicago Mercury Mine*, which used the same background surface water sample.

  - Nickel concentrations ranged from 810 mg/kg to 2,600 mg/kg and were above the background concentration of 170 mg/kg.
  - Lead concentrations ranged from <4.0 mg/kg to 22 mg/kg and were above the background concentration of 8 mg/kg in three of the five sample locations.

- Surface Water Results:
  - Mercury concentrations in both surface water samples were similar at 5.5 µg/L and 5.2 µg/L, respectively, and higher than the 2001 USGS result (0.0328 µg/L).
  - Nickel concentrations in both surface water samples were similar at 3.3 µg/L and 3.1 µg/L, respectively.
  - Chromium concentration in both surface water samples were similar at 6.8 µg/L and 6.4 µg/L, respectively.

- Determinations made by SAIC:
  - The distribution of mercury in the mine waste materials were highly variable between the different waste material samples. The highest mercury concentrations were found in soot next to the concrete furnaces.
  - Chromium concentrations in surface soils were less variable between the different waste material samples and more consistent than mercury concentrations.
  - Nickel concentrations in surface soils were typical of those generally found in serpentine soil.
  - Lead concentrations in surface soils were more consistent than mercury concentrations but were slightly higher than those generally found in serpentine soil.
  - Mercury, nickel and chromium concentrations in the surface water samples showed a typical footprint of serpentine soils and differed from the background sample, which is underlain by Franciscan Sandstone.

- Conclusions drawn by SAIC (with regards to screening data evaluated during investigation and presented on **Table 7** through **Table 12**):
  - Antimony, arsenic, manganese, mercury, and nickel in soils at the Research Mine pose a threat to human health.
  - Arsenic, chromium, copper, iron, manganese, mercury, and nickel, pose a threat to ecological receptors.
  - The following factors were cited to support these conclusions:
    - Humans and ecological life could potentially be exposed to antimony, arsenic, chromium, iron, manganese, mercury, and nickel in soils at the Research Mine. The risks associated with the exposure are anticipated to

be high. Mercury, arsenic, chromium, and iron in soil sampled at the site exceed screening levels for protection of human health ecological receptors. Nickel is also encountered at elevated levels and exceeds some screening levels for protection of human health and ecological receptors.

- Mercury exceeding residential, recreational, and ecological screening criteria have been detected in mine waste at the Research Mine. Arsenic, chromium, and mercury exceed the residential screening criteria for both USEPA and California EPA (**Table 9** and **Table 10**). Nickel concentrations exceed the resident standard for Cal-EPA (**Table 10**). In addition, iron exceeds the residential standard for USEPA's Regional Screening Level (**Table 9**), and nickel exceeds the California EPA's Human Health Screening Level (**Table 10**).
- Rainfall can cause runoff that could erode and transport mercury containing mine waste from the Research Mercury Mine to Dry Creek.

The Research Mine Removal Site Evaluation Report (SAIC, 2010a) concluded by stating that *"[b]ased on the results of the* [Removal Site Evaluation]*, BLM will pursue a non-time critical removal action* [at] *the site*."

### 2.5.5 November 2010 Engineering Evaluation and Cost Analysis Investigation

In November 2010, ECM completed an EE/CA field investigation to address important data gaps relevant to evaluating alternative non-time critical removal actions under CERCLA, including:

- The mine waste's acid generation potential,
- The mine waste's potential to leach to groundwater,
- Concentrations of metals already in groundwater near mine waste, and
- Volumes of various mine wastes.

**Appendix A** provides detailed information from the EE/CA field investigation, including site preparations, technical and specialized analytical approaches (e.g.: use of x-ray fluorescence meter, acid-base accounting, etc.), target media (i.e.: surface water, groundwater, sediment, etc.), well installation/development, and details of the topographic survey (e.g.; aerial survey, ground (areal) survey, and mapping).

The following table summarizes the information and data presented in **Appendix A** and the page where the information is located:

**Table 13: Appendix A Summary Table**

| Topic or Attachment | Appendix A Page Number |
|---|---|
| Soil, Sediment, and Waste Sample Collection | A2 |
| Surface Water Sampling | A3 |
| Groundwater Well Installation and Sampling | A3 |
| Analytical Approach | A4 |
| X-Ray Fluorescence Meter | A4 |
| Total Threshold Limit Concentrations | A5 |
| Mercury Leachability Testing and Waste Extraction Testing | A5 |
| Acid-Base Accounting and Mine Waste Classification | A5 |
| California Waste Extraction Test | A6 |
| Toxicity Characteristic Leaching Procedure | A7 |
| Summary of Results | A7 |
| Topographic Survey | A9 |
| Figure A-1: 2010 EE/CA Field Investigation XRF Samples | A10 |
| Figure A-2: Fix Lab Samples, Chicago Mine | A11 |
| Figure A-3: Fix Lab Samples, Research Mine | A12 |
| Table A-1: X-Ray Fluorescence Field Data | A13-A21 |
| Table A-2: XRF Metals versus AAM-17 Metals Laboratory Analysis | A22 |
| Table A-3: Acid Base Accounting | A23 |
| Table A-4: Waste Extraction Test Results | A24 |
| Table A-5: Toxicity Characteristic Leaching Procedure and Waste Extraction Test Results | A25 |
| Table A-6: Surface Water and Groundwater Analytical Sample Results | A26 |
| Trench Logs | A27-A41 |
| Well Completion Logs/Refusal Logs | A42-A46 |
| Well Development Logs/Well and Spring Monitoring Logs | A47-A51 |
| XRF Data versus Total Metals Graphs | A52-A59 |
| Laboratory Analytical Results | A60-A112 |

Photographs from the field investigation, including specific site features, appear in the photographic log in **Appendix B**.

The following presents the conclusions of ECM's 2010 EE/CA field investigation. All acronyms used in the table are defined in the notes beneath the table and are defined and discussed in detail in **Appendix A**.

**Table 14: EE/CA Field Investigation Results and Conclusions**

| Investigation Result | EE/CA Conclusion |
|---|---|
| 1. ABA ratio results indicate non-acidic mine drainage. The difference between ANP and AGP results were positive, further indicative of non-acidic mine drainage. | • WET testing with deionized water best simulates the leaching potential of precipitation at the Chicago Research Site, as opposed to WET testing with the more acidic citrate buffer. |
| 2. Groundwater data were collected from wells CW-1 and RW-1. There were no exceedances of any of the Cal-EPA MCLs or PHGs for any metal in either well. | • No impacts to groundwater from mine wastes.<br>• Negligible leachability of metals.<br>• The waste rock and soil at the Chicago Research Site is a Group B/C mining waste, which does not require a liner or leachate collection/removal systems, but does require action to address sediment run-off. |
| 3. The USEPA Method 6010 results for CAM-17 metals were compared to the TTLCs, which are used to classify wastes under California Title 22 regulations. There are exceedances of both nickel and mercury. There is no instance in which there is a nickel exceedance without a corresponding mercury exceedance.<br>The yellow line illustrated in **Figure 7** and **Figure 8** represent areas where mercury exceeds background. | • Mercury, with lowest background concentration, high toxicity, and similar spatial distribution in relation to other metals which exceed action levels (see **Section 4**), should be the primary driver for selecting a removal action.<br>• The mercury action level of 15.7 mg/kg was established in the *Human Health and Ecological Risk Assessment* presented in **Appendix C** and detailed in **Section 4.1**, below. |
| 4. Surface water sample CMUS is the only surface water sample to exceed the BLM Human Risk Management Criteria for Metals in Surface Water at Mining Sites for a Camper. Sample CMUS represents background conditions upstream of the Chicago mine. | • If the Chicago Mine is the source of the metals identified in this sample, a removal action targeting the source (waste and soil) will address surface water concerns. However, it is likely mine activities upstream and unrelated to Chicago Mine are the source of these concentrations. |

Notes:
WET = Waste Extraction Test
Cal-EPA = California Environmental Protection Agency
PHGs = Cal-EPA Public Health Goals
ANP = acid neutralization potential
TCLP = toxicity characteristic leaching procedure
CAM = California Administrative Manual
STLC = Soluble Threshold Limit Concentrations
MCL = Maximum Contaminant Levels
ABA = Acid-Base Accounting
AGP = acid generation potential
RCRA = Resource Conservation and Recovery Act
TTLCs = Total Threshold Limit Concentrations

# 3 SOURCE, NATURE, AND EXTENT OF CONTAMINATION

The following sections detail the type, location, estimated volume, and attributes of the contaminated materials found at the Chicago Research Site.

## 3.1 CONTAMINATED MATERIALS DEFINED

For the purposes of the EE/CA field investigation and EE/CA Report, the term *contaminated materials* includes:

- All human-produced mine waste materials including tailing piles, ore material, waste rock, soot deposits, and calcine[7] mine waste, regardless of their metals concentrations, and
- Materials with mercury levels above the most conservative criteria established in the *Human Health and Ecological Risk Assessment* (HHERA) presented in **Appendix C** and further discussed in **Section 4.1**.

Although other metals were detected at elevated levels, mercury is the driver for any potential removal action due to the extent of the low-level background exceedances of mercury across both sites. Background mercury levels exceed ecological risk criteria and some human health criteria. Background mercury has been set as the remedial goal for any area outside of, or incidental to, a known mine waste pile. Due to the areal extent of low-level mercury concentrations, mercury will drive the soil remediation.

Within areas of known waste, the removal action process will address wastes known to contain any metals that pose an unacceptable risk to human health or the ecology, as prescribed in the United States Code (U.S.C.) for CERCLA[8]. The law[9] prescribed in 42 U.S.C. §9604(a)(3) is interpreted to mean that a removal action will address the release of a naturally occurring substance when it is identified in an altered form (e.g.: a waste pile).

## 3.2 LOCATION AND VOLUME OF CONTAMINATED MATERIALS

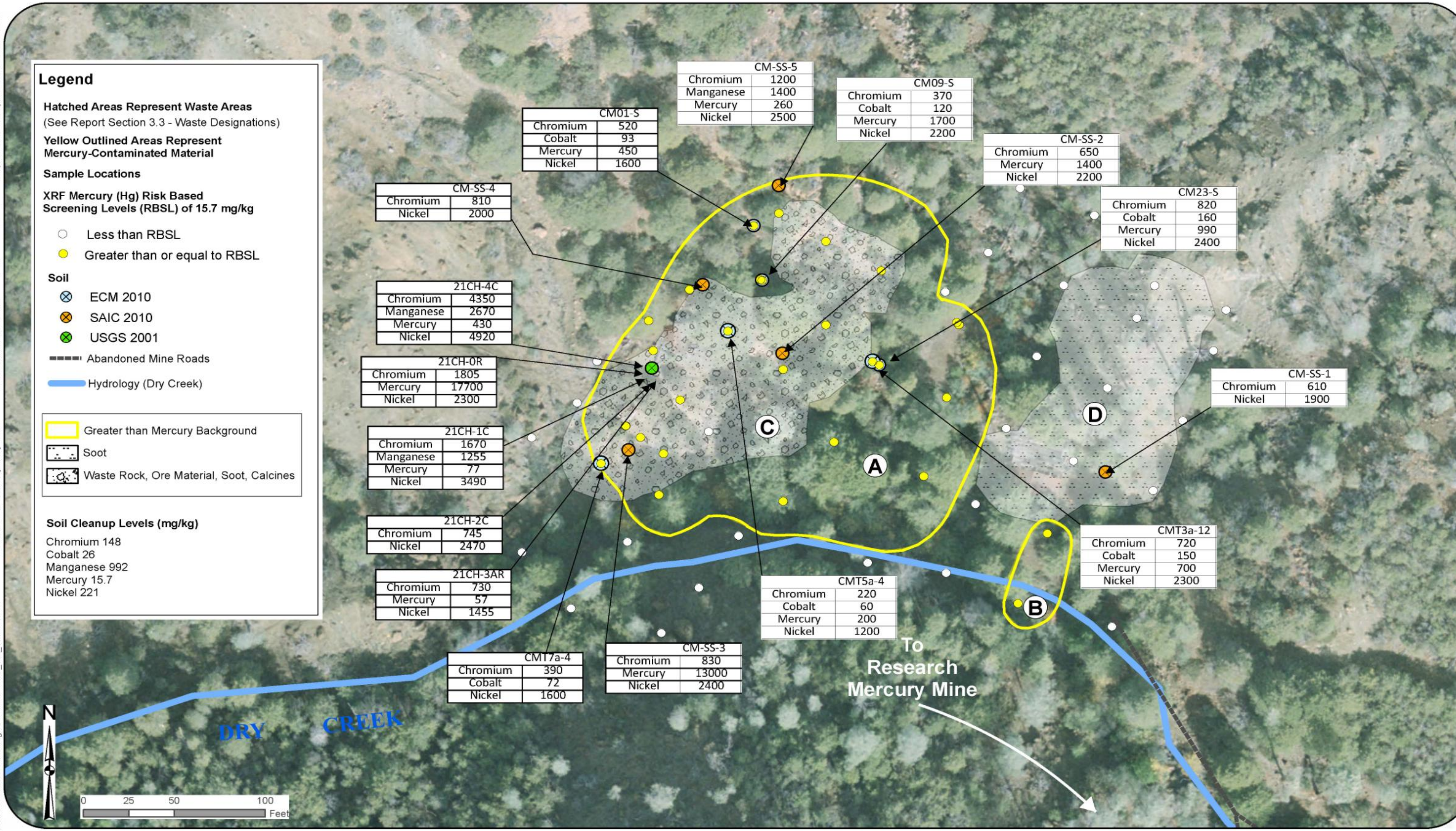
Contaminated materials at the Chicago Research Site are depicted on **Figure 7** (Chicago Mine) and **Figure 8** (Research Mine). **Table 15** provides a description of the general site location, map identifier, extents, and estimated volume (see **Appendix D** for volume calculations) of these areas of contaminated material.

---

[7] Calcines are a waste product of calcination. Calcination is the thermal process applied to ores to bring about a thermal decomposition, phase transition, or removal of a volatiles. The calcination process takes place at temperatures below the melting point of the product materials.

[8] The United States Code (U.S.C.) contains the laws or “enabling statutes” by which the Code of Federal Regulations (CFR) are regulated.

[9] United States Code, Title 42, Chapter 103, Subchapter I, Section 9604 - Limitation on Response: "The President shall not provide for a removal or remedial action under this section in response to a release or threat of release of a naturally occurring substance in its unaltered form, or altered solely through naturally occurring processes or phenomena, from a location where it is naturally found;”




Notes:
Locations for SAIC and USGS samples based on SAIC report entitled: Removal Site Evaluation Report, Chicago/Research Mercury Mine, July 2010.
Risk Based Screening Level (RBSL) background value (15.7 mg/kg) is used for mercury since it is greater than calculated RBSL.

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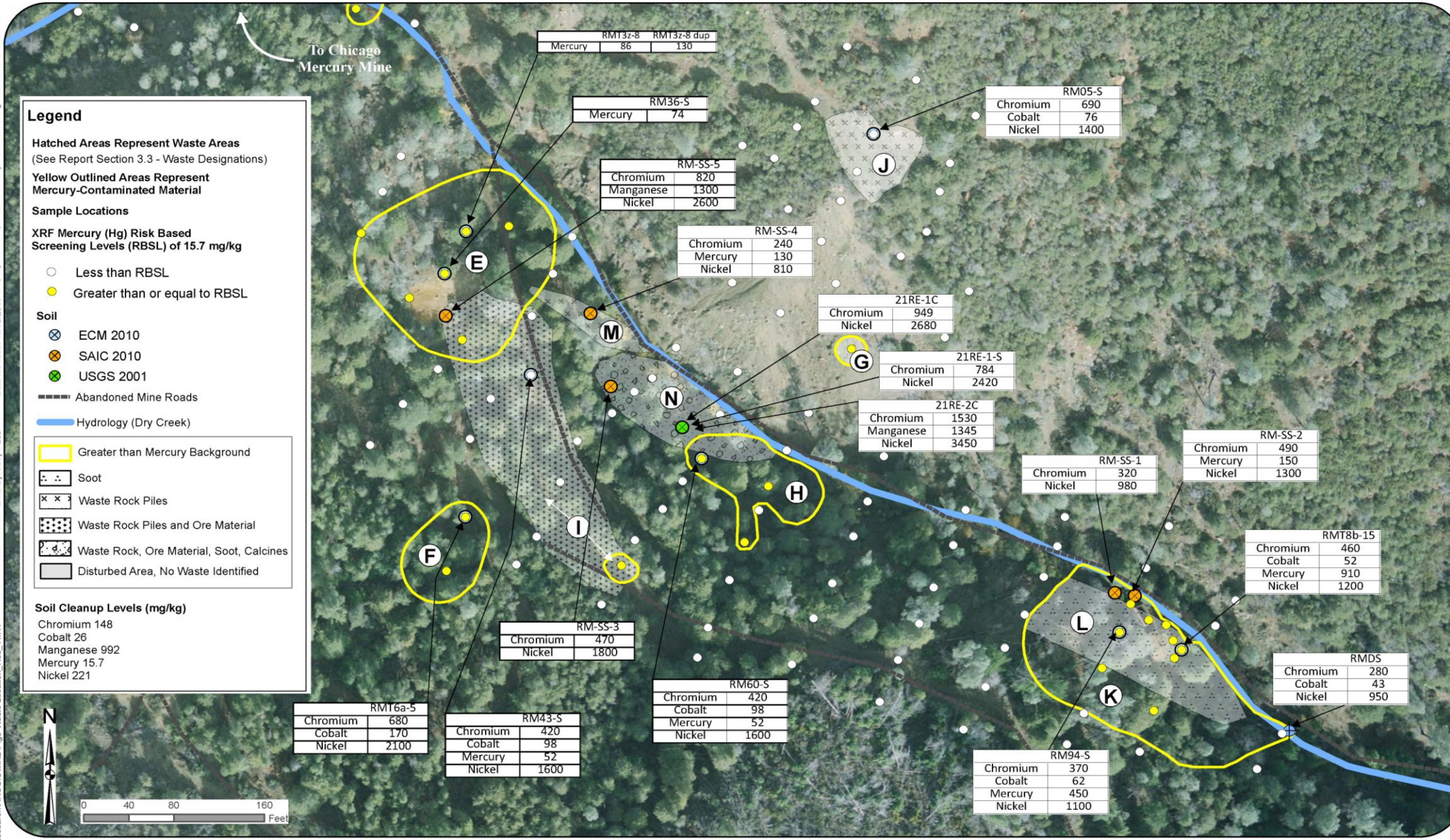
**Waste Areas and Sample Results**
**Chicago Mine**
**Lake County, California**

Engineering Evaluation/Cost Analysis Report
The Chicago Research Site

Figure 7

Path: B:\BLM\Chicago Research\ARCGIS\MXD\Fig7-WasteLocation_Chi_11x17.MXD Drafter: SMK Chkd By: Joey Pace Date Drafted: 09/20/2011 Proj Mgr: A. Campbell, P.E. Project: BLM Chicago Research Site EE/CA




Path: B:\BLM\Chicago Research\ARCGIS\MXD\Fig8-Waste Location_Res_11x17 Drafter: SMK Chkd By: Joey Pace Date Revised: 10/13/2011 Proj Mgr: A. Campbell, P.E. Project: BLM Chicago Research Site EE/CA

Notes:
Locations for SAIC and USGS samples based on SAIC report entitled: Removal Site Evaluation Report, Chicago/Research Mercury Mine, July 2010.
Risk Based Screening Level (RBSL) background value (15.7 mg/kg) is used for mercury since it is greater than calculated RBSL.

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**Waste Areas and Sample Results**
**Research Mine**
**Lake County, California**

Engineering Evaluation/Cost Analysis Report
The Chicago Research Site

Figure
**8**

**Table 15: Areas of Contamination**

| **Map Identifier** | **Physical Location** | **High Volume Estimate** (cubic yards) | **Low Volume Estimate** (cubic yards) | **Area Estimate** (square feet) |
|---|---|---|---|---|
| A | Western side of Chicago Mine along slope from upper mine entrance to south bank of Dry Creek; Extents (area estimate) determined by field XRF readings. | 1,600 | 1,300 | 14,860 |
| B | Eastern side of Chicago Mine south of the “Lower Bunkhouse” to south side of Dry Creek; Extents determined by field XRF readings. | 400 | 250 | 1,560 |
| C | Waste piles on western side of Chicago Mine along slope from upper mine entrance extending south but not reaching Dry Creek; Extents determined by SAICs visually inspection. | 20,000 | 15,000 | 22,640 |
| D | Waste encompassing Chicago Mine Lower Bunkhouse area; Extents determined by SAICs visually inspection. | 300 | 60 | 12,200 |
| E | Northwest Research Mine area. | 900 | 700 | 18,600 |
| F | Southwest Research Mine area, located at crossroad on branch road, uphill side of road. | 300 | 150 | 5,160 |
| G | Northern talus slope identified on north side of Research Mine and Dry Creek. Sample results indicate that Area G is a naturally occurring de-vegetated slope. ECM obtained extensive field measurements on a grid covering the entire talus slope. This field data, along with research into the soils and lithology in this area, indicate this talus slope is a natural formation resulting from a highly mineralized deposit at its apex. All measurements within this talus slope indicate natural deposits not requiring a removal action, with the exception of upslope Area J (where mine waste was visually observed). Area G would not be addressed by any proposed removal action. | | | |
| H | Centrally located area of mercury impacted soil and waste at the Research Mine, located adjacent to Dry Creek. | 500 | 250 | 6,010 |

| Map Identifier | Physical Location | High Volume Estimate (cubic yards) | Low Volume Estimate (cubic yards) | Area Estimate (square feet) |
|---|---|---|---|---|
| I | Waste area at Research Mine that runs parallel to Dry Creek. | 3,200 | 1,600 | 21,000 |
| J | Additional sample area located uphill from Area G; ECM visually determined this area was mine waste that was not included in the earlier waste area determinations made by SAIC. | 500 | 300 | N/A |
| K | Eastern-most mercury impacted soils at Research Mine. | 800 | 500 | 11,293 |
| L | Waste near Research Mine furnace within mercury waste area, running parallel to south bank of Dry Creek | 2,200 | 1,100 | 10,080 |
| M | Northernmost waste pile along banks of Dry Creek at Research Mine. | 1,200 | 600 | 2,160 |
| N | Centrally located area of waste at the Research Mine, located adjacent to Dry Creek. | 3,600 | 1,800 | 9,300 |

## 3.3 PHYSICAL ATTRIBUTES OF CONTAMINATION

Several areas of mine waste and contaminated material remain at the Chicago Research Site. Areas of contaminated material include waste soot, waste rock piles, mercury ore, waste soot from furnaces, and calcines from ore processing. Additional mine waste include miscellaneous wooden and metal mining debris. SAIC identified waste piles during their previous investigations, including areas of waste rock, ore material, soot, and calcines. Hashing on **Figure 7** (Chicago Mine) and **Figure 8** (Research Mine) identify their locations and extent. **Table 16** summarizes the physical attributes of the contaminated materials by area.

**Table 16: Lithologic Description/Waste Observations**

| Contaminated Material | Lithologic Description/Waste Observations |
|---|---|
| Area A | Moist red-brown to gray organic clayey soil in native areas to red brown gravelly soil along roadside and on road. |
| Area B | Large boulders and dark brown soil at base of cliff and dark brown organic soil along gully next to old road. |
| Area C | Red brown soil and tailings. |
| Area D | Red brown soil and tailings. |

| Contaminated Material | Lithologic Description/Waste Observations |
|---|---|
| Area E | Dark brown soil and talus in native areas; Some mine debris, yellow brown soil, and tailings in disturbed areas. |
| Area F | Red soil with weathered rock and boulders located on and along branch road; Medium red brown soil in more native areas |
| Area G | Red brown gravelly soil with natural talus in gully areas; Light brown soil with tailings and talus along steep, barren slopes. No mine waste associated with this area. |
| Area H | Brown soil with cobbles of tailings and talus located along the edge of wash below old road above Dry Creek. |
| Area I | Dark red-brown soil with tailings on a ridge next to gully. Medium brown-red gravelly soil with local boulders towards south end. |
| Area J | Tan soil with tailings on surface and yellow soil with tailings below 1-foot bgs. |
| Area K | Dark brown organic soil with minor gravels. |
| Area L | Brown gravelly-sandy soil with cobbles; encountered gray fractured bedrock and tailings at approximately 2-feet bgs. |
| Area M | The soil sample collected by SAIC defined this material as "soot and calcines". |
| Area N | Dark brown gravelly soil with tailings on flats along lower mining area; Red brown soil with 50% tailings and crushed rock interspersed throughout area. |

## 3.4 CHEMICAL ATTRIBUTES OF CONTAMINATION

As detailed in **Appendix A**, ECM utilized a portable X-Ray fluorescence (XRF) meter in the field to measure in-situ metals concentrations in soil, waste, and sediment samples. Two hundred and fifty nine (259) samples, including duplicates, were collected and analyzed in the field to assess metals concentrations. ECM also shipped samples to fixed-based laboratories for additional analyses, including Acid-Based Accounting (ABA), leaching, and total metals. All of these analyses are discussed in detail in **Appendix A** and are further discussed in the following subsections. **Table 17** presents a summary of the analyses performed during the 2010 EE/CA field investigation.

**Table 17: 2010 EE/CA Investigation Analytical Approach**

| Method | Rationale |
|---|---|
| Method 6010B CAM-17 Metals | Use to determine a correction factor (slope) and correlation coefficient (R) for field collected XRF metals data, as allowed by EPA Method 6200 for mercury. |
| Method 6010B CAM-17 Metals | Use to compare total metals data to the CAM-17 heavy metals, which have regulatory levels (TTLCs) that are used in California waste classification. |
| Acid-Base Accounting | Analysis of ANP and AGP provides the ABA results. A ratio of ANP to AGP of <3:1 indicates an acidic leachate, while a ratio of >3:1 indicates an acidic leachate will not be formed. In addition, the results determine which leachate will be used in the WET analysis. |
| California WET Method | ABA results of >3.1 indicate that non-acidic leaching will may occur but that acidic leaching will not. As such, a DI water solution is used to simulate landfill leaching under non-acidic conditions. Results of a WET Method analysis are compared to regulatory levels (STLCs) to determine toxicity. |
| TCLP | Used to determine if a waste is a RCRA waste subject to regulation under RCRA Subtitle C. The data are compared to the RCRA Maximum Concentration of Contaminants for the Toxicity Characteristic. Note that the Bevill Amendment exempts mining wastes from regulation under RCRA. |

Notes:
WET = Waste Extraction Test
ABA = Acid-Base Accounting
ANP = acid neutralization potential
AGP = acid generation potential
RCRA = Resource Conservation and Recovery Act
STLC = Soluble Threshold Limit Concentrations
TCLP = toxicity characteristic leaching procedure
CAM = California Administrative Manual
TTLCs = Total Threshold Limit Concentrations
DI = di-ionized

### 3.4.1 Contaminants Identified

Thirteen samples, including eight soil (surface node) samples, one sediment sample, and four waste (trench) samples, were analyzed at a fixed laboratory[10] for total metals (presented on Table A-2 in **Appendix A**)[11]. Of the 17 metals which were analyzed, mercury and nickel were detected in soil and waste (not sediment) at levels above the published regulatory limits[12] established by California Title 22 for waste toxicity levels. In addition, six waste samples (plus a duplicate) and one sediment sample were analyzed by the TCLP and WET analyses (presented on Table A-5 in **Appendix A**) for total "RCRA 8" metals[13]. Only mercury (in one waste sample)

[10] TestAmerica of San Francisco

[11] California Administrative Manual, which is now referred to as the California Code of Regulations (CCR), defines the CAM-17 metals as heavy metals whose Total Threshold Limit Concentrations (TTLCs) are used in RCRA waste classification. CCR Title 22 defines these metals as antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, mercury, molybdenum, nickel, selenium, silver, thallium, vanadium, and zinc.

[12] Total Threshold Limit Concentrations; Reference Table A-2 in **Appendix A**.

[13] Arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver.

exceeded a California Soluble Threshold Limit Concentration (STLC) limit[14], and none of the metals exceeded RCRA toxicity characteristic thresholds. Both Title 22 and RCRA exempt mine wastes from regulation as hazardous wastes.

In addition to the samples collected by ECM, the USGS and SAIC also collected samples for total metals during previous investigations (**Table 1** and **Table 3**). ECM provided all of these data to a risk assessor to complete an HHERA (presented in **Appendix C** and discussed further in **Section 4**). The HHERA identified three additional metals which present a threat to human or ecological receptors. These metals include chromium, cobalt, and manganese.

Therefore, the five contaminants of concern (COCs) identified as contributing to the need for removal action at the Chicago Research Site are:

1. Chromium
2. Cobalt
3. Manganese
4. Mercury
5. Nickel

Risk-based removal action levels (Proposed Action Levels) for these metals are presented in **Section 4**. **Table 18**, below, lists each area and the COC identified in the HHERA as posing a risk to a threat to human or ecological receptors. **Figure 7** and **Figure 8** further illustrate these results.

**Table 18: Metal Data Observations**

| Contaminated Material | Spatial Extents Defined By | Metals Above Risk-Based Removal Action Levels |
|---|---|---|
| Area A | Mercury XRF Readings | chromium, cobalt, manganese, mercury (lab and XRF), and nickel |
| Area B | Mercury XRF Readings | mercury (XRF) |
| Area C | Extents of Visually Identified Waste (mine tailings, soot, calcines, etc.) | chromium, cobalt, manganese, mercury (lab and XRF), and nickel |
| Area D | Extents of Visually Identified Waste (mine tailings, soot, calcines, etc.) | chromium and nickel |
| Area E | Mercury XRF Readings | mercury (XRF and lab) |
| Area F | Mercury XRF Readings | chromium, cobalt, nickel, and mercury (XRF) |
| Area G | n/a – no mine waste at this location | mercury (XRF)[15] |
| Area H | Mercury XRF Readings | chromium, cobalt, mercury (XRF and lab), and nickel |

14 Reference Table A-4 and Table A-5 in **Appendix A**.

15 One mercury XRF sample above background (RM-26 at 21.66 mg/kg) identified in this location. Sample and surrounding material not indicative of waste but determined to be naturally occurring from weathering of bedrock from above sample location.

| Contaminated Material | Spatial Extents Defined By | Metals Above Risk-Based Removal Action Levels |
|---|---|---|
| Area I | Mercury XRF Readings and Extents of Visually Identified Waste (mine tailings, soot, calcines, etc.) | chromium, cobalt, manganese, mercury (XRF and lab), and nickel |
| Area J | Extents of Visually Identified Waste (mine tailings, soot, calcines, etc.) | chromium, cobalt, and nickel, |
| Area K | Mercury XRF Readings | chromium, cobalt, mercury (XRF) and nickel, |
| Area L | Extents of Visually Identified Waste (mine tailings, soot, calcines, etc.) | chromium, cobalt, mercury (XRF and lab), and nickel |
| Area M | Extents of Visually Identified Waste (mine tailings, soot, calcines, etc.) | chromium, mercury (lab), and nickel |
| Area N | Extents of Visually Identified Waste (mine tailings, soot, calcines, etc.) | chromium, manganese, and nickel |

### 3.4.2 Potential for Leaching

As indicated in **Appendix A**, analytical results from samples collected from the Chicago Research Site wells (CW-1 and RW-1) indicate there is no leaching of metals occurring from the contaminated materials[16].

In addition, only one sample (RMT8b-15) exceeded an STLC. This was a trench sample collected from a waste/tailings pile at the Research Mine, which exceeded the STLC of 0.2 mg/L for mercury with a concentration of 2.3 mg/L. However, this sample is not indicative of a leaching concern for two reasons. First, nearby well RW-1 was non-detect for mercury, showing that groundwater is not impacted at Research Mine. Second, this sample had an XRF reading of 1,115.63 mg/kg; however, a deeper XRF reading in this same trench at 6-feet bgs (RMT8j-72) had an XRF result of 0.23 mg/kg. Taking into account the 10-time dilution factor when performing WET analysis, the result of 0.23 mg/kg would have a WET result of 0.023 mg/L, which is well below the STLC of 0.2 mg/L for mercury. This trench and these results illustrate that spot locations may have low-level exceedances of the STLCs, but overall, the mine waste does not present a leaching concern.

### 3.4.3 Potential for Acid Mine Drainage

As detailed in **Appendix A**, ECM used the acid-base accounting (ABA) test to evaluate the leaching potential of overburden materials. ECM complete ABA testing on 11 waste samples. Table A-3 of **Appendix A** summarized the analysis results and show that an acidic leachate/non-acidic mine drainage will not occur.

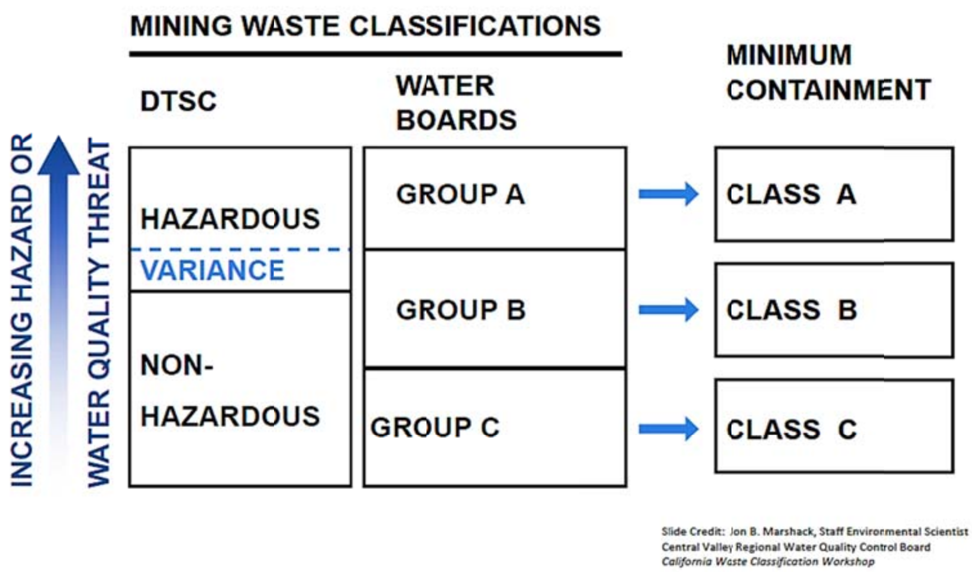
Based upon these results, the waste rock and soil at the Chicago Research Site is classifiable as a Group C mining waste with regards to leachability to groundwater. **Appendix A** explains

[16] Groundwater data is presented in **Appendix A** on Table A-6.

this classification (and the other classes of mine waste) in detail. Group C mining wastes are wastes from which any discharge would comply with an applicable water quality control plan, including water quality objectives other than turbidity.

However, the waste presents a risk to surface water quality if it is allowed to remain a source of sediment runoff to the Dry Creek and/or other tributaries. Therefore, RWQCB would consider the waste a Group B mining waste. Although the leachability results do negate the need for a liner, as a Group B mining waste, actions are required to eliminate or sufficiently reduce run-off of sediments (particularly mercury-containing waste sediments which can result in toxicity to biota from monomethyl mercury uptake). The figure on the following page graphically summarizes the various mine waste groups.

Figure 9: Mining Waste and Unit Classifications in California




Group B Mining Waste is defined in Title 27 CCR, Division 2, Subdivision 1, Chapter 7, Subchapter 1, Section 22480, as either:

1. Mining wastes that consist of (or contain) hazardous wastes, that qualify for a variance under Chapter 11 of Division 4.5 of Title 22, provided that the RWQCB finds that such mining wastes pose a low risk to water quality; or
2. Mining wastes that consist of (or contain) nonhazardous soluble pollutants of concentrations which exceed water quality objectives for, or could cause, degradation of waters of the state.

The waste at this site, based on the results of leachability tests (WET and TCLP) and ABA, meets criteria 1 as variance waste. The major impact this classification has on selecting a removal action is that Group B mining wastes with a variance do not require liners or leachate collection/removal systems, thus enabling a more expeditious removal action. This waste classification is evaluated under the ARAR requirements presented in **Section 4.1.2**, and thereby has a direct impact on evaluation of removal actions (**Section 6**).

# 4 SITE CLEANUP CRITERIA

There are two general types of cleanup criteria:

1. Risk-based cleanup criteria developed from human health risk equations using acceptable risk levels and site-specific factors, and
2. Applicable or Relevant and Appropriate Requirements (ARAR).

## 4.1 RISK-BASED CLEANUP CRITERIA

ERM-West, Inc. (ERM) prepared a *Human Health and Ecological Risk Assessment* (HHERA) in support of the non-time critical removal action at the Chicago Research site. The complete HHERA is included as **Appendix C** of this EE/CA Report. The purpose of the HHERA is to evaluate the potential for adverse human health and ecological effects that may occur as a result of potential current exposures at the at the site. Findings of the HHERA assist in determining the need for removal action and the subsequent scope of the Removal Action Alternatives to reduce the human health and ecological risks to acceptable levels.

To support the assessment of potential risks and the scope of EE/CA Removal Action Alternatives, ERM derived site-specific risk-based screening levels (RBSLs) using methods and values provided in relevant regulatory guidance, databases and/or consensus documents. Site-specific RBSLs are chemical-specific concentrations in environmental media of concern that are protective of specific human and ecological receptors. The HHERA compared site-specific RBSLs to site-specific exposure point concentrations to determine that site conditions pose a potential risk to specific receptors should no further action be taken.

The following sections present the risk-based Proposed Action Levels for soil/sediment and surface water. Risk-based numbers are not presented for waste because all waste must be removed from the site. Risk-based numbers were not calculated for groundwater because groundwater samples from the site were below the relevant regulatory levels[17].

### 4.1.1 Soil

**Table 19** presents the HHERA Proposed Action Levels for soil and sediment, as well as a more detailed summary of site-specific chemical RBSLs. These Proposed Action Levels are based on background levels established and presented in detail in the HHERA. Background mercury levels are above the ecological risk criteria; however, under CERCLA, a removal action is not required for levels below background. The lowest Proposed Action Level, the mercury background level, has been set as the remedial goal for any area outside of, or incidental to, a known mine waste pile. Within areas of known waste, the removal action would include the entire area of waste, as prescribed in 42 U.S.C. §9604(a)(3).

Implementing these Proposed Action Levels to help quantify the Removal Action Objectives (RAOs; discussed in **Section 5**), allows BLM to decide on a Removal Action with a scope that will result in soil levels which are safe for human health and ecological receptors.

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[17] Regulatory Levels include the California Maximum Contaminant Levels (MCLs) and the California Public Health Goals (PHGs). The data are presented on Table A-6 in **Appendix A**.

**Table 19**
**Site-Specific Risk-Based Screening Levels (RBSLs)**

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**SOIL**
Summary of Constituents of Concern Risk-Based Screening Levels
(all results in milligrams per kilogram)

| Chemical of Concern | Background | Exposure Point Concentration‡ | Human Health RBSLs | | Ecological RBSLs | | | | | | **Proposed Action Level** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Recreator | Construction Worker | Plant | Soil Invertebrate | California Quail | California Vole | Bewick's Wren | Trowbridge's Shrew | |
| Chromium | 148 | 956 | -- | -- | -- | -- | 249 | 112 | 6.7 | 10 | **148** |
| Cobalt | 26 | 103 | 4,300 | 20 | 13 | -- | 949 | 706 | 36 | 59 | **26** |
| Manganese | 992 | 1,185 | -- | -- | -- | -- | 13,000 | 1,512 | 1,305 | 617 | **992** |
| Mercury | 15.7 | 5,083 | 4,300 | 53 | 0.3 | 0.1 | 63 | 79 | 0.64 | 3.3 | **15.7** |
| Nickel | 221 | 2,147 | 270,000 | 200 | 38 | 280 | 741 | 87 | 6 | 2.4 | **221** |

**SEDIMENT**
Summary of Constituents of Concern Risk-Based Screening Levels
(all results in milligrams per kilogram)

| Chemical of Concern | Background | Exposure Point Concentration‡ | Human Health RBSLs | | Ecological RBSLs | | **Proposed Action Level** |
|---|---|---|---|---|---|---|---|
| | | | Recreator | Construction Worker | Sediment Biota | | |
| | | | | | TEC | PEC | |
| Chromium | 148 | 784 | -- | -- | 43 | 111 | **148** |
| Cobalt | 26 | 43 | 4,300 | 20 | -- | -- | **43** |
| Manganese | 992 | 710 | -- | -- | -- | -- | **992** |
| Mercury | 15.7 | 3.4 | 4,300 | 53 | 0.18 | 1.1 | **15.7** |
| Nickel | 221 | 2,420 | 270,000 | 200 | 23 | 49 | **221** |

**SURFACE WATER**
Summary of Constituents of Concern Risk-Based Screening Levels
(all results in milligrams per liter)

| Chemical of Concern | Background (Spring) | Exposure Point Concentration‡ | Human Health RBSLs | Ecological RBSLs | **Proposed Action Level** |
|---|---|---|---|---|---|
| | | | Construction Worker | Aquatic Biota | |
| Chromium | 0.025 | 13* | 14,000 | 0.18 | **0.18** |
| Cobalt | < 0.002 | -- | -- | NE | **0.002** |
| Manganese | no data** | 13*** | 1,300 | NE | **13** |
| Mercury | < 0.0002 | 5.5 | 2.8 | 0.0013 | **0.0002** |
| Nickel | < 0.01 | 30 | 200 | 0.052 | **0.052** |

**Notes:**
‡ = Exposure point concentration, maximum detection or 95% Upper Confidence Limit, whichever is minimum
* = Chromium: RBSL for aquatic biota is based on CrIII water quality standard and is hardness-dependent--assumed hardness of 100 mg[CaCO3]/L
** = Data not collected as part of the Method 6010B CAM-17 analysis.
*** = Data used to calculate the exposure point concentration came from samples collected by SAIC and USGS. ECM did not collect Mn data for surface water.
PEC = Probable effect concentration -- concentration above which impacts are anticipated
TEC = Threshold effect concentration -- concentration below which impacts are not anticipated
RBSLs = Risk-Based Screening Levels
**--** = Not Applicable or Not Calculated

### 4.1.2 Sediment

A Removal Action which implements the above-referenced Proposed Action Levels for soil (and also addresses all identified areas of mine waste regardless of contaminant levels) will also indirectly address sediments at the Chicago Research Site by removing or otherwise addressing the source contaminated materials such that they can no longer contribute to stream sediments.

### 4.1.3 Surface Water

**Table 19** also presents the HHERA Proposed Action Levels for surface water, which will be used to quantify the RAOs further discussed in **Section 5**. Since impacts to surface water occur through transport of sediments by way of stormwater or other transport mechanisms, potential impacts to surface water (Dry Creek and tributaries, et al) must be addressed through a removal action which targets the source media. In particular, mercury-impacted wastes and soil must be addressed to avoid acute and chronic methylmercury impacts to surface water biota through sediment transport leading to monomethyl mercury uptake by biota. As indicated in the previous section, the Proposed Action Level for mercury has been set at background. Leaching is not a concern for surface water impacts, as no leaching is occurring from the mine wastes. The elimination of leaching as a potential for contamination is discussed in detail in **Section 3.4.2** and **Appendix A**.

## 4.2 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

The BLM is responsible for the identification of potential Applicable or Relevant and Appropriate Requirements (ARARs) that pertain to any CERCLA removal action proposed for the Chicago Research Site. Section 121(d) of CERCLA requires that on-site remedial actions attain or waive Federal environmental ARARs, or more stringent State environmental ARARs, upon completion of the remedial action. The NCP also requires compliance with ARARs during remedial actions and during removal actions to the extent practicable. ARARs are identified on a site-by-site basis for all on-site response actions where CERCLA authority is the basis for cleanup.

**Table 20** presents the federal and State of California ARARs for the Chicago Research Site. There ARARs fall into three general categories:

1. Chemical-specific: ARARs that pertain to handling or control of certain chemicals based on health concerns or risks.
2. Location-specific: ARARs that control activities based on the location such as wetlands, historic sites, or sensitive ecosystems
3. Action-specific: ARARs that govern discrete actions which may include the use of certain technologies for remedial actions or use of certain types of equipment during remedial actions.

BLM evaluated these ARARs to determine if the scope of the ARAR makes it “Applicable”, “Relevant and Appropriate", or “To Be Considered”. ARARs are also evaluated to determine if only substantive portions of the ARAR are applicable or relevant and appropriate.

**Table 20**
**Applicable or Relevant and Appropriate Requirements (ARARs)**

*Engineering Evaluation/Cost Analysis Report*
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| Standard, Requirement, Criteria, or Limitation | Citation | Description | Applicable or Relevant and Appropriate? |
|---|---|---|---|
| **CHEMICAL-SPECIFIC : FEDERAL** | | | |
| Clean Water Act Water Quality Standards | 33 USC 1251-1387, Section 303(c)(2)(B)<br>40 CFR Section 440.40-440.45<br>40 CFR Part 131, Quality Criteria for Water 1976, 1980, 1986 | Chapter 26, Water Pollution Prevention and Control, sets criteria for water quality based on toxicity to aquatic organisms and human health. | Applicable for surface water requirements |
| Risk Management Criteria for Metals at BLM Mining Sites | Ford, K.L., Bureau of Land Management, 2004. Risk Management Criteria for Metals at BLM Mining Sites (Technical Note 390 Revised 2004).<br><br>BLM, 1998, Interim Revision of Wildlife Management Criteria. | BLM risk management criteria for metals at mining sites used to evaluate the potential risk posed by these metals; criteria have been developed for human, livestock, and wildlife receptors. | Applicable |
| Safe Drinking Water Act National Primary Drinking Water Regulations and Maximum Contamination Goals National Secondary Drinking Water Regulations | 40 USC 300<br>40 CFR Part 141, Subpart B, pursuant to 42 USC 300(g)(1) and 300(j)(9)<br>40 CFR Part 141, Subpart F, pursuant to 42 USC 300(g)(1)<br>40 CFR Part 143, Subpart B pursuant to 42 USC 300(g)(1) and 300(j)(9) | Establishes health-based standards for public water systems (maximum contaminant levels) and sets goals for contaminants. Establishes welfare-based (non-enforceable) standards for public water systems (secondary maximum contaminant levels) CERCLA Section 1211(d)(2)(B) provides that CERCLA response actions "shall require a level of standard or control which at least attains MCLGs established under the Safe Drinking Water Act." Section 300.430(f)(5) of the NCP provides that remedial actions must generally attain MCLs or non-zero MCLGs if water is a current or potential source of drinking water. The MCL for mercury is 0.002 mg/L. | Applicable for drinking water quality at the site |
| USEPA Region 9 Regional Screening Levels (Formerly PRGs) - "Industrial Soil Supporting" | USEPA Region 9 Regional Screening Levels (Formerly 2004 Preliminary PRGs) (November 2010)<br>http://www.epa.gov/region9/superfund/prg/ | Combine current USEPA toxicity values with standard exposure factors to estimate acceptable contaminant concentrations in different environmental media (soil air and water) that are protective of human health." | To Be Considered |
| USEPA Region 9 Regional Screening Levels (Formerly PRGs) - "Residential Soil Supporting" | USEPA Region 9 Regional Screening Levels (Formerly 2004 Preliminary PRGs) (November 2010)<br>http://www.epa.gov/region9/superfund/prg/ | Combine current USEPA toxicity values with standard exposure factors to estimate acceptable contaminant concentrations in different environmental media (soil air and water) that are protective of human health." | Not an ARAR; No residential concerns onsite. |
| **CHEMICAL-SPECIFIC : STATE/LOCAL** | | | |
| California Human Health Screening Levels (CHHSLs) | http://www.calepa.ca.gov/Brownfields/documents/2005/CHHSLsGuide.pdf | Used in evaluation of contaminated properties to calculate health based cleanup levels. | To Be Considered |
| California Safe Drinking Water Act | Title 22 California Code of Regulations (CCR) Sections 64431 and 64449(a) | Primary and secondary MCLs for public drinking water under the California SDWA of 1976. | Applicable |
| California Water Plan | Water Code §10004(a) | Provides for the orderly and coordinated control, protection, conservation, development, and utilization of the water resources of the state. | Relevant and Appropriate |
| CalTOX | http://eetd.lbl.gov/ied/era/caltox/index.html | A spreadsheet risk assessment model for multimedia exposure. | To Be Considered |
| Department of Toxic Substance Control 1999 Preliminary Endangerment Assessment Manual | http://www.dtsc.ca.gov/SiteCleanup/Brownfields/upload/SMP_REP_PEA_CH1.pdf | The human health screening evaluation process discussed in the manual can be used to assess risk associated with existing conditions or calculate health based cleanup levels for unrestricted land use. | To Be Considered |
| March 2006 *Lake County Groundwater Management Plan* | http://www.co.lake.ca.us/Government/Directory/Water_Resources/Department_Programs/Groundwater_Management.htm | The Basin Management Objectives(BMOs) identified in this document for the Collayomi Basin included an increase in monitoring of iron, manganese, sulfur, and nitrate water quality issues and the addition of monitoring for sulfide, boron, aluminum, and nickel water quality issues. | Relevant and Appropriate |
| Porter-Cologne Water Quality Act | California Water Code, Division 7: Water Quality, Water Code Sections 13000-13002 - Policy | Mandates that the quality of all the waters of the state shall be protected for use and enjoyment by the people of the state. Also mandates each Regional Board to formulate and adopt basin plans for all areas within the region. | Applicable |
| | Sections 13397 through 13398 | Establishes the policy to reduce the threat to water quality caused by abandoned mine lands. | Applicable |
| RWQCB (SFB) - Screening levels for groundwater and surface water; Soil screening levels; Industrial/Commercial. | California Regional Water Control Board, San Francisco Bay Region, 2007. *Screening for Environmental Concerns at Sites with Contaminated Soil & Groundwater.* November. November. Updated May 2008. | Guidance for the application of risk-based screening levels and decision making to sites with impacted soil and groundwater | To Be Considered |

**Table 20**
**Applicable or Relevant and Appropriate Requirements (ARARs)**

*Engineering Evaluation/Cost Analysis Report*
The Chicago Research Site

| Standard, Requirement, Criteria, or Limitation | Citation | Description | Applicable or Relevant and Appropriate? |
|---|---|---|---|
| RWQCB (SFB) - Screening levels for groundwater and surface water; Soil screening levels; Residential/Parkland/ Agricultural | California Regional Water Control Board, San Francisco Bay Region, 2007. *Screening for Environmental Concerns at Sites with Contaminated Soil & Groundwater.* November. Updated May 2008. | Guidance for the application of risk-based screening levels and decision making to sites with impacted soil and groundwater | To Be Considered |
| State of California Drinking Water Policy | State Water Resources Control Board No. 88-63 http://www.swrcb.ca.gov/board_decisions/adopted_orders/resolutions/2006/rs2006_0008_rev_rs88_63.pdf | Provides direction indicating that surface water and groundwater is considered a potential drinking water source if the TDS levels are below 3,000 mg/L (specific conductance of 5,000 µS/cm) and the yield is more than 200 gallons per day. | To Be Considered |
| State of California Water Resources Control Board Statement of Policy with Respect to Maintaining High Quality Waters in California | State Water Resources Control Board Resolution 68-18 | Resolution 68-16 establishes the policy that high quality waters of the state “shall be maintained to the maximum extent possible” consistent with the “maximum benefit to the people of the state.” | Relevant and Appropriate |
| State of California Water Resources Control Board Policies and Procedures for Investigation and Cleanup and Abatement of Discharges under California Water Code Section 13304 | State Water Resources Control Board Resolution 92-49 | Resolution 92-49 contains policies and procedures that the regional boards apply to all investigations and cleanup and abatement activities for all types of discharges subject to California Water Code Section 13304. Section III.G of the Resolution requires attainment of background water quality, or if background cannot be restored, the best water quality that is reasonable. | Relevant and Appropriate |
| Supplemental Guidance for Human Health Multimedia Risk Assessments of Hazardous Waste Sites and Permitted Facilities | http://www.dtsc.ca.gov/AssessingRisk/Supplemental_Guidance.cfm | Provides California methods and default parameters for conducting risk assessment. | To Be Considered |
| *Water Quality Control Plan for the Sacramento River and San Joaquin River Basins* | The Water Quality Objectives defined in the Regional Water Quality Control Board - Central Valley Region Basin Plan http://www.swrcb.ca.gov/rwqcb5/water_issues/basin_plans/sacsjr.pdf | §13240 of the Porter-Cologne Water Quality Control Act requires each Regional Board formulate and adopt water quality control plans, or basin plans. The Basin Plan for the Central Valley was prepared and implemented to protect and enhance the quality of waters in the region. The Basin Plan established location-specific beneficial uses and water quality objectives for surface water and groundwater of the region. | Relevant and Appropriate |
| **LOCATION-SPECIFIC : FEDERAL** | | | |
| Endangered Species Act | 316 USC § 1531 (h) through 1543 40 CFR Part 6.302 50 CFR Part 402 | Act to protect habitat of endangered and threatened species. Activities may not jeopardize the continued existence of any threatened or endangered species or destroy or adversely modify a critical habitat. | Substantive requirements are Applicable. |
| Fish and Wildlife Coordination Act | 16 USC 1251 661 et seq.; 40 CFR 6.302(g) | Requires consultation when Federal agency proposes or authorizes any modification of any stream or other water body to assure adequate protection of fish and wildlife resources. | Substantive portions are applicable. Any proposed stream restoration work should be designed so that it will not cause erosion or obstruct the natural flow of water. |
| Historic Sites, Buildings, and Antiquities Act and Executive Order 11593 | 16 USC 461 et seq. 40 CFR Part 6.301 | EPA is subject to the requirements of the Historic Sites Act of 1935, 16 U.S.C. 461 et seq., the National Historic Preservation Act of 1966, as amended, 16 U.S.C. 470 et seq., the Archaeological and Historic Preservation Act of 1974, 16 U.S.C. 469 et seq., and Executive Order 11593, entitled Protection and Enhancement of the Cultural Environment. | Substantive requirements are Applicable. BLM has identified the three standing concrete furnaces located adjacent to Dry Creek as eligible for the National Register of Historic Places. |

**Table 20**
**Applicable or Relevant and Appropriate Requirements (ARARs)**

*Engineering Evaluation/Cost Analysis Report*
The Chicago Research Site

| Standard, Requirement, Criteria, or Limitation | Citation | Description | Applicable or Relevant and Appropriate? |
|---|---|---|---|
| Migratory Bird Treaty Act | 16 USC §§ 703 et seq. | Establishes federal responsibility for the protection of the international migratory bird resource and requires continued consultation with the US Fish and Wildlife Service during remedial design and remedial construction to ensure that the cleanup of the site does not unnecessarily impact migratory birds. | Relevant and Appropriate |
| National Environmental Policy Act | 7 CFR 799 (1969)<br>http://www.epa.gov/region9/nepa/ | Section (102)(2) of NEPA requires all Federal agencies to give appropriate consideration to the environmental effects of their proposed actions. The Council on Environmental Quality regulations at 40 CFR 1507.3(b) identify those items which must be addressed in agency procedures. | Substantive requirements are Applicable. |
| Protection of Wetlands Order, Executive Order 11990 | 40 CFR Part 6 | Requires minimizing and avoiding adverse impacts to wetlands | Relevant and Appropriate |
| The Historic and Archeological Data Preservation Act of 1974 | 16 USC 469 40 CFR 6.301 | Establishes procedures to provide for preservation of historical and archeological data that might be destroyed through alteration of terrain as a result of a federal construction project or a federally licensed activity or program. | Substantive BLM has identified the three standing furnaces located adjacent to Dry Creek as eligible for the National Register of Historic Places. |
| **LOCATION-SPECIFIC : STATE/LOCAL** | | | |
| California Cultural and Paleontological Resources | Document 33.4 | State-level cultural resource protection is regulated through the provisions of Appendix K of the California Environmental Quality Act (CEQA). Paleontological resource protection is regulated through 1906 Antiquities Act. | Relevant and Appropriate |
| California Endangered Species Act (CESA) | Fish and Game Code - Section 2080;<br>Title 14 CCR Section 783 et seq | The CESA Act generally parallels the main provisions of the Federal ESA to protect habitat of rare, endangered, and threatened species. The 'take' of any species that the commission has determined to be an endangered or threatened species is prohibited. However, CESA allows incidental take for lawful development projects and emphasizes early consultation to avoid impacts on projects that have a potential for a 'take'. | Substantive requirements are Applicable. |
| California Preservation Laws | Administrative Code, Title 14, Section 4307 | No person shall remove, injure, deface or destroy any object of paleontological, archaeological, or historical interest or value. | Applicable |
| California Wildlife Conservation Act | Fish and Game Code Section 2050-2068, Section 2080, Section 3005, and Section 5650. | California Department of Fish and Game Habitat Conservation Planning Branch | Substantive requirements are Applicable. |
| **ACTION-SPECIFIC : FEDERAL** | | | |
| Bevill Amendment | RCRA Section 3001 (a)(3)(A)(ii)<br>42 USC 6921 (a)(3)(A)(ii)<br>40 CFR Section 261.4(b)(7) | Exempts most mining wastes from regulation as hazardous waste. Exempted waste includes waste from the extraction and beneficiation of minerals, and some mineral processing waste. | Applicable |
| BLM *Abandoned Mine Land Program Policy Manual Section 3720* | MS-3720;<br>http://www.blm.gov/nhp/efoia/wo/manual/manuals.html<br>http://www.blm.gov/aml/ap_manual.htm. | The BLM Abandoned Mine Land Program is administered pursuant to *Abandoned Mine Land Program Manual,* Section 3720. The Manual specifically identifies physical hazards at abandoned mine sites and how to identify environmental and ecological hazards. The manual lists and describes the statutes and regulations that authorize the BLM to address these issues. | To Be Considered |

## Table 20
## Applicable or Relevant and Appropriate Requirements (ARARs)

*Engineering Evaluation/Cost Analysis Report*
The Chicago Research Site

| Standard, Requirement, Criteria, or Limitation | Citation | Description | Applicable or Relevant and Appropriate? |
|---|---|---|---|
| BLM *Abandoned Mine Land Program Policy Handbook* | http://www.blm.gov/pgdata/etc/medialib/blm/wo/Information_Resources_Management/policy/blm_handbook.Par.14160.File.dat/h3720-1.pdf | The *Abandoned Mine Land Program Policy Handbook* is intended to provide options, tools, resources, and examples that can be considered when addressing significantly more complex remediation activities at Abandoned Mine Land Sites. The handbook provides basic information for identifying physical hazards; reducing environmental degradation caused by abandoned mines to ensure compliance with all standards and applicable Federal, State, Tribal, and local laws; and helps guide in identifying and prioritizing fomines that most affect at-risk resources and functioning ecosystems. | To Be Considered |
| Clean Air Act National Primary and Secondary Ambient Air Quality Standards National Emission Standards for Hazardous Air Pollutants | 42 USC 7409<br>40 CFR Part 50<br>40 CFR Part 61, Subparts N, O, P, pursuant to 42 USC 7412 | Establish air quality levels that protect public health, sets standards for air emissions Regulates emissions of hazardous chemicals to the atmosphere | Relevant and Appropriate pertaining to disturbance of waste material during consolidation, removal, or treatment. |
| Clean Water Act National Pollutant Discharge Elimination System Effluent Limitations | 33 USC 1342 Section 404<br>40 CFR Parts 122, 125<br>33 USC 131140 CFR Part 440 | Requires permits for the discharge of pollutants from any point source into waters of the United States. Sets standards for discharge of treated effluent to waters of the United States | Substantive requirements are Applicable |
| Closure Criteria for Municipal Solid Waste Landfills | 40 CFR Part 258.60 (a)(1-3) | Establishes design for caps. | Applicable to capping alternative |
| Comprehensive Environmental Response, Compensation, and Liability Act | CERCLA Section 121 | This section requires that all remedial actions which result in any hazardous substance, pollutants, or contaminants remaining on the site be subject to Five-Year Review to evaluate the performance of the remedy. | Applicable |
| Hazardous Materials Transportation Act: Standards Applicable to Transport of Hazardous Materials | 49 USC § 1801-1813<br>49 CFR Parts 10, 171-173 and 177 | Requires placing, packaging, documentation for the movement of hazardous materials on public roadways. | Applicable if hazardous wastes are transported off-site. |
| Resource Conservation and Recovery Act | 40 CFR Part 261, Subpart D | Defines wastes which are subject to regulation as hazardous wastes under 40 CFR Parts 262-265 and Parts 124, 270, and 271 | Applicable if hazardous wastes are transported off-site. |
| Solid Waste Disposal Act as amended by the Resource Conservation and Recovery Act Standards Applicable to Transporters of Hazardous Waste Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities | 42 USC 6901, et seq.<br>40 CFR Part 263, pursuant to 42 USC 6923<br>40 CFR Part 264, pursuant to 42 USC 6924, 6925 | Establishes standards for persons transporting hazardous waste within the US if the transportation requires a manifest under 40 CFR Part 262 Defines acceptable management standards for owners and operators of facilities that treat, store, or dispose of hazardous waste | Applicable if hazardous wastes are disposed of off-site. |
| **ACTION-SPECIFIC : STATE/LOCAL** | | | |
| California Air Quality Control Act | California Air Resources Board<br>www.arb.ca.gov | Regulates air particulates and general air quality; Administers, controls, and maintains the Statewide Best Available Control Technology (BACT) database for air quality. | Applicable to disturbance of waste material during consolidation, removal, or treatment. |
| The California Global Warming Solutions Act of 2006 | Assembly Bill 32 (AB 32) - Assembly Speaker Fabian Nunez (D-Los Angeles), Statutes of 2006, Chapter 488 | Determined the statewide 1990 greenhouse gas (GHG) emissions level as a statewide aggregate emissions limit to be achieved by 2020. AB 32 requires the California Air Resources Board to develop regulations and market mechanisms that will ultimately reduce California's greenhouse gas emissions by 25 percent by 2020. Mandatory caps are slated to begin in 2011/2012 for significant sources. | Relevant or Appropriate if waste is transported offsite involving a significant hauling effort. |
| California Hazardous Waste Disposal and Transportation Program | Title 26 CCR, Division 4 - Cal/OSHA, Division 21.5 - Health and Welfare (Prop 65);<br>Title 26 CCR, Division 22 - Department of Health Services;<br>49 CFR - Parts 100-177 and 350-399 - Department of Transportation (DOT). | Regulates transportation and disposal of hazardous waste. | Applicable if waste is transported offsite. |

## Table 20
## Applicable or Relevant and Appropriate Requirements (ARARs)

*Engineering Evaluation/Cost Analysis Report*
The Chicago Research Site

| Standard, Requirement, Criteria, or Limitation | Citation | Description | Applicable or Relevant and Appropriate? |
|---|---|---|---|
| California Health and Safety Code Definition of Hazardous Waste §25117 Hazardous Waste Criteria §25141 | http://www.calrecycle.ca.gov/LEA/Training/wasteclass/yep.htm | Recognizes the Bevill exclusion; mining wastes are subject to requirement of Chapter 6.8 with respect to "hazardous substances". | Applicable |
| California Mining Waste Regulations | 27 CCR 22470-22510 | Established three groups of mining waste:<br>Group A: Mining waste that must be managed as hazardous waste provided the Regional Water Quality Control Board finds that such mining wastes pose a significant threat to water quality<br>Group B: Mining wastes that consist of or contain hazardous wastes that qualify for a variance, provided that the Regional Water Quality Control Board finds that such mining wastes pose a low risk to water quality, or mining wastes that consist of or contain non-hazardous soluble pollutants of concentrations which exceed water quality objectives for, or could cause, degradation of waters of the state<br>Group C: Mining wastes from which any discharge would be in compliance with the applicable water quality control plan, include water quality objectives other than turbidity | Applicable |
| California Solid Waste Management Regulations | TITLE 27. Environmental Protection, Division 2. Solid Waste, Subdivision 1. Consolidated Regulations for Treatment, Storage, Processing or Disposal of Solid Waste | Applies to all disposal sites meaning active, inactive closed or abandoned, as defined in §40122 of the Public Resources Code including facilities or equipment used at the disposal sites | Applicable if solid waste is transported away from site. Relevant and Appropriate if a disposal facility is constructed as part of final action |
| California Surface Mining and Reclamation Act of 1975 | Public Resources Code, Division 2, Chapter 9, Section 2710 et seq.<br>California Code of Regulations:14CCR 3703 through 14CCR 3706, 14CCR 3710, 14CCR 3713 | Protection standards for wildlife habitat; Performance standard for backfilling, re-grading, slope stability, and recontouring; Performance standards for revegetation; Performance standards for drainage, diversion structures, waterways, and erosion control ;Performance standards for stream protection; Performance standards for closure of surface openings. | Applicable to surface stabilization, stormwater run-off controls, and/or consolidation removal action alternatives. |
| California Water Code | Chapter 3. State Water Quality Control<br>Article 4. Other Powers and Duties of the State Board<br>Section 13172 | State regulations governing the design of mining waste disposal units, the Regional Water Quality Control Board imposes specific requirements on siting, construction, monitoring, and closure and post-closure maintenance of existing and new units. Restrictions depend upon whether the wastes are Group A, B, or C and whether the units are existing or new. | Applicable to consolidation alternative |
| Department of Toxic Substance Control *Abandoned Mine lands Preliminary Assessment Handbook* | http://www.dtsc.ca.gov/sitecleanup/brownfields/upload/aml_handbook.pdf | *The Abandoned Mine Lands Preliminary Assessment Handbook* (AML Handbook) provides basic information for identifying physical hazards at Abandoned Mine Lands sites and determining whether chemicals are present that may pose a risk to human health or the environment. Specific objectives of the handbook include: how to determine if physical hazards are present; how to determine if chemical hazards are present at concentrations that pose a potential risk to human health based on residential (unrestricted) land use or through the secondary use of mine wastes; and how to determine if environmental degradation has occurred or is occurring. | To Be Considered |
| General Permits for Industrial/Construction Storm Water Discharges Requirements | http://www.waterboards.ca.gov/water_issues/programs/stormwater/industrial.shtml | The regulations require that stormwater associated with industrial/construction activity that discharges either directly to surface waters or indirectly through municipal separate storm sewers must be regulated by a NPDES permit. The regulations require facility operators to: 1. Eliminate unauthorized non-storm water discharges; 2. Develop and implement a *Storm Water Pollution Prevention Plan* (SWPPP); and 3. Perform monitoring of storm water discharges and authorized non-storm water discharges. | Substantive requirements are Applicable |

**Table 20**
**Applicable or Relevant and Appropriate Requirements (ARARs)**

*Engineering Evaluation/Cost Analysis Report*
The Chicago Research Site

| Standard, Requirement, Criteria, or Limitation | Citation | Description | Applicable or Relevant and Appropriate? |
|---|---|---|---|
| Lake County Air Pollution Control District Regulations | Chapter II – Prohibitions and Standards | Rules and regulations enacted to achieve and maintain local, state, and federal ambient air quality standards within Lake County. Air Quality standards include ambient air quality standards adopted by the state board pursuant to section 39606 of the Health and Safety Code and which have been established pursuant to Sections 108 and 109 of the federal Clean Air Act pertaining to criteria pollutants and section 169A of the federal Clean Air Act pertaining to visibility. | Relevant and Appropriate pertaining to disturbance of waste material during consolidation, removal, or treatment. |

**Notes:**
The ARARs listed are ranked in the final column as either: 1) Applicable 2) Relevant and Appropriate 3) To Be Considered, or 4) Not an ARAR; Substantive portions of an ARAR may be Applicable or Relevant and Appropriate.

Applicable requirements are cleanup standards, standards of control, and other substantive requirements, criteria or limitations that specifically address a hazardous substance, pollutant, contaminant, remedial action, location or other circumstances found at a CERCLA site.

Relevant and Appropriate requirements are cleanup standards, standards of control, and other substantive requirements, criteria, or limitations that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location or other circumstances at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site and are well-suited to the particular site.

To Be Considered (TBC) Non-promulgated advisories or guidance regarding: 1) health effects information with a high degree of credibility; 2) technical information on how to perform or evaluate site investigations or response actions; or 3) policy.

# 5 IDENTIFICATION OF REMOVAL ACTION OBJECTIVES

RAOs address the sources of contamination, the nature and extent of contamination, results of the human health and ecological risk evaluations (Proposed Action Levels, **Section 4.1**), and identified ARARs (**Section 4.2**). The RAOs control the contamination sources and eliminate the potential for exposure of human and ecological receptors to Site contamination.

The RAOs for the Chicago-Research Site are:

- Prevent or reduce human exposure (through inhalation, ingestion, and dermal contact) to COCs in waste materials;
- Prevent or reduce ecological exposure (through inhalation, ingestion, and dermal contact) to COCs in waste materials;
- Prevent or reduce potential migration of COCs, particularly mercury, in waste materials via surface runoff, erosion, and wind dispersion; and
- Prevent or reduce potential migration of COCs in waste materials to groundwater and eventual potential recharge to surface water.

## 5.1 REMOVAL ACTION JUSTIFICATION

According to 40 CFR 300.415(b), a removal action is justified if there is a threat to human health or the environment based on one or a combination of any of the eight factors listed below:

**Table 21: Removal Action Justification**

| Factor | Site Condition | Justified |
|---|---|---|
| (1) Actual or potential exposure to nearby human populations, animals, or the food chain from hazardous substances, pollutants, or contaminants. | Public access to mine waste and soil containing concentrations of metals exists, though is limited by terrain and fencing. Animal populations have access to the mine waste and soil. | Yes |
| (2) Actual or potential contamination of drinking water supplies or sensitive ecosystems. | There are no municipal wells within 5 miles of the site. No known population centers near the site derive potable water from surface water sources.<br>Dry Creek is drinking water source for wildlife. Metals concentrations in creek sediments (**Table A-1**) and surface water (**Table A-6**) have been identified. | Yes |
| (3) Hazardous substances, pollutants, or contaminants in drums, barrels, tanks, or other bulk storage containers that may pose a threat of release. | No drums, barrels, tanks, or bulk storage containers on the Site. | No |

| Factor | Site Condition | Justified |
|---|---|---|
| (4) High levels of hazardous substances, pollutants, or contaminants in soils largely at, or near, the surface, that may migrate. | Concentrations of metals in reclaimed soils subject to erosion and migration. | Yes |
| (5) Weather conditions that may cause hazardous substances, pollutants, or contaminants to migrate or be released. | Sediment subject to erosion during high flows, rain events, and snowmelt could cause waste material migration. | Yes |
| (6) Threat of fire or explosion. | No flammable materials on the Site. | No |
| (7) The availability of other appropriate federal or state response mechanisms to respond to the release. | The site is on BLM-administered Federal land and is being addressed under BLM CERCLA authorities. | Yes |
| (8) Other situations or factors that may pose threats to public health or the environment. | None. | No |

## 5.2 SCOPE OF REMOVAL ACTION

The general evaluation criteria for the analysis of potential removal actions, as defined in the 1993 USEPA document *Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA* (USEPA, 1993), are effectiveness, implementability, and cost. These criteria are discussed in detail in **Section 6**.

The scope of removal actions evaluated in this EE/CA Report focus on:

1. Compliance with RAOs, and
2. Compliance with ARARs, including conservation of the three standing concrete furnaces located adjacent to Dry Creek.

Although immediate and 100% attainment of the RAOs is not required for a removal action, it is considered a goal that is desirable pending availability of effective technologies and funding.

## 5.3 REMOVAL SCHEDULE

The BLM has determined that a non-time-critical removal action is appropriate at the Chicago Research Site. After completion of the EE/CA Report, BLM must complete an Action Memorandum. Following issuance of the Action Memorandum, BLM must secure congressional funding for the removal action. After receipt of funding, BLM will need to prepare a removal design and may need to contract the design implementation separately. A more detailed schedule can be developed once congressional funding has been secured.

# 6 IDENTIFICATION AND EVALUATION OF REMOVAL ACTION TECHNOLOGIES AND ASSEMBLY OF ALTERNATIVES

This section identifies and evaluates diverse, individual *technologies* that can help achieve RAOs. Typically, no single technology will achieve most or all RAOs. Therefore, complimentary technologies are assembled into groups of *alternatives* for a more complete evaluation based on effectiveness, implementability, and cost.

## 6.1 IDENTIFICATION OF REMOVAL ACTION TECHNOLOGIES

**Table 22: Removal Action Technologies**

| Removal Action Technology | Description |
|---|---|
| 1. No Action | This action leaves contaminated materials in their current condition and assumes no further intervention will occur. No response activities or monitoring are associated with this technology. All evaluations of technologies must include "No Action" as a baseline for comparison to the other technologies. |
| 2. Surface Water Controls | Surface water diversion controls or stormwater management structures include drainage channels, ditches, trenches, or other structures designed to prevent surface water from contacting contaminated materials and to appropriately manage any water that still does contact those materials. |
| 3. Stabilization of Existing Surfaces | Stabilization of the contamination in-place reduces the mobility of contaminants in soil. Soil stabilization seeks to trap or immobilize the contamination within the soil. |
| 4. Institutional Controls | Institutional controls restrict access to or control the use of a site. They include construction of barriers, installation of fences and gates, moats, warning signs, hostile vegetation, and designating the lands in public records (e.g., zoning and/or ownership deeds) as a repository with use restrictions. Enforcement of such controls would require periodic inspections and patrols, as wells as legal action against violators. |

| Removal Action Technology | Description |
|---|---|
| 5. On-Site Consolidation | This technology involves excavation, relocation, and placement of the waste rock and tailings materials in an on-site consolidation waste pile, cell or repository. The area of consolidation would be specifically designed and constructed to contain the waste and mining materials. |
| 6. Capping | This technology involves covering the waste material (or consolidated waste material) to limit the potential for human and ecological exposure to the contaminants, and limit the potential for off-site migration. The capping configuration would be graded so that drainage would follow the natural contours of the area. Capping would also limit stormwater flow and infiltration and promote runoff away from the contaminated areas, thereby preventing the transport of contaminated sediments to surface water bodies. |
| 7. Excavation/ Backfilling | This technology involves removing contaminated soil and waste using shovels, scrapers, and mechanical equipment such as bulldozers. Excavated areas are backfilled with clean soil, returned to original grade, and re-vegetated or otherwise stabilized to prevent erosion. |
| 8. Offsite Disposal | This action involves relocation and placement of contaminated materials in an off-site commercial landfill facility in open cells in a manner determined by the facility operator. The facility would be responsible for compliance with all applicable regulations governing solid waste disposal. |

## 6.2 REMOVAL ACTION TECHNOLOGY SCREENING

**Table 23: Removal Action Technology Screening**

| Removal Action | Site Specific Screening Evaluation |
|---|---|
| 1. No Action | Although No Action will not meet the RAOs, it is used as a baseline against which other alternatives are measured. For this reason, and because a No Action is required according to USEPA guidance, it is retained for further evaluation as a Removal Action Alternative (**Section 6.3**). |

| Removal Action | Site Specific Screening Evaluation |
|---|---|
| 2. Surface Water Controls | Surface water controls would have limited effectiveness in meeting the RAOs. Surface water controls may prevent potential off-site migration from erosion of contaminated surfaces into the drainage channels present on Site. While surface water at the Chicago-Research Site is minimal, some runoff from the waste flows directly into Dry Creek with no space to construct watershed diversion (runoff) controls. Surface water controls alone will not sufficiently address the RAOs but could be beneficial in combination with other technologies.<br><br>This technology requires access for heavy equipment such as backhoes. BLM may need to improve access roads or consider using a more expensive spider backhoe that can access the site without requiring roads. |
| 3. Stabilization of Existing Surfaces | Slope stabilization would help to meet the RAOs when employed in conjunction with other removal action technologies. Stabilization activities would include compaction of the existing waste piles and re-contouring and vegetating or berming the existing waste piles and slopes for erosion control. Stabilization may not provide a sufficient barrier to terrestrial receptors such as humans and wildlife, and applied erosion controls would require frequent maintenance and reinstallation.<br><br>This technology requires access for heavy equipment. BLM may need to improve access roads to allow equipment access to the sites. |
| 4. Institutional Controls | Land use restrictions would be necessary to prevent future activities that are inconsistent with the HHERA's exposure pathway assumptions. For example, a deed restriction would prevent future residential development, since the cleanup goals will not protect humans residing on the property full-time.<br><br>Due to the remoteness of the mine sites, enforcement of institutional controls would be difficult, but not impossible. A locked gate, followed by a long hike across private lands, limits access to the area. Additional fencing would prevent human trespassers but not ecological exposure or off-site migration of the contamination. Therefore, institutional controls would need to accompany another technology to adequately meet RAOs and ARARs. |

| Removal Action | Site Specific Screening Evaluation |
|---|---|
| 5. On-Site Consolidation | Relocation of contaminated materials to a consolidation area would eliminate the unchecked migration of contaminants when employed in conjunction with other removal action technologies to meet RAOs and ARARs. An on-site “consolidation cell” would reduce the waste volume’s area and the potential for exposure to receptors and storm water runoff, and therefore the risk to humans and wildlife.<br><br>This approach requires access for large vehicles and heavy equipment. Access road improvements may be necessary for transport of excavation equipment, backfill materials, and earthen fill/vegetative materials for re-grading and re-vegetating. |
| 6. Capping | Capping of contaminated materials (either in place or in a consolidation cell) would meet RAOs and ARARs when employed in conjunction with other removal action technologies to address areas where capping would not be technologically feasible or otherwise cost-effective.<br><br>This approach requires access for large vehicles and heavy equipment. Access road improvements may be necessary for transport of excavation equipment, backfill materials, and earthen fill/vegetative materials for re-grading and re-vegetating. |
| 7. Excavation/ Backfilling | Excavation/backfilling would meet RAOs and ARARs when applied with another technology to address the end use/disposal of the excavated contaminated materials.<br><br>This approach requires access for large vehicles and heavy equipment. Access road improvements may be necessary for transport of excavation equipment, backfill materials, and earthen fill/vegetative materials for re-grading and re-vegetating. |
| 8. Offsite Disposal | Transportation of contaminated materials to an offsite disposal facility would meet RAOs and ARARs. However, this approach is often costly and simply transfers the problem to another location. It may require over 2,000 truckloads transported over a long distance with a significant carbon footprint based on diesel emissions as well as highway congestion.<br><br>This approach requires significant roadway access to accommodate fully loaded 18-wheel dump trucks. |

## 6.3 ASSEMBLY OF REMOVAL ACTION ALTERNATIVES

The removal action technologies described in the preceding sections have been assembled into five Removal Action Alternatives, which have been analyzed with respect to the evaluation criteria (RAOs and ARARs). These alternatives have been developed based on the known nature and extent of soil contamination and results of the human and ecological risk evaluations.

- Alternative 1 – No Action
- Alternative 2 – Watershed Diversions and Institutional Controls
- Alternative 3 – Surface Stabilization/Institutional Controls
- Alternative 4 – On-Site Consolidation and Capping/Institutional Controls
- Alternative 5 – Excavation and Off-Site Disposal

**Section 7** presents a full evaluation of these alternatives.

# 7 ASSESSMENT OF REMOVAL ACTION ALTERNATIVES

The Removal Action Alternatives are evaluated based on the following overall criteria:

I. Effectiveness:
  1. Ability to Protect Human Health and the Environment (Protectiveness)
  2. Ability to Comply with ARARs
  3. Ability to Achieve RAOs
  4. Level of Treatment/Containment Expected
  5. Reduction or Elimination of Residual Concerns

II. Implementability:
  1. Technical Feasibility
     a. Availability of Equipment
     b. Availability of Personnel and Services
     c. Availability of Laboratory
  2. Administrative and Legal Feasibility
     a. Acquisition of Permits Required for Any Offsite Work
     b. Acquisition of Easement or Rights-of-Way Required
     c. Impact on Adjoining Property
     d. Ability to Impose Institutional Controls
  3. Ease of Implementation
     a. Regulatory Acceptance
     b. Community Acceptance

III. Cost:
  1. Capital Cost
  2. Post Removal Site Control Cost
  3. Long-Term Maintenance and Monitoring Costs
  4. Present Worth Cost/Present Value

Assumptions made in preparing the cost estimate have been included in **Appendix F**. **Appendix F** provides detailed cost break-downs. **Table 24** summarizes the bottom-line costs.

**Table 24: Cost Estimates for All Remedial Alternatives**

| Chicago Mine | Alternative | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Years | 0 | 30 | 30 | 30 | 5 |
| Interest (Annual Percentage Rate) | n/a | 5% | 5% | 5% | 2% |
| Capital (one-time) | $- | $336,276 | $502,451 | $533,470 | $3,017,598 |
| Maintenance & Monitoring/Year | $- | $6,423 | $10,686 | $13,763 | $2,435 |
| Post-Removal Site Control/Year | $- | $2,080 | $2,080 | $2,080 | $- |
| Present Value | $ - | $466,992 | $698,698 | $777,023 | $3,029,074 |
| Low Estimate -30% | $ - | $326,895 | $489,089 | $543,916 | $ 2,120,352 |
| High Estimate +50% | $ - | $700,488 | $1,048,048 | $1,165,535 | $4,543,611 |

| Research Mine | Alternative | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Years | 0 | 30 | 30 | 30 | 5 |
| Interest (Annual Percentage Rate) | n/a | 5% | 5% | 5% | 2% |
| Capital (one-time) | $- | $382,544 | $728,590 | $773,787 | $3,096,371 |
| Maintenance & Monitoring/Year | $- | $6,423 | $10,686 | $13,763 | $5,640 |
| Post-Removal Site Control/Year | $- | $2,080 | $2,080 | $2,080 | $2,080 |
| Present Value | $ - | $513,261 | $924,837 | $1,017,340 | $3,132,763 |
| Low Estimate -30% | $ - | $359,283 | $647,386 | $712,138 | $2,192,934 |
| High Estimate +50% | $ - | $769,891 | $1,387,255 | $1,526,011 | $4,699,145 |

## 7.1 ALTERNATIVE 1: NO ACTION

The No Action Alternative leaves contaminated materials at the Site in their current condition and assumes no further intervention will occur. Under the No Action Alternative, no response activities or monitoring would occur at the Site.

### 7.1.1 Effectiveness of Alternative 1

In the following subsections, BLM evaluates the effectiveness of a proposed No Action Alternative, which demonstrates environmental conditions that would exist if a removal action were not implemented.

#### *7.1.1.1 Protectiveness*

The No Action Alternative would not protect human health or the environment because it would not address COCs which present a risk to health. Conditions would not change on the site, and human health, ecology, and wildlife would remain at risk.

#### *7.1.1.2 Compliance with ARARs*

The No Action Alternative would not enforce compliance with ARARs because it does not address a number of human health, ecological, historical, and archaeological requirements from the ARARs listed on **Table 20**.

#### *7.1.1.3 Ability to Achieve RAOs*

The No Action Alternative would not achieve the RAOs. Storm water drainage flows over the exposed soil and waste rock piles in the form of run-on or sheet flow. Under this alternative, these flows will continue to erode waste rock and exposed surfaces, and will transport mercury-laden materials through aeolian processes[18] and through run-off flow[19].

#### *7.1.1.4 Level of Treatment/Containment Expected*

The No Action Alternative provides no containment or treatment options.

#### *7.1.1.5 Reduction or Elimination of Residual Concerns*

The No Action Alternative does not reduce the risk to human health through ingestion, inhalation, and dermal contact pathways. The toxicity, mobility and volume of contaminants would not be reduced under this alternative.

### 7.1.2 Feasibility/Implementability of Alternative 1

#### *7.1.2.1 Technical Feasibility*

The No Action Alternative is technically implementable. However, regulatory agencies or BLM personnel are unlikely to accept this alternative, given that the HHERA concluded that several waste rock and tailings piles pose an unacceptable risk to human health and the environment.

This alternative requires no onsite equipment, onsite personnel or services, nor does it require laboratory testing.

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[18] Particles transported by wind through suspension, saltation (bouncing), and creep.
[19] Erosion from source area and deposition in new location, such as Dry Creek as sediment.

#### *7.1.2.2 Administrative and Legal Feasibility*

The No Action Alternative is administratively feasible, and the availability of resources would not be an issue.

Alternative 1 requires no acquisition of permits for offsite work, requires no acquisition of easements or rights-of-way, and requires no institutional controls.

Alternative 1 could lead to high impacts to adjacent properties from erosion of exposed contaminated materials and the potential for mercury-laden sediments to travel via stormwater to Dry Creek.

#### *7.1.2.3 Ease of Implementation*

There is no implementation process associated with the No Action Alternative.

Regulatory acceptance is unlikely because this alternative does not achieve RAOs and ARARs. Community acceptance is unknown at this time but will be determined during the EE/CA Report public comment period. It is unlikely the community would accept this alternative.

### 7.1.3 Cost of Alternative 1

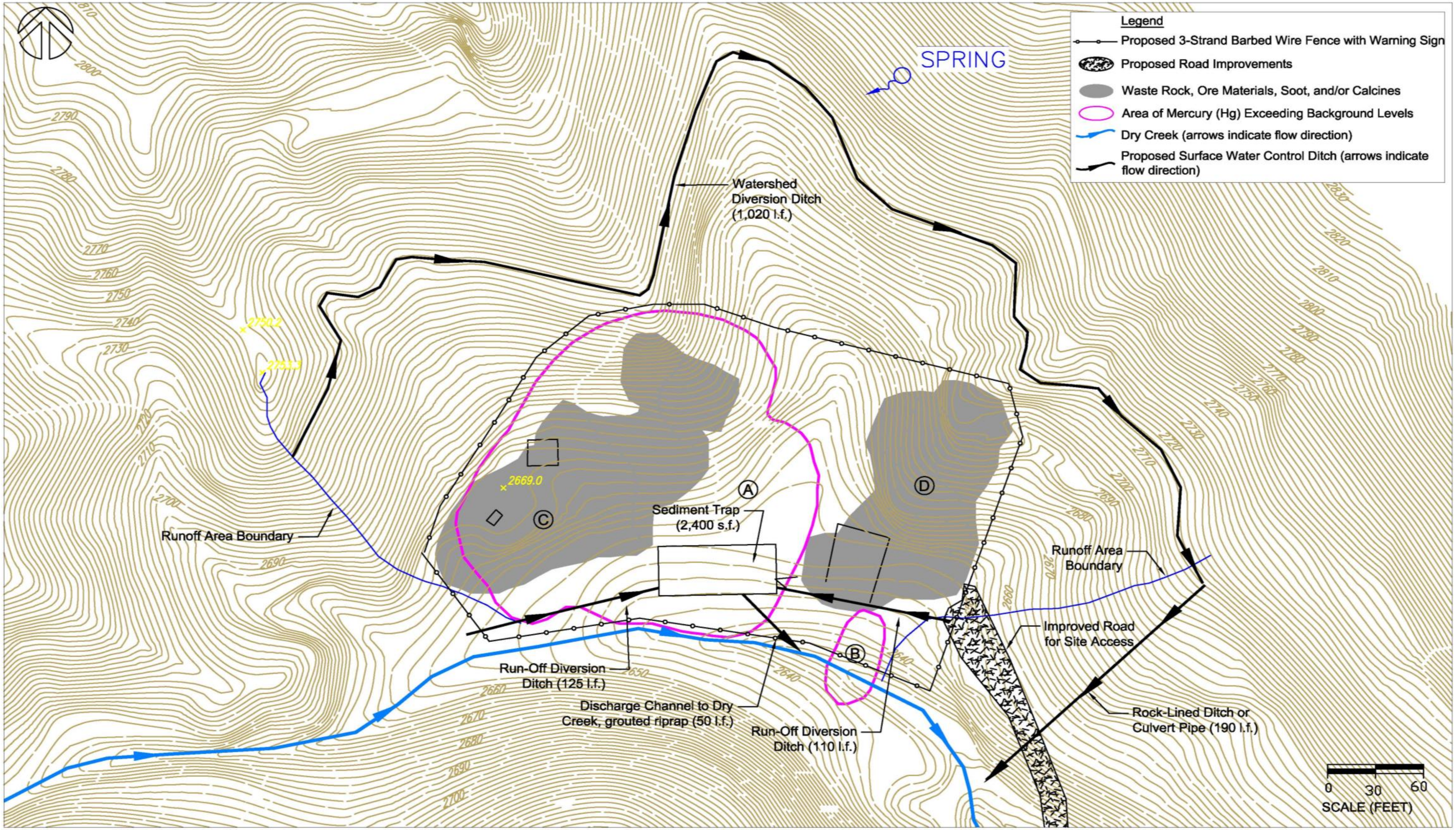
There are no capital costs or operation and maintenance costs associated with the No Action Alternative. However, there may be significant long-term costs associated with future impacts or releases. There may also be non-monetary costs associated with ecological impacts to wildlife and the aquatic community.

## 7.2 ALTERNATIVE 2: WATERSHED DIVERSIONS AND INSTITUTIONAL CONTROLS

### 7.2.1 Alternative 2 Description - Chicago Mine

*Road Improvements*

The road leading into the Chicago Mine from the south, which passes through Research Mine and out to the main road, would require improvements to allow vehicles access to the Chicago Mine Area. Improvements would include stabilization of washed out surfaces, gravel surfacing, and widening in some areas (see **Figure 10a**). It is assumed that on-site access roads within the mine areas are reconstructed or improved to allow moderate to large trucks access to the site. Staging areas would be needed for placement of work trailers, portable lavatories, and storage/stockpiling of supplies. Proper vehicle decontamination areas would be necessary to prevent the spread of contamination outside of the work areas.

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Alternative 2: Watershed Diversons and Institutional Controls
Chicago Mine
Lake County, CA
*Engineering Evaluation/Cost Analysis Report*
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Figure
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*Watershed Diversion Controls*

Surface water diversions (watershed diversions) would be constructed in the upper portion of the Chicago Mine to divert surface water away from Areas A, B, C, and D. This would involve a bermed diversion ditch and rock-lined channel system, as depicted on **Figure 10a**. The diversion ditch would run approximately 1,020 linear feet and carry run-off around the contaminated material/waste and downslope (east) towards Dry Creek. Armoring the diversion ditch with rip rap may be necessary at some locations of the drainage where there is high potential for erosion. The purpose of the diversion ditch is to prevent rainwater and other surface water from flowing over the existing contamination. Once the water reaches the discharge channel (**Figure 10a**; a 190-foot rock-lined ditch), the water flow would follow a gentler grade to Dry Creek where it would discharge.

Watershed diversion controls would be constructed to divert water that runs over Areas A, C, and D during a rain fall event or during snow melt. Diversion ditches constructed at the base of the hill at Dry Creek beneath Chicago Mine (south) would collect all water that sheet flows over the unconsolidated contaminated materials and mine waste. This water would collect in ditches, which would carry it at a gentle grade towards a constructed sediment trap to facilitate laminar flow that allows sediments to settle. Hay bales[20] at the discharge end of the sediment trap would filter any remaining sediments before allowing the water to continue to the discharge channel. The discharge channel would carry the water approximately 50 feet into the Dry Creek.

Area B, due to its proximity to Dry Creek, would not be included in the areal extent of the watershed diversion controls. As such, this area would not be protected from sheet flow during rain/snow events, and could potentially contribute to mercury sediment transport to Dry Creek.

*Institutional Controls*

Alternative 2 requires the majority of the contaminated materials to remain in-place and uncovered, except in areas where the watershed diversions are constructed, or in areas of road repair. Institutional controls, such as permanent access fencing and signage, would minimize human contact and discourage recreational activities.

The Chicago Mine is accessible via Dry Creek Road, which has a locked gate to restrict vehicle access to BLM and adjacent property owners. To limit access during construction and as a long-term deterrent, a fence would surround Areas A, C, and D, the collapsed furnace and other mine relics left in place, and the north side of Area B, except for where it abuts Dry Creek. Warning signs, posted at all gate access points and along the length of the fences at 75-foot intervals, would warn of the potential human health risks.

A deed restriction would be necessary since waste and contaminated materials would remain in-place at the site and present an exposure concern for human and ecological receptors through direct and indirect contact.

---

[20] The hay bales are a short-term measure meant to filter water pending the establishment of vegetation. The need for more permanent fixtures, such as a rock weir, would not be anticipated.

### 7.2.2 Alternative 2 Description - Research Mine

*Road Improvements*

Due to the poor maintenance of the road at Research Mine, significant stabilization and repair would be required to connect the Chicago Mine to the Research Mine (to allow materials to be brought in and out of Chicago Mine area). **Figure 10b** illustrates the parts of the main road which traverse over contaminated material in Area E through Area I. The entire main road, including these traverses, would require stabilization and a 6-inch layer of gravel to provide the surface stability necessary for the transport of machinery. Note the collapsed section of the road depicted on **Figure 10b**, which was caused by natural storm water run-off. This area of the road would require repair, plus construction of a rock-lined ditch to carry storm water unimpeded to Dry Creek beneath the repaired road.

The access road leading to the Research Mine furnaces would also need to be rebuilt. This road branches from the main road at Area E and traverses over contaminated materials through Area I.

As with Chicago Mine, significant road work would be required to create sufficient access for equipment. Staging areas would be needed for placement of work trailers, portable lavatories, and storage of supplies. Proper vehicle decontamination areas would be necessary to ensure that contamination is not spread outside of the work areas.

*Watershed Diversion Controls*

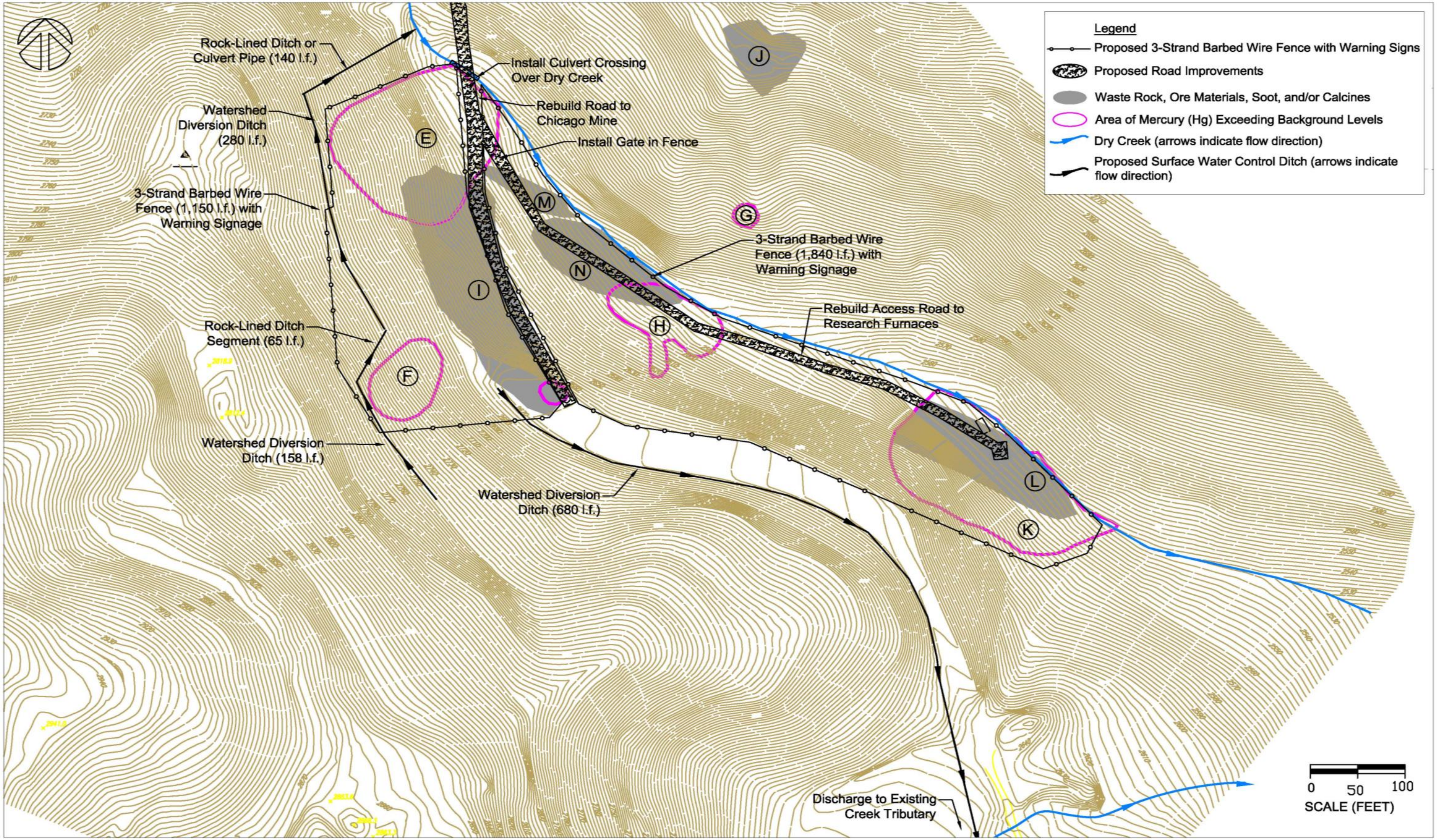
The Research Mine surface water controls are constructed differently than Chicago Mine due to the Research Mine's proximity to Dry Creek, steep grades, and the lack of areal space to construct diversion controls (sediment traps and discharge ditches). The Research Mine would therefore only be constructed with watershed diversions (**Figure 10b**), to divert surface water away from Areas E, F, H, I, J, K, L, M, and N. It appears technically impracticable to install diversion ditches for Area J, located on the north side of Dry Creek across from Research Mine, due to the steep grade, loose talus/waste materials, and protruding bedrock.

The watershed diversions for Research Mine would include five diversion ditches as **Figure 10b** indicates, on the uphill sides of each noted area. They would redirect sheet flow to the south east and northwest, diverting the water towards other diversion ditches further downslope or directly to Dry Creek via discharge to the ditches.

One rock-lined ditch would need to cross the old, abandoned mining road before continuing downslope. This portion of the road has been washed out by years of natural surface flow. This area of road would require repair, and the discharge channel may require a culvert to traverse the road, to avoid future road wash-out from the diversion controls.

*Institutional Controls*

Institutional controls at Research Mine would be similar to those implemented at Chicago Mine, with a fence constructed around the perimeter of the contaminated materials in Areas E, F, H, I, K, L, M, and N. It appears technically impracticable to install fencing for Area J. The three remaining historic furnaces would be protected within the fenced area. Signs would be posted in the same fashion as those described above for Chicago Mine.

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Alternative 2: Watershed Diversions and Institutional Controls
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Figure
10b

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A deed restriction would be necessary since waste and contaminated materials would remain in-place at the site and present an exposure concern for human and ecological receptors through direct and indirect contact.

### 7.2.3 Effectiveness of Alternative 2

The following sections provide an evaluation of the effectiveness of Alternative 2. The Watershed Diversions and Institutional Controls Alternative demonstrates environmental conditions that would exist if such actions and/or controls were implemented at the Chicago Research Site.

#### *7.2.3.1 Protectiveness*

Alternative 2 only addresses transport of contaminated materials most prone to erosion via surface water. It does not address human or ecological exposure to contaminated materials by air-borne exposure/erosion or other means of indirect contact. Nor does it address all of the contaminated materials, including Area B at Chicago Mine and Area J at Research Mine, which are only partially included in the alternative. Permanent fencing and signage provides only limited protection to human health from direct contact, and offers no protection to plants, birds, and small animals.

Alternative 2 addresses mercury exposure in a very limited way. Fencing and signage are proposed to discourage human contact with mercury-bearing waste material; however, fences and signs require maintenance, and can be tampered with or evaded. It is foreseeable that recreational users may ignore fences and signs.

#### *7.2.3.2 Compliance with ARARs*

Alternative 2 will not address all of the ARARs provided in **Table 20**. For example, the "Historic Sites, Buildings, and Antiquities Act" and Executive Order 11593[21], which subject sites under EPA administration to the requirements of the Historic Sites Act of 1935, the National Historic Preservation Act of 1966, the Archaeological and Historic Preservation Act of 1974, and Executive Order 11593, entitled *Protection and Enhancement of the Cultural Environment.* Under these requirements, the three standing furnaces at Research Mine require protection, preservation, and conservation. Because the tailings beneath these furnaces are exposed to wind and weather erosion, and are substantially weathered, they will eventually collapse if not stabilized or removed and replaced, thus allowing the furnaces to suffer severe damage or destruction. Given these conditions, Alternative 2 does not meet the substantive requirements of this ARAR.

#### *7.2.3.3 Ability to Achieve RAOs*

Alternative 2 fails to meet the following RAO requirements:

- Prevention or reduction of human exposure (through inhalation, ingestion, and dermal contact) to COCs in waste materials,
- Prevention or reduction of ecological exposure (through inhalation, ingestion, and dermal contact) to COCs in waste materials,

[21] Chapter 16, United States Code Sections 461, et seq.

- Prevention or reduction of potential migration of COCs in waste materials via erosion and wind dispersion; and
- Prevention or reduction of potential migration of COCs in waste materials via surface water (at Area J).

Alternative 2 meets the RAO requirements to:

- Prevent or reduce potential migration of COCs in waste materials via surface runoff (except in the aforementioned areas); and
- Prevent or reduce potential migration of COCs in waste materials to groundwater and eventual potential recharge to surface water.

  This RAO is met; however not necessarily by the removal action alternative. Leaching to groundwater was eliminated as a pathway based the results of the EE/CA field investigation (see **Section 3.4.2**).

#### *7.2.3.4 Level of Treatment/Containment Expected*

No level of treatment or containment would be obtainable with Alternative 2.

#### *7.2.3.5 Reduction or Elimination of Residual Concerns*

Alternative 2 would offer no reduction or elimination of residual contaminated materials.

### 7.2.4 Feasibility/Implementability of Alternative 2

#### *7.2.4.1 Technical Feasibility*

The actions required for construction Alternative 2 are technically feasible using standard methods and procedures, and through the use of a spider backhoe[22] in place of a track-driven backhoe. For Alternative 2, road improvements would not be necessary to reach Research Mine and to build the diversion trench on the east side, if a spider backhoe is used. Labor crews would have to pack fencing materials into the site by hand or on small all-terrain vehicles (ATVs).

The availability of equipment, personnel and services, and obtaining a laboratory do not present any foreseeable obstacle to the technical feasibility of this alternative.

#### *7.2.4.2 Administrative and Legal Feasibility*

Alternative 2 is both legally and administratively feasible, though it ultimately would not achieve the RAOs and ARARs.

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[22] Spider Backhoe: The spider hoe or “legs” are used for “walking” in difficult terrain. Each movement of the machine is adjusted manually by the operator. It is equipped with hydrostatic rubber tires for travels to a speed of 3.8 miles per hour on flat ground. The “legs” can “step over” small obstacles and traverse over small creeks with minimal disturbance.

Any diversion or impediment of Dry Creek requires adherence with the federal *Fish and Wildlife Coordination Act*[23]. However, because a removal action is a CERCLA action, permits and consultation would not be required.

Alternative 2 requires no acquisition of permits for offsite work, requires no acquisition of easements or rights-of-way, and offers implementable institutional controls. Impacts to adjacent properties may occur from remaining exposed materials eroding, or becoming wind-blown, or sediment laden-mercury run-off to Dry Creek from areas where stormwater controls could not be implemented.

#### *7.2.4.3 Ease of Implementation*

Alternative 2 is easier to implement than other alternatives presented herein, due to the limited heavy machinery required to complete the task and the potential to avoid modifying Dry Creek for the transport of heavy machinery.

Regulatory acceptance is not likely because this alternative does not meet RAOs and ARARs. Community acceptance is unknown at this time but will be determined during the EE/CA Report public comment period.

### 7.2.5 Cost of Alternative 2

The costs for Alternative 2 have been evaluated in detail. A complete break-out of costs is provided in **Appendix F**. **Table 24** provides a detailed summary of the costs based on the following evaluation criteria:

- Capital Cost
- Post Removal Site Control Cost
- Long-Term Maintenance and Monitoring Costs
- Present Worth Cost/Present Value

The costs for Alternative 2 are calculated individually for the Chicago Mine and the Research Mine in **Appendix F**.

The capital costs are estimated based on the following general elements for each mine location:

- Design costs
- Pre-mobilization submittals
- Mobilization
- Vegetation removal
- Construction of watershed diversions
- Road repairs (Research Mine costs include a culvert beneath road)
- Barbed wire fence installation
- Demobilization

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[23] Fish and Wildlife Coordination Act (16 U.S.C. 661-667e; the Act of March 10, 1934; Ch. 55; 48 Stat. 401), as amended by the Act of June 24, 1936, Ch. 764, 49 Stat. 913; the Act of August 14, 1946, Ch. 965, 60 Stat. 1080; the Act of August 5, 1947, Ch. 489, 61 Stat. 770; the Act of May 19, 1948, Ch. 310, 62 Stat. 240; P.L. 325, October 6, 1949, 63 Stat. 708; P.L. 85-624, August 12, 1958, 72 Stat. 563; and P.L. 89-72, 79 Stat. 216, July 9, 1965.

The post-removal costs and maintenance costs are calculated based on the following general elements for each mine location:

- Annual Site Monitoring
- Annual Maintenance
- 5-Year Maintenance
- Annual Tree Removal
- 3-Year Road Re-Grading

The Present Worth/Present Value cost is calculated based on the total of the capital costs, post-removal costs, and long-term maintenance/monitoring costs, as presented on **Table 24**.

For Alternative 2, the costs are summarized as follows:

**Table 25: Summary of Costs for Remedial Alternative 2**

| Chicago Mine | Alternative 2 |
|---|---|
| Years | 30 |
| Interest Rate (Annual Percentage Rate) | 5% |
| Capital (one-time) | $336,276 |
| Maintenance & Monitoring/Year | $6,423 |
| Post-Removal Site Control/Year | $2,080 |
| Present Value | $466,992 |
| Low Estimate (-30%) | $326,895 |
| High Estimate (+50%) | $700,488 |

| Research Mine | Alternative 2 |
|---|---|
| Years | 30 |
| Interest Rate (Annual Percentage Rate) | 5% |
| Capital (one-time) | $382,544 |
| Maintenance & Monitoring/Year | $6,423 |
| Post-Removal Site Control/Year | $2,080 |
| Present Value | $513,261 |
| Low Estimate (-30%) | $359,283 |
| High Estimate (+50%) | $769,891 |

## 7.3 ALTERNATIVE 3: SURFACE STABILIZATION / INSTITUTIONAL CONTROLS

### 7.3.1 Alternative 3 Description - Chicago Mine

*Road Improvements*

All of the road improvements for Chicago Mine, introduced in Alternative 2 (see **Section 7.2.1**), are applicable to Alternative 3, as depicted on **Figure 11a**. These improvements would facilitate access for large trucks, hydroseeding equipment, and grading equipment.

*Watershed Diversion Controls*

All of the surface water diversion and discharge features for Chicago Mine, introduced in Alternative 2 (see **Section 7.2.1**), apply to Alternative 3, as depicted on **Figure 11a**.

*Surface Stabilization*

Surface stabilization at the Chicago Mine would require erosion control blankets and jute netting to stabilize contaminated material *in-situ* in Areas A, B, C, and D. In some areas prone to high wind erosion or surface water erosion, a sprayed-on bonded fiber matrix, applied in water-slurry form using the hydroseeding process, would provide additional erosion control. The bonded fiber matrix, when applied in a water slurry, creates a high strength bonding agent which is absorbed into the substrate. This provides a blanket of interlocking wood fibers in firm contact with the soil, and a supporting subsystem provided by the bonding agent, that locks the substrate particles together to the fiber blanket, creating a strong, erosion-resistant, seal.

For surface stabilization, the collapsed furnace in Area C would need to be demolished and graded into the stabilization area prior to the hydroseeding process.

Surface stabilization requires land-clearing/removal of native vegetation to provide a “clean” substrate bonding surface for the fiber matrix and a “clear” application area for the jute netting.

*Institutional Controls*

Alternative 3 requires the majority of the contaminated materials to be stabilized in-place and covered. Institutional controls, such as permanent access fencing (see **Figure 11a**) and signage, would be necessary to minimize human disturbance and to discourage recreational activities.

A deed restriction would be necessary since waste and contaminated materials would remain in-place at the site and present an exposure concern for human and ecological receptors through direct and indirect contact. The areas selected for stabilization were identified based on risk-based Proposed Action Levels. The contaminated material in the stabilization areas exceed the Proposed Action Levels. In addition, the soil and sediments outside of the stabilization areas meet the Proposed Action Levels, but may exceed an RBSL or regulatory screening level for exposure. Therefore, a deed restriction would be required to limit exposure to human receptors.

BLM may also elect to restore the ruggedness to the landscape in the area surrounding the mine, to minimize human trespass and prevent larger recreational access such as all-terrain vehicles.

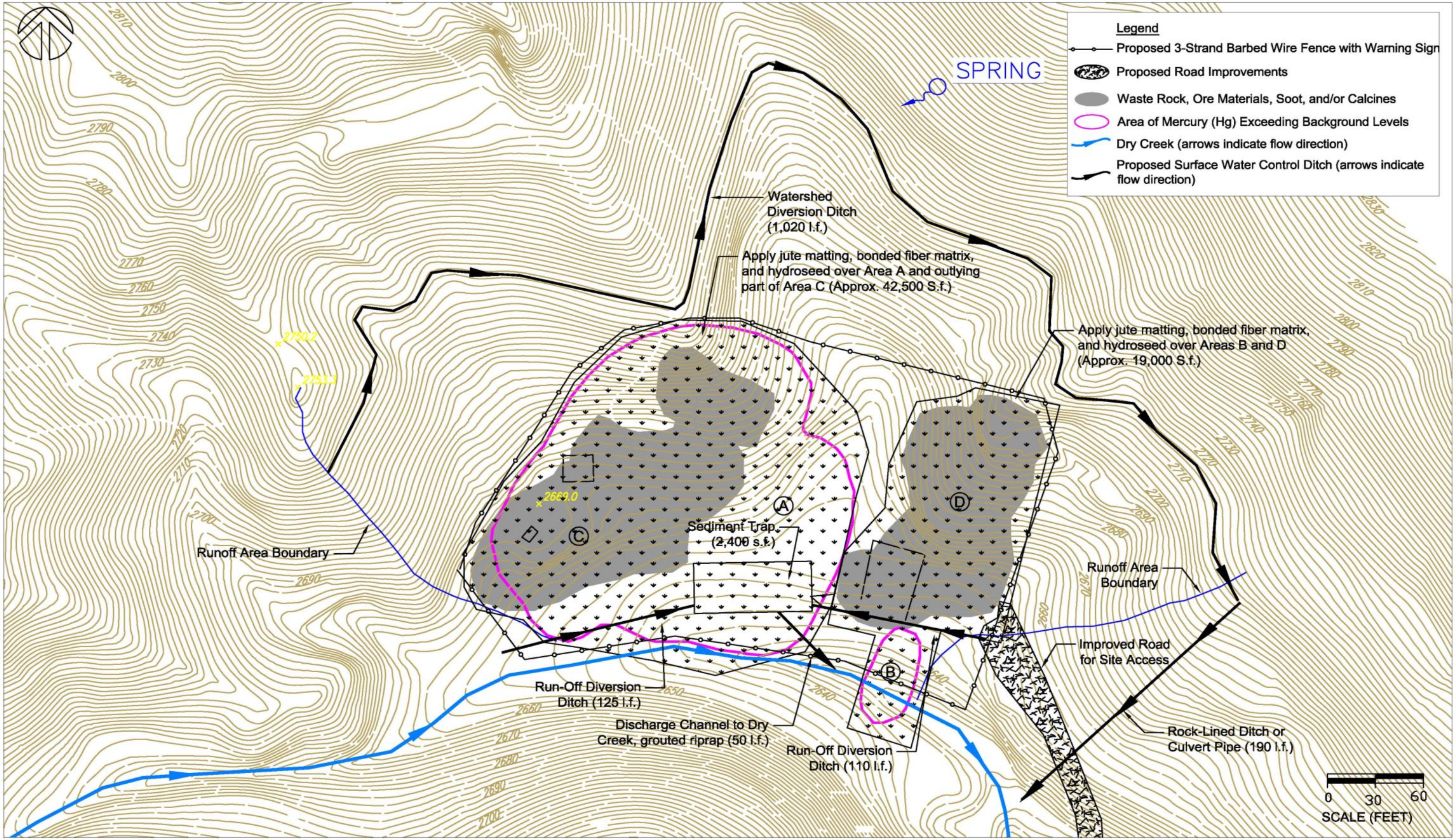


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Figure **11a**

### 7.3.2 Alternative 3 Description - Research Mine

*Road Improvements*

All of the road improvements for Research Mine, introduced in Alternative 2 (see **Section 7.2.2**), are applicable to Alternative 3, as depicted on **Figure 11b**.

*Watershed Diversion Controls*

All of the surface water diversion and discharge features for Research Mine, introduced in Alternative 2 (see **Section 7.2.2**), apply to Alternative 3, as depicted on **Figure 11b**.

*Surface Stabilization*

Surface stabilization at the Research Mine would require erosion control blankets, jute netting, and sprayed-on bonded fiber, to stabilize contaminated material *in-situ* in Areas E, F, H, I, K, L, M, and N. It appears technically impracticable to stabilize the steep, unstable slope for Area J.

In addition, north of Area L along the Dry Creek bank, tailings beneath the three historic furnaces are considerably weathered. To maintain the furnaces and stabilize the tailings/ contaminated waste, the bank of Dry Creek would need to be stabilized and armored by a retaining wall and stabilization of materials abutting the retaining wall (see below under *Decontamination and Fortification of Furnaces*).

*Decontamination and Fortification of Furnaces*

A hazardous materials (Haz-Mat) team would need to utilize decontamination equipment for the three historic furnaces at Research Mine to remove all mercury-laden materials and restore the surfaces to levels safe for human and ecological exposure. These furnaces would remain as historic landmarks.

As indicated above, a retaining wall, approximately 120 feet in length and at least 4-feet high, would be needed to stabilize and maintain the area surrounding the furnaces to provide them with a strong foundation.

*Institutional Controls*

Institutional controls at Research Mine would be similar to those implemented at Chicago Mine, with a fence constructed around the perimeter of the contaminated materials in Areas E, F, H, I, K, L, M, and N. It appears technically impracticable to install fencing around Area J. The three remaining historic furnaces would be protected within the fenced area. Signs would be posted in the same fashion as those described above for Chicago Mine.

As discussed for the Chicago Mine in **Section 7.3.1**, a deed restriction would be required for a site remediated to risk-based criteria.

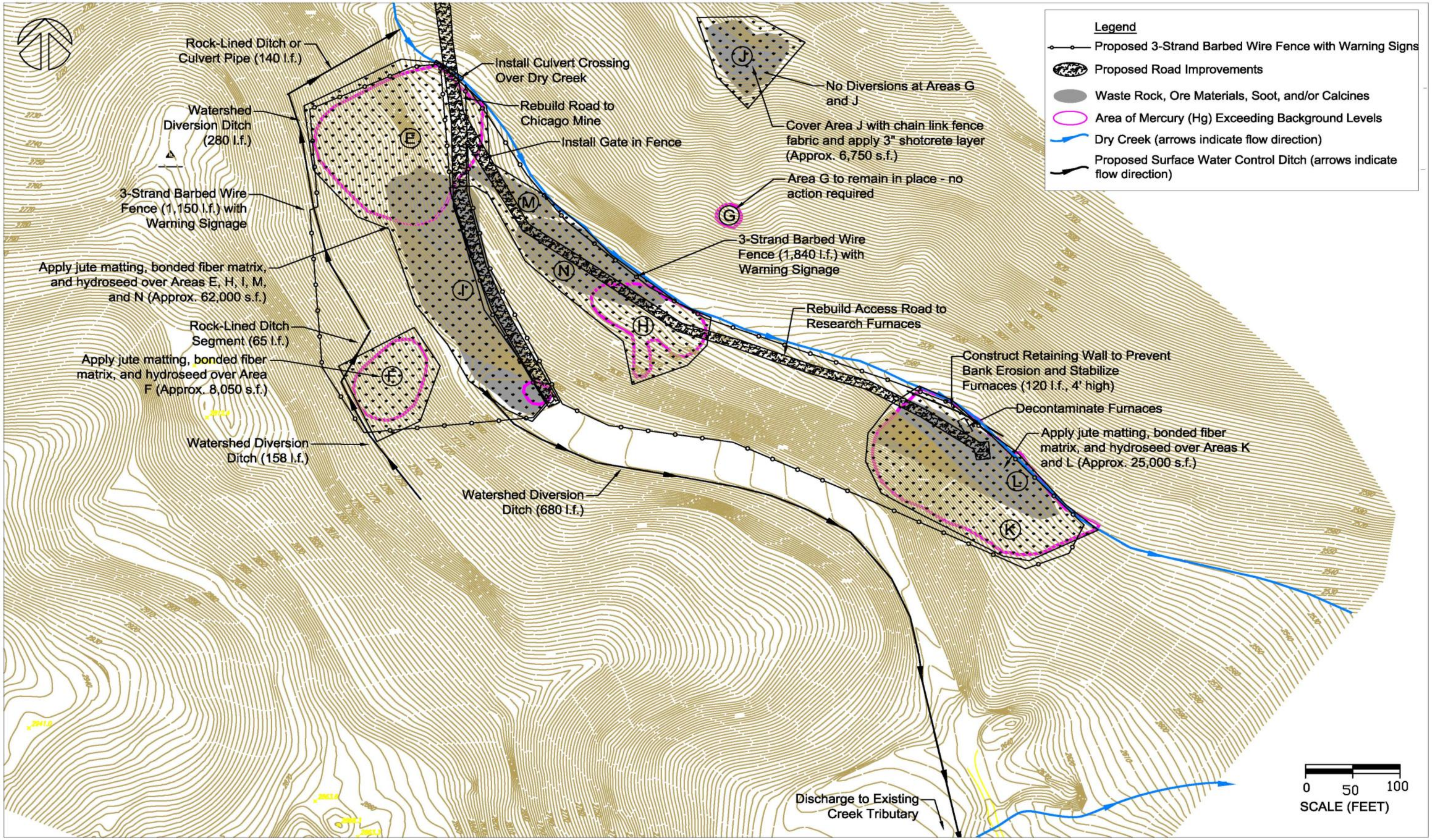


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Figure **11b**

### 7.3.3 Effectiveness of Alternative 3

The following sections provide an evaluation of the effectiveness of Alternative 3. The Surface Stabilization / Institutional Controls Alternative demonstrates environmental conditions that would exist if such actions and/or controls were implemented.

#### *7.3.3.1 Protectiveness*

Alternative 3 reduces exposure of humans and the environment to COCs. This alternative may meet some, but not all, ARARs and RAOs. The alternative does not limit direct exposure, as the waste would remain in place with no cap. However, it provides considerable protection from sediment erosion to surface water, especially in conjunction with stormwater controls.

This alternative would address transport of contaminated materials most prone to erosion via air, gravity, and surface water. Surface water run-on (at both mines) and run-off (at Chicago Mine) are minimized through diversion structures, thus limiting surface water contact with the waste material. This alternative would also reduce direct human contact with the solid materials in the waste rock and tailings piles through hydroseed matting and institutional controls. Permanent fencing, signage, a deed restriction, and an increase in land ruggedness, would protect the exposed areas and improve the chances of natural revegetation, providing even more stability.

#### *7.3.3.2 Compliance with ARARs*

The lack of stabilization, stormwater controls, and fencing in Area J of Research Mine leaves contaminated materials uncovered, presenting a slight sediment erosion risk to Dry Creek, and a risk of direct exposure to humans and ecological receptors. Institutional controls alone will not mitigate these risks. Therefore, Alternative 3 would fail to meet the substantive requirements of a number of the ARARs provided in **Table 20**.

In addition, although the removal of natural vegetation to perform the stabilization activities does not directly violate a site ARAR, the incidental disturbance to natural habitat may be a potential concern with regards to the substantive requirements of the California Wildlife Conservation Act.

#### *7.3.3.3 Ability to Achieve RAOs*

Alternative 3 fails to meet the following RAO requirements:

- Prevention or reduction of human exposure (through inhalation, ingestion, and dermal contact) to COCs in waste materials, because the stabilization measures do not meet the substantive requirements of a cap, and
- Prevention or reduction of ecological exposure (through inhalation, ingestion, and dermal contact) to COCs in waste materials.

Alternative 3 meets the RAO requirements to:

- Prevent or reduce potential migration of COCs in waste materials via erosion and wind dispersion (except in the aforementioned areas);
- Prevent or reduce potential migration of COCs in waste materials via surface runoff (except in the aforementioned areas); and

- Prevent or reduce potential migration of COCs in waste materials to groundwater and eventual potential recharge to surface water.

  This RAO is met; however not necessarily by the removal action alternative. Leaching to groundwater was eliminated as a pathway based the results of the EE/CA field investigation (see **Section 3.4.2**).

#### *7.3.3.4 Level of Treatment/Containment Expected*

This alternative would institute a minimal level of containment. Burrowing animals, human trespass, and severe geological (earthquake) or meteorological (flood) events would significantly alter the landscape and expose contaminated materials. The erosion controls would also require periodic restoration due to the eventual decomposition of the jute matting and the sprayed fiber matrix.

Other than decontamination of the three standing furnaces at Research Mine, this alternative provides no level of treatment.

#### *7.3.3.5 Reduction or Elimination of Residual Concerns*

This alternative would do little to address residual concerns, other than the stabilization of the three furnaces at Research Mine and the significant reduction in sediment transport to Dry Creek.

### 7.3.4 Feasibility/Implementability of Alternative 3

#### *7.3.4.1 Technical Feasibility*

This alternative is technically feasible, though it will require significant improvements to access roads and may result in alterations to Dry Creek (for heavy equipment to traverse), thereby potentially resulting in consultations under the federal *Fish and Wildlife Coordination Act.*

In addition, the practicability of this alternative is questionable because it requires significant land clearing. The surface removal of native vegetation in the areas outlying the waste piles will destroy its underground root system, thus destabilizing the surface areas which then must be stabilized again with artificial materials.

Finally, the source of borrow soil may be a significant issue if it cannot be obtained from an area relatively local to the Chicago Mine Site. Avoiding the desertification of the surrounding hillsides should be a primary objective, to avoid creating a distinctive new natural stormwater run-off path or causing a complete change in the natural run-off channeling. Suitable borrow may be found near the Helen Mine north tailings repository.

The availability of equipment, personnel and services, and obtaining a laboratory do not present any foreseeable obstacle to the technical feasibility of this alternative.

#### *7.3.4.2 Administrative and Legal Feasibility*

As indicated, significant improvements to access roads may result in alterations to Dry Creek for heavy machine to traverse. This will implement a consultation period under the federal *Fish and Wildlife Coordination Act* and would possibly require special permitting and permissions for any locations off-site.

Alternative 3 requires no acquisition of easements or rights-of-way, and offers implementable institutional controls. Some impacts to adjacent lands may occur if remaining exposed materials erode or become wind-blown. Some impacts to adjoining properties may also occur during construction activities and/or road repair work.

#### *7.3.4.3 Ease of Implementation*

Due to the significant road improvements required for heavy machinery to access the Chicago Research Site stabilization areas, this alternative will be more difficult to implement than Alternatives 1 and 2.

Regulatory acceptance is possible but concerns will likely exist because this alternative does not meet all RAOs and ARARs. Community acceptance is unknown at this time but will be determined during the EE/CA public comment period.

### 7.3.5 Cost of Alternative 3

The costs for Alternative 3 have been evaluated in detail. A complete break-out of costs is provided in **Appendix F**. **Table 24** provides a detailed summary of the costs based on the following evaluation criteria:

- Capital Cost
- Post Removal Site Control Cost
- Long-Term Maintenance and Monitoring Costs
- Present Worth Cost/Present Value

The costs for Alternative 3 are calculated individually for the Chicago Mine and the Research Mine in **Appendix F**.

The capital costs are estimated based on the following general elements for each mine location:

- Design costs
- Pre-mobilization submittals
- Mobilization
- Vegetation removal
- Construction of watershed diversions
- Furnace decontamination and retaining wall (at Research Mine only)
- Re-vegetation including jute mats and hydroseeding
- Road repairs (Research Mine costs include a culvert beneath road)
- Barbed wire fence installation
- Demobilization

The post-removal costs and maintenance costs are calculated based on the following general elements for each mine location:

- Annual Site Monitoring
- Annual Maintenance
- 5-Year Maintenance
- Annual Tree Removal
- 3-Year Road Re-Grading

The Present Worth/Present Value cost is calculated based on the total of the capital costs, post-removal costs, and long-term maintenance/monitoring costs, as presented on **Table 24**.

For Alternative 3, the costs are summarized as follows:

**Table 26: Summary of Costs for Remedial Alternative 3**

| Chicago Mine | Alternative 3 |
|---|---|
| Years | 30 |
| Interest Rate (Annual Percentage Rate) | 5% |
| Capital (one-time) | $502,451 |
| Maintenance & Monitoring/Year | $10,686 |
| Post-Removal Site Control/Year | $2,080 |
| Present Value | $698,698 |
| Low Estimate (-30%) | $489,089 |
| High Estimate (+50%) | $1,048,048 |

| Research Mine | Alternative 3 |
|---|---|
| Years | 30 |
| Interest Rate (Annual Percentage Rate) | 5% |
| Capital (one-time) | $728,590 |
| Maintenance & Monitoring/Year | $10,686 |
| Post-Removal Site Control/Year | $2,080 |
| Present Value | $924,837 |
| Low Estimate (-30%) | $647,386 |
| High Estimate (+50%) | $1,387,255 |

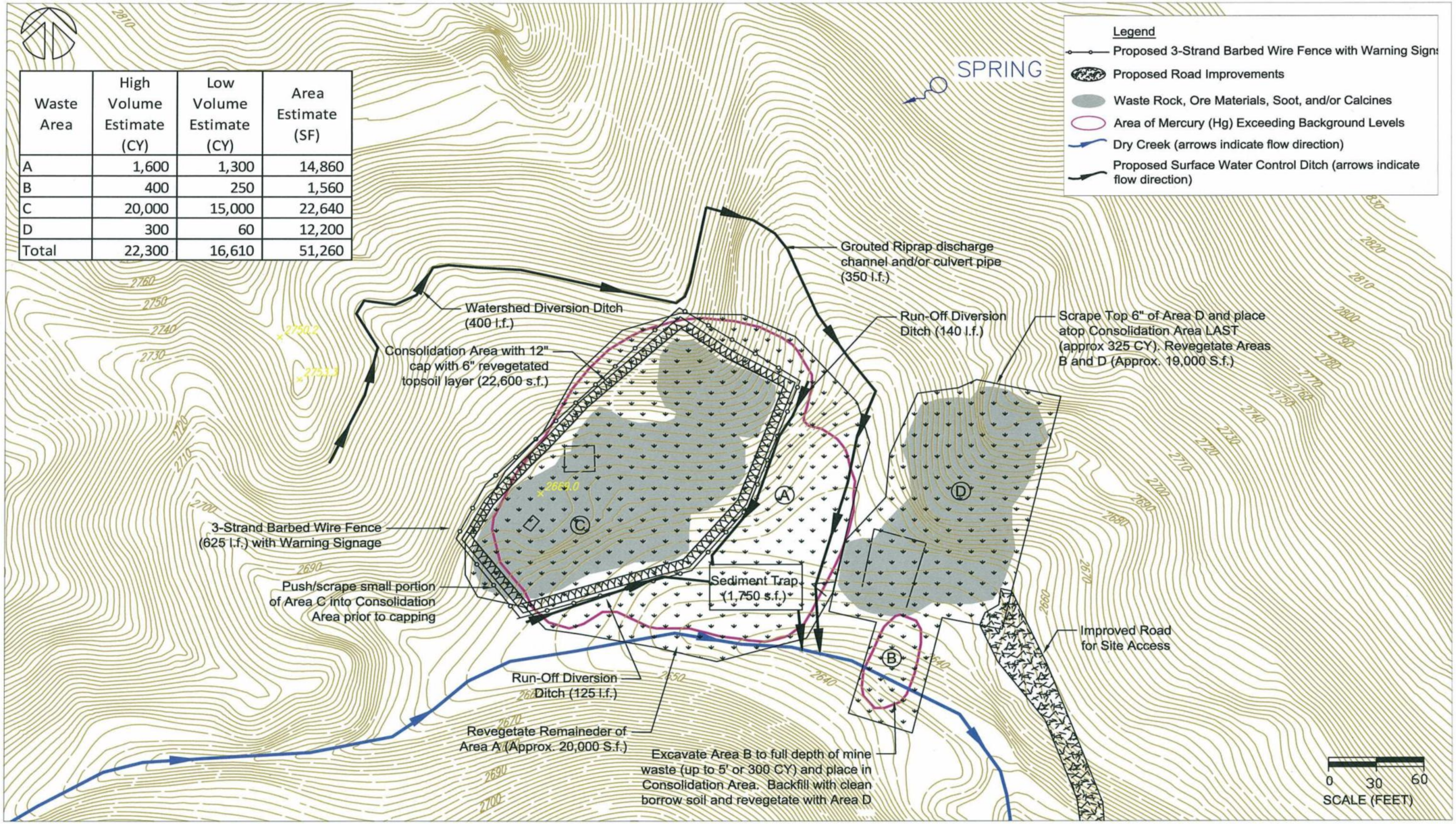
## 7.4 ALTERNATIVE 4: ON-SITE CONSOLIDATION AND CAPPING / INSTITUTIONAL CONTROLS

### 7.4.1 Alternative 4 Description - Chicago Mine

*Road Improvements*

All of the road improvements for Chicago Mine, introduced in Alternative 2 (see **Section 7.2.1**), are applicable to Alternative 4, as depicted on **Figure 12a**. These improvements will facilitate access for earth moving and grading equipment.

| Waste Area | High Volume Estimate (CY) | Low Volume Estimate (CY) | Area Estimate (SF) |
|---|---|---|---|
| A | 1,600 | 1,300 | 14,860 |
| B | 400 | 250 | 1,560 |
| C | 20,000 | 15,000 | 22,640 |
| D | 300 | 60 | 12,200 |
| Total | 22,300 | 16,610 | 51,260 |

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Proj. Manager

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Chkd by:

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Alternative 4: On-Site Consolidation and Capping/ICs
Chicago Mine
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Figure 12a

*Watershed Diversion Controls*

Similar, but less extensive surface water diversion and discharge features for Chicago Mine, introduced in Alternative 2 (see **Section 7.2.1**), apply to Alternative 4, as depicted on **Figure 12a**. The purpose of these controls is to protect the consolidation area cap, as opposed to limiting sediment transport. See notes in **Section 7.4.3.1** regarding the purpose/use of the sediment trap in regards to this alternative.

*Leaching Considerations for Consolidation Cell*

**Section 3.4.2** established that the metals in contaminated materials do not leach to groundwater. **Section 3.4.3** showed that acid mine drainage will not occur at the Chicago Mine and/or the Research Mine.

The waste rock and soil at the Chicago Research Site is classifiable as a Group C mining waste with regards to leachability groundwater. Group C mining wastes are wastes from which any discharge would comply with an applicable water quality control plan, including water quality objectives other than turbidity. Although the leachability results negate the need for a liner, RWQCB would still consider the waste as Group B because of the potential for sediment erosion.

*Onsite Consolidation*

The onsite consolidation cell for Chicago Mine (Chicago Consolidation Area) would be placed where the contaminated material in Area C is already located. The contaminated material from Areas A, B, and D would be scraped up and transported to the Chicago Consolidation Area. The Chicago Consolidation Area would be approximately 22,600 square feet and would require capping and revegetation (further described below).

The contaminated materials for excavation/scraping and consolidation would be as follows:

- Area A: Scrape the top 12 inches, resulting in up to 1,600 cubic yards of contaminated material for removal to consolidation cell.
- Area B: Excavate to full depth of mine waste, up to approximately 5 feet, resulting in up to 300 cubic yards of contaminated material for removal to consolidation cell.
- Small portion of Area C outside of consolidation cell: Push/scrape the small portion of Area C into the Consolidation Area (see **Figure 12a**).
- Area D: Scrape the top 6 inches, resulting in approximately 325 cubic yards of contaminated material for removal to consolidation cell. Add this material to the consolidation cell last because the material is bulkier, less impacted with COCs, and may help deter burrowing animals.

Fugitive dust emissions would be eliminated by laying down water spray during excavation and soil operations, and will conform to the California Code of Regulations and applicable EPA regulations for earth-moving activities in non-contaminated areas.

*Mine Debris Removal*

The collapsed furnace in Area C would need to be razed and removed with all of the other old mine debris (if of no historic value), such as building materials from the two collapsed bunkhouses and the collapsed hoist located at Dry Creek. The mine debris would be added to the consolidation cell.

*Confirmation Sampling*

Following the removal and placement of the contaminated material in the consolidation cell, confirmation sampling would verify removal of COCs to the extent practicable. Confirmation samples would be collected mercury, chromium, cobalt, manganese, and nickel. Once confirmation sampling shows that mercury concentrations are below risk criteria designated for the project, capping and re-vegetation activities would be completed.

*Capping and Re-vegetation*

The Chicago Consolidation Area would require approximately 1,260 cubic yards of borrow soil to create a 12-inch cap, with an additional 6-inch layer of re-vegetated amended soil on top of the borrow soil. Areas A, B and D would require the following:

- Area A: Place six inches of amended soil and re-vegetate with native, drought-tolerant species; approximately 20,000 square feet.
- Area B: Backfill with clean borrow soil and re-vegetate; approximately 1,700 square feet.
- Area D: Re-vegetate approximately 17,000 square feet.

Care must be taken near the banks of the Dry Creek during restoration activities to avoid re-vegetation with any plants which would grow along the banks of the creek and ultimately obstruct or alter flow. Special care must also be taken to ensure gravity and/or streamflow will not erode and undermine the restored creek banks.

*Institutional Controls*

Alternative 4 requires the majority of the contaminated materials to be consolidated and covered. Institutional controls, such as permanent access fencing around the Chicago Consolidation Area (see **Figure 12a**), signage, and thorny vegetation, would be necessary to minimize human disturbance and to discourage recreational activities on the cap.

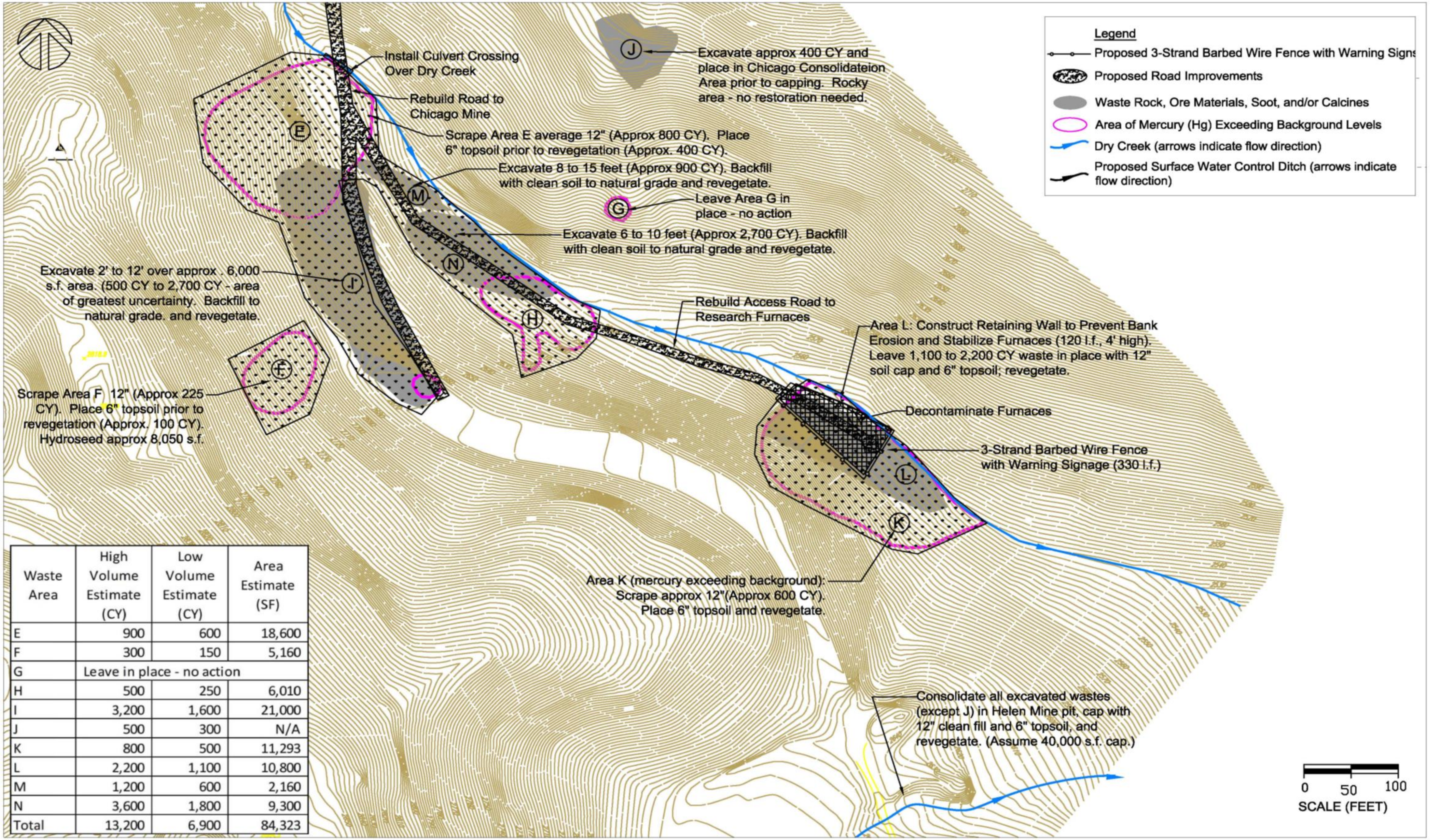
As discussed in **Section 7.3.1**, a deed restriction would be required for a site remediated to risk-based criteria to minimize trespassing and reduce exposure risks.

BLM may also elect to restore the ruggedness to the landscape in the area surrounding the mine, to minimize human trespass and prevent larger recreational access such as all-terrain vehicles.

### 7.4.2 Alternative 4 Description - Research Mine

*Road Improvements*

All of the road improvements for Research Mine, introduced in Alternative 2 (see **Section 7.2.2**), are applicable to Alternative 4, as depicted on **Figure 12b**. In addition, special decontamination areas would be needed to sanitize the trucks to ensure contaminated material is not tracked between the Research Mine and Helen Mine.




| Waste Area | High Volume Estimate (CY) | Low Volume Estimate (CY) | Area Estimate (SF) |
|---|---|---|---|
| E | 900 | 600 | 18,600 |
| F | 300 | 150 | 5,160 |
| G | Leave in place - no action | | |
| H | 500 | 250 | 6,010 |
| I | 3,200 | 1,600 | 21,000 |
| J | 500 | 300 | N/A |
| K | 800 | 500 | 11,293 |
| L | 2,200 | 1,100 | 10,800 |
| M | 1,200 | 600 | 2,160 |
| N | 3,600 | 1,800 | 9,300 |
| Total | 13,200 | 6,900 | 84,323 |

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Alternative 4: On-site Consolidation and Capping/ICs
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Figure
**12b**

*Watershed Diversion Controls*

The surface water diversion and discharge features for Research Mine, introduced in Alternative 2 (see **Section 7.2.2**), do not apply to Alternative 4. The Research wastes consolidated in the Helen Mine Consolidation Area would be protected by the watershed diversions installed as part of the Helen Mine removal action.

*Leaching Considerations for Consolidation Cell*

As established in **Section 3.4.3** and again above for Chicago Mine in **Section 7.4.1**, the waste rock and soil at the Chicago Research Site is classifiable as a Group C mining waste and does not require a consolidation cell liner or leachate collection/removal system.

*Consolidation*

There is no room to establish a consolidation cell at the Research Mine, nor is it effective or convenient to transport all of the material from Research Mine to the Chicago Consolidation Area. As such, a consolidation cell for contaminated material would be established at the Helen Consolidation Area (the aforementioned Helen Mine open pit).

The contaminated material for excavation/scraping and consolidation would be as follows:

- Area E: Scrape an average of 12 inches; remove approximately 800 cubic yards.
- Area F: Scrape an average of 12 inches; remove approximately 225 cubic yards.
- Area H: Scrape approximately 12 inches; remove approximately 400 cubic yards.
- Area I: Excavate 2 feet to 12 feet over an area of approximately 6,000 square feet; remove approximately 500 to 2,700 cubic yards.
- Area J: Excavate approximately 400 cubic yards. *This material would be placed in the Chicago Consolidation Area.*
- Area K: Scrape approximately 12" on both sides of creek; remove approximately 600 cubic yards.
- Area L: Construct a retaining wall to prevent bank erosion and stabilize furnaces with a retaining wall (as discussed in **Section 7.3.2**). Leave 1,100 to 2,200 cubic yards of contaminated material in place for foundation support for the furnaces.
- Area M: Excavate 8 to 15 feet; remove approximately 900 cubic yards.
- Area N: Excavate 6 to 10 feet; remove approximately 2,700 cubic yards.

The excavation and removal of contaminated material would require a significant amount of vegetation clearing (shrub/tree removal).

Fugitive dust emissions would be eliminated by laying down water spray during excavation and soil operations, and will conform to the California Code of Regulations and applicable EPA regulations for earth-moving activities in non-contaminated areas.

*Mine Debris Removal*

Any mine debris associated with forming mining operations, such as the remains of the brick retort and chimney on the south bank of Dry Creek, would be removed and transported to the Helen Consolidation Area.

*Confirmation Sampling*

Following the removal of the contaminated material and its placement in the consolidation cell, confirmation sampling would be conducted to verify that contamination was fully removed to the extent practicable. Confirmation samples would be collected for total COC metals. Once confirmation sampling shows that COCs concentrations are below risk criteria designated for the project, capping and re-vegetation activities would be completed.

*Capping and Re-vegetation*

The Helen Consolidation Area would require an anticipated 40,000 square foot cap of borrow soil to create a 12-inch cap, with an additional 6-inch layer of re-vegetated amended soil on top of the borrow soil.

Areas E through N would require the following restoration activities:

- Area E: Lay 6 inches (approximately 400 cubic yards) of amended soil prior to re-vegetating with native, drought-tolerant vegetation.
- Area F: Lay 6 inches (approximately 100 cubic yards) of amended soil prior to re-vegetating and hydroseeding approximately 8,050 square feet for stability.
- Area H: Lay 6 inches of amended soil prior to re-vegetating.
- Area I: Area J: Backfill to natural grade and re-vegetate where appropriate.
- Area J: Rocky area - no restoration needed.
- Area K: Lay 6 inches of amended soil and re-vegetate.
- Area L: To avoid damaging the furnace foundations, leave 1,100 to 2,200 CY waste in place for furnace foundation support and cap with 12 inches of soil and 6 inches of amended soil. Re-vegetate where appropriate.
- Area M: Backfill with clean soil to natural grade and re-vegetate.
- Area N: Backfill with clean soil to natural grade and re-vegetate.

Care must be taken near the banks of the Dry Creek during restoration activities to avoid re-vegetation with any plants which would grow along the banks of the creek and ultimately obstruct or alter flow. Special care must also be taken to ensure gravity and/or streamflow will not cause erode or undermine the restored creeks banks.

*Decontamination and Fortification of Furnaces*

The decontamination and stabilization of the three Research Mine Furnaces would be the same in this alternative as described in Alternative 3 (see **Section 7.3.2**). This includes the construction of a concrete retaining wall to stabilize the creek bank and the furnace foundations.

*Institutional Controls*

Institutional controls at the Helen Consolidation Area would be similar to those implemented at Chicago Mine, with a fence constructed around the perimeter of the consolidation cell (see **Figure 12b**). At the Research Mine, the three remaining historic furnaces would need to be protected within a fenced area with appropriate signage.

As discussed in **Section 7.3.1**, a deed restriction would be required for a site remediated to risk-based criteria.

### 7.4.3 Effectiveness of Alternative 4

The following subsections evaluate the effectiveness of Alternative 4. The On-Site Consolidation and Capping / Institutional Controls Alternative demonstrates environmental conditions that would exist if such actions and/or controls were implemented.

#### *7.4.3.1 Protectiveness*

The consolidation cells associated with Chicago Mine and Helen Mine would provide an adequate level of environmental protection, considering the chemical and physical characteristics and the physical location of the materials to be addressed. However, it is possible that residual contamination may exist within the surrounding soils after excavation. The action would effectively reduce contaminant mobility by capping the highest risk media sources, primarily mercury-contaminated waste materials, in a secure on-site repository.

The capped consolidation cells with associated storm water controls would effectively prevent percolation through the waste materials by deflecting surface water and preventing sediment erosion. Alternative 4 also prevents direct exposure by accumulating the contaminated material and capping the material into two smaller, easier to manage, consolidation areas (Chicago and Helen).

The sediment trap, installed as part of the storm water run-off controls, would not be constructed for the same reason as in earlier alternatives. In Alternative 2 and 3, the sediment trap would be installed to allow mercury-laden sediment to settle out before reaching Dry Creek. For Alternative 4, the purpose of the sediment trap is to reduce water influx to the Dry Creek, allowing natural vegetation to restore itself along the creek and thus eventually restoring the natural erosion controls along Dry Creek.

#### *7.4.3.2 Compliance with ARARs*

Alternative 4 addresses all ARARs.

#### *7.4.3.3 Ability to Achieve RAOs*

Alternative 4 meets all RAOs, with explanations and minor exceptions noted:

- Prevent or reduce human exposure (through inhalation, ingestion, and dermal contact) to COCs in waste materials;

  Alternative 4 meets this ARAR by reducing exposure and/or eliminating exposure in the areas where contaminated material is completely removed.

- Prevent or reduce ecological exposure (through inhalation, ingestion, and dermal contact) to COCs in waste materials;

  Alternative 4 meets this ARAR by blocking exposure to human receptors and reducing exposure to ecological receptors. Ecological exposure is not prevented or eliminated due to the ability for burrowing animals to enter the consolidation areas and the area of capped contaminated material near the Research Mine furnaces. A special precaution was addressed at the Chicago Consolidation Area by placing bulky, low COC-impact waste in the consolidation cell last before capping to deter burrowing animals.

Total protection of ecological receptors is not possible because background COC levels already exceed the ecological, risk-based screening levels. Alternative 4 still protects ecological receptors better than Alternatives 1, 2 and 3.

Institutional controls at the Research Mine near the furnaces and the Chicago Mine consolidation cell would further limit the potential for human exposure and cap disturbance.

- Prevent or reduce potential migration of COCs in waste materials via surface runoff, erosion, and wind dispersion; and

  RAO achieved through large reduction in migration potential.

- Prevent or reduce potential migration of COCs in waste materials to groundwater and eventual potential recharge to surface water.

  RAO achieved; leaching to groundwater was eliminated as a pathway based the results of the EE/CA field investigation (see **Section 3.4.2**).

#### *7.4.3.4 Level of Treatment/Containment Expected*

No treatment is proposed with this alternative with the exception of the capping control. A high level of containment, with the use of institutional controls in conjunction with the consolidation cell caps, can be expected with proper maintenance.

#### *7.4.3.5 Reduction or Elimination of Residual Concerns*

Residual concerns are reduced considerably by excavating away a lot of the contaminated material and reducing the areal size of contamination. Contaminated material is almost completely removed from the Research Mine.

### 7.4.4 Feasibility/Implementability of Alternative 4

#### *7.4.4.1 Technical Feasibility*

As with Alternative 3, locating a viable source for the borrow soil for Alternative 4 may present a difficult implementation obstacle. Soil must be obtained from an area which will not result in negative impacts to the natural landscape and would not result in offsite impacts. Suitable borrow may be found near the Helen Mine north tailings repository. Again, as with Alternative 3, this alternative would require significant road improvements.

The availability of equipment, personnel and services, and obtaining a laboratory would not present any foreseeable obstacle to the technical feasibility of this alternative.

#### *7.4.4.2 Administrative and Legal Feasibility*

Significant improvements to access roads may result in alterations to Dry Creek for heavy machinery to traverse. This will implement a consultation period under the federal Fish and Wildlife Coordination Act and would possible require special permitting and permissions for areas offsite.

Alternative 4 requires no acquisition of easements or rights-of-way, and offers implementable institutional controls. Some impacts to adjacent lands may occur if remaining exposed materials erode or become wind-blown. Some impacts to adjoining properties may also occur during construction activities and road repair work.

#### *7.4.4.3 Ease of Implementation*

Regulatory acceptance is likely with Alternative 4 because it achieves RAOs and ARARs. Community acceptance is unknown at this time but will be determined during the EE/CA Report public comment period. It is likely the community would accept this alternative as protective. BLM adopted a similar approach to the remediation of the Helen Mine.

### 7.4.5 Cost of Alternative 4

The costs for Alternative 4 have been evaluated in detail. A complete break-out of costs is provided in **Appendix F**. **Table 24** provides a detailed summary of the costs based on the following evaluation criteria:

- Capital Cost
- Post Removal Site Control Cost
- Long-Term Maintenance and Monitoring Costs
- Present Worth Cost/Present Value

The costs for Alternative 4 are calculated individually for the Chicago Mine and the Research Mine in **Appendix F**.

The capital costs are estimated based on the following general elements for each mine location:

- Design costs
- Pre-mobilization submittals
- Mobilization
- Vegetation removal
- Construction of consolidate cell (for Research Mine, refers to Helen Consolidation Cell)
- Capping of consolidation cell
- Construction of watershed diversions
- Furnace decontamination and retaining wall (at Research Mine only)
- Re-vegetation with native plants
- Road repairs (Research Mine costs include a culvert beneath road)
- Barbed wire fence installation
- Demobilization

The post-removal costs and maintenance costs are calculated based on the following general elements for each mine location:

- Annual Site Monitoring
- Annual Maintenance
- 5-Year Maintenance
- Annual Tree Removal
- 3-Year Road Re-Grading

The Present Worth/Present Value cost is calculated based on the total of the capital costs, post-removal costs, and long-term maintenance/monitoring costs, as presented on **Table 24**.

For Alternative 4, the costs are summarized as follows:

**Table 27: Summary of Costs for Remedial Alternative 4**

| Chicago Mine | Alternative 4 |
|---|---|
| Years | 30 |
| Interest Rate (Annual Percentage Rate) | 5% |
| Capital (one-time) | $533,470 |
| Maintenance & Monitoring/Year | $13,763 |
| Post-Removal Site Control/Year | $2,080 |
| Present Value | $777,023 |
| Low Estimate (-30%) | $543,916 |
| High Estimate (+50%) | $1,165,535 |

| Research Mine | Alternative 4 |
|---|---|
| Years | 30 |
| Interest Rate (Annual Percentage Rate) | 5% |
| Capital (one-time) | $773,787 |
| Maintenance & Monitoring/Year | $13,763 |
| Post-Removal Site Control/Year | $2,080 |
| Present Value | $1,017,340 |
| Low Estimate (-30%) | $712,138 |
| High Estimate (+50%) | $1,526,011 |

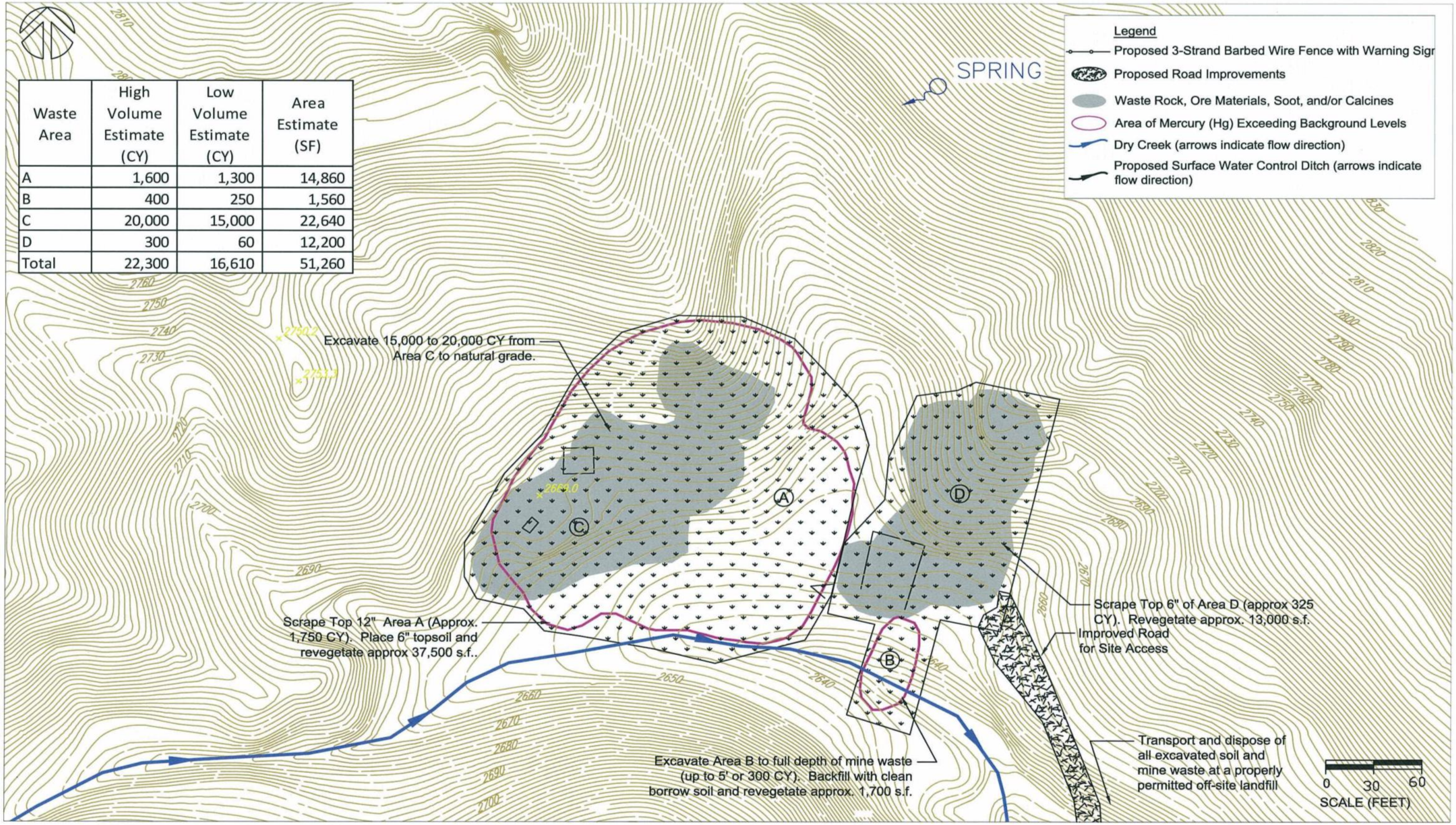
## 7.5 ALTERNATIVE 5: EXCAVATION AND OFF-SITE DISPOSAL

### 7.5.1 Alternative 5 Description - Chicago Mine

*Road Improvements*

All of the road improvements for Chicago Mine, introduced in Alternative 2 (see **Section 7.2.1**), apply to Alternative 5, as depicted on **Figure 13a**. Significant road work would be required to create sufficient access for equipment and waste hauling. Staging areas will be needed for placement of work trailers, portable lavatories, storage of supplies, and staging of waste stockpiles awaiting off-site disposal. Covers of vehicles and proper vehicle decontamination and tracking control would be necessary to ensure that contamination is not spread outside of the work areas as the vehicles leave for offsite disposal.

| Waste Area | High Volume Estimate (CY) | Low Volume Estimate (CY) | Area Estimate (SF) |
|---|---|---|---|
| A | 1,600 | 1,300 | 14,860 |
| B | 400 | 250 | 1,560 |
| C | 20,000 | 15,000 | 22,640 |
| D | 300 | 60 | 12,200 |
| Total | 22,300 | 16,610 | 51,260 |

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Chicago Mine
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Figure
**13a**

*Excavation*

The excavation areas for Chicago Mine would include:

- Area A: Scrape top 12 inches of contaminated material; remove approximately 1,750 cubic yards.
- Area B: Excavate to full depth of mine waste, potential up to 5 feet of contaminated material; remove approximately 300 cubic yards.
- Area C: Excavate 15,000 to 20,000 cubic yards, down to natural grade.
- Area D: Scrape top 6 inches of contaminated material; remove approximately 325 cubic yards.

Appropriate storm water pollution prevention measures such as drainage swales, sediment ponds, or silt fencing will be incorporated into the project to minimize the potential for adverse impacts to water quality during construction and excavation activities. Fugitive dust emissions will be eliminated by laying down water spray during excavation and soil operations, and will conform to the California Code of Regulations and applicable EPA regulations for earth-moving activities in non-contaminated areas.

Significant care would be required when excavating near the banks of the Dry Creek in Areas A and B to avoid altering or obstructing the natural flow of water in any way. The use of hand held equipment is preferable to avoid heavy machinery impacts at the creek bank.

*Off-Site Disposal*

The requirement for disposal in a California commercial landfill is 20 mg/kg total mercury and 0.2 mg/L dissolved mercury. This scope assumes that 80% of the wastes would not pass the requirements for non-hazardous materials disposal in a California facility, and would thus be required to be disposed of as special manifested non-RCRA regulated waste, in a Class I hazardous waste facility (CleanHarbors, Inc., Lokern Landfill, Buttonwillow, CA). It is assumed that the remaining 20% of materials removed from the site could be disposed of at a California Class II landfill (Recology, Inc., Hay Road Landfill, Vacaville, CA).

The California Solid Waste Management Regulations apply to all disposal sites, including facilities or equipment used at the disposal sites. This is an applicable ARAR which must be addressed if any solid waste is transported away from site.

*Confirmation Sampling*

Following the removal of the contaminated material from each area, confirmation sampling would verify that contamination was fully removed to the extent practicable. Confirmation samples would be collected for total COC metals. Once confirmation sampling shows that COC concentrations are below risk criteria designated for the project, restoration activities would be completed.

*Restoration Activities*

The depressions left by excavated materials must be re-graded to direct surface water into natural channels and drainages. All disturbed areas would be re-graded for positive drainage, and then vegetated with native species as soon as practicable in order to minimize constructionrelated sediment transport. Post removal site control (operations and maintenance) would consist of minor erosion repair to the channel systems.

The following restoration activities are proposed for the excavated areas of contaminated material:

- Area A: Place 6" of amended soil and re-vegetate approximately 37,500 square feet of land.
- Area B: Backfill with clean borrow soil and re-vegetate approximately. 1,700 square feet of land.
- Area C: Excavate and return to natural grade.
- Area D: Re-vegetate approximately 13,000 square feet of land.

Care must be taken near the banks of the Dry Creek in Areas A and B during restoration activities to avoid vegetation with any plants which would grow along the banks of the creek and ultimately obstruct or alter flow. Special care must also be taken to ensure gravity and/or streamflow will not erode or undermine the restored creek banks.

*Institutional Controls*

A deed restriction would be required for the Chicago Mine because it would be remediated to a risk-based (background) level, which in some cases is higher than an RBSL or regulatory screening level.

### 7.5.2 Alternative 5 Description - Research Mine

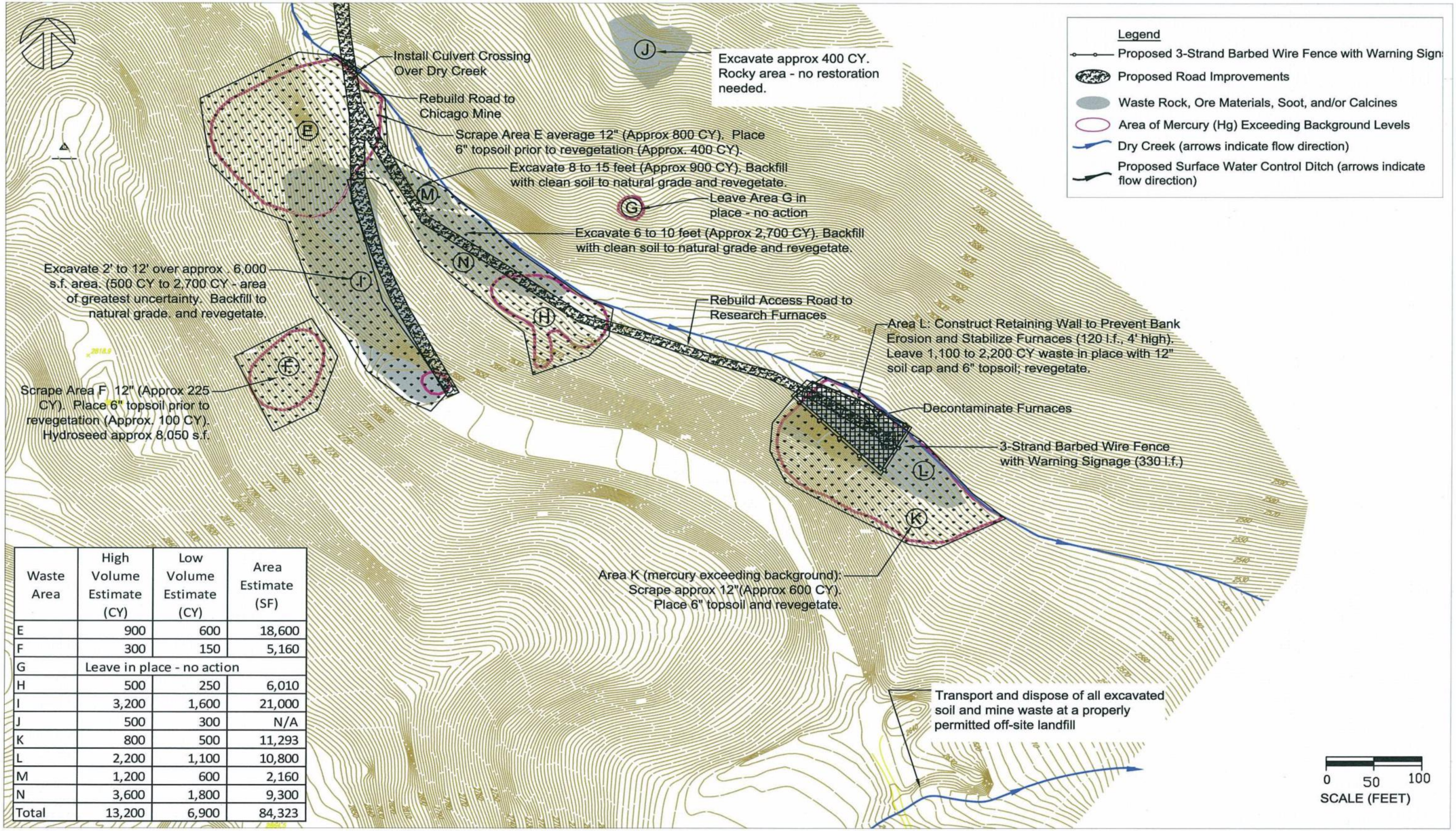
*Road Improvements*

All of the road improvements for Research Mine, introduced in Alternative 2 (see **Section 7.2.2**), are applicable to Alternative 5, as depicted on **Figure 13b**.

*Excavation*

The contaminated material for excavation at the Research Mine would include:

- Area E: Scrape an average of 12 inches; remove approximately 800 cubic yards.
- Area F: Scrape an average of 12 inches; remove approximately 225 cubic yards.
- Area H: Scrape approximately 12 inches; remove approximately 400 cubic yards.
- Area I: Excavate 2 feet to 12 feet over an area of approximately 6,000 square feet; remove approximately 500 to 2,700 cubic yards.
- Area J: Excavate approximately 400 cubic yards. This material would be placed in the Chicago Consolidation Area.
- Area K: Scrape approximately 12" on both sides of creek; remove approximately 600 cubic yards.
- Area L: Construct a retaining wall to prevent bank erosion and stabilize furnaces with a retaining wall (as discussed in **Section 7.3.2**). Leave 1,100 to 2,200 cubic yards of contaminated material in place for foundation support for the furnaces.

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|---|---|---|---|
| E | 900 | 600 | 18,600 |
| F | 300 | 150 | 5,160 |
| G | Leave in place - no action | | |
| H | 500 | 250 | 6,010 |
| I | 3,200 | 1,600 | 21,000 |
| J | 500 | 300 | N/A |
| K | 800 | 500 | 11,293 |
| L | 2,200 | 1,100 | 10,800 |
| M | 1,200 | 600 | 2,160 |
| N | 3,600 | 1,800 | 9,300 |
| Total | 13,200 | 6,900 | 84,323 |

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Figure **13b**

- Area M: Excavate 8 to 15 feet; remove approximately 900 cubic yards.
- Area N: Excavate 6 to 10 feet; remove approximately 2,700 cubic yards.

Significant care would be required when excavating near the banks of the Dry to avoid altering or obstructing the natural flow of water in any way. The use of hand held equipment is preferable to avoid heavy machinery impacts at the creek bank.

*Off-Site Disposal*

The disposal criteria for the Research Mine would be the same as those required for the Chicago Mine (see **Section 7.5.1**).

*Mine Debris Removal*

Any mine debris associated with forming mining operations, such as the remains of the brick retort and chimney on the south bank of Dry Creek, would require offsite disposal.

*Decontamination and Fortification of Furnaces*

The decontamination and stabilization of the three Research Mine Furnaces would be the same in this alternative as described in Alternative 3 (see **Section 7.3.2**).

*Confirmation Sampling*

Following the removal of the contaminated material from each area, confirmation sampling would verify that contamination was fully removed to the extent practicable. Confirmation samples would be collected for total COC metals. Once confirmation sampling shows that COC concentrations are below risk criteria designated for the project, restoration activities would be completed.

*Restoration Activities*

Areas E through N would require the following restoration activities:

- Area E: Lay 6 inches (approximately 400 cubic yards) of amended soil prior to re-vegetating.
- Area F: Lay 6 inches (approximately 100 cubic yards) of amended soil prior to re-vegetating and hydroseeding approximately 8,050 square feet for stability.
- Area H: Lay 6 inches of amended soil prior to re-vegetating.
- Area I: Backfill to natural grade and re-vegetate where appropriate.
- Area J: Rocky area - no restoration needed.
- Area K: Lay 6 inches of amended soil and re-vegetate.
- Area L: Leave 1,100 to 2,200 CY waste in place for furnace foundation support and cap with 12 inches of soil and 6 inches of amended soil. Re-vegetate where appropriate.
- Area M: Backfill with clean soil to natural grade and re-vegetate.
- Area N: Backfill with clean soil to natural grade and re-vegetate.

Care must be taken near the banks of the Dry Creek during restoration activities to avoid vegetation with any plants which would grow along the banks of the creek and ultimately obstruct or alter flow. Special care must also be taken to ensure gravity and/or streamflow will not erode and undermine the restored creeks banks.

*Institutional Controls*

Institutional controls would be recommended in the area surrounding the capped waste at the Research Mine near the furnaces. Signs and fencing would be sufficient to protect this area from human trespass. Fencing would deter larger animals, and placing coarser material under the 18-inch cap would deter smaller animals from digging into the waste.

A deed restriction would be required for the Research Mine because it would be remediated to a risk-based (background) level, which in some cases is higher than an RBSL or regulatory screening level.

### 7.5.3 Effectiveness of Alternative 5

The following subsections evaluate the effectiveness of Alternative 5. The Excavation and Off-Site Disposal Alternative demonstrates environmental conditions that would exist if such actions were implemented.

#### *7.5.3.1 Protectiveness*

This alternative provides the highest possible level of environmental protection at the local level. The complete removal of waste materials from the currently exposed, uncontrolled environment to a permitted facility eliminates the on-site potential for human and/or ecological exposure through inhalation, ingestion, and dermal contact.

The hauling operations would not be confined to BLM property, and the hauling distance to the landfill poses a limited potential exposure to the public. Special care would be taken to assure trucks are decontaminated before leaving the Chicago Research Site and that truck covers prevent wind-blown dust. The offsite commercial landfill alternative has the highest level of long-term effectiveness, as the landfill would have a post-closure monitoring and maintenance period of 30 years or longer and will presumably have site security, environmental monitoring, maintenance requirements, and other systems required of a commercial facility.

At the global sustainability level, this alternative involves over 2,000 dump trucks transporting contaminated material to an offsite (distant) landfill. It will congest highways and create significant diesel and greenhouse gas (GHG) emissions.

#### *7.5.3.2 Compliance with ARARs*

Alternative 5 addresses all ARARs except one. The introduction of high levels of GHG emissions would fail to meet the substantive requirements of The California Global Warming Solutions Act of 2006 (see **Table 20**).

#### *7.5.3.3 Ability to Achieve RAOs*

All Chicago Research RAOs would be met with this alternative, as follows:

- Prevention of human exposure (through inhalation, ingestion, and dermal contact) to COCs in waste materials;
- Prevention of ecological exposure (through inhalation, ingestion, and dermal contact) to COCs in waste materials;

- Prevention of potential migration of COCs in waste materials via surface runoff, erosion, and wind dispersion; and
- Prevention of potential migration of COCs in waste materials to groundwater and eventual potential recharge to surface water.

#### *7.5.3.4 Level of Treatment/Containment Expected*

Alternative 5 would provide nearly 100% treatment of the known areas of contaminated material at the Chicago Research Site through excavation and disposal. The area of capping at the Research Mine furnaces would remain an area of potential exposure, which is why institutional controls are recommended in this area. An extremely high level of containment can be expected at the offsite disposal facility.

#### *7.5.3.5 Reduction or Elimination of Residual Concerns*

This alternative is considered permanent, and is thus effective in both the short-term and long-term. This alternative will almost completely eliminate residual concerns at the Chicago Research Site. The only remaining areas of concern would include:

- The 1,100 to 2,200 cubic yards of waste remaining in place at Research Mine near the furnaces. This waste will be capped with a 12-inch soil cap and 6 inches of re-vegetated amended soil. The cap and the surrounding fence would require periodic maintenance.
- On-going monitoring and inspection of Dry Creek would be necessary in Areas A, B, H, L, M, and N, to ensure gravity and/or erosion have not caused collapsed along the banks in the restoration area.

### 7.5.4 Feasibility/Implementability of Alternative 5

#### *7.5.4.1 Technical Feasibility*

The limitations of site access and the volume of contaminated material to be removed, play a key role in the implementability of this alternative. Alternative 5 would require redevelopment of site access roads to accommodate two-way traffic by large trucks and space for them to maneuver during loading. Steep slopes and rough terrain will limit equipment performance, even with road improvements for easier access.

The necessary equipment, personnel, and laboratory services for excavating and transporting the waste are available to support implementation of this removal action.

#### *7.5.4.2 Administrative and Legal Feasibility*

Permits and easements would possibly be required in areas of significant road improvements.

Alternative 5 offers implementable institutional controls. Some impacts to adjoining properties would occur during construction activities and road repair work.

#### *7.5.4.3 Ease of Implementation*

A very high level of operational requirements, including excavation, consolidation, compaction, grading, and the transport of waste, would be incurred with Alternative 5. Difficulties would be experienced in carrying out hauling scenario logistics.

Regulatory acceptance is likely with Alternative 5 because it meets RAOs. However, failure to support the initiatives of The California Global Warming Solutions Act may meet with regulatory resistance. Community acceptance is unknown at this time but will be determined during the EE/CA Report public comment period. The community would probably accept this alternative as protective, but they may object to highway congestion by waste haulers.

### 7.5.5 Cost of Alternative 5

The costs for Alternative 5 have been evaluated in detail. A complete break-out of costs is provided in **Appendix F**. **Table 24** provides a detailed summary of the costs based on the following evaluation criteria:

- Capital Cost
- Post Removal Site Control Cost
- Long-Term Maintenance and Monitoring Costs
- Present Worth Cost/Present Value

The costs for Alternative 5 are calculated individually for the Chicago Mine and the Research Mine in **Appendix F**.

The capital costs are estimated based on the following general elements for each mine location:

- Design costs
- Pre-mobilization submittals
- Mobilization
- Vegetation removal
- Excavation
- Waste hauling and disposal (assumes 80% to Class I landfill and 20% to Class II landfill)
- Furnace decontamination and retaining wall (at Research Mine only)
- Re-vegetation
- Road repairs (Research Mine costs include a culvert beneath road)
- Barbed wire fence installation
- Demobilization

The post-removal costs and maintenance costs are calculated based on the following general elements for each mine location:

- Annual Site Monitoring
- Annual Maintenance
- 5-Year Maintenance
- Annual Tree Removal
- 3-Year Road Re-Grading

The Present Worth/Present Value cost is calculated based on the total of the capital costs, post-removal costs, and long-term maintenance/monitoring costs, as presented on **Table 24**.

For Alternative 5, the costs are summarized as follows:

**Table 28: Summary of Costs for Remedial Alternative 5**

| Chicago Mine | Alternative 5 |
|---|---|
| Years | 5 |
| Interest Rate (Annual Percentage Rate) | 2% |
| Capital (one-time) | $3,017,598 |
| Maintenance & Monitoring/Year | $2,435 |
| Post-Removal Site Control/Year | $- |
| Present Value | $3,029,074 |
| Low Estimate (-30%) | $2,120,352 |
| High Estimate (+50%) | $4,543,611 |

| Research Mine | Alternative 5 |
|---|---|
| Years | 5 |
| Interest Rate (Annual Percentage Rate) | 2% |
| Capital (one-time) | $3,096,371 |
| Maintenance & Monitoring/Year | $5,640 |
| Post-Removal Site Control/Year | $2,080 |
| Present Value | $3,132,763 |
| Low Estimate (-30%) | $2,192,934 |
| High Estimate (+50%) | $4,699,145 |

# 8 COMPARATIVE ANALYSIS OF REMOVAL ACTION ALTERNATIVES

**Table 29** summarizes the removal action alternatives and ranks the alternatives from most likely to least likely to achieve all of the removal action goals **Table 30** presents a detailed comparative analysis of the evaluation criteria for each alternative.

**Table 29: Summary and Ranking of Alternatives**

| Rank | Alternative | Effectiveness | Feasibility/ Implementability | Median Present Value Cost |
|---|---|---|---|---|
| 1 | Alternative 4: On-Site Consolidation and Capping / Institutional Controls | Addresses ARARs. Achieves RAOs with exception of some waste in place. | Difficult to implement but feasible | Chicago: $777,023<br>Research: $1,017,340 |
| 2 | Alternative 5: Excavation and Off-Site Disposal | Addresses most ARARs. Achieves RAOs with exception of some waste in place. | Very difficult to implement | Chicago: $3,029,074<br>Research: $3,132,763 |
| 3 | Alternative 3: Surface Stabilization / Institutional Controls | Does not achieve all RAOs. Does not address all ARARs. | Moderately easy to implement; Feasible. | Chicago: $698,698<br>Research: $924,837 |
| 4 | Alternative 2: Watershed Diversions and Institutional Controls | Does not achieve all RAOs. Does not address all ARARs. | Easily implemented; Feasible | Chicago: $466,992<br>Research: $513,261 |
| 5 | Alternative 1: No Action | Does not achieve any RAOs. Does not address ARARs. | Easily Implemented; Not Administratively Feasible | Chicago: $0<br>Research: $0 |

**Table 30**
**Comparative Analysis of Removal Action Alternatives**

*Engineering Evaluation/Cost Analysis Report*
The Chicago Research Site

| EVALUATION CRITERIA | ALTERNATIVE 1 NO ACTION | ALTERNATIVE 2 RUN-ON & RUN-OFF CONTROLS/ INSTITUTIONAL CONTROLS | ALTERNATIVE 3 SURFACE STABILIZATION/ INSTITUTIONAL CONTROLS | ALTERNATIVE 4 ON-SITE CONSOLIDATION AND CAPPING /INSTITUTIONAL CONTROLS | ALTERNATIVE 5 EXCAVATION AND OFF-SITE DISPOSAL |
|---|---|---|---|---|---|
| ***EFFECTIVENESS*** | ***Overall: Does not achieve any RAOs. Does not meet ARARs.*** | ***Overall: Does not achieve all ARARs and RAOs*** | ***Overall: Does not achieve all ARARs and RAOs; Achieves some.*** | ***Overall: Achieves all ARARs. Achieves RAOs with exception of some waste in place.*** | ***Overall: Achieves all ARARs. Achieves RAOs with exception of some waste in place.*** |
| Protective of Public Health and Community | No | Yes, with successful implementation of Institutional Controls | Yes, with successful implementation of Institutional Controls | Yes, with successful implementation of Institutional Controls | Yes, with successful implementation of Institutional Controls |
| Protective of Workers During Implementation | Not Applicable | Yes, with proper health and safety implemented | Yes, with proper health and safety implemented | Yes, with proper health and safety implemented | Yes, with proper health and safety implemented |
| Protective of the Environment | No | Somewhat; Ecological risks remain; Direct contact risks remain which can be partially mitigated with ICs | Somewhat; Waste in place an ecological concern without maintenance and imposing strict ICs | Yes, with maintenance and imposing ICs | Yes, with maintenance and imposing ICs |
| Complies with ARARs | No | No | No | Yes | Yes |
| Achieves All RAOs | No | No | No | Yes | Yes |
| Level of Containment Expected | None | None | Minimal level of containment; Burrowing animals and human trespass would expose contaminated materials | A high level of containment, with the use of institutional controls in conjunction with the caps; Requires proper maintenance | An extremely high level of containment from disposal at the offsite disposal facility |
| Reduction or Elimination of Residual Concerns | None | None | Moderate; Includes stabilization of furnaces at Research Mine and reduction in sediment transport | Moderate to High; Residual concerns remain in maintaining cap and instituting ICs | Very High; Minimal areas of concern remain |
| ***IMPLEMENTABILITY*** | ***Overall: Easily Implemented; Not Administratively Feasible*** | ***Overall: Easily implemented; Feasible*** | ***Overall: Moderately easy to implement; Feasible.*** | ***Overall: Difficult to implement but feasible*** | ***Overall: Very difficult to implement*** |
| Technical Feasibility: Availability of Equipment | None Required | Available | Available | Available | Available |
| Technical Feasibility: Availability of Services | None Required | Available | Available | Available | Available |
| Technical Feasibility: Availability of Laboratory Testing Capacity | None Required | Available | Available | Available | Available |
| Technical Feasibility: Off-site Treatment and Disposal Capacity | None Required | None Required | None Required | Offsite disposal capacity is sufficient for mine debris removal | CleanHarbors, Inc., Lokern Landfill, Buttonwillow, CA |

**Table 30**
**Comparative Analysis of Removal Action Alternatives**

*Engineering Evaluation/Cost Analysis Report*
The Chicago Research Site

| EVALUATION CRITERIA | ALTERNATIVE 1 NO ACTION | ALTERNATIVE 2 RUN-ON & RUN-OFF CONTROLS/ INSTITUTIONAL CONTROLS | ALTERNATIVE 3 SURFACE STABILIZATION/ INSTITUTIONAL CONTROLS | ALTERNATIVE 4 ON-SITE CONSOLIDATION AND CAPPING /INSTITUTIONAL CONTROLS | ALTERNATIVE 5 EXCAVATION AND OFF-SITE DISPOSAL |
|---|---|---|---|---|---|
| Technical Feasibility: Can Be Implemented in One Year | Yes | Yes | Yes | Yes, barring any significant consultation periods for CEQA, CESA, or other ARAR-related administration | Yes barring any significant consultation periods for CEQA, CESA, or other ARAR-related administration |
| Administrative and Legal Feasibility: Acquisition of Permits for Offsite Work | Not Applicable | None Required | Grading of potential soil borrow area; Special permits as required for offsite impacts from road repairs in habitat-protected areas | Grading of potential soil borrow area; Special permits as required for offsite impacts from road repairs in habitat-protected areas | Special permits as required for offsite impacts from road repairs in habitat-protected areas |
| Administrative and Legal Feasibility: Acquisition of Permits for Site Work | Not Applicable | Permits not required but substantive requirements are applicable | Permits not required but substantive requirements are applicable | Permits not required but substantive requirements are applicable | Permits not required but substantive requirements are applicable |
| Administrative and Legal Feasibility: Acquisition of Easement or Rights-of-Way | Not Applicable | None Required | None Required | None Required | Only if significant road improvements are required offsite to accommodate truck staging/traffic. |
| Administrative and Legal Feasibility: Impact on Adjoining Property | Moderate to High; Unchanged from current status | Moderate to High; Sediment erosion and wind-blown contaminants | Low to Moderate; Sediment erosion | Low to Moderate; Construction activities may impact offsite from truck traffic; | Low to High; Special precautions must be implemented during construction activities |
| Administrative and Legal Feasibility: Ability to Impose Institutional Controls | Not Applicable | Recommended ICs are implementable | Recommended ICs are implementable | Recommended ICs are implementable | Recommended ICs are implementable |
| Ease of Implementation: Regulatory Acceptance | Unlikely | Unlikely | Possible; Concerns will exist due to RAOs and ARARs not fully met. | Likely | Possible; Cost will be prohibitive. Truck hauling traffic may present greenhouse gas emissions concern. |
| Ease of Implementation: Community Acceptance | Unlikely | Unknown until public comment period | Unknown until public comment period | Unknown until public comment period | Unknown until public comment period |
| ***COST*** | ***No Capital, Monitoring, or Post-Removal Costs*** | ***Range below includes Capital, Monitoring, & Post-Removal Costs*** | ***Range below includes Capital, Monitoring, & Post-Removal Costs*** | ***Range below includes Capital, Monitoring, & Post-Removal Costs*** | ***Range below includes Capital, Monitoring, & Post-Removal Costs*** |
| Chicago Mine • Present Worth Cost/ Present Value | $ - | $466,992 | $698,698 | $777,023 | $3,029,074 |
| Chicago Mine • Present Worth Cost/ Present Value (Low Estimate: -30%) | $ - | $326,895 | $489,089 | $543,916 | $2,120,352 |
| Chicago Mine • Present Worth Cost/ Present Value (High Estimate: +50%) | $ - | $700,488 | $1,048,048 | $1,165,535 | $4,543,611 |

**Table 30**
**Comparative Analysis of Removal Action Alternatives**

*Engineering Evaluation/Cost Analysis Report*
The Chicago Research Site

| EVALUATION CRITERIA | ALTERNATIVE 1<br>NO ACTION | ALTERNATIVE 2<br>RUN-ON & RUN-OFF CONTROLS/<br>INSTITUTIONAL CONTROLS | ALTERNATIVE 3<br>SURFACE STABILIZATION/<br>INSTITUTIONAL CONTROLS | ALTERNATIVE 4<br>ON-SITE CONSOLIDATION AND CAPPING /INSTITUTIONAL CONTROLS | ALTERNATIVE 5<br>EXCAVATION AND OFF-SITE DISPOSAL |
|---|---|---|---|---|---|
| Research Mine • Present Worth Cost/ Present Value | $ - | $513,261 | $924,837 | $1,017,340 | $3,132,763 |
| Research Mine • Present Worth Cost/ Present Value (Low Estimate: -30%) | $ - | $359,283 | $647,386 | $712,138 | $2,192,934 |
| Research Mine • Present Worth Cost/ Present Value (High Estimate: +50%) | $ - | $769,891 | $1,387,255 | $1,526,011 | $4,699,145 |

**Notes:**
ARARs: Applicable or Relevant and Appropriate Requirements
RAOs = Removal action objectives
ICs = Institutional Controls (i.e.: fencing, signage, deed restriction)
CEQA: California Environmental Quality Act of 1970
CESA: California Endangered Species Act
O&M: Operations and maintenance

# 9 RECOMMENDED REMOVAL ACTION ALTERNATIVE

## 9.1 EVALUATION PROCESS FOR SELECTING RECOMMENDED ACTION

As directed by EPA guidance, the five removal action alternatives presented in this EE/CA Report have been evaluated against three general criteria: effectiveness, implementability, and cost. The specific components of each criterion are defined as follows:

I. Effectiveness:
   1. Ability to Protect Human Health and the Environment (Protectiveness)
   2. Ability to Comply with ARARs
   3. Ability to Achieve RAOs
   4. Level of Treatment/Containment Expected
   5. Reduction or Elimination of Residual Concerns

II. Implementability:
   1. Technical Feasibility
      a. Availability of Equipment
      b. Availability of Personnel and Services
      c. Availability of Laboratory
   2. Administrative and Legal Feasibility
      a. Acquisition of Permits Required for Any Offsite Work
      b. Acquisition of Easement or Rights-of-Way Required
      c. Impact on Adjoining Property
      d. Ability to Impose Institutional Controls
   3. Ease of Implementation
      a. Regulatory Acceptance
      b. Community Acceptance

III. Cost:
   1. Capital Cost
   2. Post Removal Site Control Cost
   3. Long-Term Maintenance and Monitoring Costs
   4. Present Worth /Present Value Cost

## 9.2 RECOMMENDED REMOVAL ACTION

The BLM preferred alternative is Alternative 4, On-Site Consolidation and Capping with Institutional Controls. Alternative 4 will best meet the criteria established for effectiveness, implementability, and cost. After seeking input from the public and responding to comments received, the BLM will prepare an Action Memorandum to be signed by management indicating the selected removal action.

# 10 REFERENCES

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