PART1: DECLARATION

1.1 Site Name and Location

National Priorities List (NPL) Site Information (shown on Figure 1): Iron Mountain Mine (IMM), Shasta County, California (approximately 9 miles northwest of Redding, California)

Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS) Identification Number CAD980498612

Operable Unit Information (shown on Figure 2): Spring Creek Arm of Keswick Reservoir

Operable Unit (OU) Number 5

The location map is shown on Figure 1, and site features are shown on Figure 2.

1.2 Statement of Basis and Purpose

This decision document presents the selected remedial action for control of releases of hazardous substances (i.e., contaminated sediment) from the Spring Creek Arm of Keswick Reservoir (the Spring Creek Arm or the Arm), OU 5 of the Iron Mountain Mine Site. The selected remedial action was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This decision is based on the Administrative Record file for this Record of Decision (ROD).

The State of California concurs with the selected remedial action for contaminated sediment in the Spring Creek Arm of Keswick Reservoir.

1.3 Assessment of the Site

The mines and waste rock piles at the IMM Site are discharging acidic waters, typically with a high concentration of heavy metals. The discharges are referred to as acid mine drainage, or AMD. AMD discharged from IMM is transported via Spring Creek through the Spring Creek Reservoir into the Spring Creek Arm. These features are shown on Figure 2. As a result of past mining activities and IMM AMD releases, the affected water bodies upstream of the Spring Creek Debris Dam (SCDD) are essentially devoid of aquatic life and amphibians that are dependent upon that aquatic life. Down gradient of the SCDD, as the metal-rich acidic water discharged from IMM mixes with the higher pH freshwater in Keswick Reservoir, hydrous metal oxides precipitate and are deposited within the Spring Creek Arm of Keswick Reservoir. As discussed in greater detail in Section 1.4, remedial actions that have been implemented to control the sources of AMD have reduced the acidity and reduced the metals content by 95 percent in surface water down gradient from IMM.

The Sediment Remedial Investigation (RI) Report (EPA, 2002a) characterizes the nature and extent of contaminated sediment at Iron Mountain Mine. Historical deposition, accumulation, and mixing of metals-enriched sediment and precipitates has formed three distinct deposits or piles of contaminated sediment within the Spring Creek Arm, identified in a downstream direction as Piles A, B, and C. The total volume of contaminated sediment within the Arm is approximately 280,000 cubic yards. The heavy metals contained in the contaminated sediment include, among others, arsenic, copper, cadmium, iron, nickel, and zinc. The concentrations of these metals are toxic to aquatic life.

The results of a benthic invertebrate study (EPA, 2002a) demonstrated areas of severely impoverished benthic community and no plant life in areas associated with the sediment piles within the Spring Creek Arm and lower Keswick Reservoir. Testing has shown that if the sediments move into the water column, the water can be toxic to aquatic life, even if diluted 44 times. The pollutants in the sediments are particularly toxic to organisms and habitat at the bottom of the creek and fish in early life stages.

The technical memorandum Updated Human Health and Ecological Risk Evaluations for the Spring Creek Arm of Keswick Reservoir, Appendix E of the Sediment Feasibility Study (FS) (CH2M HILL, 2004), evaluated the potential risk to human health and ecological receptors from contaminated sediment in the Arm. The risk evaluation concludes that contaminated sediment in the Spring Creek Arm does not pose a current or future unacceptable risk to human health and welfare; however, the contamination has resulted in great ecological impact to benthic and aquatic communities in the Arm.

The fishery resources and other sensitive aquatic species in the Sacramento River below Keswick Dam are the primary natural resources at risk from the mobilization of contaminated sediment from the Spring Creek Arm. These species, particularly at the early life stages present in the Sacramento River, are particularly sensitive to toxic metals such as copper and zinc.

Uncontrolled flows from SCDD into the Arm during major storm events, in conjunction with high flows from Spring Creek Power Plant (SCPP), could scour and move sediment located within the Spring Creek Arm, which would then enter Keswick Reservoir and carry this mass of metals into the Sacramento River ecosystem. The locations of SCDD and SCPP are shown on Figure 2. During such an event, Sacramento River water quality would be expected to be highly toxic to aquatic life. It is also expected that significant quantities of the toxic sediments would deposit into the gravels of the important Sacramento River spawning grounds. These sediments would threaten the early life stages of salmon and steelhead present at the time of the deposit. These deposited toxic sediments would be expected to continue to contaminate the spawning grounds until difficult cleanup operations could be performed. Since salmon return in cycles of three to four years, contamination in the spawning grounds over an extended period of time could jeopardize the survival of the entire population of salmon.

If conditions are such that high flows coincide in both SCDD and SCPP, and the reservoir-pool level is down, large quantities of the existing sediment would be expected to erode and be transported into the main stem of Keswick Reservoir and into the Sacramento River downstream of Keswick Dam. Increasing the reservoir elevation or decreasing the discharge from the SCPP could reduce this potential; however, these options significantly restrict

reservoir and power plant operations and do not completely eliminate the erosion potential. Under conditions of high discharge from SCPP and SCDD and low Keswick Reservoir water elevations, it is likely that over time, much of the sediment in the Spring Creek Arm would be transported into the Sacramento River.

Through the performance of the Sediment RI and Sediment FS, the U.S. Environmental Protection Agency (EPA) has determined that the response action selected in this Record of Decision (ROD) is necessary to protect the environment from actual or threatened releases of hazardous substances. Actual or threatened releases of contaminated sediment from the Arm, if not addressed by implementing an appropriate response action, may present a substantial endangerment to the Sacramento River ecosystem downstream of Keswick Dam.

1.4 Description of Prior Remedial Actions

Completed and ongoing remedial actions to control the sources of AMD have significantly reduced the acidity and metals content in surface water discharged from IMM to downstream water bodies. There are four prior RODs at this Site.

The first ROD for the IMM Site (ROD 1), signed in October 1986, provided for implementation of limited source control actions to begin lessening the IMM AMD discharges and also provided water management capability to manage the ongoing IMM AMD releases to surface waters. Specific activities authorized by ROD 1 include a diversion of Slickrock Creek around contaminant-bearing landslide debris, diversion of Upper Spring Creek to the Flat Creek drainage, and a partial cap of Brick Flat Pit and seven subsidence areas. All of these projects have been completed.

Pursuant to Records of Decision signed by EPA in 1992 (ROD 2) and 1993 (ROD 3), virtually all AMD releases from the three largest sources of IMM AMD (the Richmond portal, the Lawson portal, and the Old/No. 8 Mine Seep) are treated at the IMM treatment plant. In these RODs, EPA selected the high density sludge (HDS) treatment process to ensure the long-term reliability, effectiveness, and cost-effectiveness of IMM treatment and sludge disposal operations. The treatment residuals are disposed of onsite in the inactive open pit mine, Brick Flat Pit. The response actions implemented pursuant to these two RODs have significantly reduced the release of hazardous substances from the Site. During the five-year period of Water Years 1999 through 2003, collection and treatment of portal AMD discharges resulted in an average reduction in sitewide copper discharges of 88 percent and an average reduction in zinc discharges of 95 percent (CH2M HILL, 2003) from the uncontrolled site-wide metal discharges prior to EPA's remedial action.

The fourth ROD for the IMM Site (ROD 4), signed in September 1997, provided for collection and treatment of AMD discharges from the widespread area sources in the Slickrock Creek watershed at Iron Mountain Mine. ROD 4 provided for design and construction of a 220-acre-foot (ac-ft)-capacity retention reservoir to collect area sources of AMD discharges for treatment, clean surface water diversion facilities, erosion control for arsenic-laden tailings, an additional AMD conveyance pipeline, and a tunnel for gravity discharge of treated effluent to Spring Creek. The remedy will permit treatment of essentially all of the IMM AMD from the Slickrock Creek area sources, which comprise approximately 60 to 70 percent of the remaining uncontrolled copper and 40 to 50 percent of the remaining uncontrolled

zinc and cadmium releases from the IMM Site. Construction of the dam and associated facilities for the Slickrock Creek Retention Reservoir was completed in the spring of 2004. Startup and shakedown testing was completed in June 2004. Operation of the remedy under ROD 4, in combination with completed remedial actions to control the sources of AMD, will result in a total reduction of contaminants discharged from SCDD of 95 percent from the pre-1994 discharge.

The EPA has determined that further study is warranted with regard to continued development and evaluation of remedial alternatives for the Boulder Creek area source AMD discharges, which are not currently controlled or collected for treatment. The EPA anticipates that additional remedial investigation and feasibility study efforts will be conducted to evaluate control strategies for the area sources in Boulder Creek.

1.5 Description of the Selected Remedy

The selected remedial action is the fifth ROD for the IMM Superfund cleanup action. The objectives of the selected remedy are to (1) prevent the migration and deposition of contaminated sediment from the Spring Creek Arm into the Sacramento River downstream of Keswick Dam and (2) reduce metal loads and suspended solids associated with contaminated sediment to meet protective water quality standards. The selected remedy will involve the partial dredging of sediment in the Spring Creek Arm that is most susceptible to erosion, and disposal of dredged sediment in an engineered disposal cell located adjacent to Spring Creek Reservoir. Dredging will remove about 50 to 60 percent of the volume of the existing contaminated sediment in the Arm. Sediment that is less susceptible to erosion will not be dredged at deeper depths in the most downstream pile, Pile C. The selected remedy will include operational restrictions on Keswick Reservoir pool elevations during rare storm or flood events to prevent erosion of sediment remaining at deeper depths within the Arm.

Contaminated sediment has also been deposited in other areas of the IMM Site, in the Spring Creek Reservoir and the main body of Keswick Reservoir, that are not addressed by this remedy, but sediment in these areas is less susceptible to erosion or is contained by existing controls. The remedy for Spring Creek Arm sediment would be consistent with and would not affect potential future remedies for these other areas of contaminated sediment. The selected remedy for contaminated sediment in the Spring Creek Arm would be consistent with other potential response actions for the remaining area sources of IMM discharges (i.e., the Boulder Creek area sources of AMD). Completed, ongoing, and potential remedies to control AMD significantly reduce the source of contaminated sediment by reducing the metal loads discharged from SCDD and the subsequent formation of new precipitates in Keswick Reservoir.

The major components of the selected remedy include:

- Removal of contaminated sediment in the Spring Creek Arm of Keswick Reservoir to an elevation that minimizes contaminated sediment loss during all operational scenarios of SCPP, SCDD, and Keswick Reservoir except for rare storm events when combined with operations of the Central Valley Project (CVP) facilities that would be very unlikely during such large storms

- Operational controls to restrict Keswick Reservoir water levels under rare storm or flood conditions to prevent releases from SCPP and SCDD that could scour sediment remaining at greater depths in Pile C
- Continued restrictions on the release schedule and criteria for the discharge of water from SCDD to the Spring Creek Arm
- Limited residual management for sediment in Pile A, Pile B, or the main channel of the Spring Creek Arm that is technically infeasible to dredge and is susceptible to erosion
- Short-term monitoring and resuspension management during implementation of the remedial action
- Conveyance of dredge discharge from the Spring Creek Arm to the dewatering/disposal cell
- Ex situ physical and chemical treatment of dredge discharge to separate solids and liquids for disposal and achieve compliance with applicable or relevant and appropriate requirements (ARARs) for discharge of filtrate and overflow
- Disposal of dewatered solids in an engineered upland disposal cell located on the IMM CERCLA site, adjacent to Spring Creek Reservoir
- Conveyance and discharge of return water from the disposal cell to Spring Creek Reservoir
- Long-term monitoring, disposal cell maintenance and institutional controls

1.6 Statutory Determinations

1.6.1 Protection of Human Health and the Environment

Risk evaluations conducted by EPA indicate that contaminated sediment and surface water in the Spring Creek Arm do not pose a current or future unacceptable risk to human health and welfare. Therefore, the selected remedy is focused on assuring the protection of the environment.

The fishery resources and other sensitive aquatic species in the Sacramento River below Keswick Dam are the primary natural resources at risk from the mobilization of contaminated sediment from the Spring Creek Arm. This fishery and ecosystem is the focus of the cleanup for OU5. These species, particularly at the early life stages present in the Sacramento River, are particularly sensitive to toxic metals such as copper and zinc. The National Oceanic and Atmospheric Administration (NOAA) has identified this section of the Sacramento River as the most important salmon habitat in California.

This selected remedy is protective of the environment with respect to the releases of hazardous substances from the Spring Creek Arm of Keswick Reservoir that could harm the important Sacramento River ecosystem. Removal of contaminated sediment from the Spring Creek Arm that is most susceptible to erosion, and disposal of dredged sediment in an upland disposal cell, will mitigate the risk for release events of contaminated sediment. The

selected remedy will reduce the metal loads and suspended solids associated with contaminated sediment discharged from the Spring Creek Arm.

It is uncertain whether the selected remedy would ensure that a benthic community will be re-established in the Spring Creek Arm following implementation. Continued releases of dissolved copper from IMM sources via Spring Creek Reservoir would likely prevent the re-establishment of the benthic community. However, the selected remedy will improve conditions and a benthic community might become re-established to some extent. The selected remedy is also expected to indirectly improve aquatic habitat in Keswick Reservoir by limiting future mobilization of contaminated sediment and redeposition in Keswick Reservoir.

While the remedy is expected to essentially eliminate the risk posed by releases of hazardous substances from the Spring Creek Arm to the Sacramento River, the remedy does not respond to the remaining uncontrolled releases of hazardous substances from the IMM Site. The EPA therefore anticipates that the remedy will not fully protect human health and the environment and that additional remedial action will be required to respond to releases of hazardous substances from the IMM Site.

1.6.2 Compliance with ARARs

Except for those ARARs that EPA is waiving for this interim remedy, the selected remedy will comply with all Federal and State ARARs. The ARARs selected in this ROD apply only to the remedial actions selected in this ROD. This ROD does not alter or amend the prior ARAR determinations by EPA for this site as selected in RODs 1-4.

The EPA is waiving compliance with certain ARARs on the basis that this remedial action is an interim action that will not respond to all releases of hazardous substances from the IMM Site. This interim action is not expected to provide for compliance with all ARARs at all times because the remedial action for contaminated sediment in the Spring Creek Arm does not address remaining uncontrolled releases from the IMM Site, such as AMD releases from area sources in the Boulder Creek watershed.

Since the actions selected in this ROD are interim actions that leave some releases of hazardous substances unabated, EPA is relying on the ARARs waiver for "interim measures" (CERCLA § 121(d)(4)(A); 40 CFR § 300.430(f)(1)(ii)(C)(1)) for this remedial action. In particular, the EPA anticipates that once the remedial actions selected in this ROD have been implemented, water quality in Keswick Reservoir and the Sacramento River will improve as the result of reducing metal loads and suspended solids associated with contaminated sediment. EPA does not anticipate that this remedy, in conjunction with the other remedies implemented to date, will be sufficient to ensure compliance with (1) the numeric, chemical-specific water quality standards contained in the National Toxics Rule (NTR), California Toxics Rule (CTR) and the Basin Plan for copper, cadmium, or zinc, and (2) California Fish and Game Code § 5650 (which prohibits discharge of contaminants "deleterious to fish, plant life, or bird life"). The EPA is therefore waiving compliance with those standards for the interim action selected in this ROD to the extent those standards cannot be achieved by the remedy selected in this ROD. EPA is also employing the interim action waiver to waive the applicable requirements of SWRCB Resolution 92-49. EPA is continuing to study the

feasibility of implementing additional controls on the remaining Site discharges. These requirements will be addressed in the final ROD for the IMM site.

1.6.3 Cost-Effectiveness

The EPA has determined that the selected remedy is cost-effective pursuant to evaluations in accordance with § 300.430(f)(1)(ii)(D) of the NCP.

1.6.4 Permanent Solutions and Treatment Technologies

The EPA has determined that the selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized for the remedial action for the contaminated sediment in the Spring Creek Arm of Keswick Reservoir. The selected remedy uses ex-situ physical and chemical treatment of dredge discharge as a significant portion of the remedy.

The contaminated sediment within the Spring Creek Arm is not considered to constitute a principal threat waste because the contaminated sediment can be contained in a reliable manner through the implementation of the selected remedy. AMD generated at the IMM Site is considered a principal threat waste because it is highly toxic and presents significant risk to human health and the environment should exposure occur. Completed remedial actions to control the sources of AMD through collection and treatment at the IMM treatment plant have significantly reduced the acidity and metals content in surface water from IMM. However, EPA has not selected a remedy that treats the source of the IMM AMD discharges, the mineral body itself, in a manner that prevents the formation of AMD because EPA is not currently aware of such an approach that could be effectively implemented at IMM. EPA encourages the continued development and evaluation of alternatives that may partially satisfy the preference for treatment as a principal element, and this issue will be addressed in the final decision document for the Site.

1.6.5 Five-year Review Requirements

The selected remedy will result in hazardous substances, pollutants, or contaminants remaining onsite above levels that allow for unlimited use and unrestricted exposure. Following completion of the remedial actions selected in this ROD, contaminated sediment, that will be susceptible to erosion only under rare storm event and very unlikely CVP facility operational scenarios, will remain in deeper portions of the Spring Creek Arm in Pile C. Sediment that will be dredged from the Spring Creek Arm will be dewatered and disposed in an engineered, upland disposal cell located adjacent to Spring Creek Reservoir. This disposal location is within the boundaries of the IMM CERCLA site. Section 121(c) of CERCLA and the NCP at 40 C.F.R. 300.430(f)(5)(iii)(C) therefore require EPA to conduct a statutory review within 5 years after initiation of remedial action, and at least every 5 years thereafter, through the standard CERCLA review process. The reviews will be conducted to ensure that the selected remedy continues to be protective of human health and the environment.

1.7 ROD Certification Checklist

The following information is included in the Decision Summary (Part 2) of this ROD. Additional information can be found in the Administrative Record file for this ROD.

- Baseline risk represented by the COCs - Section 2.7
- Performance criteria for the sediment cleanup established for Remedial Action Objectives and the basis for these levels - Section 2.12.4
- How source materials constituting principal threats are addressed - Section 2.11
- Current and reasonably anticipated future land use assumptions used in the baseline risk assessment and ROD - Section 2.6
- Potential land use that will be available at the Site as a result of the selected remedy - Section 2.6.1
- Estimated capital, annual operation and maintenance and total present worth costs, discount rate, and the number of years over which the remedy cost estimates are projected - Section 2.12.3 and Table 16
- Key factor(s) that led to selecting the remedy - Sections 2.12.1

Cleanup levels are not established for the sediment remedial action. Meeting the remedial action objectives (RAOs) will be the primary and fundamental indicator of performance, the ultimate aim of which is protection of the environment. Although restoration of a benthic community in the Spring Creek Arm and Keswick Reservoir may occur as the result of the overall IMM Site remediation, the RAOs for this ROD (presented in Section 2.8) focus on the protection of the Sacramento River ecosystem, and do not require the removal of all contaminated sediment to eliminate ecological risks in the Spring Creek Arm or Keswick Reservoir due to the ongoing IMM metal discharges. Rather, the RAOs focus on mitigating potential ecological risks that could result from the release of contaminated sediment to the Sacramento River. By meeting the performance criteria presented in Section 2.12.4, the remedy will achieve RAOs.

1.8 Authorizing Signature

Elizabeth J. Adams

September 30, 2004

Elizabeth J. Adams, Chief
Site Cleanup Branch
U.S. Environmental Protection Agency

Date

PART 2: THE DECISION SUMMARY

2.1 Site Name, Location, and Description

2.1.1 Site Name

The Iron Mountain Mine (IMM) Superfund site is located in Shasta County, California, approximately 9 miles northwest of the City of Redding (Figure 1). The collection of mines on Iron Mountain is known as Iron Mountain Mines. The Iron Mountain Mines are the southernmost mines in the West Shasta Mining District. The District encompasses more than a dozen sulfide mines that have been worked for silver, gold, copper, zinc, and pyrite.

The CERCLIS Identification Number for the IMM Superfund site is CAD980498612.

The lead agency for the IMM Superfund site is the EPA. The support agencies are State and federal agencies that support the activities of the EPA in accordance with the NCP. The State support agencies include the California Department of Toxic Substances Control (DTSC), Central Valley Regional Water Quality Control Board (RWQCB), Department of Fish and Game (CDFG), and the State Water Resources Control Board (SWRCB). DTSC is the lead agency for the State of California. Federal agencies involved in the IMM Superfund cleanup include the U. S. Bureau of Reclamation (Reclamation), U. S. Fish and Wildlife Service (USFWS), and the National Oceanic and Atmospheric Administration (NOAA).

2.1.2 Site Location

The IMM Site includes the inactive mines on Iron Mountain and areas where hazardous substances released from the mines have come to be located. The IMM Site contains approximately 4,400 acres of land that includes the inactive mining properties on Iron Mountain; the several inactive underground and open pit mines; numerous waste piles; abandoned mining facilities; mine drainage treatment facilities; the downstream reaches of Boulder, Slickrock, Flat, and Spring Creeks; Spring Creek Reservoir; Keswick Reservoir (which includes both the Spring Creek Arm and the main body of Keswick Reservoir); and the Sacramento River affected by drainage from IMM (see Figure 1).

This decision document presents the selected remedial action for control of releases of contaminated sediment from the Spring Creek Arm of Keswick Reservoir (the Spring Creek Arm or the Arm). The Spring Creek Arm is Operable Unit 5 (OU-5) for the IMM Site.

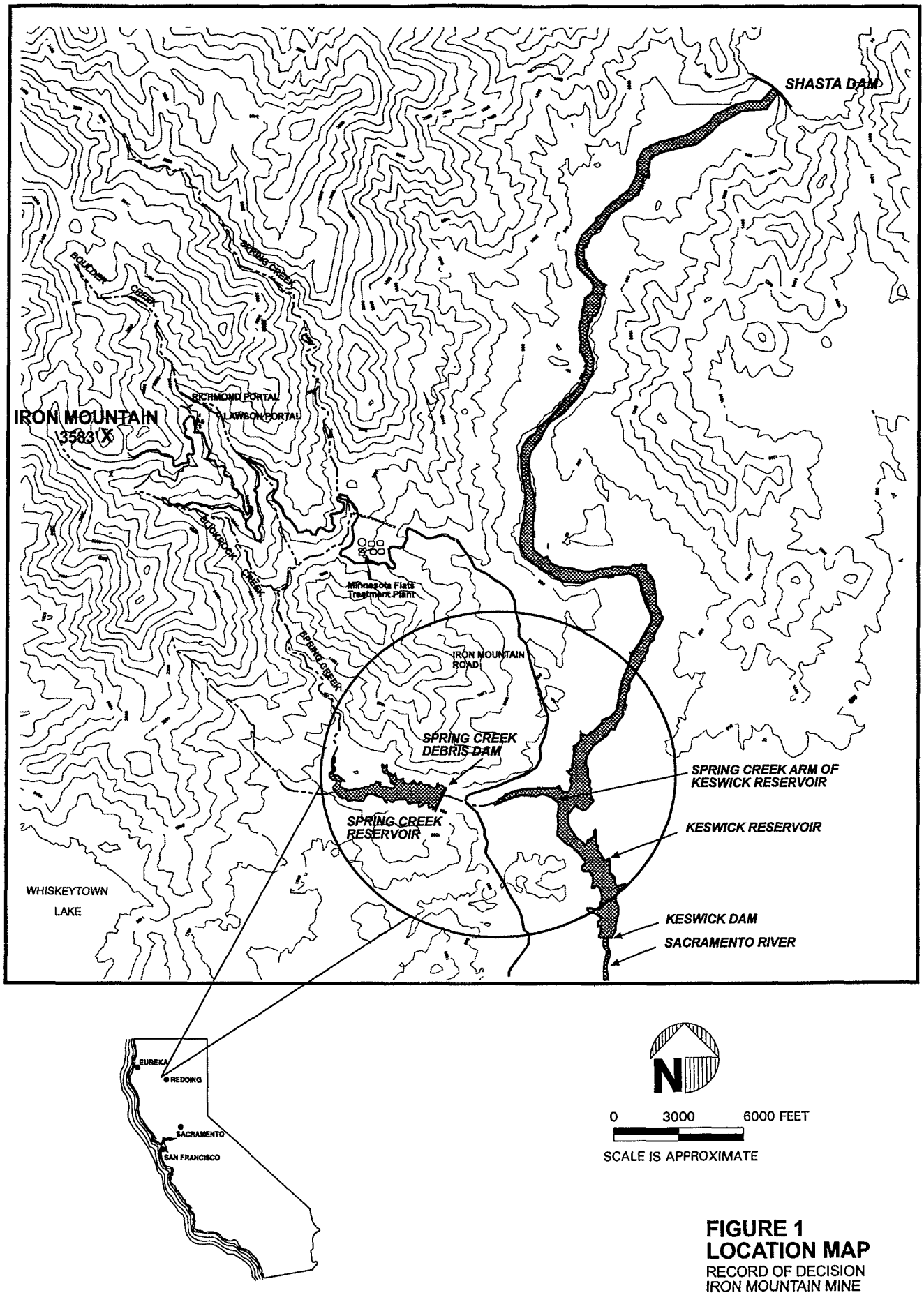

FIGURE 1
LOCATION MAP
RECORD OF DECISION
IRON MOUNTAIN MINE
SHASTA COUNTY, CALIFORNIA

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2.1.3 Site Description

Iron Mountain contains copper, zinc, silver, gold, and pyrite deposits that have been commercially mined since 1879. In the early twentieth century, the Site was one of the largest copper mines in the United States. Mineral extraction methods varied widely. Underground mining ceased in 1956, and surface mining ceased in 1963.

Several, and possibly all, of the mines and the waste rock piles are discharging acidic waters, typically with a high content of heavy metals. These discharges are herein referred to collectively as acid mine drainage, or AMD. Within the IMM property, the two largest sources of AMD are the Richmond Mine and the Hornet Mine. Both of these sources drain into Boulder Creek. The third largest source, the Old/No. 8 Mine Seep, drains into Slickrock Creek.

Boulder and Slickrock Creeks are major tributaries to Spring Creek, and Spring Creek is a tributary to the Sacramento River. Spring Creek flows into Spring Creek Reservoir (the impoundment created by Spring Creek Debris Dam [SCDD]), and enters the Sacramento River at Keswick Reservoir (created by Keswick Dam). Keswick Dam is located approximately 8 miles below Shasta Dam. The Spring Creek Arm is the portion of Keswick Reservoir directly below SCDD and is located 1.4 miles upstream of Keswick Dam. The Arm is oriented due east of SCDD and is approximately two-thirds of a mile long. Figure 2 is an aerial photo showing these features.

AMD discharged from IMM is transported via Spring Creek through the Spring Creek Reservoir into the Spring Creek Arm. The Spring Creek Arm serves as a mixing basin for metal-rich acidic waters and sediments released from behind SCDD and freshwater from Shasta Dam, Whiskeytown Reservoir, and Keswick Reservoir. Mixing metal-rich, low-pH water from SCDD with higher-pH water results in precipitation of hydrous metal oxides, which can be colloidal in nature. This phenomenon has resulted in deposition, accumulation, and mixing of metal-enriched sediment and precipitates in the Spring Creek Arm and lower Keswick Reservoir.

Completed and ongoing remedial actions to control the sources of AMD at IMM have significantly reduced the acidity and metals content in surface water from IMM. Starting in 1994, virtually all of the AMD discharged from the Richmond Mine, Hornet Mine, and Old/No. 8 Mine Seep has been treated at the IMM treatment plant constructed onsite at Minnesota Flats. From 1994 to 1996 the AMD was treated using the simple mix treatment method. Since January 1997, a high density sludge (HDS) treatment system has provided an improved means of treating these discharges. Further cleanup efforts under ROD 4 have recently been completed in the Slickrock Creek watershed at IMM. Among other items, ROD 4 provides for construction of a retention reservoir to collect AMD area source discharges in the Slickrock Creek Basin for treatment. Treatment of these IMM AMD flows by the completed remedial actions pursuant to ROD1 through ROD4 will result in a total reduction of copper, cadmium, and zinc discharged from IMM sources of approximately 95 percent of the pre-1994 discharge.

The fishery resources and other sensitive aquatic species in the Sacramento River below Keswick Dam are the primary natural resources at risk from the continuing uncontrolled IMM heavy metal discharges or mobilization of contaminated sediments from the Spring

Creek Arm. As a result of past mining activities and current IMM AMD releases, the affected water bodies upstream of the SCDD are essentially devoid of aquatic life and amphibians that are dependent upon that aquatic life.

2.2 Site History and Enforcement Activities

2.2.1 History of Site Activities that Led to Current Problem

Iron Mountain was first secured for mining purposes in 1865 because of the presence of a large gossan cap, a surface mineral deposit that is the result of the oxidation of pyrite (iron sulfide) that weathered over geologic time to form a surface mineral deposit that is largely iron oxide containing small amounts of gold and silver. Various individuals held the property and conducted limited mining for the recovery of silver from the gossan areas in the late 1800s. The waste-generating activities that created the surface sources of AMD likely began in the 1880s when the gossan was first mined on a large scale, and waste rock, that was removed to reach the ore, was apparently dumped into ravines and eventually washed into the creeks.

Beginning in late 1894, Mountain Mines, Ltd., began operation of the mine. In approximately 1896, Mountain Copper Company, LTD. (Mountain Copper) acquired ownership of the mine. Under Mountain Copper, IMM became the largest producer of copper in California and the sixth largest producer in the country during the first quarter of the twentieth century. High-grade copper ore and other minerals in the deposits were mined in Old Mine until 1907, No. 8 Mine from 1907 until as late as 1923, Hornet Mine from 1907 to 1926, the Richmond Mine from 1926 through 1956, and Brick Flat Pit from 1929 to 1942 and 1955 to 1962.

In 1967, Stauffer Chemical Co. (SCC) acquired Mountain Copper. In 1968, SCC obtained legal title to the properties comprising IMM from its wholly owned subsidiary, Mountain Copper Company, Ltd. SCC originally took steps to reopen the mine, but the price of sulfur dropped to a point that caused the option to be uneconomical. SCC operated the copper cementation plant on Boulder Creek during its ownership of the Site and continued to investigate the commercial mining potential of the property. In November 1976, the Central Valley RWQCB issued an order to SCC requiring the abatement of the continuing water pollution from the mountain.

In December 1976, SCC transferred ownership of 31 parcels on Iron Mountain to Iron Mountain Mines, Inc. (IMMI), and in December 1980, SCC transferred five additional parcels to IMMI.

IMMI, a California corporation, is the current owner of the mining properties at Iron Mountain. But, certain property interests retained by SCC's successor at the Site are in the process of being transferred to BLM pursuant to a Consent Decree (signed in December 2000) between SCC, the State of California, and the federal government.

IMMI constructed a copper cementation plant on Slickrock Creek in 1977. IMMI has intermittently operated this plant and the copper cementation plant on Boulder Creek to recover copper from the AMD.

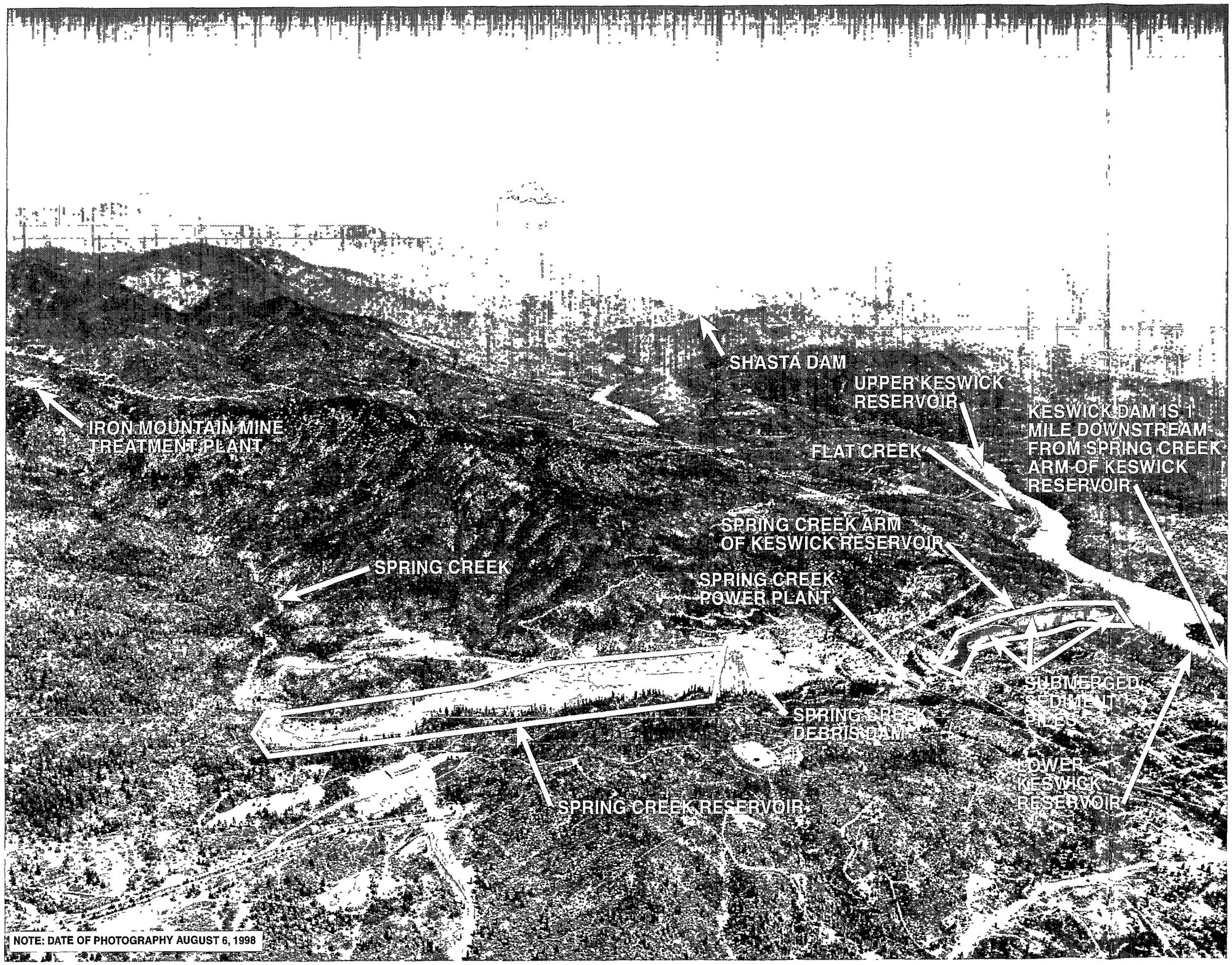

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FIGURE 2
SITE FEATURES
RECORD OF DECISION
IRON MOUNTAIN MINE
SHASTA COUNTY, CALIFORNIA

2.2.2 Impacts of Mining Activity at Iron Mountain

Generation and Discharge of Acid Mine Drainage

Mining activities have fundamentally altered the geochemical and hydrologic conditions at Iron Mountain. In an undisturbed condition, a series of geologic and geochemical factors combined to permit the several large masses of sulfide mineralization to remain in place below the water table over geologic time. Now that mining has altered those conditions, however, the massive mineralization is no longer protected by the water table from oxidation, which in turn has exposed the mineralization to conditions that permit the rapid oxidation and release of acidity and metals from that deposit. These mining-induced changes are the source of the severe pollution problem at IMM.

Metals such as copper, zinc, iron, cadmium, gold, and silver are commonly found as part of massive sulfide mineral deposits. When iron sulfide (pyrite) is exposed to moisture and an oxidant (such as free oxygen or aqueous ferric iron), the pyrite oxidizes and releases acidity. Copper, zinc, aluminum, cadmium, and manganese are released into the AMD in parallel chemical reactions. Pyrite oxidation is aided by certain bacteria which form ferrous iron, hydrogen ions, and sulfate ions. The ferrous iron is subsequently oxidized to ferric iron, which acts as an oxidant, attacking additional pyrite and other metal sulfides, which produces additional hydrogen ions. The resulting low-pH water containing the dissolved metals then discharges from the mine, and mixes with and contaminates surface water. This is the general process for the formation of AMD at IMM, and the movement of AMD down Spring Creek and into Spring Creek Reservoir.

The rate of oxidation of the mineralized zone is accelerated when the surface area of the pyrite deposit exposed to oxidizing conditions is increased by mining. At IMM, the historical operations at the Site included both open-pit and underground mining. The mining operations fractured massive sulfide deposits that had been contiguous and relatively unfractured, rubblized great quantities of the pyritic orebody through collapse of the underground openings, and lowered the water table through construction of haulage drifts and tunnels. The end result is exposure of a vast surface area to the oxidizing process and production of great quantities of AMD in a relatively short time period.

Mine wastes such as waste rock and tailings that were disposed of adjacent to the mines also contain residual sulfide materials that oxidize when exposed to water and air. Mine wastes with greater pyritic surface area available under oxidizing conditions produce stronger acidic discharges at greater rates of AMD production. The mine workings draining Iron Mountain still contain more than 12 million tons of unmined, disturbed massive sulfide deposits. IMM is unusual in the strength and rate of acid production and the subsequent release of large quantities of heavy metals into the environment.

Precipitation of Metal Hydroxides and Formation of Sediments

Over time, surface flows from the IMM Site have carried various mine wastes, native sediment that might contain metals, and AMD downstream via the Spring Creek drainage into the Sacramento River system. As the AMD mixes with rain and other surface waters at a higher pH, hydrous metal oxides, primarily iron oxyhydroxides, precipitate. The topography and varying flow velocities within the Spring Creek Arm channel (influenced by the discharges from Shasta Dam, Spring Creek Power Plant [SCPP], and SCDD) acted

upon the metal-enriched sediments and precipitates and influenced how these materials settled out within the Spring Creek Arm of Keswick Reservoir. As a result, three major contaminated sediment piles (Piles A, B, and C, with Pile A being closest to SCDD and Pile C being closest to Keswick Reservoir) were deposited in the Spring Creek Arm primarily between the completion of SCDD in 1963 and 1994, when the IMM treatment plant became operational. Deposition likely continued after 1994, although at a substantially reduced rate. The presence of metal-enriched material on the bottom of the Spring Creek Arm has been shown to severely impact aquatic life in those areas.

2.2.3 History of Federal and State Site Investigations

The following summarizes the history of federal and State site investigations of (1) AMD sources and discharge and (2) contaminated sediment in Spring Creek Reservoir and Keswick Reservoir.

Acid Mine Drainage Sources and Discharge

Remedial investigation (RI) activities at Iron Mountain began in September 1983, when Iron Mountain was placed on the CERCLA National Priorities List of the nation's most contaminated sites.

EPA issued a remedial investigation/feasibility study (RI/FS) report in 1985 and an FS Addendum in 1986. The 1985 RI report characterized the entire IMM Site with respect to the nature and extent of contamination.

The EPA signed the first Record of Decision for the IMM Site in October 1986. ROD 1 selected an interim remedy for the Sitewide OU, identifying a number of specific projects. These projects included the construction of a partial cap over the Richmond mineralized zone, including a cap of Brick Flat Pit; construction of a clean surface water diversion in Slickrock Creek to avoid AMD-generating waste rock; construction of a diversion of the Upper Spring Creek to avoid polluting its cleaner water and filling Spring Creek Reservoir; construction of a diversion of the South Fork of Spring Creek for a similar purpose; a study of the feasibility of filling mine passages with low-density cellular concrete; and an enlargement of SCDD, the exact size of which would be selected after a determination of the effectiveness of the other remedies. EPA selected a 9,000-acre-foot reservoir as the preliminary size in ROD 1. Underlying studies indicated that a 15,000-acre-foot reservoir would be required for a protective remedy. In its selection of a smaller reservoir size, EPA relied on a "fund-balancing" waiver, which permits EPA to waive compliance with protective standards for cleanups that are being paid for by the Superfund.

The EPA's Public Health Risk Assessment was updated in 1991. Site characterization studies continued for the Boulder Creek watershed, and EPA prepared a second RI/FS report for that area in 1992. An Endangerment Assessment (EA) was prepared in 1992 to characterize and evaluate the current and potential threats to the environment that may be posed by IMM contaminants migrating to the groundwater, surface water, and air.

The Boulder Creek OU ROD (ROD 2), signed in September 1992, addressed remedial actions for (1) AMD from the Richmond portal (Richmond Mine) and Lawson portal (Hornet Mine), the two largest sources of acidity and metals contamination at Iron

Mountain; and (2) the numerous waste rock piles, tailing piles, seeps, and contaminated sediments that also affect contaminant levels in Boulder Creek.

Site characterization studies continued for the Slickrock Creek watershed, and EPA prepared an RI/FS report for that area in 1993. The Old/No. 8 Mine Seep OU ROD (ROD 3), signed in September 1993, addressed the third largest source of contaminant discharges at IMM.

On the basis of the results of its ongoing monitoring program, EPA concluded that the area source discharges of heavy metals, especially copper, zinc, and cadmium, were closely associated with the intense storm-related high runoff events that characterize the hydrology of the Spring Creek watershed at IMM.

Through a formal action in 1991 known as an explanation of significant differences (ESD), EPA revoked the fund-balancing waiver upon which EPA relied for ROD 1. This formal action removed the legal basis for EPA's tentative selection of a 9,000-acre-foot reservoir in ROD 1 in lieu of a larger, more protective dam. Consistent with the SCDD enlargement component of ROD 1 and the ESD, EPA conducted engineering and other studies regarding enlarging the SCDD. These studies indicated that a reservoir of at least 15,000 acre-feet would be required.

Because of the projected increased costs of the SCDD enlargement and the availability of other new information, EPA decided to expand its studies, re-evaluate other remedial technologies, and publish for public review and comment a new feasibility study and proposed plan.

In June 1994, EPA published a Water Management FS, which examined potential remedial alternatives that could control, treat, or manage the safe release of continued uncontrolled contaminant discharges from the numerous and widely dispersed area sources in the Boulder Creek and Slickrock Creek watersheds at IMM. In the 1994 Water Management FS, EPA developed five alternatives for detailed evaluation. These alternatives included a range of approaches that relied on source control, collection and treatment, and water management technologies. Although some area sources could be readily identified and remediated (such as waste piles), a large proportion of the area source discharge was associated with buried and collapsed mine workings and was, in general, difficult to identify and characterize.

The approaches used in the remedial alternatives developed and evaluated in the Water Management FS relied more heavily on collection and treatment and water management technologies rather than on source control. In June 1994, EPA issued a Proposed Plan with a set of remedial actions for the IMM area source AMD discharges.

During the public comment period for the 1994 Proposed Plan, a potentially responsible party (PRP), Rhone-Poulenc, Inc. (Rhone-Poulenc, a successor to SCC) (through its representative, Stauffer Management Company [SMC]), submitted a Focused Feasibility Study (FFS). The FFS identified a range of general collect and treat alternatives for the area source releases from the Slickrock Creek watershed. Rhone-Poulenc urged EPA to delay selecting a remedy so that an additional season of data could be collected. The EPA determined that delay in remedy selection was justified because the information

submitted by Rhone-Poulenc suggested that it was technically feasible (and also more cost-effective) to control the IMM pollution on the mountain rather than simply diluting the pollution by enlarging the SCDD and controlling the discharge rate into Keswick Reservoir.

This delay permitted Rhone-Poulenc and EPA an opportunity to collect additional data to characterize the IMM area source AMD discharges in the Boulder Creek watershed and characterize and define key hydrologic and engineering factors for the development and evaluation of the Slickrock Creek "dam and treat" approach. Rhone-Poulenc and EPA developed remedial design concepts for proposed Slickrock Creek and Boulder Creek remedies. In August 1995, EPA and Rhone-Poulenc presented their respective analyses and conclusions with regard to the ongoing Boulder Creek studies to a panel of senior technical specialists for review and technical comment. Consistent with the panel comments, EPA concluded that adequate control of the Boulder Creek area sources was feasible, but deferred action on developing and evaluating proposed remedial approaches for these sources to allow time for additional study. EPA issued the Boulder Creek Remedial Alternatives Study in 1995.

The EPA incorporated these and other investigations into a Water Management Feasibility Study Addendum (FSA) in May 1996. The FSA evaluated an additional remedial alternative as a supplement to the June 1994 Water Management Feasibility Study. EPA's May 1996 Public Comment Water Management FSA updated the public record to include an evaluation of an alternative that addressed only the remediation of Slickrock Creek, Alternative SR1. In May 1996, EPA formally announced that it proposed to select Alternative SR1 as its "Preferred Alternative" for the contaminated Slickrock Creek flows. The EPA proposed to perform additional studies regarding the Boulder Creek area source AMD discharges to support further development and evaluation of alternatives for decision making.

The EPA signed the fourth Record of Decision (ROD4) for the Slickrock Creek OU at the IMM Site in September 1997. The selected remedy includes the construction of the Slickrock Creek Retention Reservoir to assure the collection and treatment of the contaminated storm water flows to address the principal threat posed by contaminant releases from area sources within the Slickrock Creek watershed at the IMM Site.

Contaminated Sediment

This section discusses investigations of contaminated sediment formed from the precipitation of heavy metals in AMD discharged from IMM to the Spring Creek watershed. Contaminated sediments in the Spring Creek Arm of Keswick Reservoir are considered to be the fifth operable unit (OU-5) for the IMM Site.

Historical investigations began in 1960 with Reclamation's investigation of the geology of the foundation rock for design of SCDD. Following construction of SCDD, Reclamation conducted a series of investigations and reports related to siltation, pollution problems, and chemical and grain-size analysis of sediment in Spring Creek, Spring Creek Reservoir, and the Spring Creek Arm of Keswick Reservoir. Additional investigations were also performed by other agencies, including analysis of acid volatile sulfide and simultaneously extractable metals in Keswick Reservoir sediments by USFWS in 1993,

collection of high-resolution seismic reflection data by the U.S. Geological Survey (USGS) in 1993 and 1994, and a chemical and toxicological characterization of Keswick Reservoir sediments by CDFG in 1995. These investigations are summarized in the *Final Iron Mountain Mine Sediment Remedial Investigation Report* (EPA, 2002a).

EPA conducted site characterization activities in 1997 and 1998 to support the RI of contaminated sediment. These activities were a collaborative effort among EPA, USGS, and Reclamation. The Sediment RI identified four study areas: Spring Creek Reservoir, the Spring Creek Arm, upper Keswick Reservoir, and lower Keswick Reservoir. A comparison of RI data with historical data was performed as part of the site characterization for the Sediment RI. EPA issued the *Final Iron Mountain Mine Sediment Remedial Investigation Report* (Sediment RI) in 2002. The RI included surface water, sediment, and pore water sampling results for physical, geochemical, and biological characterization.

Additional investigations of the contaminated sediment were performed in 1998 through 2003. A treatability study was conducted in 1998 in conjunction with the Sediment RI. Results are discussed in the *Technical Memorandum – Iron Mountain Mine Sediments Treatability Study* (CH2M HILL, 2000). A bathymetric and geophysical survey was conducted in 2001 to provide three-dimensional data on the distribution and volume of fine-grained sediment in Keswick Reservoir. Results are summarized in the *Keswick Reservoir Bathymetric and Geophysical Survey Report* (David Evans and Associates, Inc., 2002). Treatability testing was conducted in 2003 on Spring Creek Arm sediment to support the development and evaluation of remedial alternatives. Results are summarized in the *Iron Mountain Mine Sediments Treatability Study Report* (CH2M HILL, 2004a).

Modeling and engineering analyses that were performed as part of the Feasibility Study for OU-5 indicate that the uncontrolled flows from SCDD during major storm events, in conjunction with high flows from SCPP, have the potential to erode sediment in the Spring Creek Arm. When combined with conditions of low reservoir elevations, sediment would be transported into the main stem of Keswick Reservoir and into the Sacramento River downstream of Keswick Reservoir. Investigations, including laboratory toxicity testing and field benthic surveys that were performed as part of the RI for OU-5, indicate that the mobilization of contaminated sediments into the Sacramento River could cause significant adverse impacts to important fishery resources. Downstream of Keswick Reservoir and IMM, the Sacramento River provides high-quality habitat for spawning and rearing fish, including anadromous fish populations such as chinook salmon and steelhead.

In June 2004, EPA issued for public comment the *Iron Mountain Mine Sediment Feasibility Study Report* (Sediment FS) (EPA, 2004). The Sediment FS developed and evaluated remedial alternatives to minimize or eliminate the potential for mobilization of contaminated sediment from the Spring Creek Arm into the Sacramento River ecosystem. In August 2004, EPA issued a Proposed Plan presenting its preferred alternative for remediation of the contaminated sediment located in the Spring Creek Arm.

2.2.4 History of CERCLA Enforcement Activities and Remedial Actions

The EPA has identified the following persons as PRPs: the former owner and operator, Aventis CropScience USA, Inc. (the successor to Rhone-Poulenc, who in turn is the successor to Stauffer Chemical Company and Mountain Copper, Ltd.) and the current owner and operator, Iron Mountain Mines, Inc., and its president and sole shareholder, Mr. T. W. Arman.

In December 2000, the United States and the State of California successfully settled cost recovery litigation with Aventis CropScience USA. The settlement provides funding that ensures proper operation and maintenance of the remedies implemented pursuant to RODs 1 though 4. The settlement also provided funds to the Natural Resource Trustees to conduct restoration activities at IMM, and to EPA and the State to fund limited additional site remediation activities. The settlement does not provide sufficient funds to address the remedial actions selected in this ROD.

EPA's cost recovery litigation is continuing with respect to the liability of IMMI and Mr. T. W. Arman.

A history of remedial actions at the IMM Site is summarized in Table 1. Following Table 1 is a discussion of significant CERCLA enforcement activities and remedial actions related to (1) AMD sources and discharge, and (2) contaminated sediment in Spring Creek Reservoir and Keswick Reservoir.

TABLE 1

History of Remedial Actions at Iron Mountain Mine Superfund Site

Iron Mountain Mine Record of Decision 5, Shasta County, California

Date	Event
1958	The Boulder Creek Copper Precipitation Plant was constructed to reduce the toxicity of water flowing from Spring Creek.
1963	All mining operations were closed down, except operation of the copper cementation plant.
1960 through 1963	Reclamation built the SCDD to regulate the contaminant discharges from IMM and to prevent sediment buildup at the SCPP.
1964	Operation of the SCPP began.
1977	A copper cementation plant was constructed on Slickrock Creek to remove copper from the water discharge at the Old/No. 8 Mine Seep.
1980	SWRCB, U.S. Water and Power Resources Service, and CDFG signed the *Memorandum of Understanding (MOU) to Implement Actions to Protect the Sacramento River System from Heavy Metal Pollution from Spring Creek and Adjacent Watersheds.* The MOU presented release schedule and criteria for discharge of water from SCDD to the Spring Creek Arm.
1983	IMM was placed on the National Priorities List.
1986	EPA issued the first ROD (ROD 1) for interim remedial action.
1988 through 1989	Brick Flat Pit and various caved ground areas on Iron Mountain were capped. Tailings from Minnesota Flats were removed, deposited in Brick Flat Pit, and capped. The Richmond adit was rehabilitated to access and evaluate the condition of the mine workings. Slickrock Creek was diverted around Big Seep and an overburden dump.
1989	A temporary emergency treatment plant began operation to handle the most concentrated discharges emanating from the Richmond and Lawson portals pursuant to UAO 89-18 and was later expanded pursuant to UAO-92-26.

TABLE 1	
History of Remedial Actions at Iron Mountain Mine Superfund Site	
Iron Mountain Mine Record of Decision 5, Shasta County, California	
Date	**Event**
1990	Clean water from Upper Spring Creek was diverted to Flat Creek to decrease the volume of flow into Spring Creek Reservoir pursuant to UAO 90-08. The United States filed its cost recovery litigation against Rhone-Poulenc, IMMI and Mr. T. W. Arman
1992	EPA issued the second ROD (ROD 2), selecting construction of a treatment plant to treat discharges from the Richmond and Lawson portals.
1993	EPA issued the third ROD (ROD 3), selecting capture and treatment of discharges from the Old/No. 8 Mine Seep. The NMFS issued its *Biological Opinion for the Operation of the Federal Central Valley Project (CVP) and the California State Water Project* to address effects of the long-term operation of the CVP by Reclamation on Sacramento River winter-run Chinook salmon.
1994	A lime neutralization treatment process, consisting of an aerated simple mix (ASM), was completed at Minnesota Flats Treatment Plant (MFTP) by PRPs pursuant to UAO 93-01 and UAO 94-12. The plant treated mine water and released it to Spring Creek at higher pH levels. Sludge was produced from the treated ASM discharges, discharged to drying beds, and hauled to Brick Flat Pit. This operation effectively removed more than 99 percent of all contaminants from the water. PRPs operated and maintained the IMM treatment plant pursuant to UAO 94-12.
1996	A high density sludge (HDS) treatment plant was completed at the MFTP site. The HDS process produced a denser sludge than the ASM process was capable of producing, thus prolonging the useful life of Brick Flat Pit as a final sludge disposal site, and reducing operating expenses.
1997	EPA issued the fourth ROD (ROD 4), providing for design and construction of a dam and reservoir in the Slickrock Creek Basin to collect and treat IMM AMD from Slickrock Creek area sources. PRPs designed the ROD4 remedy and constructed several components of the remedy pursuant to UAO 97-16.
2000	A settlement was concluded between the United States and State of California, and Aventis CropScience USA, Inc. to fund future cleanup costs at IMM Site. A statement of work was issued for Site operations and maintenance.
2001	Pursuant to the settlement, EPA began construction on the Slickrock Creek Retention Reservoir (SCRR) component of ROD 4. CH2M HILL was selected to perform the construction for EPA, and CH2M HILL procured Stimpel-Wiebelhaus & Associates as the construction subcontractor.
2003	The Brick Flat Pit Dam was raised to increase the available volume for disposal of high density sludge produced at MFTP treatment plant.
2003	The Richmond Mine Adits and Drifts Rehabilitation was completed.
2004	Construction of the dam and associated facilities for SCRR was completed. Startup and shakedown period began in March. In conjunction with previous remedial actions at IMM, SCRR is expected to reduce contaminant discharge from SCDD to 5 percent of the discharge prior to 1994.

Acid Mine Drainage Sources and Discharge

The EPA's Superfund program began to assess the Iron Mountain pollution problem shortly after the enactment of the Superfund law in December 1980. On April 5, 1982, EPA issued general notices of liability to SCC and IMMI for the past and continuing releases of hazardous substances from Iron Mountain and the resulting damage to, and destruction of, natural resources.

The IMM Site was listed on the National Priorities List in 1983. EPA signed the first ROD (ROD 1) in October 1986. The remedial actions specified in ROD 1 included the

construction of a partial cap over the Richmond mineralized zone and capping Brick Flat Pit; a diversion of clean surface water in Slickrock Creek to by-pass AMD-generating waste rock; a diversion of the Upper Spring Creek to avoid polluting its cleaner water and filling Spring Creek Reservoir; a diversion of the South Fork of Spring Creek for a similar purpose; and an enlargement of SCDD, the exact size of which would be selected after a determination of the effectiveness of the other remedies.

During 1987 and 1988, EPA sought a court order to ensure access to the Site for the purpose of constructing the first of these actions. The court granted EPA access and ordered the property owner not to interfere with the remedial actions.

On July 19, 1988, EPA initiated construction of the partial cap over the Richmond mineralized zone. As part of that construction, EPA remediated tailings materials from the Minnesota Flats area and other selected areas, by placing the materials into Brick Flat Pit below an impermeable membrane or "cap." The EPA completed construction of the partial cap in July 1989. Through Reclamation, EPA began construction of the Slickrock Creek diversion in July 1989 and completed construction in January 1990. Under EPA Administrative Order 90-08, ICIA, on behalf of Rhone-Poulenc, began construction of the Upper Spring Creek (USC) diversion in July 1990. The USC diversion became operational in January 1991.

In addition to the activities implemented pursuant to ROD 1, EPA recognized the need for further actions. During the 1988-89 rainy season, EPA operated an emergency treatment plant at the Site to reduce the toxicity of the AMD releases.

In August 1989, EPA issued Administrative Order 89-18, which required the PRPs to operate an emergency treatment plant at the Site to reduce the toxicity of the AMD discharges for the upcoming 1989-90 rainy season and to provide for metals removal for future years until remedial actions could be selected and implemented. This plant was to be comparable in scope and operation to the plant operated by EPA the previous winter. Pursuant to that order, ICIA, on behalf of Rhone-Poulenc, constructed the treatment plant and operated this treatment plant during the 1989-90, 1990-91, and 1991-92 rainy seasons.

The EPA also issued Administrative Order 91-07, requiring the PRPs to operate and maintain EPA-constructed remedial actions and the remedial projects undertaken by the PRPs under other orders.

Because of the continuing drought in California and the critical fishery conditions, EPA issued Administrative Order 92-26 on September 2, 1992, for the 1992-93 rainy season, requiring that additional emergency measures be implemented, including increasing the capacity of the treatment plant.

As part of its ongoing efforts to control the AMD from IMM, EPA conducted an operable unit feasibility study to develop and evaluate remedial alternatives for the AMD discharges in the Boulder Creek watershed. The EPA's 1992 RI report summarizes the data which show the concentration, volume, and historic patterns of releases of AMD from the Boulder Creek watershed at IMM. On September 30, 1992, EPA signed ROD 2, a Record of Decision that selected treatment of the AMD discharges from the Richmond and

Lawson portals, the two largest AMD discharges at IMM, on an interim basis in a lime neutralization HDS treatment plant. That Record of Decision also selected the consolidation and capping of seven waste piles onsite. Under ROD 2, treatment plant sludges are to be disposed of onsite in the inactive open pit mine, Brick Flat Pit, which was modified to comply with applicable disposal standards.

On November 3, 1992, EPA issued Administrative Order 93-01, requiring the PRPs to design and construct all necessary facilities to collect, convey, and treat the discharges of AMD from the Richmond and Lawson portals (including facilities for disposal of treatment sludges). Administrative Order 93-01 also required the PRPs to excavate, consolidate, and cap seven waste piles. Pursuant to that order, ICIA, on behalf of Rhone-Poulenc, agreed to design and construct the treatment plant and to excavate, consolidate, and cap the seven waste piles. However, ICIA opposed EPA's selection of the HDS process technology and refused to implement that portion of Order 93-01. EPA decided to use Superfund funds to build the HDS components of the treatment plant selected in ROD 2, reserving its rights to recover the costs of doing so.

The EPA continued to conduct studies to control the AMD discharges from IMM and performed an operable unit feasibility study to develop and evaluate remedial alternatives for the AMD discharges in the Slickrock Creek watershed. In February 1993, EPA published an RI/FS report summarizing data regarding AMD discharges in the Slickrock Creek watershed. The February 1993 RI/FS developed and evaluated remedial alternatives for the Old/No. 8 Mine Seep AMD discharges. On September 24, 1993, EPA signed ROD 3 selecting treatment of the AMD discharges from the Old/No. 8 Mine Seep on an interim basis at the IMM lime neutralization HDS treatment plant, as appropriately modified.

On April 19, 1994, EPA issued Administrative Order 94-12, requiring the PRPs to design and construct all necessary facilities to collect, convey, and treat the discharges of AMD from the Old/No. 8 Mine Seep. Administrative Order 94-12 also required the PRPs to operate the IMM treatment plant. SMC (a subsidiary of ICIA and subsequently Zeneca), on behalf of Rhone-Poulenc, agreed to design and construct the collection and conveyance facilities and the necessary modifications to the IMM treatment plant to ensure treatment of the Old/No. 8 Mine Seep AMD discharges. Rhone-Poulenc also agreed to operate the aerated simple mix components of the IMM treatment plant.

The aerated simple mix treatment plant became fully operational in October 1994. Since 1994, the IMM treatment plant has treated essentially all of the AMD discharges from the Richmond and Lawson portals and the Old/No. 8 Mine Seep. EPA constructed the HDS components of the treatment plant, which became operational in January 1997. The EPA amended Administrative Order 94-12 to clarify requirements pertaining to HDS plant operations.

In 1995, EPA issued the Water Management Feasibility Study and a Proposed Plan that proposed to enlarge the Spring Creek Debris Dam to increase the capacity of Spring Creek Reservoir to hold contaminated IMM runoff to 15,000 acre-feet. In commenting on the Proposed Plan, SMC proposed an alternative that would collect and treat contaminated runoff from the Slickrock Creek watershed. EPA performed a detailed evaluation of SMC's proposed alternative and in May 1996 issued the Water Management FS

Amendment and a revised Proposed Plan proposing to collect and treat the contaminated runoff from the Slickrock Creek watershed.

The EPA signed the fourth Record of Decision for the IMM Site on September 30, 1997, selecting the collection and treatment of the Slickrock Creek area source AMD discharges. Among other items, ROD 4 provided for design and construction of a 220-acre-foot (ac-ft)-capacity retention reservoir to collect area sources of AMD discharges in the Slickrock Creek Basin for treatment, clean surface-water diversion facilities, a hematite erosion control structure, an additional AMD conveyance pipeline, and a tunnel for gravity discharge of treated effluent to Spring Creek. The remedy will permit treatment of essentially all of the IMM AMD from the Slickrock Creek area sources, which comprise approximately 60 to 70 percent of the remaining uncontrolled copper and 40 to 50 percent of the remaining uncontrolled zinc and cadmium releases from the IMM Site.

On September 30, 1997, EPA issued Administrative Order 97-16 for the PRPs to comply with ROD 4. SMC, on behalf of Rhone-Poulenc, agreed to design and construct the ROD 4 remedial action.

In 1999, Rhone-Poulenc merged with Hoechst to create Aventis S.A., the parent company to Aventis CropScience USA.

In December 2000, the United States and the State of California successfully settled cost recovery litigation with one of the IMM PRPs (Aventis CropScience USA). The settlement provides funding that ensures proper operation and maintenance of the remedies implemented pursuant to RODs 1 though 4. The settlement also provides additional funding to provide for natural resource restoration activities at IMM, and some limited additional cleanup activities at IMM. Cost recovery litigation continues with Iron Mountain Mines, Inc., and its president and primary owner, Mr. T. W. Arman.

EPA completed construction of the dam and associated facilities for SCRR in the spring of 2004. Startup and shakedown testing began in March 2004. Operation of SCRR and associated facilities under ROD 4, in combination with completed remedial actions to control the sources of AMD, will result in a total reduction of contaminants discharged from SCDD by 95 percent from the pre-1994 discharge.

Other remedial actions that have been completed during the construction period for SCRR include raising the Brick Flat Dam to increase the available volume for disposal of high density sludge produced at the Minnesota Flats Treatment Plant (MFTP) and rehabilitation of the Richmond Mine adits and drifts.

Contaminated Sediment

No Superfund remedial actions or enforcement activities have yet been conducted under CERCLA to address contaminated sediments deposited in the Spring Creek Reservoir, Spring Creek Arm of Keswick Reservoir, or the main body of Keswick Reservoir. However, Reclamation and other support agencies have performed actions to manage the discharge of pollutants from the Spring Creek watershed into the Sacramento River ecosystem to minimize impacts of the IMM metal discharges on human health and the environment.

In 1963, Reclamation constructed the SCDD to help control the toxic releases from Spring Creek and to prevent sediment from forming a delta in the vicinity of the SCPP tailrace. The SCDD allowed for the formation of Spring Creek Reservoir and the storage and the controlled release of contaminated water from the Spring Creek Basin.

IMM contaminated water contained in the Spring Creek Reservoir is currently released in a controlled manner by Reclamation in accordance with the requirements of the 1980 Memorandum of Understanding (MOU) (SWRCB et al., 1980). The MOU is an agreement among the SWRCB, U.S. Water and Power Resources Service (a predecessor to Reclamation), and CDFG that presents the short- and long-term actions and responsibilities of the signatory agencies in minimizing toxicity problems in the vicinity of Spring Creek. The MOU presents the release schedule and criteria for the discharge of water from SCDD to the Spring Creek Arm and establishes a monitoring program. Now that the SCRR is operational, data will be acquired to support renegotiation of the 1980 MOU.

Reclamation also operates SCDD and Keswick Reservoir to comply with requirements of the 1993 National Marine Fisheries Service (NMFS) Biological Opinion (NMFS, 1993). The 1993 Biological Opinion addresses the effects of the long-term operation of the Central Valley Project (CVP) by Reclamation, in conjunction with the Department of Water Resources' (DWR) State Water Project, on Sacramento River winter-run Chinook salmon. The Biological Opinion was prepared by NMFS in response to a request from Reclamation for formal consultation pursuant to Section 7 of the Endangered Species Act. The Biological Opinion requires that Reclamation maintain Keswick Reservoir at or above the normal operating level during all operation of SCPP, to prevent scouring of metals-laden sediment from the Spring Creek Arm. Currently, Reclamation restricts the operating level of Keswick to between 578 and 587 feet msl. The Biological Opinion also includes additional monitoring requirements for SCDD outflow and the Sacramento River below Keswick Dam, and requires Reclamation to operate SCDD to target metals concentration levels specified by the RWQCB's Water Quality Control Plan for the Sacramento River and San Joaquin River Basins (Basin Plan), except during extremely critical water years (NMFS, 1993).

In June 2004, EPA issued the Sediment FS for public comment. The Sediment FS develops and evaluates remedial alternatives to minimize or eliminate the potential for mobilization of contaminated sediment from the Spring Creek Arm into the Sacramento River ecosystem. In August 2004, EPA issued a Proposed Plan presenting its preferred alternative for sediment in the Spring Creek Arm.

The selected sediment remedial action is expected to be a Fund Lead action. The 2000 settlement with Rhone-Poulenc does not provide funds to implement the sediment remedy. It is uncertain whether EPA's cost recovery litigation with IMMI and Mr. T. W. Arman would provide adequate funds.

2.3 Highlights of Community Participation

The EPA has regularly provided information to the public regarding the Superfund cleanup activities at Iron Mountain. The community has maintained interest in the progress of cleanup at the Site. Prior to the winter rainy seasons of 1991 and 1992, community

involvement was moderate. Community interest and involvement increased in 1992 as a result of the special release of 92,000 acre-feet of valuable water resources from Shasta Lake to dilute pollution from the IMM Site (during serious drought conditions). Since that time, interest in the progress of the EPA Superfund cleanup of the IMM AMD discharges has remained significant from the community and other state and federal agencies.

Throughout the cleanup activities, EPA has regularly provided information to the local television news and the press regarding the ongoing study and cleanup actions, and this has resulted in significant media coverage. The EPA has provided regular updates on the progress of cleanup actions through the release and distribution of factsheets and through presentations to local community groups. With the assistance of the Shasta County Library, EPA has also made copies of critical documents related to the Site available for public review. This local information repository also includes copies of the Administrative Record for this ROD as well as RODs 1 through 4.

2.3.1 Public Participation for Previous RODs

The EPA issued its first Record of Decision for the IMM Site in October 1986. The EPA has issued factsheets regarding that decision and commencement of remedial design (July 1987), commencement of remedial action (July 1988), implementation of emergency response treatment actions (February 1989), and the performance of a demonstration program under EPA's Superfund Innovative Technology Evaluation (SITE) program (August 1991). The EPA also updated its Community Relations Plan, which was finalized in May 1990.

In May 1992, EPA issued a Proposed Plan for the Boulder Creek OU at IMM. The Proposed Plan provided an update on the status of remedial and emergency response activities at the Site. The May 1992 Proposed Plan summarized EPA's development and evaluation of remedial alternatives for the AMD discharges from the Richmond and Lawson portals and invited public comment on EPA's proposed cleanup approach. The EPA held a public meeting in June 1992 to present its Proposed Plan, to answer questions, and to receive public comments. In September 1992, EPA issued its second Record of Decision for the Site. The second Record of Decision selected the interim treatment remedy described above.

In February 1993, EPA issued a Proposed Plan for the Old/No. 8 Mine Seep OU to address the AMD discharges from this source at IMM. The Proposed Plan provided an update on the status of remedial and emergency response activities at the Site. The February 1993 Proposed Plan summarized EPA's development and evaluation of remedial alternatives for the AMD discharges from the Old/No. 8 Mine Seep and invited public comment on EPA's proposed cleanup approach. The EPA held a public meeting in February 1993 to present its Proposed Plan, to answer questions, and to receive public comments. The EPA issued its third Record of Decision for the Site in September 1993, selecting the interim treatment remedy described above for these AMD discharges.

In October 1993, EPA issued a Technical Assistance Grant (TAG) to the Shasta Natural Science Association. The grant provided funding to support the development and dis-

semination of information to the community regarding EPA's IMM cleanup activities. The TAG was annually extended through March 1997 and has now expired.

In 1995, EPA issued the Water Management Feasibility Study and a Proposed Plan that proposed to enlarge the Spring Creek Debris Dam to increase the capacity of Spring Creek Reservoir to hold contaminated IMM runoff to 15, 000 acre-feet. In commenting on the Proposed Plan, SMC proposed an alternative that would collect and treat contaminated runoff from the Slickrock Creek watershed. EPA performed a detailed evaluation of SMC's proposed alternative.

In May 1996, EPA issued the Water Management Feasibility Study Addendum and a revised Proposed Plan to implement a "dam and treat" remedy for the Slickrock Creek watershed largely derived from the most effective alternative identified by a PRP (Rhone-Poulenc) in its Focused FS. The remedy involved diverting upper Slickrock Creek flows (and flows from the unmined side of Slickrock Creek Valley) around the most heavily mining-impacted reach of Slickrock Creek and collecting and treating the most heavily impacted reach of Slickrock Creek. The EPA proposed to perform further study of the Boulder Creek area source AMD discharges to support the additional development and evaluation of remedial alternatives for these sources.

The public comment period was held for 60 days (EPA extended the public comment period in response to a request from Rhone-Poulenc). In May 1996, EPA held a public meeting in Redding, California, to present EPA's Proposed Plan, to answer questions, and to receive public comments. The EPA also participated in a June 1996 community workshop that was organized by the Shasta Natural Science Association (the IMM TAG grantee) to present the Proposed Plan, answer questions, and invite community participation in the decisionmaking process. In September 1997, EPA issued its fourth Record of Decision for the Site. The fourth Record of Decision selected the interim treatment remedy described above.

On May 6, 2004, EPA hosted a dedication ceremony for the Slickrock Creek Retention Reservoir, completed under ROD 4. Representatives from interested State and Federal agencies attended the ceremony as well as members of the local television news and press. A factsheet was prepared summarizing completed remedial actions to control AMD and potential future remedial actions at the IMM Site.

2.3.2 Public Participation for Sediment Proposed Plan

In August 2004, EPA issued a Proposed Plan to address environmental threats posed by contaminated sediment in the Spring Creek Arm of Keswick Reservoir. The Proposed Plan presented EPA's preferred cleanup alternative, Partial Dredge with Disposal. The preferred alternative provides for partial removal of contaminated sediment that is most susceptible to erosion and disposal of the sediment in an engineered disposal cell adjacent to Spring Creek Reservoir. The alternative would be designed to fully remove contaminated sediment in areas that have high erosion potential (Piles A and B and sediment in the main channel of the Arm) and partially remove sediment located in a deep water area of the Spring Creek Arm (Pile C) so that the remaining sediment would not be susceptible to erosion except under rare and very unlikely circumstances.

The EPA provided a public comment period from August 11, 2004, to September 13, 2004, for the proposed remedial action described in the Proposed Plan. The Proposed Plan, Sediment FS, Sediment RI, and other supporting documents were available to the public in the Administrative Record File maintained at the EPA Records Center in San Francisco, California, and information repositories maintained at the Shasta County Library in Redding, California, and Meriam Library, California State University-Chico, in Chico, California.

An announcement for a public meeting, the comment period, and the availability of the Proposed Plan and supporting documentation was published in the Record Searchlight, a newspaper of general circulation in Redding, California, on August 11, 2004. On August 25, 2004, EPA held a public meeting in Redding, California, to present EPA's Proposed Plan, to answer questions, and to receive public comments. The public meeting was attended by approximately 40 people. Fifteen community members asked questions during the meeting, and eight community members submitted oral comments during the official comment period of the public meeting. EPA also received written comments from four community members and two local government agencies: the Redding Municipal Utilities District and the Shasta County Air Quality Management District. EPA also received letters of concurrence from two state support agencies: DTSC and CDFG. The EPA carefully reviewed, analyzed, and considered the comments that were received. The comments are summarized under the State and Community Acceptance subsections of Section 2.10. The EPA has provided detailed responses to the comments on the 2004 Proposed Plan in the Responsiveness Summary, Part 3 of this Record of Decision. The Administrative Record includes a transcript of the public meeting held in connection with the 2004 Proposed Plan.

2.4 Scope and Role of Response Action

2.4.1 Role of IMM Remedial Action

The overall objective of EPA's IMM Superfund cleanup program is to eliminate IMM AMD discharges that are harmful to human health and the environment. Due to the complexity and magnitude of the pollution problem, EPA divided the IMM response action into separate operable units. This approach enabled EPA to address the most serious problems quickly and to achieve a rapid reduction in hazardous substance releases. The previous RODs and areas that were addressed include:

- ROD 1 – the open pit at Brick Flat Pit, caved ground areas above the Richmond Mine, Minnesota Flats tailings pile, Slickrock Creek and Upper Spring Creek surface water diversions, rehabilitation of the underground mine workings in the Richmond Mine
- ROD 2 – Boulder Creek watershed, including Richmond and Lawson portal AMD discharges, seven pyritic mine waste piles
- ROD 3 – Old/No. 8 Mine seep flow
- ROD 4 – Slickrock Creek watershed area sources of AMD discharge

The construction of the remedial actions selected in RODs 1 through 4 has been completed. The dam and associated facilities for SCRR under ROD 4 were completed in the spring of 2004, and the effectiveness of the remedy will be evaluated as the SCRR becomes operational. Completed and ongoing remedial actions at IMM will significantly improve surface water quality below SCDD, decrease the frequency, duration, and toxicity of SCDD spills of IMM AMD, make significant progress in improving water quality in and below Keswick Reservoir, and provide improved water quality above the SCDD. With the completion of the ROD 4 remedial action, heavy metals discharged through SCDD are expected to be reduced by 95 percent from the pre-1994 discharge.

Despite the effectiveness of the completed and ongoing remedies, in the absence of further remediation, uncontrolled releases of IMM contaminants over SCDD spillway are estimated to continue to occur every 4 to 8 years. Water quality criteria may still be exceeded under some circumstances in the Sacramento River downstream of Keswick Dam, and regular exceedances of water quality are likely to continue in areas of Keswick Reservoir and in the Spring Creek watershed due to the few remaining sources of contamination. The most significant remaining areas of contamination include (1) heavy metal sediment associated with past and current release of IMM AMD (in Spring Creek Reservoir, the Spring Creek Arm and main body of Keswick Reservoir, and other areas) and (2) the area sources of AMD in the Boulder Creek Basin. The remedial action selected in this ROD addresses the contaminated sediment that is located in the Spring Creek Arm of Keswick Reservoir.

Studies of the remaining site issues are currently underway. These studies will assess the feasibility of further source control, the appropriateness and feasibility of relying on water management options as a component of a final Site remedy, and the need for other response actions. Proceeding in this phased manner enhances the ability of EPA to evaluate the feasibility of restoring portions of the receiving waters in the Spring Creek watershed and other affected water bodies.

2.4.2 Scope of Problem Addressed by Selected Remedial Action

This Record of Decision represents an interim remedy for a portion of the Site. The specific problems addressed by the selected remedy are the ongoing and threatened environmental impacts caused by metal-laden sediment in the Spring Creek Arm of Keswick Reservoir. The contaminated sediment in the Spring Creek Arm has resulted in ecologically significant impacts to benthic communities in the Arm. Investigations indicate that mobilization of contaminated sediments from the Spring Creek Arm into the Sacramento River downstream of Keswick Dam could cause significant adverse impacts to important fishery resources. Downstream of Keswick Reservoir and IMM, the Sacramento River provides high-quality habitat for spawning and rearing fish, including the Sacramento River Winter-run Chinook salmon listed as endangered by the United States and the State of California, and the Sacramento River Spring-run Chinook salmon listed as threatened.

If toxic sediments were deposited into the gravels of these important spawning grounds, the early life stages of the salmon and steelhead would be threatened. The deposited toxic sediments would be expected to continue to contaminate the spawning grounds until difficult cleanup operations could be performed, and these cleanup operations may not be able to fully restore the spawning grounds. Since salmon return in cycles of three to four years, contamination of the spawning grounds over an extended period could jeopardize the survival of the entire population of salmon.

The objectives of the remedial action will be to (1) minimize or prevent the migration and deposition of contaminated sediment from the Spring Creek Arm into the Sacramento River downstream of Keswick Dam and (2) reduce metal loads and suspended solids associated with contaminated sediment to meet protective water quality standards.

Because this remedy is not intended to address all remaining uncontrolled AMD releases from IMM, the remedy continues to rely on operations of the SCDD to provide for the safe release of the continuing IMM contaminant discharges from the Spring Creek Reservoir. EPA anticipates that the release schedule and criteria for SCDD will be revised to reflect the reduced metal loads from the IMM Site once data become available to characterize the effectiveness of EPA's remedial actions under ROD 4.

EPA has determined that this interim action is consistent with future remedial action and is necessary to reduce significant risks as soon as possible. This remedial action addresses contaminated sediment with the greatest potential for erosion and subsequent migration and deposition into sensitive areas of the Sacramento River.

Contaminated sediment has also been deposited in other areas of the IMM Site that are not addressed by this remedy, but sediment in these areas is less susceptible to erosion or is contained by existing controls. Contaminated sediment currently located in the Spring Creek Reservoir upstream of SCDD is contained by the debris dam. The Sediment FS presents a review of 9 years of water quality monitoring data of the discharge from SCDD. Total and dissolved metals concentrations are very similar in the discharge from SCDD, demonstrating that little contaminated sediment has been detected in SCDD discharge. Sediment in the main body of Keswick Reservoir has a lower potential for release and migration downstream of Keswick Dam than sediment in the Spring Creek Arm because of the greater depth of water in Keswick Reservoir and the location of the sediment at greater depths in the reservoir, with 60 to 80 feet of water above the sediment. The remedy for Spring Creek Arm sediment would be consistent with and would not affect potential future remedies for these other areas of contaminated sediment.

The selected remedy for contaminated sediment in the Spring Creek Arm is also consistent with other potential response actions for the remaining area sources of IMM discharges. Completed, ongoing, and potential remedies to control AMD significantly reduce the source of contaminated sediment by reducing the metal loads discharged from SCDD and the subsequent formation of new precipitates in the waters of the State.

2.5 Site Characteristics

This section presents an overview of the portion of the IMM Site to be addressed by the selected remedy, the Spring Creek Arm of Keswick Reservoir. Included in this section is a description of site features, dams and power plants, previous sediment investigations, a conceptual model, the extent of contamination, and the contaminant migration potential.

2.5.1 Site Features and Surface Water Pathways

Site features for the area of interest are identified in the aerial photograph presented as Figure 2. Spring Creek is a tributary to the Sacramento River, approximately 14.5 miles long, with a 17-square-mile drainage area. The major tributaries to Spring Creek include the South Fork of Spring Creek, Slickrock, and Boulder Creeks. Historically, the Spring Creek drainage transported sediment and low-pH, high metals-content surface water from IMM to the lower reaches of the drainage, which terminates in Spring Creek Reservoir, the impoundment created by SCDD. Spring Creek flows from Spring Creek Reservoir, through the Spring Creek Arm, and enters the Sacramento River at Keswick Reservoir, created by Keswick Dam. Keswick Dam is located approximately 8 miles below Shasta Dam. The Spring Creek Arm is 1.4 miles upstream of Keswick Dam.

The Spring Creek Arm is the portion of Keswick Reservoir directly below SCDD. The Arm is oriented due east of SCDD and is approximately two-thirds of a mile long. Discharges from SCDD flow into the Spring Creek Arm and enter the Sacramento River at Keswick Reservoir. The area upstream of the confluence of Spring Creek is referred to as upper Keswick Reservoir and is not impacted by discharges from the IMM Site via Spring Creek. The area downstream of the confluence with Spring Creek is referred to as lower Keswick Reservoir.

Downstream of Keswick Dam, the Sacramento River provides high-quality habitat for spawning and rearing fish, including anadromous fish populations. This segment of the Sacramento River supports diverse fishery resources including migratory populations of Chinook salmon (*Oncorhynchus tshawytscha*), steelhead trout (*Oncorhynchus mykiss*), and resident populations of rainbow trout (*Oncorhynchus mykiss*). The Sacramento River winter-run Chinook salmon is listed as endangered by the State of California, and the Sacramento River spring-run Chinook salmon is listed as threatened.

2.5.2 Dams and Power Plants

Flow through Keswick Reservoir is currently constrained by three dams. Construction of Shasta Dam, located upstream of the IMM Site, and Keswick and Spring Creek Debris dams, located downstream of the IMM Site, have influenced water quality in the Sacramento River and its tributaries. Shasta Dam and Shasta Power Plant, Keswick Dam and Keswick Power Plant, and SCDD and the nearby SCPP are part of the CVP operated by Reclamation. At Shasta and Keswick power plants, electricity is generated using water from their respective dams. SCPP generates power from water piped from Whiskeytown Reservoir, not from Spring Creek water. In addition to the three dams discussed in this section, the dam and associated facilities for SCRR were completed in the spring of 2004 and are collecting area sources of AMD discharges in the Slickrock Creek Basin for treatment.

Shasta Dam

Shasta Dam was completed in 1945. Data collected prior to the dam's completion demonstrate that the Sacramento River upstream of Spring Creek contained elevated concentrations of copper. Elevated Sacramento River copper concentrations upstream of Spring Creek resulted from the uncontrolled discharges from other mines in the West Shasta Mining District, adjacent to the area now submerged beneath Shasta Lake.

Since the construction of Shasta Dam, discharges from these mines enter Shasta Lake and are diluted by the much greater volume of the relatively clean Shasta Lake water. A significant portion of the copper and other metals precipitate and are deposited within Shasta Lake. A consequence of the construction of Shasta Dam has been improvement in the year-round water quality of the Sacramento River downstream of Shasta Dam. Concentrations of dissolved copper in releases from Shasta Dam averaged 2.0 micrograms per liter (µg/L) and total copper averaged 2.7 µg/L during the period from October 1998 through July 2003, as presented in the 2003 Five-year Review for IMM (CH2M HILL, 2003).

Shasta Power Plant

Shasta Dam has five 15-foot-diameter penstocks leading to Shasta Power Plant's five main generating units and two station service units. Shasta Power Plant's generators had an original capacity of 379,000 kilowatts (kW) in 1945. By 2003, their capacity had been increased to 646,000 kW through various upgrades.

Keswick Dam

Reclamation completed construction of Keswick Dam, located approximately 4.5 miles northwest of Redding, in 1950. The dam and reservoir are used to equalize flow discharged from Shasta Dam and SCPP and to generate power. The flow equalization capacity of Keswick Reservoir enables relatively constant flow in the Sacramento River downstream of Keswick Dam while power is generated each day at Shasta Dam and SCPP during periods of peak demand.

Keswick Power Plant

Keswick Reservoir operates both as an afterbay for Shasta Power Plant and forebay for Keswick Power Plant. The hydroelectric generators in Keswick Power Plant are designed to operate within a normal reservoir water elevation range of 574 to 587 feet msl. The minimum pool elevation of Keswick Reservoir, that is, the minimum elevation to provide water to the hydroelectric generator penstocks, is 568 feet msl. The maximum reservoir operating level is 587 feet, which is the elevation of the spillway. Keswick Power Plant has an installed capacity of 105 megawatts, consisting of three 35-megawatt vertical shaft generators. The range of operating levels in Keswick Reservoir has been reduced because of concerns that sediment with high metals concentrations in the Spring Creek Arm would mobilize. The lower end of the elevation range has been raised by 4 feet, to a current operating range of 578 to 587 feet msl.

Spring Creek Debris Dam

SCDD was constructed in 1963 to regulate the discharge flow rate of metal-rich contaminated Spring Creek into the Sacramento River and to reduce or prevent sediment in the Spring Creek Basin from entering the Spring Creek Arm. The reservoir is operated to provide maximum storage capacity and flow regulation for the rainy season. The initial capacity of the reservoir, following construction, was approximately 5,870 ac-ft. The storage capacity has been reduced by sediment accumulation.

A reconnaissance-feasibility investigation of the Spring Creek Basin was performed in the fall of 1957 in preparation for the construction of SCDD. A preconstruction investigation was performed in 1960. At that time, no biological activity (fish or algae) was noted in the polluted section of Spring Creek. According to Reclamation records, all sediment was excavated from the existing Spring Creek Arm prior to construction of SCDD. Additional excavations were completed on the left and right abutments, at the locations of the spillway and the outlet works. Areas occupied by smelter wastes required excavation, generally at depths up to 5 feet.

SCDD was completed in the summer of 1963. Reclamation operated SCDD with the intent of meeting water quality standards in the Sacramento River downstream of Keswick Dam. However, the small size of Spring Creek Reservoir, relative to the contaminant load and volume of flow discharged from IMM, resulted in numerous uncontrolled releases from SCDD prior to implementation of EPA remedial actions. Reclamation has attempted to alleviate the effects of uncontrolled releases of water over SCDD through releases of water from Shasta Dam.

Spring Creek Power Plant

Immediately downstream of the debris dam is SCPP, a hydropower facility that receives high-quality water from the Trinity River System via a pipeline from Whiskeytown Reservoir. The power plant does not operate with water from Spring Creek. The SCPP is operated by Reclamation and serves as a source of peaking power to the Western Area Power Administration (WAPA) electrical grid. During power generation, the SCPP discharges up to a maximum of 4,900 cfs to the Spring Creek Arm.

During winter releases from SCDD, an acceptable level of dilution for the metal-rich, acidic water is targeted through releases from Whiskeytown Reservoir (via SCPP) and Shasta Dam. The required minimum flow from SCPP during SCDD releases is 250 cubic feet per second (cfs). These low-flow releases are required to flush Spring Creek Reservoir water through the Spring Creek Arm.

Impacts of Spring Creek Arm Sediment on Power Plant Operations

The range of operating levels of Keswick Reservoir has been reduced because of concerns that sediment with high metals concentrations in the Spring Creek Arm would become mobilized. The lower end of the elevation range has been raised by 4 feet, to a current operating range of 578 to 587 feet msl. This restriction limits the ability of the CVP facilities to produce power during peak demand periods, and reduces the value of the power produced by the CVP facilities.

An analysis of the consequences of the Keswick Reservoir operational restrictions on the ability of Shasta, Spring Creek, and Keswick Power Plants to meet peak power demands demonstrates that approximately 200 million kWh of power are annually generated off-peak instead of during peak demand. The restricted Keswick Reservoir operations cause the CVP to lose $3 to $6 million annually (Mortimeyer, 2003).

2.5.3 Sediment Investigations

Numerous publications and other literature describe the IMM Site, background information, and historical investigations. Summaries of literature dating back to 1960 are included in the Sediment RI, and a comparison of current data with historical data was performed as part of the site characterization for the RI. The recent investigations on IMM sediment are discussed in this section.

Sediment Remedial Investigation (1997 and 1998)

EPA conducted initial site characterization activities for the Sediment RI in 1997 and 1998. Investigations were performed by EPA's contractor (CH2M HILL), U.S. Geological Survey (USGS), and Reclamation. The Sediment RI (EPA, 2002a) identified four study areas: Spring Creek Reservoir, the Spring Creek Arm, upper Keswick Reservoir, and lower Keswick Reservoir. Site characterization activities conducted as part of the Sediment RI included:

- Sampling – Sampling activities included onshore drilling, test pit excavations in Spring Creek Reservoir, barge-mounted offshore drilling, and a subaqueous investigation from boats and a barge. Samples were collected of surface water, ghost-layer water, ghost-layer sludge, sediment, and pore water. The ghost layer is a metals-enriched colloidal material found in suspension over the sediment and ranges from 6 inches to 2 feet in thickness.
- Physical characterization – Analyses were conducted to assess the physical attributes of collected samples, including percent moisture, particle size analysis, and bulk density.
- Geochemical characterization – Laboratory chemical analyses were conducted on the ghost layer, sediment, and pore water samples from each study area.
- Biological characterization – Biological characterization consisted of bioaccumulation sampling and analysis in Spring Creek Reservoir; a benthic survey in the Spring Creek Arm, upper Keswick Reservoir, and lower Keswick Reservoir; and toxicity testing conducted on Spring Creek Arm and lower Keswick Reservoir sediment pore water.

Treatability Study (1998)

A treatability study was conducted in 1998 on sediment from the Spring Creek Arm. Results are discussed in the *Technical Memorandum – Iron Mountain Mine Sediments Treatability Study* (CH2M HILL, 2000). The treatability testing was conducted in conjunction with the Sediment RI. The focus of the 1998 Treatability Study was treatment requirements for materials that might be dredged from the Arm. Some testing was

conducted on sediment samples from Keswick Reservoir and Spring Creek Reservoir for comparison. The 1998 Treatability Study was conducted in three phases:

- Phase I – General characterization of the physical and chemical properties of sediment samples from the Spring Creek Arm, Keswick Reservoir, and Spring Creek Reservoir
- Phase II – More detailed chemical characterization, flocculation, and settlement jar testing on samples from the Spring Creek Arm
- Phase III – Capillary suction time testing and specific filtration index testing on sediment from the Spring Creek Arm

Bathymetric and Geophysical Survey (2001)

Because of the degree of uncertainty in volume estimates of contaminated sediment in the Spring Creek Arm, EPA conducted a bathymetric and geophysical survey in 2001 to provide three-dimensional data on the distribution and volume of fine-grained sediment. The survey was completed for EPA by CH2M HILL and David Evans and Associates, Inc. Results are summarized in the *Keswick Reservoir Bathymetric and Geophysical Survey Report* (David Evans and Associates, Inc., 2002). The survey was conducted within the Spring Creek Arm and over approximately 1.4 miles within Keswick Reservoir, from just north of the Arm to Keswick Dam. Precision bathymetry, subbottom profiling, and Acoustic Doppler Current profiling were used to obtain detailed data on the reservoir bottom, shallow stratigraphy, and current speed and direction.

Treatability Study and Sediment Sampling (2003)

Additional treatability testing was conducted in 2003 on Spring Creek Arm sediment to support the development and evaluation of sediment removal and capping alternatives. For sediment removal alternatives, the Treatability Study assessed the treatment requirements, settling rates, and dewatering characteristics of dredged sediment from the Spring Creek Arm. Solid-liquid separation testing was conducted in two phases: (1) 2-liter jar tests (small-scale settling tests), and (2) 7-foot-high, 6-3/8-inch-diameter column tests (large-scale dewatering tests). For development and evaluation of an in situ sediment capping alternative, the 2003 Treatability Study assessed the compressibility of in situ sediment. In addition, discrete sediment samples were also collected for metals analysis to support updates to the human health risk evaluation. The results of the treatability testing are summarized in the *Iron Mountain Mine Sediments Treatability Study Report* (CH2M HILL, 2004a).

2.5.4 Conceptual Model

The conceptual site model is displayed on Figure 3 and shows the surface water pathways and metal sources. The conceptual site model reflects conditions of Spring Creek as of 1994, prior to remedial actions in the area, to provide an understanding of how contamination in Spring Creek Reservoir and the Spring Creek Arm was transported and deposited. Elements of the IMM sediment conceptual site model include the flow regime, site chemical characteristics, and routes of exposure. A conceptual model highlighting

potential exposure pathways for human and ecological receptors is presented in Section 2.7, Summary of Site Risks.

Flow Regime

An understanding of the uncontrolled and controlled flow conditions within the IMM system is fundamental to understanding the conceptual site model. At present, uncontrolled flow conditions exist above Spring Creek Reservoir, except for surface water retained by SCRR and minor volumes of flow retained temporarily at the IMM treatment plant. In addition, the Spring Creek Diversion, constructed by EPA in 1991, diverts approximately 6 square miles (40 percent) of the Spring Creek watershed into the Flat Creek drainage.

Flows within the Spring Creek Arm originate primarily from SCDD and SCPP, with minor inflow from Shasta Dam releases. The estimated dissolved copper and zinc concentrations in Spring Creek Reservoir and the release rate from Shasta Dam and SCPP are the controlling factors determining the allowable discharge from SCDD.

Typically, Reclamation controls the release rate from SCDD in a manner that matches the discharges from Shasta Dam and SCPP, so that water quality criteria are met downstream of Keswick Dam. These procedures are based on the agreements in the 1980 MOU (SWRCB et al., 1980). During the infrequent periods in which Spring Creek Reservoir is full and the discharge from SCDD is uncontrolled (via overtopping of the spillway), Reclamation may increase discharges from Shasta Dam or SCPP to meet water quality standards downstream of Keswick Dam. Spring Creek Reservoir water quality is expected to improve with the completion of SCRR and associated facilities. EPA expects that the 1980 MOU will be renegotiated once data are acquired to characterize the effectiveness of EPA's remedial action to construct the SCRR. The renegotiation of the 1980 MOU, however, is not required by this ROD. Reduction in metals concentrations will allow additional releases from SCDD and lower dilution requirements from Shasta Dam and SCPP.

Releases from Keswick Reservoir are used to regulate the flow of the Sacramento River and to maintain water quality standards in the river. The key characteristics of inflows to Keswick Reservoir and releases from Keswick Dam are shown in Table 2.

The hydrodynamics of the Spring Creek Arm and the quantity of metals released from SCDD influence the deposition and resuspension of sediment. The highest flows in the Arm result from SCPP rather than SCDD releases. The historical maximum daily flow released from SCPP is 4,860 cfs; the historical maximum flow released from SCDD is 1,700 cfs. Average flows are also considerably higher from SCPP.

Peak flows from SCDD occur during winter and early spring in response to the filling of Spring Creek Reservoir. A typical release from SCDD is approximately 40 to 100 cfs, and a high release flow is approximately 400 cfs (Fujitani, 1998). Concurrent flows from SCPP are highly variable, ranging from a minimum of 250 cfs required during SCDD releases to a maximum of 4,900 cfs (Reclamation, 2000, 2001). Power plant releases are generally higher during the day in response to increased power demand requirements.

Dissolved metals are transported down the Spring Creek drainage and are partially buffered by higher pH waters and native soil. Some metals further oxidize and begin to precipitate, co-precipitate, and adsorb.

$3Me^{+2}+Ca(HCO_3)_2+O_2+2H_2O \rightarrow 3Me(OH)_2+Ca^{+2}+2CO_2$

Hydrous metal oxides mix and coat native soil. Coarse materials settle. Acidic water, containing dissolved metals and suspended precipitates, and fine sediments remain available for release behind SCDD.

$4Me^{+2}+O_2+4H^+ \leftrightarrow 4Me^{+3}+2H_2O$

$Me^{+3}+3H_2O \leftrightarrow Me(OH)_3+3H^+$

Hydrolysis results in low pH.

Oxidation of primary sulfide minerals occurs.

$2MeS_2+7O_2+2H_2O \rightarrow 2Me^{+2}+4SO_4^{-2}+4H^+$

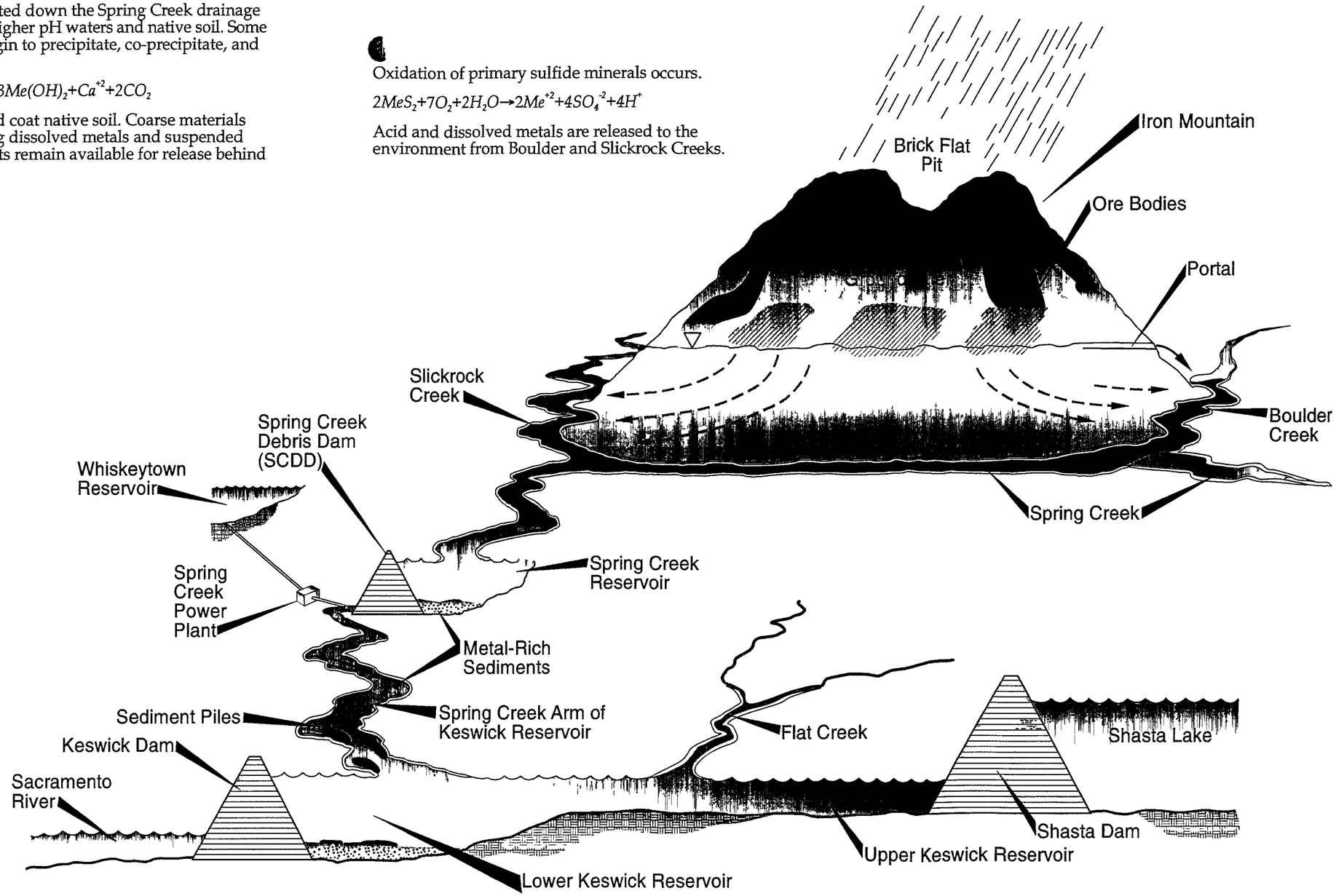
Acid and dissolved metals are released to the environment from Boulder and Slickrock Creeks.

Contaminated waters are released from SCDD, mixing with high quality water from SCPP and Keswick Reservoir. Metals precipitate, co-precipitate, and adsorb.

$Me^{+3}+3OH^- \rightarrow Me(OH)_3\downarrow$

$Me^{+2}+2OH^- \rightarrow Me(OH)_2\downarrow$

Metal-rich sediments and precipitates settle and are compressed as more sediments and precipitates are deposited. This can change redox and pH conditions within these deposits, possibly changing the adsorption/desorption equilibrium.



Unsettled colloids/silts/clays in water column pass through Keswick Dam and into Sacramento River below.

Water flow patterns carry metal-enriched colloidal precipitates and silts/clays into Lower Keswick Reservoir, where additional settling of these materials can take place.

FIGURE 3
CONCEPTUAL MODEL
RECORD OF DECISION
IRON MOUNTAIN MINE
SHASTA COUNTY, CALIFORNIA

E072004014RDD_05 (8/3/04)

TABLE 2	
Keswick Reservoir Inflow and Release Characteristics	
Iron Mountain Mine Record of Decision 5, Shasta County, California	
Inflows and Releases	**Key Characteristics**
SCDD Outlet	Low to moderate flow volume (approximately 90 percent of flows are 100 cfs or lower). However, flow has been as high as 1,700 cfs. Very high copper concentrations (200 to 1,000 parts per billion [ppb]).
SCPP	Low to moderate flow volume (50 to 4,900 cfs). Very low copper concentrations (near 1 ppb).
	Releases generally support peak power production. Keswick Dam is operated to store or release these flows for regulation of the Sacramento River.
Shasta Dam	Moderate to very high flow volume (generally 3,000 to as high as 80,000 cfs). Low to moderate copper concentrations (1 to 5 ppb). Releases support peak power production except under very high flow releases. Keswick Dam is operated to store or release these flows for regulation of the Sacramento River.
Keswick Reservoir Accretion Flows	Low to moderate flow volume (500 to 7,000 cfs). Low to moderate copper concentration (generally 3 to 6 ppb). Peak flow characteristics – Keswick Dam is operated to store or release these flows for regulation of the Sacramento River.
Keswick Dam	Moderate to very high flow volume (generally 3,000 to as high as 80,000 cfs). Low to moderate copper concentrations (2 to 6 ppb), except during AMD spills (generally 6 to 14 ppb). Releases regulate Sacramento River flow and provide baseload power production.
Source: *Response to Comments, Water Management Feasibility Study and Addendum* (EPA, 1997b)	

Site Chemical Characteristics and Formation of Sediment

Over time, surface flows from the IMM Site have carried various mine wastes, native sediment that might contain metals, and AMD downstream via the Spring Creek drainage into the Sacramento River system. The Spring Creek Arm serves as a mixing basin for metal-rich acidic waters and sediment released from SCDD, and freshwater from Shasta Dam, Whiskeytown Reservoir, and Keswick Reservoir. Mixing metal-rich, low-pH water from SCDD with higher pH water results in precipitation of hydrous metal oxides (HMOs). A pH of approximately 4 will result in the formation of hydrous metal oxides, primarily iron and aluminum. If the pH rises above 5, other metals, such as copper, co-precipitate and adsorb onto the hydrous metal oxides. The newly formed precipitates have a very small particle size (colloidal) and tend to remain in suspension. They might agglomerate and settle, and as more precipitation occurs in the higher pH water, precipitates from upstream and native sediment might become coated. As these precipitates form and begin to settle, the waters within the Spring Creek Arm become correspondingly lower in dissolved iron, copper, and aluminum.

The topography and varying flow velocities within the Spring Creek Arm channel (influenced by the discharges from Shasta Dam, SCPP, and Spring Creek Reservoir) acted upon the metal-enriched sediments and precipitates and influenced how these materials settled out within the Arm. Figure 4 shows three bends in the Arm that influence the flow velocity and backwater effects. Each bend causes an eddy that permits the mixing and

settling of sediments and precipitates into the three major deposits or piles (Piles A, B, and C). The three sediment piles were deposited primarily between 1963 when SCDD was completed and 1994 when the IMM treatment plant became operational. Deposition likely continued after 1994, although at a reduced rate. Sediment has also been deposited in lower Keswick Reservoir downstream from the Spring Creek Arm.

Current and Potential Routes of Exposure

The Spring Creek Arm and main body of Keswick Reservoir are used for recreational activities, including fishing and boating. The potential routes of human exposure to site contaminants include incidental ingestion and dermal contact with Spring Creek Arm surface water and sediment by future recreational users. As discussed in Section 2.7, the human health risk evaluation indicates that surface water and sediment in the Spring Creek Arm do not pose a current or future unacceptable risk to human health and welfare.

The potential routes of ecological exposure include exposure of aquatic resources to site contaminants in surface water and sediment in the Spring Creek Arm. These resources include several sport fish species that may periodically range into the Arm and benthic communities. In addition, exposure of aquatic resources to site-related chemicals in the Sacramento River downstream of Keswick Reservoir has been historically documented. The important Sacramento River salmon and steelhead spawning grounds are also threatened by the potential mobilization of toxic sediments from the Spring Creek Arm into the Sacramento River. Contamination of the spawning gravels with these toxic sediments would threaten the early life stages of salmon and steelhead. Contamination of the spawning grounds over an extended period could jeopardize the survival of the entire populations.

2.5.5 Chemicals of Concern

Chemicals of concern (COCs) at the Site are limited to heavy metals associated with AMD and HMO precipitates. Results of sediment benchmark screening conducted as part of the ecological risk assessment identified the following chemicals of ecological concern (COECs): arsenic, cadmium, copper, nickel, and zinc. Of these metals, arsenic and copper had the highest factors of exceedances above benchmark screening levels and likely pose the greatest risk to aquatic resources. In addition, iron was determined to be primarily responsible for acute toxicity of pore water to the water flea (*Ceriodaphnia dubia*) during porewater bioassays. Therefore, iron is also considered a COEC. Results from the risk evaluation will be discussed in greater detail in Section 2.7.

2.5.6 Extent of Contamination

Table 3 provides a summary of metals concentrations for sediment samples collected during the Sediment RI. Investigations conducted under the Sediment RI targeted four study areas: Spring Creek Reservoir, the Spring Creek Arm, upper Keswick Reservoir, and lower Keswick Reservoir. Upper Keswick Reservoir has not been impacted by discharges from the IMM Site via Spring Creek. Table 3 allows comparison of Spring Creek Reservoir, Spring Creek Arm, and lower Keswick Reservoir sediment with conditions in upper Keswick Reservoir.

TABLE 3

Sediment Metals Concentration Summary

Iron Mountain Mine Record of Decision 5, Shasta County, California

Statistics	Copper (ppm)	Iron (%)	Zinc (ppm)
Average Values			
Spring Creek Reservoir	468	9.8	164
Spring Creek Arm, Pile A	767	14	584
Spring Creek Arm, Pile B	1,050	15	775
Spring Creek Arm, Pile C	1,598	17	1,144
Upper Keswick Reservoir	225	4.8	208
Lower Keswick Reservoir	857	8.6	730
Minimum Values			
Spring Creek Reservoir	253	4.4	99
Spring Creek Arm, Pile A	245	5.4	262
Spring Creek Arm, Pile B	406	6	180
Spring Creek Arm, Pile C	199	4	85
Upper Keswick Reservoir	217	4	162
Lower Keswick Reservoir	212	5.0	101
Maximum Values			
Spring Creek Reservoir	958	21.3	340
Spring Creek Arm, Pile A	1,747	36	3,693
Spring Creek Arm, Pile B	1,943	38	2,388
Spring Creek Arm, Pile C	4,765	47	6,578
Upper Keswick Reservoir	243	5	235
Lower Keswick Reservoir	1,738	19.5	1,391
Standard Deviation			
Spring Creek Reservoir	140	3.6	55
Spring Creek Arm, Pile A	389	7.7	621
Spring Creek Arm, Pile B	442	6.9	458
Spring Creek Arm, Pile C	844	8.1	1,182
Upper Keswick Reservoir	12.4	0.5	33.9
Lower Keswick Reservoir	441	4.33	385

Notes:
Table taken from Sediment RI (Table 3-18). Table includes 63 samples from Spring Creek Reservoir; 43 from Spring Creek Arm Pile A; 43 from Pile B; 72 from Pile C; 4 from upper Keswick Reservoir; and 9 from lower Keswick Reservoir.
ppm = parts per million

Although elevated concentrations of copper, iron, and zinc have been detected in sediment samples from Spring Creek Reservoir and lower Keswick Reservoir, these areas of sediment contamination are not addressed by the selected remedy. As discussed in greater detail under Section 2.5.7, Contaminant Migration Potential, sediment in these areas is less susceptible to erosion or is contained by existing controls. This section describes the extent of contamination in the Spring Creek Arm.

The Spring Creek Arm is approximately two-thirds of a mile long and flows approximately due east. Deposition, accumulation, and mixing of metals-enriched sediment and precipitates has formed three distinct deposits or piles within the Arm: Piles A, B, and C, as shown on Figure 4. The photograph used for Figure 4 was taken at a time when the reservoir was drawn down, and portions of the normally submerged piles were exposed.

Estimates of the volume and thickness of the piles in the Spring Creek Arm were determined using a bathymetric and geophysical survey conducted in 2001 (David Evans and Associates, Inc., 2002). The survey provided three-dimensional data on the distribution and volume of fine-grained sediment. Sediment thickness contours developed using results from the bathymetric survey and geophysical survey are illustrated on Figure 5. Volume estimates derived from the 2001 survey are presented in Table 4. The piles increase both in volume and thickness in the downstream direction. For the conceptual model, sediment piles (Piles A, B, and C) are defined as areas where the thickness of fine-grained sediment is greater than or equal to 4 feet. Approximately 90 percent of the volume of contaminated sediment, or 250,000 cubic yards (cy), is located in the three piles. The remaining 10 percent of the volume of contaminated sediment in the Arm is located outside of the pile boundaries at a thickness less than 4 feet.

TABLE 4

Estimates for In situ Sediment Piles – Spring Creek Arm of Keswick Reservoir

Iron Mountain Mine Sediment Feasibility Study

Location	Volume[a] (cy)	Pile Area[b] (acres)	Pile Thickness (feet)	
			Average[c]	Maximum
Spring Creek Arm (Total)	284,000			
Pile A	28,000	2.7	7	10
Pile B	47,000	3.8	8	14
Pile C	177,000	7.2	22	37
Spring Creek Arm Channel[d]	32,000			

[a]Source: David Evans and Associates, Inc., 2002, and CH2M HILL, 2004a

[b]Pile boundaries defined as sediment thickness of 4 feet

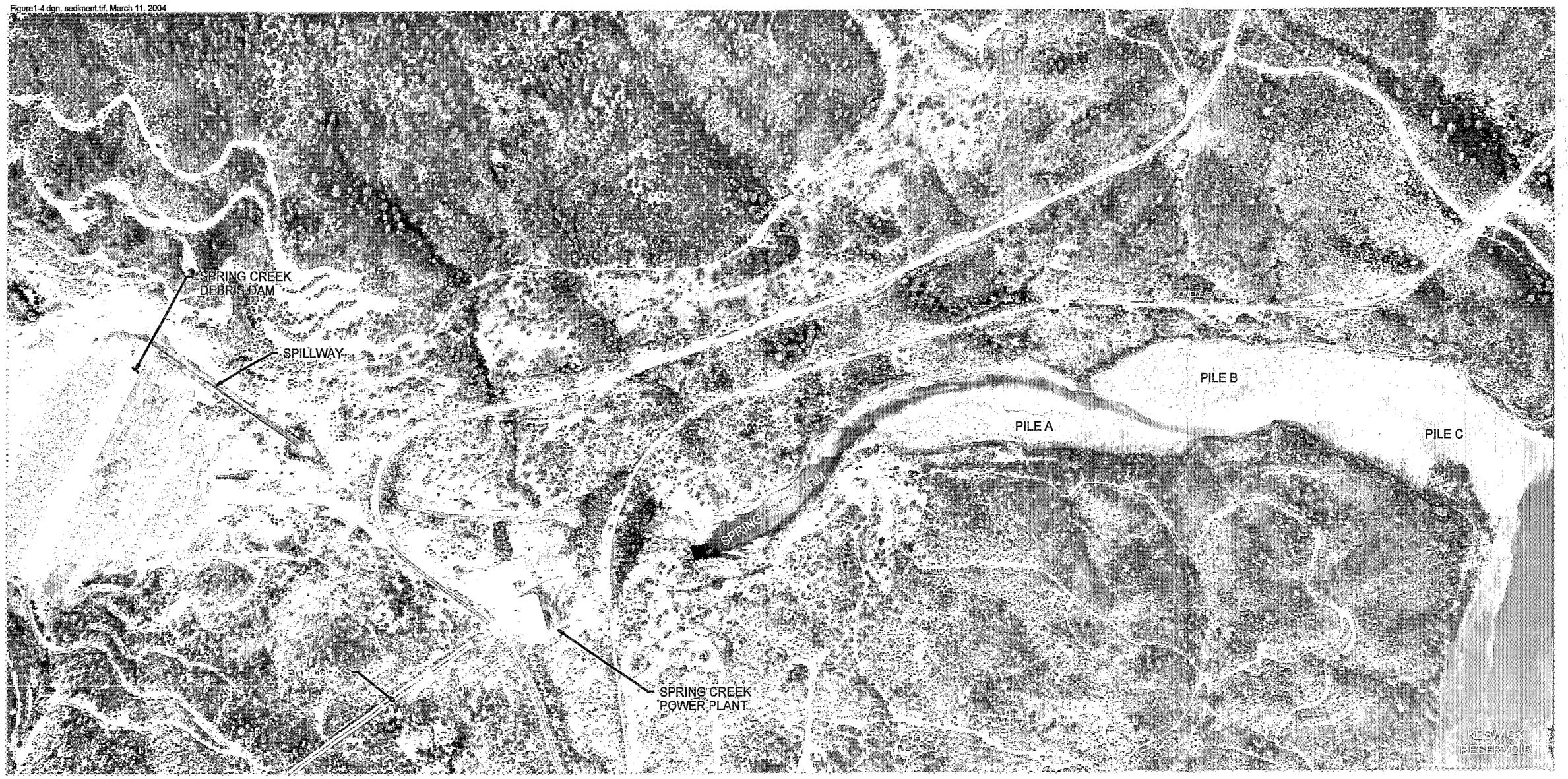
[c]Estimated from sediment thickness isopach map

[d]Sediment located outside of sediment pile boundaries

An approximate description of the stratigraphy of the piles was developed from soil borings drilled during the RI and sediment sampling conducted by the USGS in 1993. A layer of variable thickness (generally 6 inches to 2 feet) forms the cloudy surface of each pile. This layer, referred to as the ghost layer, consists primarily of metals-enriched colloidal material in suspension over the pile. Sediment below the ghost layer consists primarily of gelatinous material that is sludge-like in nature and of variable density, intermixed with sand and clay.

The sludge layers consist primarily of metals-enriched precipitates and are variable in thickness. Compared to typical saturated sediment, these sludge layers have a high water content. Bottom material of the Spring Creek Arm, located beneath the fine-grained

Figure1-4.don, sediment.tif, March 11, 2004



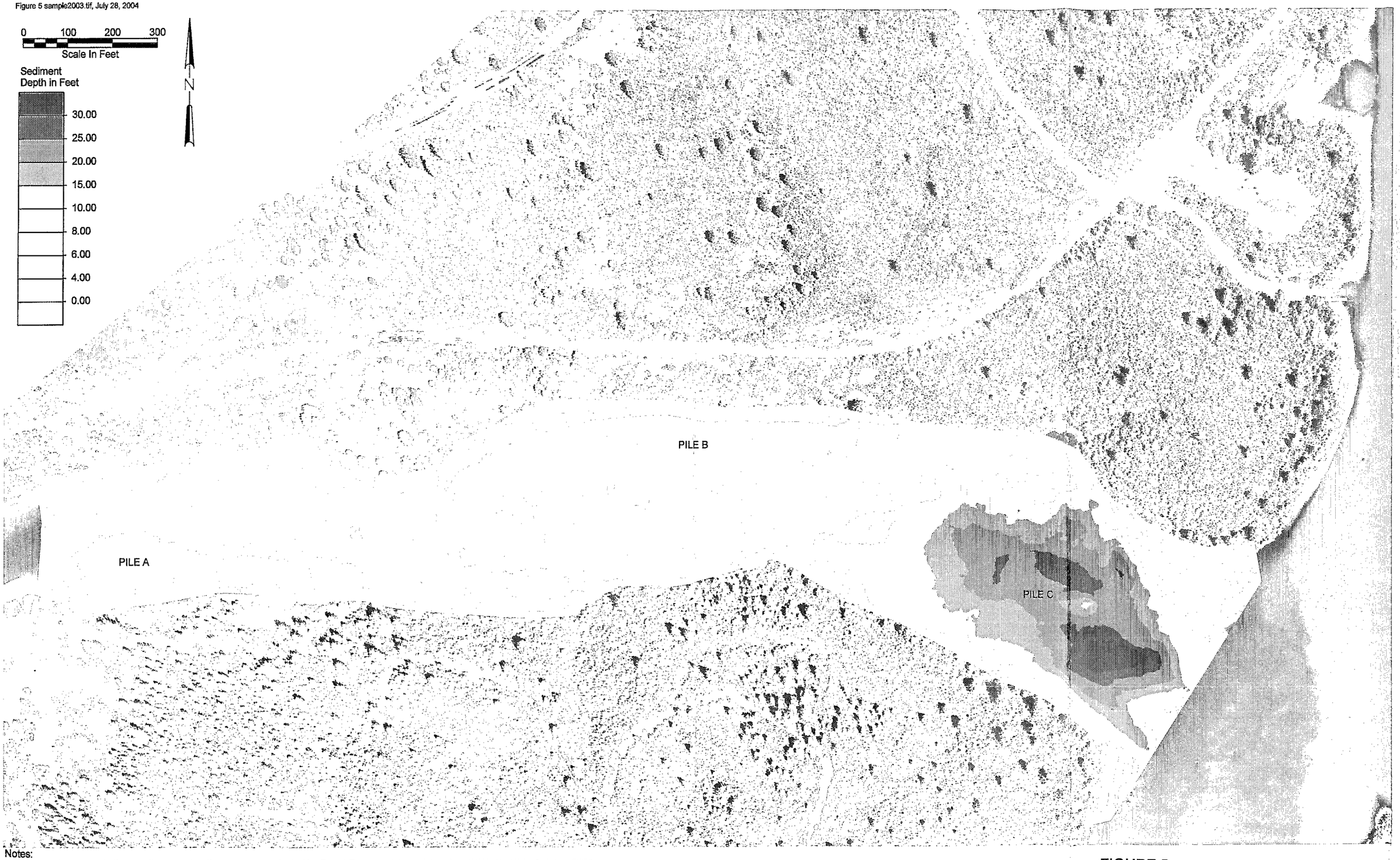
N

0 200 400 600

Notes:
1. Date of Photography: October 8, 1998
2. Reservoir lowered to a minimum elevation of 568.9 feet msl.

FIGURE 4
LOCATION OF SEDIMENT
PILES IN SPRING CREEK ARM
RECORD OF DECISION
IRON MOUNTAIN MINE
SHASTA COUNTY, CALIFORNIA

Figure 5 sample2003.tif, July 28, 2004



Notes:
1. This drawing presents the results of a subbottom survey conducted by David Evans and Associates, Inc. (DEA, 2001) in October 2001.
2. Units: U.S. Survey Feet.
3. Horizontal Datum: North American Datum of 1927 (NAD27), State Plane Coordinate System (SPCS), California Zone 1.
4. Vertical Datum: National Geodetic Vertical Datum of 1929 (NGVD29) as provided by Bureau of Reclamation.
5. Data represent thickness of fine-grain sediments.
6. Areas with white shading indicate no sediment accumulation.
7. Date of Photography: October 8, 1998

FIGURE 5
GEOPHYSICAL SURVEY SEDIMENT
ISOPACH MAP FOR SPRING CREEK ARM
RECORD OF DECISION
IRON MOUNTAIN MINE
SHASTA COUNTY, CALIFORNIA

sediment and metal precipitates of the piles, has been characterized as fine to medium sand, brown to black in color, with cobbles and gravel in some locations.

Physical characterization from the 1998 and 2003 treatability studies demonstrated differences in densities and moisture contents of sediment from the top and bottom halves of the piles. In the 2003 Treatability Study, the average bulk density and percent solids (by mass) of sediment composite samples from the top halves of Piles A, B, and C equaled 1.10 kilograms per liter (kg/L) and 16 percent, respectively. In contrast, the average bulk density and percent solids of sediment composite samples from the bottom halves of the piles equaled 1.43 kg/L and 46.6 percent, respectively. For comparison, the percent solids of typical sediment (particulate material derived through erosion processes, rather than chemical precipitation processes) ranges from 70 to 85 percent.

The summary of metals concentrations in Spring Creek Arm sediment shows a relatively uniform increase of copper and zinc concentrations moving downstream through the system from Spring Creek Reservoir to Piles A, B, and C (Table 3). Iron increases somewhat from Spring Creek Reservoir to Pile A and then remains relatively constant within the Arm. As part of sediment sample collection for the 2003 Treatability Study (CH2M HILL, 2004a), nine samples were collected of fine-grained sediment and HMO sludge at discrete depths from cores in Piles A, B, and C. These samples were analyzed for metals to update the risk evaluation. Sediment samples were analyzed for a wider range of metals than examined in the Sediment RI. A summary of these data is presented in Table 5.

TABLE 5

Spring Creek Arm Sediment Metals Concentration Summary from 2003 Sediment Sampling

Iron Mountain Mine Record of Decision 5, Shasta County, California

Analyte	Minimum Concentration[a]	Average Concentration[a]	Maximum Concentration[a]	Standard Deviation[a]	Bottom Material Concentration[b]
Antimony	0.9	4.1	7.7	2.8	0.5
Arsenic	86	168	392	98	5
Cadmium	2.4	5.3	9.4	2.2	0.5
Chromium	20	66	194	59	27
Copper	456	1,822	3,890	1,053	75
Iron (%)	8.1	18.7	38.5	10.7	4.6
Lead	32	49	72	13	2
Nickel	2	57	290	99	15
Silver	1.3	3.5	7.4	2.1	0.2
Zinc	321	768	1,050	254	63

a Summary statistics are provided for nine samples collected within Piles A, B, and C. Results are in mg/kg for all analytes other than iron.
b Bottom material was identified as clayey gravel. Data presented are for Sample No. SCAKR-C-100, collected from 13 to 13.5 feet below the top of Pile C.

In addition, one sample was collected of the bottom material (clayey gravel) beneath Pile C. Concentrations of arsenic, cadmium, copper, iron, lead, and zinc were up to two orders

of magnitude lower in the sample of clayey gravel from the bottom of Pile C than the samples of fine-grained sediment and HMO sludge collected from the sediment piles.

2.5.7 Contaminant Migration Potential

Spring Creek Arm of Keswick Reservoir

Uncontrolled flows from SCDD during major storm events, in conjunction with high flows from SCPP, have the potential to transport sediment within the Spring Creek Arm. If conditions are such that high flows coincide in both SCDD and SCPP, and the reservoir-pool level is down, existing sediment is expected to erode and be transported farther in the Arm and eventually into the main stem of Keswick Reservoir and into the Sacramento River downstream of Keswick Dam. Increasing the reservoir elevation or decreasing the discharge can reduce this potential; however, these options do not completely eliminate the erosion potential.

The Hydrologic Engineering Center-River Analysis System (HEC-RAS), a computer modeling system developed by the U.S. Army Corps of Engineers, was used to hydraulically model the Spring Creek Arm and adjacent portions of Keswick Reservoir as part of the Sediment FS. Velocity results from the model were compared against a permissible velocity to determine possible sediment movement at various depths of reservoir pools, and various SCDD and SCPP operational conditions. Conclusions from the model indicated that Piles A, B, and C within the Spring Creek Arm are presently vulnerable to erosion.

Erosion potential is greatest under high discharge from SCPP and SCDD and low Keswick Reservoir water elevations (578 feet msl or less). Under these conditions, the HEC-RAS model velocities in most locations within the three sediment piles were one to six times greater than the permissible velocity and up to eight times greater than the permissible velocity in the channel outside the pile boundaries. Under conditions of high discharge from SCPP and SCDD and low Keswick Reservoir water elevations, it is likely that over time, much of the sediment in the Spring Creek Arm would be transported to the main stem of Keswick Reservoir.

As discussed previously, Reclamation currently maintains Keswick Reservoir above 578 feet msl during releases from SCPP to limit erosion. Under conditions that are more typical of current operation scenarios, when the combined discharge from SCPP and SCDD is as high as 4,900 cfs and Keswick Reservoir elevation is as low as 578 feet msl, sediment within and surrounding Piles A and B would be subject to erosion. In general, model velocities within and surrounding Piles A and B marginally exceed the permissible velocity.

Even without dewatering the Spring Creek Arm, some fraction of HMO moves through the Arm into lower Keswick Reservoir and beyond. This movement is primarily a function of size and agglomeration of the colloidal HMOs and water velocity through the Spring Creek Arm. The hydraulic velocity is increased by an increase in flow or a decrease in water elevation in the Spring Creek Arm.

The metals concentrations for the Spring Creek Arm were used to estimate the percentage of iron and copper retained within the Arm relative to the total mass of metals passing

through SCDD. Data from Reclamation, RWQCB, USGS, the *Final Remedial Investigation* (EPA, 1985), and the Sediment RI were used to develop an estimate of the mass of iron and copper remaining in the Arm. Calculations suggest that, of the total mass passed through SCDD since 1964, 12 percent of the total iron released and 5 percent of the total copper released is retained within the Spring Creek Arm. These results indicate the majority of the copper and iron released from Spring Creek Reservoir has been transported out of the Spring Creek Arm into Keswick Reservoir and into the Sacramento River downstream of Keswick Dam.

Spring Creek Reservoir

Discharge of metals through SCDD has decreased considerably because of remedial actions upstream. Discharge of contaminants from SCDD is expected to be reduced to 5 percent of the pre-1994 discharge with the completion of SCRR and associated facilities. Literature references (Propokovich, 1991) have indicated that there is a potential to transport sediment from the Spring Creek Reservoir through SCDD into the Spring Creek Arm. However, review of 9 years of water quality monitoring data of the discharge from SCDD for total and dissolved metals demonstrated that little contaminated sediment has been detected in SCDD discharge. Total metals concentrations detected in SCDD discharge are nearly identical to the dissolved values (see Sediment FS). If significant contaminated sediment were present in SCDD discharge, higher total metals concentrations (as compared to dissolved concentrations) would be expected. On the basis of source control upstream of the SCDD and ongoing controlled operations of SCDD by Reclamation, Spring Creek Reservoir is not considered a significant source of ongoing metals release. The feasibility of restoring this area, the appropriateness and feasibility of relying on water management options as a component of a final Site remedy, and the need for other response actions will be further evaluated in future studies and RODs.

Keswick Reservoir

A large accumulation of sediment is present in Keswick Reservoir and extends from the mouth of the Spring Creek Arm to the base of Keswick Dam. The estimated volume of sediment in Keswick Reservoir derived from the 2001 bathymetric and geophysical survey was 1.1 million cy. This is an estimate of all fine-grained sediment in lower Keswick Reservoir and includes uncontaminated sediment deposited from sources upstream of the Spring Creek Arm.

Using high-resolution seismic reflection data collected in 1993 and 1994, the USGS estimates the volume of contaminated sediment in Keswick Reservoir as 144,000 cy (USGS, 1998). Sediment in the main body of Keswick Reservoir has a lower potential for release and migration downstream of Keswick Dam than sediment in the Spring Creek Arm because of the greater depth of water in Keswick Reservoir and the location of the sediment at greater depths in the reservoir (approximately 60 to 80 feet below the water surface).

As discussed for sediments in Spring Creek Reservoir, the feasibility of restoring this area and the need for other response actions will be further evaluated in future studies and RODs.

2.6 Current and Potential Future Land and Water Uses

2.6.1 Adjacent Land Uses

The City of Redding has a population of approximately 87,000 people and is located approximately 9 miles from the Site. The closest community is Keswick, located just east of the Site, and less than one mile south of the Spring Creek Arm.

The land surrounding the Spring Creek Arm is owned by the federal government (i.e., public lands) or Southern Pacific Railroad. The Shasta County General Plan Map for the South Central Region designates the following land uses within one mile of the Spring Creek Arm: Natural Resource Protection-Open Space (N-O), Rural Residential (RA or RB), and Suburban Residential (SR). However, no private residential land directly adjoins the Spring Creek Arm or the Spring Creek Reservoir.

Keswick Reservoir is used for recreational activities (e.g., fishing and boating). Land access to the Spring Creek Arm is limited because of steep shores and limited locations where roads or trails extend down to the Arm. Primary access to the Spring Creek Arm is by water from the boat ramp located on the main body of Keswick Reservoir, just to the north of the Spring Creek Arm. Additional access is provided to limited sections of the Arm by the extension of the Sacramento River Trail, constructed by the Bureau of Land Management (BLM) on the old Southern Pacific railroad bed. The section of the Sacramento River downstream from Keswick Reservoir (i.e., below Keswick Dam) currently serves as the water source for the City of Redding, and is used for recreational activities, including fishing and boating.

There is no expectation for the future use of the land adjacent to the Spring Creek Arm to change. The Shasta County General Plan Map indicates the majority of the land surrounding the Arm is public lands and will not be developed for residential, commercial, or industrial use. The General Plan is the official land use policy document for Shasta County. Zoning classifications as well as other development policies must be consistent with the General Plan. A proposed change to the County's adopted land use policies or maps contained in the General Plan would require advertised public hearings because of potential environmental and/or land use impacts.

2.6.2 Natural Resource Uses

Keswick Reservoir and the Sacramento River downstream of Keswick Reservoir are major components of Reclamation's water distribution system in California. In addition to providing valuable water resources, these surface waters provide recreational opportunities and high-quality habitat for spawning and rearing fish, including anadromous fish populations.

The Central Valley Project (CVP) is one of the nation's major water conservation developments and is a central component of the California water distribution system. Purposes of the CVP include:

- Providing irrigation water
- Supply of domestic and industrial water

- Flood control
- Generation of electric power
- Conservation of fish and wildlife
- Improving Sacramento River navigation
- Providing recreational opportunities
- Enhancing water quality

Specifically, Keswick Dam and Reservoir are used to equalize flow discharged from Shasta Dam and SCPP to enable a relatively constant flow in the Sacramento River downstream of Keswick Dam. Shasta Power Plant, Keswick Power Plant, and SCPP provide power first to meet the project facilities requirements, and then remaining energy is marketed to various customers in northern California. Shasta Power Plant and SCPP are classified as peaking plants, while Keswick Power Plant is a run-of-the-river plant.

As discussed in Section 2.5.2, the past and current IMM AMD discharges continue to impact the beneficial uses of the CVP water resources. Although the current IMM metal discharges have been reduced by 95 percent from the uncontrolled levels, it remains necessary to make low-flow releases from SCPP during releases from SCDD to flush the contaminated water through the Spring Creek Arm to prevent the buildup of metal concentrations in the Arm. The sediment deposits in the Spring Creek Arm that have resulted from past IMM metal releases restrict the range of operating levels of Keswick Reservoir because of concerns that sediment with high metals concentrations in the Spring Creek Arm would become mobilized.

The portion of Keswick Reservoir affected by IMM AMD has reduced recreational value. The resident trout fishery in Keswick Reservoir and the main body of the Sacramento River is impacted by both the heavy metal contaminants in the water column of the mixing zones and the heavy sediment loading caused by the precipitation of iron and other heavy metals discharged from the IMM Site over the past century.

The Sacramento River salmon fishery (downstream of Keswick Dam) is the most important fishery in the State of California. The salmon fishery has experienced large population declines because of a number of factors, including the IMM AMD impacts. The Sacramento River Winter-run Chinook salmon is listed as endangered by the United States and the State of California, and the Sacramento River Spring-run Chinook salmon is listed as threatened. The Sacramento River also supports a major steelhead trout and resident rainbow trout fishery.

Spring Creek Reservoir was constructed in part as a mitigation measure for the AMD discharges and does not support aquatic life, nor is it currently used for any recreational purpose. The Spring Creek Reservoir meters the Spring Creek watershed surface waters, contaminated by the continuing uncontrolled IMM AMD area source discharges, into the Sacramento River at Keswick Reservoir. The portions of Spring Creek impacted by IMM AMD are essentially lifeless.

2.7 Summary of Site Risks

2.7.1 Conceptual Site Model

The conceptual site model (CSM) identifies the means by which human or ecological receptors at or near the Spring Creek Arm may contact chemicals in environmental media. The CSM provides a current understanding of the sources of contamination, physical setting, beneficial uses of water, current and future land use, and identifies potentially complete human and ecological exposure pathways for the Spring Creek Arm. The CSM was used to identify potentially complete exposure pathways that warrant human health and ecological evaluations.

The conceptual exposure model was formulated according to guidance, with the use of professional judgment and information on contaminant sources, release mechanisms, routes of migration, potential exposure points, potential routes of exposure, and potential receptor groups associated with the site. Figure 6 presents the conceptual exposure model schematic for the site.

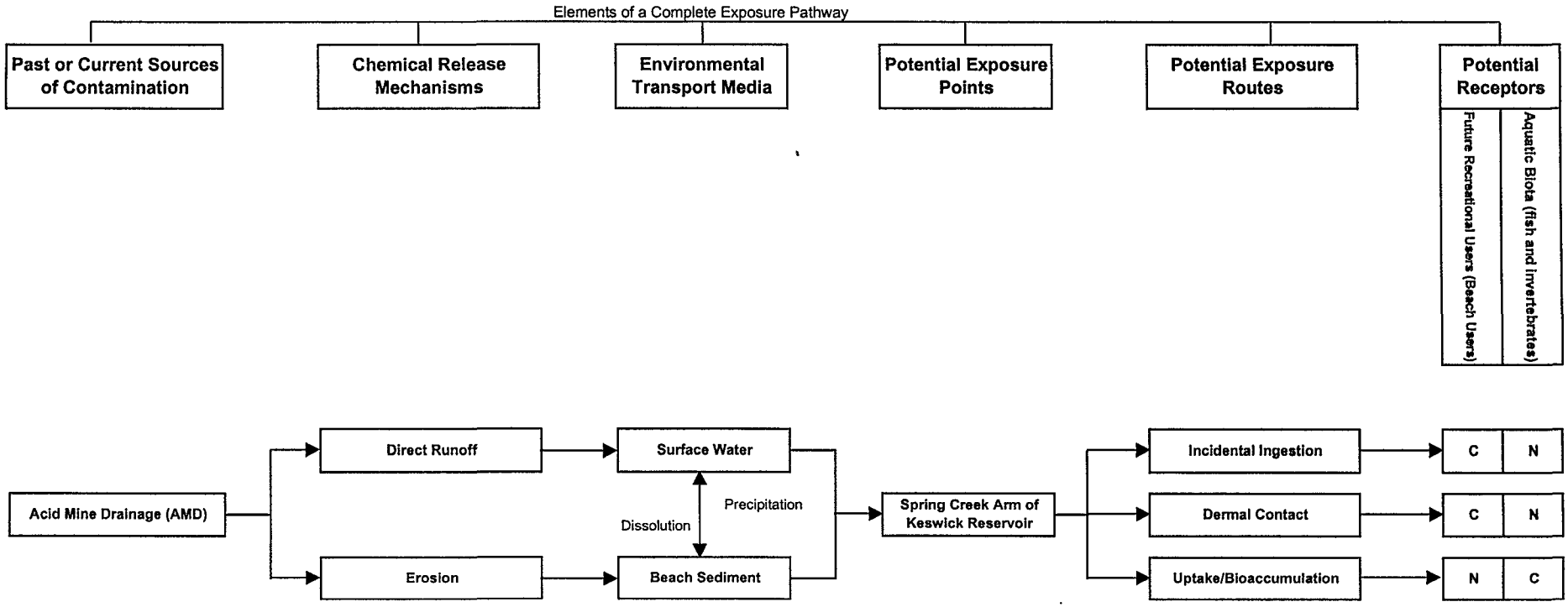
Based on current understanding of present and future land and water uses at or near the site, the following potentially complete human exposure pathways were considered for the site:

- Incidental ingestion and dermal contact with Spring Creek Arm surface water by future recreational users (This pathway was evaluated as part of the baseline risk assessment [PRC, 1991].)
- Incidental ingestion and dermal contact with Spring Creek Arm sediment by future recreational users (Evaluation of this pathway was revised as part of the 2004 updated human health risk evaluation [CH2M HILL, 2004b].)

Based on the current understanding of available habitat types and wildlife potentially using the Spring Creek Arm, and the beneficial use of surface water, the most plausible potentially complete ecological exposure pathways exist for the following scenarios:

- Potential exposure of aquatic resources to site-related chemicals in surface water in the Spring Creek Arm (This pathway was evaluated as part of the *Environmental Endangerment Assessment* [EPA, 1992a].)
- Potential exposure of aquatic resources to site-related chemicals in sediment in the Spring Creek Arm (Evaluation of this pathway was revised as part of the 2004 updated ecological risk evaluation [CH2M HILL, 2004b].)

Additionally, exposure of aquatic resources to site-related chemicals in the Sacramento River downstream of Keswick Reservoir has been historically documented. The potential for toxicity to aquatic resources downstream of the Spring Creek Arm was also discussed in the Ecological Risk Evaluation.



Notes:

C = Potentially complete pathway

N = Incomplete pathway

FIGURE 6
CONCEPTUAL EXPOSURE MODEL FOR POTENTIAL HUMAN AND ECOLOGICAL RECEPTORS
RECORD OF DECISION
IRON MOUNTAIN MINE
SHASTA COUNTY, CALIFORNIA

RDD\FIG6.xls

2.7.2 Human Health Risk Evaluation

The baseline risk evaluation estimated current and future risks posed by the Site in the absence of any remedial action. This section summarizes human health risk methodology and conclusions made in the technical memorandum *Updated Human Health and Ecological Risk Evaluations for the Spring Creek Arm of Keswick Reservoir*, Appendix E of the Sediment FS (CH2M HILL, 2004b; EPA, 2004). The memorandum was an update to previous human health and ecological risk evaluations at the IMM Site related to sediments in the Spring Creek Arm of Keswick Reservoir (PRC, 1991; EPA, 1992a).

Exposure Assessment

An assessment of chemical intake was conducted in accordance with applicable EPA guidance documents for risk assessment. The procedures used for this risk evaluation are consistent with those described in the following guidance documents:

- Risk Assessment Guidance for Superfund (RAGS) – Volume I: Human Health Evaluation Manual, Part A (Interim Final) (EPA, 1989)
- Risk Assessment Guidance for Superfund– Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment Interim) (EPA, 2001)

Chemical intakes were calculated for the exposure scenarios developed in the CSM and based on available media at the site and current and future land use.

The surface water exposure pathway, incidental ingestion and dermal contact with Spring Creek Arm surface water by future recreational users, was previously evaluated as part of the human health risk assessment conducted in 1991 by PRC Environmental Management, Inc. (PRC, 1991). The 1991 risk assessment concluded that individuals who come into direct contact with or ingest water from Keswick Reservoir are not currently at risk. Therefore, the surface water exposure pathway is not considered to pose significant risk to human health and was not further evaluated in the updated human health risk evaluation.

In the 1991 risk assessment, noncancer toxicity risks were also quantified for the consumption of fish from the Sacramento River for four contaminants of concern (cadmium, copper, iron, and zinc). The risk evaluation was conducted using exposure point concentrations derived using two approaches:

(1) Metals concentrations directly measured in the liver of resident rainbow trout collected in the Sacramento River below Keswick Dam

(2) Modeled metals concentrations in edible fish tissues based on bioconcentration factors for the specific metals

Hazard indices calculated by PRC using fish liver data were above regulatory thresholds; hazard indices were calculated as 2.2 for average concentrations and 5.9 for reasonable maximum exposure (RME) concentrations. Copper and cadmium were the primary contributors of risk. However, PRC concluded that risk calculations based on fish liver data very likely exaggerate the risk of consumption of fish. Humans usually eat only fish

muscle and not soft tissues (i.e., liver), and concentrations of metals in the muscle are expected to be much less than the concentrations found in the liver. Hazard indices were also calculated using metal concentrations in the Sacramento River and modeled metals concentrations in edible fish tissues based on bioconcentration factors for the specific metals. Hazard indices calculated using bioconcentration estimates were 0.16 using average concentrations and 0.76 using RME concentrations, below the regulatory threshold value of 1.0. Based on calculations using bioconcentration estimates, consumption of fish is not considered to pose a significant risk to human health. This pathway was not further evaluated in the updated human health risk evaluation.

Since the 1991 risk assessment, EPA obtained and reviewed sediment data from a 1997 USGS investigation and a 2003 sediment sampling event that indicated additional chemical constituents other than those previously evaluated were detected at elevated concentrations. Risks related to the Spring Creek Arm sediment exposure pathway were further evaluated using these additional data. This exposure pathway includes incidental ingestion and direct contact with contaminated sediment by a hypothetical current and future recreational user (modeled as a youth). Major assumptions regarding exposure frequency, duration, and other exposure factors included in the exposure assessment are detailed in Appendix E of the Sediment FS (CH2M HILL, 2004b).

Chemicals of Potential Concern and Exposure Point Concentrations

Considering the historical activities in the watershed, COCs are limited to heavy metals associated with AMD and HMO precipitates. Ten metals were identified in the human health and ecological risk evaluations as chemicals of potential concern (COPCs): antimony, arsenic, cadmium, chromium, copper, iron, lead, nickel, silver, and zinc.

Table 6 presents the COPCs and exposure point concentration (EPC) determined from Spring Creek Arm sediment samples. The EPC is the concentration that was used to estimate the exposure and risk from each metal. As will be discussed in greater detail in this section, results from the human health and ecological risk evaluations were used to identify COCs from this list of COPCs.

The EPCs for the Spring Creek Arm were calculated in accordance with EPA guidance for statistical analysis of monitoring data (EPA, 2002b). Table 6 includes the range of concentrations detected for each metal, as well as the frequency of detection, the EPC, and the statistical measure used to derive the EPC.

Toxicity Assessment

Toxicity values for the COPCs were compiled from the *Integrated Risk Information System* (IRIS) (EPA, 2003) and Health Effects Assessment Summary Tables (HEAST) (EPA, 1997c).

Carcinogens. Table 7 provides carcinogenic risk information which is relevant to chemicals of concern in Spring Creek Arm sediment. Of the COPCs evaluated, oral carcinogenic slope factors are only available for arsenic.

TABLE 6
Spring Creek Arm Sediment Exposure Point Concentrations
Iron Mountain Mine Record of Decision 5, Shasta County, California

Chemical	Concentration Detected			No. of Samples	No. of Detects	Percent Detects	95% Normal UCL	95% Lognormal UCL	EPC	Statistical Measure
	Min.	Max.	Mean							
Antimony	0.48	7.7	3.9	9	8	89	5.8	18	5.8	Normal (Student's-t)
Arsenic	4.6	933	285	31	31	100	350	510	362	Bootstrap-t
Cadmium	0.49	37	6.1	31	31	100	8.1	8.3	8.3	Lognormal
Chromium	3.4	194	24	31	30	97	47	48	48	Lognormal
Copper	75	4,765	1,262	181	181	100	1,353	1,422	1,361	Bootstrap-t
Iron	39,672	469,895	160,986	181	181	100	170,393	172,812	170,863	Bootstrap-t
Lead	2.4	393	73	31	31	100	94	110	112	Bootstrap-t
Nickel	2.1	290	35	31	31	100	53	52	71	Bootstrap-t
Silver	0.21	19	7.0	31	21	68	8.8	12	9.1	Bootstrap-t
Zinc	63.4	6578	892.5	181	181	100	999	973.6	974	Lognormal

Notes:
All units are in mg/kg, milligrams per kilogram.
EPC = *exposure point concentration*, UCL = *upper confidence level*

TABLE 7
Summary of Cancer Toxicity Values Used in the Human Health Risk Evaluation
Iron Mountain Mine Record of Decision 5, Shasta County, California

Chemical Name	Oral Cancer Slope Factor	Dermal Cancer Slope Factor	Slope Factor Units	Weight of Evidence/Cancer Guideline Description	Source
Antimony	--	--	--	D	--
Arsenic	1.5	1.5	$(mg/kg\text{-}day)^{-1}$	A	IRIS, 2003
Cadmium	--	--	--	B1	--
Chromium	--	--	--	A	--
Copper	--	--	--	D	--
Iron	--	--	--	--	--
Lead	--	--	--	B2	--
Nickel	--	--	--	D	--
Silver	--	--	--	D	--
Zinc	--	--	--	D	--

Notes:
-- = not applicable
IRIS = Integrated Risk Information System, U.S. EPA
A – human carcinogen; B1 – probable human carcinogen, indicates that limited human data are available; B2 – probable human carcinogen, indicates sufficient evidence in animals and inadequate or no evidence in humans; and D – Not classifiable as a human carcinogen

Because carcinogenic slope factors and noncarcinogenic reference doses (see next section) are not available for the dermal route of exposure, dermal slope factors and reference doses used in the risk evaluation were extrapolated from oral values. An adjustment

factor is sometimes applied, and is dependent upon how well the chemical is absorbed via the oral route. Adjustments are particularly important for chemicals with less than 50 percent adsorption via the ingestion route. Adjustment was not necessary for arsenic. Therefore, the same value presented for the oral cancer slope factor was used as the dermal cancer slope factor for arsenic.

Noncarcinogens. Table 8 provides non-carcinogenic toxicity factors which are relevant to the COPCs in Spring Creek Arm sediment. Toxicity data available for oral exposures have been used to develop oral reference doses (RfDs).

TABLE 8

Summary of Non-cancer Toxicity Values Used in the Human Health Risk Evaluation

Iron Mountain Mine Record of Decision 5, Shasta County, California

Chemical Name	Oral RfD Value	Oral RfD Units	Dermal RfD Value	Dermal RfD Units	Source	Date
Antimony	4.00E-04	mg/kg-day	6.00E-06	mg/kg-day	IRIS	2003
Arsenic	3.00E-04	mg/kg-day	3.00E-04	mg/kg-day	IRIS	2003
Cadmium	5.00E-04	mg/kg-day	1.25E-05	mg/kg-day	IRIS	2003
Chromium	3.00E-03	mg/kg-day	7.50E-05	mg/kg-day	IRIS	2003
Copper	4.00E-02	mg/kg-day	4.00E-02	mg/kg-day	HEAST	1997
Iron	3.00E-01	mg/kg-day	3.00E-01	mg/kg-day	PRG	1997
Lead	--	--	--	--	--	--
Nickel	2.00E-02	mg/kg-day	8.00E-04	mg/kg-day	IRIS	2003
Silver	5.00E-03	mg/kg-day	5.00E-03	mg/kg-day	IRIS	2003
Zinc	3.00E-01	mg/kg-day	3.00E-01	mg/kg-day	IRIS	2003

Notes:
-- = not applicable
IRIS = Integrated Risk Information System, U.S. EPA
HEAST = Health Effects Assessment Summary Tables (HEAST) FY 1997 Update. EPA-540-R-97-036. July 1997.
PRG = EPA Region IX PRG Tables, October 2002

As discussed for carcinogens, reference doses are not available for the dermal route of exposure. Thus, the dermal slope factors and reference doses used in the assessment have been extrapolated from oral values. An adjustment factor is sometimes applied, and is dependent upon how well the chemical is absorbed via the oral route. Adjustments are particularly important for chemicals with less than 50 percent adsorption via the ingestion route. Dermal toxicity factors were derived in accordance with guidance in Appendix A of RAGS (EPA, 1989).

Lead. Potential risks from lead concentrations were evaluated using different methods than those conventionally used for other carcinogens and noncarcinogens. For direct contact pathways, the EPCs for lead in sediment were compared to the EPA Region IX residential soil preliminary remediation goal (PRG) of 400 mg/kg. The residential soil PRG is based on EPA's Integrated Exposure Uptake Biokinetic (IEUBK) model. The IEUBK model is designed to predict probable blood-lead concentrations for children between 6 months and 7 years of age who have been exposed to lead through various sources (air, water, soil, dust, and in utero contributions from the mother).

Risk Characterization

For carcinogens, risks are generally expressed as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to the carcinogen. The excess lifetime cancer risks are determined by multiplying the intake level with the cancer slope factor.

These risks are probabilities that usually are expressed in scientific notation (e.g., $1x10^{-6}$). An excess lifetime cancer risk of $1x10^{-6}$ indicates that an individual experiencing the reasonable maximum exposure estimate has a 1 in 1,000,000 chance of developing cancer as a result of site-related exposure. This is referred to as an "excess lifetime cancer risk" because it would be in addition to the risks of cancer individuals face from other causes such as smoking or exposure to too much sun. The chance of an individual developing cancer from all other causes has been estimated to be as high as one in three. EPA's generally acceptable risk range for site-related exposures is 10^{-4} to 10^{-6}. The chronic daily intake was calculated for each exposure pathway (i.e., incidental ingestion and dermal contact) using exposure factors such as exposure frequency, exposure duration, body weight, etc. The exposure assumptions for calculating the chronic daily intake are provided in Appendix E of the Sediment FS (CH2M HILL, 2004b, EPA 2004).

The potential for noncarcinogenic effects is evaluated by comparing an exposure level over a specified time period with a reference dose (RfD) derived for a similar exposure period. An RfD represents a level that an individual may be exposed to that is not expected to cause any deleterious effect. The ratio of estimate intake (i.e., exposure) to toxicity value (i.e., RfD) is called a hazard quotient (HQ). An HQ<1 indicates that a receptor's dose of a single contaminant is less than the RfD, and that adverse noncarcinogenic effects from that chemical are unlikely. Additionally, a hazard index (HI) is generated by adding the HQs for all chemical(s) of concern that affect the same target organ (e.g., liver) or that act through the same mechanism of action within a medium or across all media to which a given individual may reasonably be exposed. An HI<1 indicates that, based on the sum of all HQs from different contaminants and exposure routes, adverse noncarcinogenic effects from all contaminants are unlikely. An HI>1 indicates that site-related exposures may present a risk to human health.

The potential exposure to Spring Creek Arm sediment was evaluated under a recreational user scenario. Potential routes of exposure to sediment include incidental ingestion and dermal contact. The following assumptions were used to estimate reasonable maximum exposure (RME) for hypothetical current and future recreational users:

> A 45.8-kilogram youth was assumed to be exposed to sediment for 12 days per year, over a 9-year duration.

The excess lifetime cancer risk (ELCR) estimates for the recreational user scenario are summarized in Table 9.

The cumulative ELCR from all carcinogenic COPCs is 1×10^{-5}. This risk level indicates that if no cleanup action is taken, an individual would have an increased probability of 1 in 100,000 of developing cancer as a result of site-related exposure to the COPCs. This risk level is within the EPA Superfund regulatory target risk threshold range of 1×10^{-6} to 1×10^{-4}. The primary contributor to risk is arsenic (100 percent contribution).

TABLE 9
Recreational User Scenario – Potential Excess Lifetime Cancer Risk, Spring Creek Arm Sediment
Iron Mountain Mine Record of Decision 5, Shasta County, California

	Ingestion			Dermal				
Chemical	**CDI**	**CDI Units**	**ELCR**	**CDI**	**CDI Units**	**ELCR**	**Total ELCR**	**Percent Contribution**
Arsenic	6.68E-06	mg/kg-day	1.0E-05	2.13E-06	mg/kg-day	3.2E-06	1.3 E-05	100.00
Total Risk			1.0E-05			3.2E-06	1.3 E-05	

Notes:
CDI = chronic daily intake
ELCR = excess lifetime cancer risk

Table 10 provides hazard quotients (HQs) for each route of exposure (i.e., incidental ingestion or dermal contact) and the hazard index (HI, sum of hazard quotients) for all routes of exposure. The Risk Assessment Guidance (RAGS) for Superfund states that, generally, an HI greater than one indicates the potential for adverse noncancer effects. The HI for exposure to Spring Creek Arm sediment is 0.3, which is below the regulatory threshold value.

TABLE 10
Recreational User Scenario – Potential Noncarcinogenic Risk, Spring Creek Arm Sediment
Iron Mountain Mine Record of Decision 5, Shasta County, California

	Ingestion		Dermal			
Chemical	**CDI (mg/kg-day)**	**HQ**	**CDI (mg/kg-day)**	**HQ**	**Total HI**	**Percent Contribution**
Antimony	8.31E-07	<0.01	--	--	<0.01	0.6
Arsenic	5.19E-05	0.2	1.66E-05	0.06	0.2	70
Cadmium	1.19E-06	<0.01	1.26E-08	<0.01	<0.01	1.0
Chromium	7E-06	<0.01	--	--	<0.01	0.7
Copper	2E-04	<0.01	--	--	<0.01	1.5
Iron	2E-02	0.08	--	--	0.08	25
Lead	2E-05	--	--	--	--	--
Nickel	1E-05	<0.01	---	--	<0.01	0.2
Silver	1E-06	<0.01	--	--	<0.01	0.1
Zinc	1E-04	<0.01	--	--	<0.01	0.1
Total Risk		0.3		0.06	0.3	

Notes:
CDI = chronic daily intake
HQ = hazard quotient
HI = hazard index
-- = Toxicity criteria are not available to quantitatively address this route of exposure.

As discussed previously, potential risks from lead concentrations were evaluated using different methods than those conventionally used for other carcinogens and noncarcinogens. All detected concentrations of lead were below the Region IX residential PRG of 400 mg/kg.

In summary, the human health risk evaluation indicates that contaminated sediment in the Spring Creek Arm does not pose a current or future unacceptable risk to human health or welfare.

2.7.3 Ecological Risk Evaluation

This section summarizes ecological risk methodology and conclusions made in the technical memorandum *Updated Human Health and Ecological Risk Evaluations for the Spring Creek Arm of Keswick Reservoir*, Appendix E of the Sediment FS (CH2M HILL, 2004b, EPA 2004). The risk evaluation used the sediment data presented in the human health risk summary (Section 2.7.2) and previous studies (e.g., bioassays, benthic bioassessments, etc.) to assess the potential current and future risk to benthic and aquatic communities in the absence of any remedial actions.

The procedures used for the ecological risk evaluation were consistent with those described in the following guidance documents:

- Guidelines for Ecological Risk Assessment (EPA, 1998)
- Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments (EPA, 1997d)

Ecological Risk Methodology

Potential effects to benthic and aquatic communities were assessed using an approach which considers multiple lines of evidence collectively (EPA, 1998). The results from the historical and current environmental evaluations were collectively considered. The following lines of evidence were evaluated to identify the potential for risk to aquatic resources:

- Identification of chemical concentrations in sediment that exceed effects-based screening benchmarks (e.g., threshold effect concentrations [TEC], probable effect concentrations [PEC], and upper effects threshold [UET] screening levels)
- Direct measurement of infaunal toxicity using sediment and porewater bioassays
- Rapid bioassessment of benthic community

The results of each of these lines of evidence are briefly discussed below.

Additionally, the ecological risk evaluation discussed the potential for adverse effects to fishery resources downstream of Keswick Reservoir using data from California Department of Fish and Game (CDFG) investigations.

Benthic Exposure and Effects Estimation. Benthic receptors are directly exposed to constituents in the media in which they live, and because toxicity values for these taxa are expressed in terms of media concentrations, site media concentrations (i.e., Spring Creek

Arm sediment data) were directly compared with benthic macroinvertebrate screening benchmarks. This ecological evaluation used the TEC and PEC provided in the "Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems" (MacDonald et al., 2000) and the UET from the National Oceanic and Atmospheric Administration's (NOAA) *Screening Quick Reference Tables* (Buchman, 1999) for screening benchmarks.

TEC and PEC screening levels represent estimates of the level below which adverse effects to benthic macroinvertebrates are not expected to occur and above which adverse effects are expected to occur, respectively (MacDonald et al., 2000). Constituent concentrations in sediment falling between their respective TEC and PEC screening levels represent the range where adverse effects would occasionally occur. Because no threatened or endangered invertebrate species were identified in the Spring Creek Arm, it is most appropriate to base management decisions regarding the toxicity of the sediments on population-level effects rather than each individual. Considering this, the PEC is the most appropriate screening level for supporting management decisions regarding the potential toxicity of the sediments for benthic macroinvertebrates.

EPCs for COPECs in sediment were calculated as the lesser of either the maximum value or the ninety-fifth percentile UCL of sediment chemistry data. EPCs for all results and chemical concentrations from individual samples were used for the benchmark comparisons. Table 11 provides a comparison of the estimated sediment EPCs with freshwater sediment benchmarks. The EPC basis and summary statistics for the COPECs were presented in Table 6.

TABLE 11
Comparison of Exposure Point Concentrations with Sediment Benchmarks
Iron Mountain Mine Record of Decision 5, Shasta County, California

Chemical	EPC	TEC	Factor of Exceedance	PEC	Factor of Exceedance	UET	Factor of Exceedance
Antimony	5.8	---	---	---	---	3	1.9
Arsenic	362	9.79	36.9	33	11.0	17	21.3
Cadmium	8.3	0.99	8.3	4.98	1.7	3	2.8
Chromium	48	43.4	1.1	111	0.4	95	0.5
Copper	1,361	31.6	43.1	128	10.6	86	15.8
Iron	170,863	---	---	---	---	---	---
Lead	112	35.8	3.1	128	0.9	127	0.9
Nickel	71	22.7	3.1	48.6	1.5	43	1.6
Silver	9.1	---	---	---	---	4.5	2.0
Zinc	974	121	8.0	459	2.1	520	1.9

Notes:
-- = not available
All units are in mg/kg, milligrams per kilogram
EPC = exposure point concentration; TEC = threshold effects concentration
PEC = probable effects concentration; UET = upper effects threshold
Factor of exceedance is calculated as the EPC divided by the sediment benchmark concentration (i.e., TEC, PEC, or UET).

EPCs exceeding applicable screening benchmarks (i.e., a factor of exceedance greater than 1.0) indicate that there is a potential for adverse risk to benthic species; however, the results of the benchmark screening are considered collectively with the other lines of evidence discussed in the following subsections.

Sediment Bioassays. The results of bioassay tests conducted on sediment samples from Spring Creek Reservoir during the RI were reported in *Bioassay Report: Acute and Chronic Definitive Bioassays Conducted September 24 through November 27, 1997* (provided as Appendix F of the RI Report [EPA, 2002a]). The following bioassays were conducted to determine the toxicity of sediment and soil at the site:

- Chronic exposure of earthworms (*Eisenia foetida*) (14-day survival and growth) to dry sediment or soil
- Chronic exposure of lettuce seeds (*Lactuca sativa*) (28-day germination and growth) to dry sediment or soil
- Acute (LC_{50}) and chronic (no observed/lowest observed) exposure of amphipods (*Hyalella azteca*) to wet sediment
- Forty-five day growth and survival bioassays with wet sediments using yellow nutsedge (*Cyperus esculentus*)
- Acute 96-hour frog embryo toxicity assay-*Xenopus* (FETAX) tests with wet sediment samples, measuring survival and malformation rate

All five of these bioassays indicated that sediment and soil were toxic at 100 percent or lower concentrations. Results of the earthworm tests indicated that toxicity (statistically significant mortality) was generally observed in soil samples of less than 25 percent whole soil. Lettuce seed bioassays indicated that toxicity of soils to this species was at soils concentrations of less than 25 percent whole soil for all samples tested.

Wet sediment tests with amphipods had adverse effects at sediment concentrations ranging from 1 to 15 percent whole sediment for all samples tested. Lethal effects (LC_{50}) concentrations ranged from 2.5 to 13.1 percent whole sediment. Nutsedge tests indicated that for all sediments tested, adverse effects were seen at the 100 percent sediment concentration.

The FETAX assays indicated that all sediments tested had malformation rates (EC_{50}) at sediment concentrations of less than 25 percent whole sediment. Lethal effects (LC_{50}) for frogs were seen at whole sediment concentrations ranging from 12.1 percent to less than 25 percent.

Rapid Bioassessment - Benthic Invertebrate Study. A one-time sampling and analysis of benthic invertebrates was conducted at locations associated with sediment piles within the Spring Creek Arm, lower Keswick Reservoir, and background areas within upper Keswick Reservoir. Results of that investigation are presented in Appendix G of the RI Report, *Keswick Reservoir Fall 1997 Benthic Invertebrate Study* (Slotton, et al., 1998; EPA, 2002a). This investigation found dramatically reduced benthic diversity and biomass within Sediment Piles A, B, and C and in lower Keswick Reservoir in comparison

to similar depth ranges in upper Keswick Reservoir. The numerical abundance of benthic invertebrates in and downstream of the Arm ranged from 0.55 to 9.2 percent of the numerical abundance of upper Keswick Reservoir. Similarly, the benthic biomass ranged from 0.05 to less than 20 percent of the benthic biomass in upper Keswick Reservoir areas. This represents reductions of greater than 90 percent in numerical abundance and greater than 80 percent in benthic biomass in comparison to control areas. The results of this investigation demonstrated areas of severely impoverished benthic community associated with the sediment piles within the Spring Creek Arm and lower Keswick Reservoir.

Porewater Bioasssays with *Ceriodaphnia dubia*. Acute 48- and 96-hour toxicity tests with sediment porewaters prepared from samples collected from Piles A, B, and C within the Spring Creek Arm were conducted to determine the lethality of these solutions to *Ceriodaphnia dubia* (*C. dubia*). Results of these toxicity tests are presented in Appendix H of the RI Report, *An Evaluation of the Toxicity of Sediment Porewater from the Iron Mountain Superfund Site to Ceriodaphnia dubia* (Pacific Eco-Risk Labs, 1998; and EPA, 2002a).

Acute toxicity tests with porewater from Pile A and Pile B sediments indicated that 48-hour and 96-hour LC_{50}s were in the range of 0.8 to 1.8 percent porewater (dilution of 125:1 to 55:1) in the samples tested. In acute toxicity tests with Pile C porewaters, 48- and 96-hour LC_{50}s ranged from 0.6 percent to 2.2 percent porewater for samples collected from 0 to 10 feet in depth. Background samples from Shasta, Whiskeytown, and the laboratory demonstrated no significant mortality in 100 percent porewater.

As a result of the findings of these acute and chronic tests, a Phase I toxicity identification evaluation (TIE) was conducted with sediment porewater from Pile C. Results of this evaluation indicated that iron was primarily responsible for the acute toxicity of this porewater to *C. dubia*.

The results of these bioassays with sediment elutriates and porewater are consistent with the bioassays of bulk sediment and soil samples. All of these bioassays demonstrated that constituents in these media contribute to significant toxicity to invertebrates, plants, and amphibians.

Aquatic Resources Downstream of Keswick Reservoir. The Sacramento River between Keswick and Squaw Hill Bridge, near Vina, includes areas designated as prime salmon and steelhead spawning areas (CDFG Code Section 1505). These areas are used by salmon species listed as threatened and endangered, including two state-listed species: Sacramento River winter-run and spring-run Chinook salmon (*Oncorhynchus tshawytscha)*. When low reservoir elevations are combined with high power plant discharges, sediment could be mobilized to expose listed species of salmon in Sacramento River spawning areas to contaminants during sensitive life stages. At least one such event has occurred during the past 20 years, on May 25, 1988. Six weeks after the release of contaminated sediment, sediment "sludge" samples were collected in redd areas (e.g., salmonid spawning areas) downstream of Keswick Dam. Copper, zinc, and cadmium were detected at elevated concentrations of 364, 864, and 5 mg/kg in the downstream

area (Turtle Bay West, CDFG data). This discharge was believed to effect the Sacramento River as far downstream as Hamilton City.

The CDFG evaluated the potential toxicity of resuspended Keswick Reservoir sediment to fish and invertebrates residing in the Sacramento River (Finlayson et al., 2000). Bulk sediment and elutriate water bioassay tests were conducted using rainbow trout (*O. mykiss*), amphipods (*H. azteca*), and cladocerans (*C. dubia*). The tests were conducted to simulate conditions that could occur during an actual discharge of sediments to the Sacramento River. Both bulk sediment and elutriate bioassay tests resulted in significant toxicity, and the authors indicated a good correlation with zinc concentrations was observed, although they believe low pH and alkalinity conditions could have influenced survival rates. These results indicate that if significant downstream releases of sediment from the Spring Creek Arm occur, bulk sediment and sediment elutriate waters represent a significant potential hazard to aquatic life (including state-listed salmonid species) in the Sacramento River downstream of Keswick Dam, particularly the early life stages of salmon and steelhead. Because cleanup of toxic sediments in the spawning grounds would be expected to be a difficult operation, toxic conditions could extend over a several year period and jeopardize the survival of the entire populations.

Ecological Risk Characterization

To provide confidence in decision making for the Spring Creek Arm, potential effects to benthic communities were assessed using an approach which considers multiple lines of evidence collectively (EPA, 1998). The results of each of these lines of evidence are summarized in Table 12.

TABLE 12
Summary of Risk Characterization Lines of Evidence
Iron Mountain Mine Record of Decision 5, Shasta County, California

Evidence	Result	Explanation
Benthic Benchmark Screening	+	2003 – Several COPEC concentrations (using historical and current sediment data) exceed each of the sediment benchmarks (copper and arsenic showed the highest risk).
Sediment Bioassays	+	1997 – Amphipod bioassays showed adverse effects at sediment concentrations from 1 to 15 percent whole sediment. Nutsedge tests indicated toxic effects in 100 percent samples in all sediments tested. FETAX assays indicated significant malformations (EC_{50} of <25 percent whole sediment) and mortality (LC_{50}s of 12.1 to 25 percent whole sediment) in all sediments tested.
Rapid Bioassessment – Benthic Invertebrate Study	+	1997 – Results indicate dramatic reductions in benthic diversity and biomass in Spring Creek Arm Piles A, B, and C when compared with reference areas.
Porewater Bioassays	+	1998 – Significant mortality (LC_{50}s all <2.2 percent) to *Ceriodaphnia dubia* occurred when exposed to sediment porewater from Piles A, B, and C in the Spring Creek Arm.

+ = indicates that the evidence is consistent with the occurrence of the endpoint effect.

When considering the collective weight of evidence using sediment benchmark comparisons, rapid bioassessment, and bioassay results for potential risk to aquatic/benthic communities, sufficient evidence exists to conclude that the identified COPCs are resulting in

ecologically significant impacts to these communities in the Spring Creek Arm. Essentially all the lines of evidence support this conclusion.

Additionally, data collected following historical releases of sediment from the Spring Creek Arm and bulk sediment and elutriate water bioassay tests on aquatic species indicate that a significant release of sediment from the Spring Creek Arm could adversely impact downstream fisheries within the Sacramento River. A release would pose a serious potential risk to United States and California-listed spring-run Chinook salmon (threatened species), winter-run Chinook salmon (endangered species), and other aquatic resources.

Chemicals of Concern

Considering the results of the sediment benchmark screening, sediment constituents exceeding PECs have been identified as chemicals of ecological concern (COECs). The COECs include: arsenic, cadmium, copper, nickel, and zinc. Of these metals, arsenic and copper had the highest factors of exceedances above PECs and likely pose the greatest risk to aquatic resources. A PEC was not available for iron; however, porewater studies indicated that iron could have been responsible for *C. dubia* toxicity; therefore, iron is also considered a COEC.

2.7.4 Basis for Remedial Action

The risk evaluations indicate that contaminated sediment in the Spring Creek Arm does not pose a current or future unacceptable risk to human health and welfare. However, the contamination has resulted in ecologically significant impacts to benthic and aquatic communities in the Arm. Additionally, a potential future release of contaminated sediment could adversely impact important downstream fisheries through the deposition of sediments containing toxic levels of metals in spawning beds of the Sacramento River. The site risk evaluation indicates that remedial action is warranted and identified the contaminants and exposure pathways that need to be addressed by remedial action. EPA has determined that the response action selected in this ROD is necessary to protect the environment from actual or threatened releases of hazardous substances into the environment.

2.8 Remedial Action Objectives

Remedial action objectives (RAOs) provide a general description of what the cleanup is expected to accomplish and provide a design basis for remedial alternatives. RAOs define the extent of site cleanup required to protect human health and the environment. Where applicable, RAOs take into consideration COCs, routes of exposure and receptors, and acceptable contaminant concentrations for each impacted medium at the Site. RAOs developed for the remedial action selected in this ROD are:

- Protect the Sacramento River ecosystem from releases of heavy metals originating from the Spring Creek Arm, by preventing the mobilization and redeposition of contaminated sediment into important fishery spawning habitats located in the Sacramento River downstream of Keswick Dam.

- Prevent adverse impacts on water quality and the beneficial uses of the Sacramento River below Keswick Dam, by reducing the metal loads and suspended solids associated with contaminated sediment discharged from the Spring Creek Arm to the Sacramento River.

Achievement of the above RAOs is expected to have the following ancillary benefits:

- Increase the possibility that a benthic community could become re-established in the Spring Creek Arm.
- Improve aquatic habitat in Keswick Reservoir through remedial actions in the Spring Creek Arm.
- In addition, it is expected that operation of the SCDD and power plant may be subject to reduced restrictions regarding Keswick Reservoir operating levels. However, renegotiation of current restrictions on Keswick Reservoir operations is not required under this ROD.

The selected remedy will not address upgradient sources of contaminant discharges from the IMM Superfund Site. These discharges are being addressed through other remedial actions currently underway (e.g., SCRR) and potential future remedial action decisions for the IMM Site.

2.9 Description of Alternatives

2.9.1 General

This section provides a brief description of remedial alternatives developed to address contaminated sediment in the Spring Creek Arm of Keswick Reservoir. Alternatives were developed to provide a range of waste management options that vary in the extent of active remediation and the extent to which they rely on long-term management of residuals and untreated wastes. In accordance with CERCLA guidance, remedial alternatives were developed by assembling technology types (e.g., dredging) and process options chosen to represent the various technology types (e.g., hydraulic dredging). The "no action" alternative was also evaluated.

The Sediment FS evaluated the three major cleanup methods for sediment in accordance with the *Contaminated Sediment Guidance for Hazardous Waste Sites*, OSWER 9355.0-85 (EPA, 2002c). These cleanup methods include natural recovery, in situ capping, and dredging (or excavation) with treatment or disposal. During the identification and screening of technologies, EPA determined that monitored or enhanced natural recovery would not satisfy RAOs. Natural recovery uses ongoing, naturally occurring processes to contain, destroy, or otherwise reduce the bioavailability or toxicity of contaminants in sediment. Biological or chemical transformation would be too slow in the Spring Creek Arm to provide remediation to acceptable levels in a reasonable timeframe for the metals of concern. The potential for migration of contaminated sediment in the Spring Creek Arm would remain during implementation of natural recovery. Therefore, an alternative was not developed that included natural recovery as the sole component of the remedy.

Six alternatives were developed and screened in the Sediment FS. Table 13 presents a summary of the components of each alternative. These alternatives include no further action, institutional controls, capping, dredging, and a combination of capping and dredging. The most promising alternatives identified during the screening were selected for further development.

The sixth alternative summarized in Table 13 was dropped during screening. That alternative was designed to limit the mobilization of contaminated sediment in the Spring Creek Arm using controls that limit SCDD releases and power plant operations. No engineering controls or active remediation were included in Alternative 6. Such operational controls would not significantly improve long-term protection compared to existing conditions. More details regarding this alternative and the screening process are provided in the Sediment FS (EPA, 2004).

The alternatives described in this section are those that were retained for further analysis following screening in the Sediment FS. The cost and design details provided for the five alternatives passing initial screening are based on preliminary engineering estimates. More detailed cost estimates and designs will be completed in the Remedial Design phase of the cleanup.

2.9.2 Alternative 1 – No Action

The No-action Alternative is evaluated to determine the risks that would be posed to public health and the environment if no further actions were taken to reduce the potential for mobilization of contaminated sediment into the Sacramento River. This alternative also serves as a basis for comparison with the other remedial alternatives under consideration. The No-action Alternative for the Sediment FS should be considered as "No Further Action." Under the No-action Alternative, contaminated sediment would be left in place in the Spring Creek Arm and no engineering controls would be used to contain the sediment. This alternative assumes continued operation of SCDD and Keswick Reservoir in accordance with the 1980 MOU (SWRCB et al., 1980) and the 1993 Biological Opinion (NMFS, 1993). The MOU is an agreement among the SWRCB, United States Water and Power Resources Service (the predecessor to Reclamation), and the CDFG that presents the short- and long-term actions and responsibilities of the signatory agencies to minimize toxicity problems in the vicinity of Spring Creek. The 1993 Biological Opinion addresses the effects of Reclamation's long-term operation of the CVP, in conjunction with the Department of Water Resource's State Water Project, on Sacramento River Winter-run Chinook salmon (NMFS, 1993). Reclamation would continue to control the release rate from SCDD in a manner that matches the discharges from Shasta Dam and the SCPP so that water quality criteria are met downstream of Keswick Dam. Reclamation would continue low-flow releases from SCPP during SCDD releases to flush Spring Creek Reservoir water through the Spring Creek Arm. Keswick Reservoir operating levels would continue to be restricted within an operating range of 578 feet msl to 587 feet msl during all operation of SCPP to limit scouring of contaminated sediment from the Spring Creek Arm.

TABLE 13

Alternative Components Summary

Iron Mountain Mine Record of Decision 5, Shasta County, California

General Response Action or Technology	Description	Alternatives									
		1	2A	2B	3A	3B	4A	4B	5A	5B	6
No Action		X									
Operational Controls	Restrictions on SCDD and power plant operations, access, and/or recreational use		X	X	X	X	X	X	X	X	X
Containment – In situ Subaqueous Cap	Covering piles with coarse sand and/or armoring stone (gravel and riprap)		X	X					X	X	
Sediment Removal –Dredging	Removal of contaminated sediment to the extent technically feasible				X	X					
	Partial removal of contaminated sediment (to 560 feet msl)						X	X	X	X	
Limited Residual Management	Evaluating and minimizing mobilization potential for small volumes of residual sediment remaining in dredged areas				X	X	X	X	X	X	
Resuspension Management	Controls to limit suspension and migration of contaminated sediment during remedial action, such as Best Management Practices (BMPs), engineering design, and sediment curtain barriers		X	X	X	X	X	X	X	X	
Materials Transport/Conveyance	Pumping dredge discharge to treatment area disposal cell				X	X	X	X	X	X	
Ex-situ Physical and Chemical Treatment of Dredge Discharge	Treatment of dredge discharge, including polymer addition, pH adjustment, and gravity settling in dewatering/disposal cell				X	X	X	X	X	X	
Disposal in Upland Disposal Cell	Disposal cell adjacent to Spring Creek Reservoir				X		X		X		
	Disposal cell adjacent to Iron Mountain Road					X		X		X	
Return-water Conveyance and Discharge	Piping return water to Spring Creek Reservoir				X	X	X	X	X	X	
Monitoring	Short-term monitoring during implementation of remedial action		X	X	X	X	X	X	X	X	
	Long-term monitoring following implementation of remedial action		X	X	X	X	X	X	X	X	

2.9.3 Alternative 2 – Capping the Sediment in Place (In situ Subaqueous Sediment Cap)

Alternative 2 provides for placement of a subaqueous cap over contaminated sediment in the Spring Creek Arm. As part of the technology screening and conceptual design, a cap consisting of granular and rock material was selected as a less expensive and more technically feasible option compared to other capping options. The cap would be designed to contain sediment and limit mobilization of sediment into the Sacramento River. The sediment would remain in place (*in situ*); no sediment would be removed under Alternative 2. Alternative 2 includes two subalternatives: capping the full extent of the Spring Creek Arm (Alternative 2A) and capping sediment in Piles A, B, and C (Alternative 2B). Alternative 2B would contain about 90 percent of the volume of contaminated sediment in the Arm, but the cap would extend over only 60 percent of the area of the Arm.

Placement of capping materials would be limited to times when SCPP is not operating and no flow is being released from SCDD. This would facilitate construction and limit migration of suspended sediment. Other methods to limit suspension and migration of contaminated sediment might include best management practices, engineering design, and sediment curtain barriers. Alternative 2A is estimated to require 3 years to construct, and Alternative 2B would require 2 years.

The engineered cap would be designed to contain sediment during the greatest anticipated discharges to the Spring Creek Arm under low and high reservoir water elevations. No restrictions would be required on Keswick Reservoir operating elevations or maximum SCPP release rates. Both Alternatives 2A and 2B include use controls to prevent dredging or construction activities within the Spring Creek Arm that could damage the cap. Alternatives 2A and 2B include long-term maintenance of the cap and long-term monitoring of the effectiveness of the remedial action, including surface water quality monitoring and monitoring of cap integrity.

2.9.4 Alternative 3 – Full Dredge with Disposal in Upland Dewatering/ Disposal Cell

Alternative 3 provides for removal of contaminated sediment in the Spring Creek Arm to the full extent technically feasible. The target volume of contaminated sediment to be removed is 284,000 cy. As part of the technology screening and conceptual design, hydraulic dredging was selected as a more flexible and lower cost option with higher production rates in comparison to other dredging methods. Discharge from a hydraulic dredge would be pumped to a treatment and disposal area, where solids would be separated from liquid during dewatering. Treatment would include the addition of polymer, to flocculate and aid in the settling of solids, and lime, to improve water quality by raising the pH and precipitating metals.

Solids would be disposed in the upland, engineered disposal cell, and water would be discharged to the Spring Creek Reservoir. As part of the technology screening and conceptual design, an engineered, upland disposal cell was selected as a more protective disposal option than in-water disposal and more administratively feasible than disposal in Brick Flat Pit. Alternative 3 includes two subalternatives that evaluate different locations

for the engineered disposal cell: Alternative 3A (behind SCDD, adjacent to Spring Creek Reservoir) and Alternative 3B (adjacent to Iron Mountain Road, about 1 mile north of the Spring Creek Arm). Both locations are the IMM CERCLA site. The disposal cell at either location would include a low permeability cover and liner and a filtrate collection and removal system.

Dredging would primarily be limited to times when SCPP is not operating and no flow is being released from SCDD. This would allow easier anchoring and movement of dredging equipment and limit migration of suspended sediment. Other methods to limit suspension and migration of contaminated sediment might include best management practices, engineering design, and sediment curtain barriers. Alternatives 3A and 3B are estimated to require 3 to 4 years to complete.

A small percentage of sediment would likely remain in the Spring Creek Arm after dredging is complete because the sediment is technically infeasible to remove for reasons such as underwater obstructions or digging depths. The residual sediment would be managed as necessary to provide long-term erosion protection during future power plant operations. Management of the residual contaminated sediment could range from monitored natural recovery to placing a small cap of clean material (e.g., sand and gravel) over contaminated sediment. The extent of residual management would be dependent on the amount of sediment remaining in the Arm after dredging and the potential for erosion.

Following sediment removal and residual management, no restrictions would be required on Keswick Reservoir operating elevations or maximum SCPP release rates. The disposal cell would require long-term maintenance and management in the form of cover maintenance, collection and disposal of filtrate, monitoring, inspections and institutional controls.

2.9.5 Alternative 4 – Partial Dredge with Disposal in Upland Dewatering/Disposal Cell

Alternative 4 provides for partial removal of sediment in the Spring Creek Arm that is most susceptible to erosion. For the conceptual design, it was assumed contaminated sediment would be removed to an elevation of 560 feet msl, which would allow removal of approximately 55 percent of the volume of contaminated sediment (158,000 cy). Dredging to an elevation of 560 feet msl would remove all of Pile A, all of Pile B, and approximately one-third of Pile C. Approximately 126,000 cy of fine-grained sediment would remain in Pile C below an elevation of 560 feet msl following dredging. The removal elevation would be further evaluated during the remedial design.

As described for Alternative 3, discharge from the dredge would be pumped to a treatment and disposal area, where solids would be separated from liquid during dewatering. Solids would be disposed in an upland, engineered disposal cell, and water would be discharged to the Spring Creek Reservoir. Similar to Alternative 3, Alternative 4 includes two subalternatives that evaluate different locations for the engineered disposal cell: Alternative 4A (adjacent to Spring Creek Reservoir) and Alternative 4B (adjacent to Iron Mountain Road).

Alternative 4 would include methods to limit suspension and migration of contaminated sediment during in-water work as described for Alternative 3. Following dredging, a small percentage of sediment might remain in Pile A, Pile B, or the main channel of the Spring Creek Arm because it is infeasible to remove for reasons such as underwater obstructions. Alternative 4 would also include management of limited volumes of residual sediment in Pile A, Pile B, or the main channel that is infeasible to remove and could be potentially eroded under restricted operational scenarios described below. Alternatives 4A and 4B are estimated to require 2 to 3 years to complete.

Limited restrictions would be required on Keswick Reservoir operating levels to prevent erosion of sediment remaining in Pile C. During rare flood events, operational restrictions would be needed to maintain Keswick Reservoir above 578 feet msl (the lower end of current operations). EPA's analysis indicates that restrictions would be required when discharges from SCPP and SCDD approach 6,600 cfs. The flow of 6,600 cfs is equivalent to the upper end of SCPP capacity and the historical maximum flow from SCDD. Alternative 4 includes long-term monitoring and disposal cell maintenance as discussed for Alternative 3. These operating restrictions may be incorporated into a future revision of the 1980 MOU. Alternatively, such restrictions may be included in a stand-alone agreement between EPA, the State of California, Reclamation and others.

2.9.6 Alternative 5 - Partial Dredge with In situ Subaqueous Sediment Cap for Pile C

Alternative 5 is similar to Alternative 4 in that it provides for partial removal of sediment in the Spring Creek Arm that is most susceptible to erosion. However, Alternative 5 also provides for placement of a cap to contain sediment that remains after dredging. As discussed for Alternative 4, for the conceptual design, it was assumed contaminated sediment would be removed to an elevation of 560 feet msl, which would allow removal of approximately 55 percent of the contaminated sediment (158,000 cy). Approximately 126,000 cy of fine-grained sediment would remain in Pile C below an elevation of 560 feet msl. A subaqueous cap would be placed over sediment remaining in Pile C. Alternative 5 would also include management of residual sediment surrounding Piles A and B as necessary to provide long-term erosion protection during future power plant operations.

As described for Alternative 3, discharge from the dredge would be pumped to a treatment and disposal area, where solids would be separated from liquid during dewatering. Solids would be disposed in an upland, engineered disposal cell, and water would be discharged to the Spring Creek Reservoir. Similar to Alternatives 3 and 4, Alternative 5 includes two subalternatives that evaluate different locations for the engineered disposal cell: Alternative 5A (adjacent to Spring Creek Reservoir) and Alternative 5B (adjacent to Iron Mountain Road). Alternatives 5A and 5B are estimated to require 3 years to complete.

No restrictions would be required on Keswick Reservoir operating elevations or maximum SCPP release rates. The cap would require periodic inspections, long-term maintenance, and land use restrictions. Alternative 5 also includes long-term monitoring and disposal cell maintenance as discussed for Alternative 3.

2.10 Comparative Analysis of Alternatives

The detailed analysis of alternatives consists of an assessment of individual alternatives against nine evaluation criteria identified in the NCP and a comparative analysis that focuses on the relative performance of each alternative against those criteria. The resulting strengths and weaknesses of the alternatives are weighed to identify the alternative providing the best balance among the nine criteria. The nine evaluation criteria specified by the NCP in 40 CFR §300.430(e)(9) are: (1) overall protection of human health and the environment; (2) compliance with ARARs; (3) reduction of toxicity, mobility, or volume through treatment; (4) long-term effectiveness and permanence; (5) short-term effectiveness; (6) implementability; (7) cost; (8) State acceptance; and (9) community acceptance. Assessment of two of the nine criteria, State acceptance and community acceptance, is not completed until after comments on the Proposed Plan are received.

The NCP (40 CFR Section 300.430(e)(9)(iii)) categorizes these nine criteria into three types: (1) threshold criteria, (2) primary balancing criteria, and (3) modifying criteria. Each type of criteria has its own weight when it is evaluated. Threshold criteria are requirements that each alternative must meet to be eligible for selection as the preferred alternative, and include overall protection of human health and the environment and compliance with ARARs (unless a waiver is obtained). Primary balancing criteria are used to weigh effectiveness and cost tradeoffs among alternatives. The primary balancing criteria include long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; and cost. Modifying criteria include State support agency acceptance and community acceptance. These assessments reflect the State (or support agency's) and community's apparent preferences among or concerns about alternatives.

Other than the No-action Alternative, each alternative addresses the remediation of contaminated sediment in the Spring Creek Arm of Keswick Reservoir. The consideration of alternatives that address contaminated sediments in the Spring Creek Arm without addressing contaminated sediment in other portions of the site or AMD in the Boulder Creek watershed is consistent with 40 CFR § 300.430(a)(ii)(A), which identifies as a program management principle that "[s]ites should generally be remediated in operable units when necessary or appropriate to achieve significant risk reduction quickly, when phased analysis and response is necessary or appropriate given the size and complexity of the Site, or to expedite the completion of total Site cleanup."

In this section, the relative performance is evaluated and the advantages and disadvantages identified for each of the following alternatives:

- Alternative 1 – No Action
- Alternative 2 – In situ Subaqueous Sediment Cap
  - 2A – Cap Full Extent of the Spring Creek Arm
  - 2B – Cap Piles A, B, and C
- Alternative 3 – Full Dredge
  - 3A – Disposal Cell Adjacent to Spring Creek Reservoir
  - 3B – Disposal Cell Adjacent to Iron Mountain Road

- Alternative 4 – Partial Dredge
  - 4A – Disposal Cell Adjacent to Spring Creek Reservoir
  - 4B – Disposal Cell Adjacent to Iron Mountain Road
- Alternative 5 – Partial Dredge with In situ Subaqueous Sediment Cap over Pile C
  - 5A – Disposal Cell Adjacent to Spring Creek Reservoir
  - 5B – Disposal Cell Adjacent to Iron Mountain Road

Section 2.10.1 presents the comparative analysis of Alternatives 1, 2A, 2B, 3, 4, and 5. Section 2.10.2 presents the comparative analysis of the two disposal locations evaluated under Alternatives 3, 4, and 5. A summary of the comparative analysis is presented in Table 14.

2.10.1 Comparative Analysis of Alternatives 1, 2A, 2B, 3, 4, and 5

Overall Protection of Human Health and the Environment

The overall protection of human health and the environment criterion addresses whether a remedy provides adequate protection and describes how risks posed through each pathway are eliminated, reduced, or controlled through treatment, engineering controls, or institutional controls.

Alternative 1, the No-action Alternative, provides inadequate protection of the environment, particularly the Sacramento River ecosystem. Under the No-action Alternative, unacceptable long-term environmental risks would remain for sediment erosion, movement, and deposition in sensitive areas of the Sacramento River. Uncontrolled flows from SCDD during major storm events, in conjunction with high flows from SCPP, have the potential to transport sediment within the Spring Creek Arm.

Sediment erosion modeling results (see Section 2.5.7) indicate that if high flows coincide in both SCDD and SCPP, and the reservoir-pool level is down, sediment in Piles A, B, and C and the main Spring Creek Arm channel have a high potential for erosion.

Discharge of contaminated sediment is capable of causing significant adverse impacts to the important fishery resources of the Sacramento River below Keswick Dam, including spawning areas that are critical for survival of two federal and state-listed species, Sacramento River Winter-run and Spring-run Chinook salmon. Early life stages of fish, such as the eggs and fry, would be particularly susceptible to the toxic contaminants in the sediment. The No-action Alternative provides only a continuation of restrictions on SCDD operations and Keswick Reservoir levels. These restrictions help to mitigate sediment erosion during normal operating conditions, but are not reliable or effective long-term controls for all potential operation scenarios. The deposition of significant quantities of toxic sediments into the spawning grounds of the Sacramento River for an extended period before a cleanup could be accomplished could jeopardize the survival of the entire Sacramento River salmon population.

All alternatives evaluated that include active remediation (i.e., sediment removal or containment) would reduce the metal loads and suspended solids discharged from the Spring Creek Arm to the Sacramento River and would allow protective water quality standards for the Sacramento River ecosystem to be met. Alternative 3 would provide the greatest

protection of the environment and the Sacramento River ecosystem through the full removal of contaminated sediment in the Spring Creek Arm to the extent technically feasible and disposal in an engineered upland disposal cell. These actions would permanently and effectively prevent mobilization of contaminated sediment from the Spring Creek Arm and deposition of the sediment into important fishery spawning habitats.

Under Alternatives 2, 4, and 5, all or portions of the contaminated sediment would remain in place within the Arm. Under Alternatives 4 and 5, sediment most susceptible to erosion would be removed and disposed in an engineered upland disposal cell.

Alternative 5 is considered to be more protective than Alternative 4 because engineering controls would be used to contain sediment remaining in the Arm following dredging. Under Alternative 5, sediment remaining the Spring Creek Arm would be capped; the subaqueous cap would be designed to withstand the greatest anticipated discharge to the Spring Creek Arm under low and high reservoir elevations. Under Alternative 4, limited institutional controls would be used to restrict the Keswick Reservoir operating range during rare release events that could cause erosion of remaining sediment. Sediment transport modeling results indicate sediment remaining in Pile C below an assumed removal elevation of 560 feet msl would be susceptible to erosion during flood events when the combined discharge from SCPP and SCDD approaches historical maximum flows. A combination of low Keswick Reservoir elevations and high SCPP discharge would be highly unlikely.

Under Alternative 2, contaminated sediment would be covered with a cap to prevent mobilization of sediment in the Spring Creek Arm. The subaqueous cap would be designed to withstand the greatest anticipated discharge to the Arm under low and high reservoir elevations. Cap components are expected to physically isolate sediment contaminants from the benthic environment. The effectiveness and permanence of the subaqueous cap would be entirely dependent on the adequacy of long-term maintenance and repair of eroded areas and long-term use restrictions to prohibit construction or dredging activities that could damage the integrity of the cap.

Alternative 2A would be more protective than Alternative 2B because the full extent of the Spring Creek Arm would be capped. Alternative 2B includes capping the sediment piles, which comprise 90 percent of the volume of contaminated sediment in the Spring Creek Arm. Alternative 2B is designed to minimize the potential for large releases of contaminated sediment from the Spring Creek Arm, but uncapped sediment, which comprises approximately 10 percent of the total volume in the Arm, might be transported into Keswick Reservoir over time.

It is uncertain whether a benthic community will be re-established in the Spring Creek Arm under any of the alternatives. Future releases of dissolved copper from Spring Creek Reservoir, which are not targeted by remedial actions evaluated for the Spring Creek Arm, might limit growth of aquatic plants following remedial action. Following removal of fine-grained sediment and collodial HMO precipitates under Alternatives 3, 4, and 5, remaining bottom material would be coarser and less susceptible to erosion. However, because of historical smelting activities conducted in the Spring Creek watershed, metals concentrations associated with the bottom material might still inhibit establishment of a benthic community.

TABLE 14

Comparative Analysis Matrix
Iron Mountain Mine Record of Decision 5, Shasta County, California

Component	Alternative 1 No Action	Alternative 2A In situ Subaqueous Cap over Full Extent of Arm	Alternative 2B In situ Subaqueous Cap over Piles A, B, and C	Alternative 3 Full Dredge	Alternative 4 Partial Dredge	Alternative 5 Partial Dredge with In situ Subaqueous Sediment Cap for Pile C	Upland Dewatering/ Disposal Cell adjacent to Spring Creek Reservoir	Upland Dewatering/ Disposal Cell adjacent to Iron Mountain Road
Description	No further action. Existing restrictions on SCDD and Keswick Reservoir operations would be maintained.	Place cap over contaminated sediment in the Spring Creek Arm.	Place cap over contaminated sediment in Piles A, B, and C.	Remove contaminated sediment in Spring Creek Arm to extent technically feasible. Dewater and treat dredge discharge. Dispose of solids in upland dewatering/disposal cell.	Remove sediment in Spring Creek Arm that is most susceptible to erosion. Dispose of solids in upland dewatering/disposal cell.	Remove sediment in Spring Creek Arm that is most susceptible to erosion. Place cap over sediment remaining in Pile C. Dispose of solids in upland dewatering/disposal cell.	Alternatives 3A, 4A, and 5A	Alternatives 3B, 4B, and 5B
Overall Protectiveness	Long-term risks of sediment erosion, migration, and redeposition in sensitive areas of Sacramento River. Discharge of contaminated sediment could cause significant adverse impacts to important fishery resources.	Protective. Limits mobilization of contaminated sediment. Requires long-term maintenance and land use restrictions to be effective.	Less protective than 2A. Reduces potential for large releases of sediment. Uncapped sediment might be flushed into Keswick Reservoir over time.	Most protective alternative. Removal of sediment and disposal in engineered upland disposal cell would permanently prevent mobilization of contaminated sediment.	Protective. Sediment that is most susceptible to erosion would be removed. Limited restrictions on Keswick Reservoir operations would be required to prevent erosion of sediment remaining in Pile C when releases from SCPP and SCDD approach historical maximum discharges.	Very protective. Partial removal of sediment combined with capping of residual sediment would minimize risk of mobilization of contaminated sediment.	Disposal cell would be constructed and maintained to minimize long-term risks of contaminant discharge to surface water or groundwater.	
ARAR Compliance	Will not comply with ARARs.	Would allow for compliance with water quality goals below Keswick Dam. Capping would comply with location-specific ARARs.		Would allow for compliance with water quality goals during dredging. Dredging would comply with location- and action-specific ARARs.	Same as 3.	Same as 3.	Disposal cell construction and maintenance, discharge of filtrate and overflow, and wetlands surveys and mitigation would comply with ARARs.	
Long-term Effectiveness	Not effective. Long-term risk of sediment erosion. Existing restrictions on SCDD and Keswick Reservoir operations are not reliable long-term controls.	Effective long-term. Cap would limit mobilization of sediment. Cap would require long-term maintenance and land use restrictions to remain effective.	Less effective than 2A. Uncapped sediment might be flushed into Keswick Reservoir over time.	Extremely effective long-term. Removal would prevent mobilization of contaminated sediment. Small percentage of sediment that is infeasible to dredge would remain in Arm and require management.	Effective long-term. Partial removal of sediment would provide long-term reduction of risk of mobilization of contaminated sediment. Limited restrictions on Keswick Reservoir operations would be required during rare releases to Arm to prevent erosion of remaining sediment.	Very effective long-term. Partial removal of sediment combined with capping of remaining sediment would provide long-term reduction of risk of mobilization of contaminated sediment.	Disposal cell would require long-term management. Disposal cell would be constructed and maintained to minimize long-term risk of contaminant releases.	
							Located within impacted watershed and behind SCDD, reducing long-term risks to groundwater or surface water.	Located outside of impacted Spring Creek watershed.
Reduction of Toxicity, Mobility, or Volume through Treatment	No reduction in toxicity, mobility, or volume through treatment.	No reduction in toxicity, mobility, or volume through treatment.		Dredge discharge would be treated and dewatered to reduce volume requiring disposal and mobility of metals. Target volume of in situ sediment to be removed and treated is 284,000 cy.	Dredge discharge would be treated and dewatered to reduce volume requiring disposal and mobility of metals. Target volume of in situ sediment to be removed and treated is 158,000 cy. Approximately 126,000 cy would remain in Pile C.	Same as 4.		

TABLE 14

Comparative Analysis Matrix
Iron Mountain Mine Record of Decision 5, Shasta County, California

Component	Alternative 1 No Action	Alternative 2A In situ Subaqueous Cap over Full Extent of Arm	Alternative 2B In situ Subaqueous Cap over Piles A, B, and C	Alternative 3 Full Dredge	Alternative 4 Partial Dredge	Alternative 5 Partial Dredge with In situ Subaqueous Sediment Cap for Pile C	Upland Dewatering/ Disposal Cell adjacent to Spring Creek Reservoir	Upland Dewatering/ Disposal Cell adjacent to Iron Mountain Road
Short-term Effectiveness	Does not meet remedial action objectives.	Minimal risk to human health during implementation. Short-term risks to environment from resuspension and subsequent migration of sediment during in-water work. Risks would be mitigated using controls such as best management practices, engineering design, and sediment curtain barriers.		Similar to 2. Estimated as 3 to 4 years to implement.	Similar to 2. Estimated as 2 to 3 years to implement.	Similar to 2. Estimated as 3 years to implement.	Minimal short-term risks to community during implementation. Disturbed seasonal wetlands would be impacted, requiring mitigation measures.	Greater short-term risks to community during implementation; disposal site readily accessible. Disturbed seasonal wetlands would be impacted, requiring mitigation measures.
		Estimated as 3 years to implement.	Estimated as 2 years to implement.					
Implementability	Requires coordination with Reclamation to maintain existing restrictions on SCDD and Keswick Reservoir operations	Technical challenges with cap placement due to unique properties of sediment and high metals concentrations of sediment and pore water. Requires coordination with Reclamation to implement land use restrictions.		Technical challenges with dredging due to unique properties of sediment, digging depths up to 60 feet, and organic debris and obstructions in Pile C.	Most implementable alternative involving active remediation. Lower digging depths than 3.	Lower digging depths than 3. Technical challenges with cap placement. Requires mobilization of dredging and capping equipment.	Access road would be flooded for portions of the year.	Might be subject to more stringent construction and/or long-term monitoring requirements.
Cost				Alternatives 3A/3B	Alternatives 4A/4B	Alternatives 5A/5B		
Capital	$0	$11,300,000	$8,210,000	$26,000,000 / $26,300,000	$18,600,000 / $18,400,000	$20,800,000 / $20,600,000	See costs for specific alternatives.	See costs for specific alternatives.
Annual O&M	$0	$280,000	$195,000	$123,000 / $119,000	$106,000 / $102,000	$160,000 / $156,000		
50-year Present Value	$0	$17,900,000	$12,800,000	$28,900,000 / $29,100,000	$21,100,000 / $20,800,000	$ 24,500,000 / $24,200,000		
State Acceptance	Not acceptable. Not protective of the environment.	Not acceptable. Concerns regarding the durability and maintenance of cap material.		Acceptable.	Acceptable.	Acceptable. Concerns expressed regarding technical implementability.	Acceptable. Located within impacted watershed and behind SCDD, reducing long-term risks to groundwater or surface water.	Not acceptable. Increased risks to human health and the environment.
Community Acceptance	Not acceptable to most community members. Not protective of the environment.	No comments were submitted regarding capping.		Acceptable. Several community members and the City of Redding (Redding Municipal Utilities) expressed concerns regarding short-term environmental impacts during dredging.			Acceptable.	Not acceptable. A community member expressed concerns regarding potential impacts to the community and recreational uses of the area.

Remedial actions in the Spring Creek Arm are expected to indirectly improve aquatic habitat in Keswick Reservoir by limiting future mobilization of contaminated sediment and redeposition into Keswick Reservoir.

Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)

Applicable requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site. Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal or state environmental siting law that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site. Only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be applicable or relevant and appropriate. In addition to legally binding laws and regulations, EPA is to consider proposed standards and non-promulgated advisories or guidance that, while not legally binding, provide useful information regarding the performance of the remedy. These other standards are referred to as "To Be Considered" standards or TBCs.

Compliance with ARARs addresses whether a remedy will meet all federal and state environmental laws and/or provide a basis for a waiver from any of these laws. These ARARs are divided into chemical-specific, action-specific, and location-specific groups. Compliance with the most significant chemical-, action-, and location-specific ARARs is discussed below.

Chemical-specific Applicable or Relevant and Appropriate Requirements. None of the remedial alternatives fully complies with chemical-specific water quality ARARs because none of the alternatives would alone achieve National toxics Rule (NTR), Basin Plan or CTR criteria in Spring Creek, its tributaries, or in portions of Keswick Reservoir under all circumstances following completion of the construction of the respective remedial alternative. These water bodies are impacted by remaining discharges of AMD from the IMM Site. Continued discharges of AMD from the IMM Site are not being addressed in this action, but are being addressed under remedial actions currently underway (e.g., SCRR) and will be considered under future remedial action decisions. Therefore, it would be appropriate to invoke an interim remedy ARARs waiver to the degree that it is anticipated these discharges may result in exceedances of water quality ARARs in Spring Creek and portions of Keswick Reservoir.

With respect to the CTR and Basin Plan water quality ARARs, the following analysis assumes that the remedial alternatives analyzed herein will not affect the remaining ongoing IMM AMD discharges. ARARs for zinc, copper and cadmium, for purposes of the following analysis, are assumed to be waived (once construction is complete) using the aforementioned interim action waiver. As stated above, EPA analysis subsequent to the issuance and implementation of remedial actions selected in this ROD is expected to address the issue of whether NTR, CTR and Basin Plan water quality ARARs can be met

on a Site-wide basis. Also, the ARARs discussed in the following comparative analysis are identified only for the purposes of analyzing remedial alternatives to address remediation of the Spring Creek Arm sediments. Nothing in this ROD amends or alters ARARs determinations made by EPA in prior RODs for this Site.

Under Alternative 1, no action would be taken to reduce the metal loads and suspended solids associated with contaminated sediment discharged from the Spring Creek Arm to the Sacramento River. A release of contaminated sediment from the Spring Creek Arm would not meet NTR, CTR and Basin Plan water quality criteria in the Sacramento River downstream of Keswick Dam.

Alternatives 2, 3, 4, and 5 would comply with chemical-specific ARARs for the Sacramento River, at the point of compliance during construction. These alternatives include active remediation (i.e., sediment removal or containment) that would reduce the metal loads and suspended solids discharged from the Spring Creek Arm to the Sacramento River and would allow protective water quality standards for the Sacramento River ecosystem to be met.

Location-specific Applicable or Relevant and Appropriate Requirements Alternative 1, the No-action Alternative, would not comply with location-specific ARARs. A release of contaminated sediment from the Spring Creek Arm would not comply with CDFG Code Section 5650, which prohibits discharge of contaminants "deleterious to fish, plant life, or bird life."

All alternatives involving active remediation would comply with location-specific ARARs.

Proposed remedial actions, except no action, would increase the long-term protection of affected species. Subaqueous capping under Alternative 2, or dredging under Alternatives 3, 4, and 5, would comply with the Fish and Wildlife Conservation Act and the Fish and Wildlife Coordination Act, which require federal agencies involved in the structural modification of a natural stream or water body to take action to protect fish and wildlife resources that might be affected by the selected action.

Placement of fill within jurisdictional wetlands, sediment removal, discharge of filtrate and overflow from a dewatering/disposal cell, placement of capping material in the Spring Creek Arm, and surface-water diversions would require compliance with the substantive requirements in Section 404 of the Clean Water Act. Onsite CERCLA actions are exempt from obtaining permits that would otherwise be required under applicable laws and regulation, but actions proposed under Alternatives 2, 3, 4, and 5 would meet the substantive requirements.

The upland disposal cell proposed under Alternatives 3, 4, and 5 would be constructed in compliance with location-specific ARARs. Disturbed seasonal wetlands, as well as willow and willow/cottonwood riparian habitats, have been identified in the vicinity of both disposal locations and would be given special consideration according to ARARs. Location-specific ARARs allow for a project to be constructed that would impact wetlands, but would require special-status species surveys, wetlands mitigation, or other compensatory actions.

Action-specific Applicable or Relevant and Appropriate Requirements. Alternative 1 includes no active remediation; therefore, no action-specific ARARs would apply. No action-specific ARARs have been identified for the capping component of Alternative 2. Alternatives 3, 4, and 5 would comply with action-specific ARARs during dewatering and disposal of dredged sediment.

Construction, monitoring, and maintenance of the upland disposal cell would comply with the relevant and appropriate requirements of the State of California Water Code §13172 and regulations promulgated thereunder (27 CCR) for a mining waste management unit. Discharge of filtrate and overflow from the upland dewatering/disposal cell would comply with the substantive requirements of the National Pollutant Discharge Elimination System (NPDES) permit program. The embankment structure of the dewatering/disposal cell would meet the criteria to be considered a Jurisdictional Dam by the California Division of Safety of Dams. As such, substantive requirements of the Dam Safety Act and Division 3 of the California Water Code are ARARs for the construction of the disposal cell embankment.

Long-term Effectiveness and Permanence

Long-term effectiveness and permanence refers to the ability of a remedy to maintain reliable protection of human health and the environment over time. This criterion includes the consideration of residual risk that will remain onsite following remediation and the adequacy and reliability of controls.

Each alternative, except the No-action Alternative, provides some degree of long-term protection. Alternative 3 would provide the greatest long-term effectiveness and permanence through the full removal of contaminated sediment in the Spring Creek Arm to the extent feasible and disposal in an engineered upland disposal cell. The disposal cell would be constructed and maintained to prevent contaminant releases to surface water or groundwater. The disposal cell would require long-term maintenance and management in the form of cover maintenance, collection and disposal of filtrate, monitoring, and inspections. Following dredging, it is estimated that a small percentage of residual contaminated sediment might remain in dredged areas because of technical difficulties with complete removal. Management of residual sediment would range from monitored natural recovery to limited capping effort, as necessary.

Under Alternatives 2, 4, and 5, all or portions of the contaminated sediment would remain in place within the Arm. Under Alternatives 4 and 5, sediment most susceptible to erosion would be removed. Alternative 5 would provide greater long-term protection than Alternative 4 because engineering controls (capping) would be used to contain sediment remaining in the Arm following dredging. Alternative 4 relies on limited institutional controls to restrict the Keswick Reservoir operating range during rare release events that could cause erosion of remaining sediment.

Alternative 2 relies solely on capping to prevent mobilization of sediment in the Spring Creek Arm. No sediment would be removed under Alternative 2. The effectiveness and permanence of Alternatives 2A and 2B is dependent entirely on the adequacy of maintenance of capping components and land use restrictions to prevent dredging or construction activities that could damage the integrity of the cap.

Alternative 2A would provide greater long-term effectiveness than Alternative 2B because the full extent of the Spring Creek Arm would be capped. Alternative 2B includes capping only the sediment piles. Alternative 2B is designed to minimize the potential for large releases of contaminated sediment from the Spring Creek Arm, but uncapped sediment, which comprises approximately 10 percent of the total volume in the Arm, might be transported into Keswick Reservoir over time. In addition, erosion of uncapped sediment in the Arm could undermine the edge of the cap under Alternative 2B. For this reason, Alternative 2B provides less long-term erosion protection and cap stability than Alternative 2A.

During the Sediment FS, EPA conducted an analysis to estimate the long-term stability of sediment contained in situ within the Spring Creek Arm following capping or partial removal under Alternatives 2, 4, and 5. Slopes of all sediment piles would be stable under static conditions. However, the slopes of Pile C could fail under strong earthquake conditions, under existing conditions, following capping, or following partial removal. To increase the stability of Pile C under strong earthquake conditions, additional controls may be needed, including dredging to flatten steep slopes or construction of a stone buttress at the base of Pile C. The stability of Pile C under strong earthquake conditions and the need for additional controls would be further evaluated in the remedial design.

Reduction of Toxicity, Mobility, or Volume through Treatment

Reduction of toxicity, mobility, or volume through treatment refers to the anticipated performance of the treatment technologies that may be included as part of a remedy. This criterion refers to the preference for a remedy that uses treatment to reduce health hazards, contaminant migration, or the quantity of contaminants at the Site.

Alternative 1, the No-action Alternative, and Alternative 2, In situ Subaqueous Capping, do not include treatment as a component of the remedy.

Under Alternatives 3, 4, and 5, contaminated sediment is removed from the Arm by dredging, and the mobility and volume of contamination is reduced during treatment and dewatering of dredge discharge. Dredge discharge would be treated and dewatered to reduce the volume requiring disposal and to meet ARARs for discharge of filtrate and overflow to Spring Creek Reservoir. Although the toxicity of dewatered solids would not be reduced, the mobility of metals would be reduced by increased pH and resultant metals precipitation. The disposal cell would be engineered to minimize long-term impacts of contamination to groundwater and surface water.

A greater volume of dredge discharge is treated under Alternative 3 than under partial dredging in Alternatives 4 and 5. Under Alternative 3, dredging activities would target the full volume of contaminated sediment in the Spring Creek Arm, approximately 284,000 cy. Alternatives 4 and 5 include partial dredging to remove sediment most susceptible to erosion. Under Alternatives 4 and 5, the target volume of sediment to be removed under the conceptual design is 158,000 cy, which includes removal of Pile A, Pile B, sediment located in the channel outside of the pile boundaries, and approximately one-third of the volume of Pile C. Approximately two-thirds of Pile C (126,000 cy of sediment) would remain in the Spring Creek Arm following dredging as part of Alternatives 4 and 5.

Short-term Effectiveness

Short-term effectiveness addresses the period of time needed to implement the remedy and any adverse impacts that may be posed to workers, the community, and the environment during construction and operation of the remedy until cleanup levels are achieved.

Alternatives are estimated to require 2 to 4 years to implement. Capping activities under Alternative 2A are estimated to require 3 years to complete, and Alternative 2B would require 2 years. Dredging activities under Alternative 3 are estimated to require 3 to 4 years to complete. Alternative 4 is estimated to require 2 to 3 years to implement. Implementation of Alternative 5, including partial dredging and capping of sediments remaining in Pile C, is estimated to require 3 years to complete. The estimated times to implement each alternative assume a 60-day working window could be arranged each year when SCPP could be shut down. The timing and duration of in-water work would require further evaluation and consultation with Reclamation during remedial design.

All alternatives evaluated that include active remediation and in-water work (i.e., dredging or placement of cap materials) could present short-term impacts to the environment during implementation of the remedial action. The magnitude of short-term impacts is expected to be similar among alternatives. Alternatives are expected to pose only minimal risk to the community or workers during remedial action.

In-water work, including placement of cap materials, dredging, prop-wash of vessels, and anchor placement can cause resuspension of sediment. The suspended sediment might be transported outside the construction zone and settle in other areas. Resuspension of contaminated sediment might impact aquatic biota adjacent to the construction zone. EPA will implement multiple controls during in-water work to mitigate risks to the environment by minimizing the disturbance and re-suspension of sediment and/or the migration of suspended sediment. These controls would limit water quality impacts resulting from in-water construction to short-term increases in suspended sediment in the construction area. In-water work would primarily be limited to periods when SCPP is not operating and no flow is being released from SCDD. This would facilitate construction, allow easier anchoring and movement of equipment, and limit migration of suspended sediment. Other methods to limit suspension and migration of contaminated sediment might include best management practices, engineering design, and sediment curtain barriers. Monitoring would be performed during remedial action to determine effectiveness of resuspension management and to allow early detection of potential problems.

Alternatives involving capping have additional concerns regarding potential short-term impacts to the environment. Capping material would need to be applied slowly and uniformly to avoid problems with bearing capacity or slope failures of the sediment piles. Uncontrolled release of a large amount of material or the buildup of a localized mound of cap material could result in a bearing capacity failure. If this occurs, cap material could penetrate into the contaminated deposit and could cause sediment to resuspend and disperse into the water column. Consolidation of underlying sediment during placement of cap material could result in a release of pore water and associated metals. Calculations indicate consolidation-driven advective flux of pore water during placement of cap materials would not result in a significant increase in metals concentrations in Keswick Reservoir.

Construction and operation of the dewatering/disposal cell under Alternatives 3, 4, and 5 would require additional considerations of potential impacts to the community and to the environment. It is assumed no intermediate cover would be placed over the disposal cell between dredging seasons under Alternatives 3, 4, and 5. Therefore, access restrictions and physical barriers around the disposal cell location would be important to reduce risks of exposure to the community and ecological receptors. Disturbed seasonal wetlands, as well as willow and willow/cottonwood riparian habitats, have been identified in the vicinity of both disposal locations evaluated under Alternatives 3, 4, and 5. Wetland impacts would occur as a result of disposal site construction at either location, and mitigation would be required.

Because no remedial action would be taken under Alternative 1, no additional short-term risks to the community or to workers would occur as a result of implementing the alternative. Similarly, no environmental impact from construction activities would occur. However, RAOs would not be met.

Implementability

Implementability addresses the technical and administrative feasibility of a remedy from design through construction and operation. Factors such as availability of services and materials, administrative feasibility, and coordination with other governmental entities are considered.

Technical Feasibility. The No-action Alternative, Alternative 1, requires no additional effort and has no technical feasibility issues. Implementation of any alternative evaluated that involves active remediation would present technical challenges, primarily resulting from the unique characteristics of fine-grained sediment and collodial HMO precipitates in the Spring Creek Arm. However, all alternatives evaluated are considered technically implementable. Of the alternatives that include active remediation, Alternative 4 would present the smallest number of technical challenges to implementation, and Alternatives 2 and 3 would be the most difficult alternatives to implement.

Placement of cap materials under Alternatives 2 and 5 would be technically difficult because of the fine-grained size and high moisture content of the sediment in the Spring Creek Arm and high metals concentrations of the sediment and pore water. Cap material would need to be applied slowly and uniformly to avoid problems with bearing capacity or slope failures of the sediment piles. The fine grained nature and high moisture content of the sediments make it likely that capping efforts would result in the mobilization of some quantity of fine grained sediments into downstream areas, reducing the overall effectiveness of this approach. Cap placement would present fewer technical challenges under Alternative 5 than Alternative 2 because the cap would be placed over a smaller area, the deeper sediments are more dense and compacted, and riprap would not be needed for erosion control.

Several engineering challenges would affect implementability of dredging and treatment and dewatering of dredge discharge under Alternatives 3, 4, and 5 because of the sediment and site characteristics. Submerged trees and vegetation are located in shallow areas (i.e., at depths less than 20 feet) along the eastern shore of Pile C (see Figure 4). Some of the trees remain upright, while others have fallen. The trees and vegetation are likely to

affect dredging operations by limiting movement of the barge or dredging equipment. Methods for dealing with the obstructions will be investigated during the remedial design and may include using a mechanical clamshell dredge around the obstructions or removing trees and vegetation before dredging begins. During the remedial design, it may also be determined that a portion of the contaminated sediment in this area is infeasible to remove.

The sediment in the Spring Creek Arm has relatively low solids content; therefore, dredged material would consist of a low percent solids, requiring handling of large volumes of dredge discharge. Sediment from the top of the sediment piles has different characteristics than sediment from the bottom of the piles, resulting in different solids concentrations and treatment requirements for dredge discharge. Uncertainties exist regarding scale-up of information obtained from the treatability jar and column testing for application to full-scale dewatering of dredge discharge. These uncertainties would need to be further evaluated during the remedial design phase of a dredging remedial action. Dredging would be conducted in a phased approach with lower dredging rates the first year to allow refinement of dredging and dewatering processes and resolve remaining questions.

Partial dredging under Alternatives 4 and 5 would have fewer technical challenges than full removal under Alternative 3 because the dredging depth would be shallower and the abandoned railway trestle would provide less of an obstacle to partial removal of Pile C. Under full removal in Alternative 3, sediment in Pile C would be difficult to dredge because the depth of water and thickness of sediment would require dredging of sediment approximately 60 feet below the waterline. Removal efficiencies would be substantially reduced at these depths and might require modifications to a dredge. The deeper sediment in Pile C is located at the mouth of the Spring Creek Arm, which creates increased technical challenges regarding management of suspended sediment during dredging activities. Additionally, the presence of the abandoned railway trestle would complicate dredging operations in the vicinity of the trestle. Because only one-third of Pile C would be removed, the partial dredging operations under Alternatives 4 and 5 would be impacted significantly less than the full dredging operations under Alternative 3.

Administrative Feasibility. Alternative 1 includes continuation of existing restrictions on SCDD operations and Keswick Reservoir operating levels, which are feasible because those restrictions are required by the 1980 MOU, the 1993 Biological Opinion and Reclamation's Operational Criteria and Plan (OCAP).

All the alternatives that involve active remediation would require only minimal or no restrictions on Keswick Reservoir operating levels once the remedy is implemented, and would therefore present fewer administrative challenges than the no-action alternative.

Alternative 4 includes new limited long-term restrictions on Keswick Reservoir operations to prevent mobilization of sediment remaining in Pile C. These restrictions would maintain reservoir elevations above 578 feet msl (the low end of current operations) during rare flood events when the combined discharge from SCPP and SCDD approaches historical maximum releases. Restrictions implemented under Alternative 4 would not be as stringent as existing restrictions and would occur only infrequently. As such, it is believed that implementation of these restrictions will be feasible through renegotiation

of the 1980 MOU or by means of a separate agreement. After the completion of in-water work, no restrictions would be required on Keswick Reservoir operating elevations or the maximum SCPP discharge rates under Alternatives 2, 3, or 5. All alternatives include restrictions on the release schedule and criteria for the discharge of water from SCDD to the Spring Creek Arm to meet water quality criteria in the Sacramento River downstream of Keswick Dam. They also include requirements for low-flow releases from SCPP during SCDD releases to flush Spring Creek Reservoir water through the Spring Creek Arm. Alternatives 2 and 5, which include placement of a large in situ subaqueous cap, require coordination with Reclamation for implementation of land use restrictions to prevent dredging or construction activities within the Arm that would compromise the integrity of the subaqueous cap.

For ease of implementation and to reduce the short-term impacts from sediment resuspension, placement of cap materials and dredging would primarily be restricted to periods when the SCPP could be shut down. Shutdown of SCPP would prevent Reclamation from generating power during this period; however, it is expected that there would be minimal loss in overall power generation, as no excess water would be discharged and power generation would only be deferred. Shutdown of SCPP would require scheduling and coordination with Reclamation. All the alternatives involving active remediation assume a 60-day shutdown period per year would be arranged. The timing and duration of in-water work would require further evaluation and consultation with Reclamation during remedial design.

Cost

The estimated cost of each alternative encompasses all engineering, construction, and O&M costs incurred over the life of the project. According to CERCLA guidance, cost estimates for remedial alternatives were developed with an expected accuracy range of -30 to +50 percent.

The costs of remedial alternatives were compared using the estimated present value of the alternative. The net present value allows costs for remedial alternatives to be compared by discounting all costs to the year that the alternative is implemented. In the *Guide to Developing and Documenting Cost Estimates During the Feasibility Study* (EPA, 2000), EPA suggests that the period of analysis for present value analysis should be equivalent to the project duration, to provide a complete life cycle cost estimate of the remedial alternative. Most of the remedial alternatives developed for IMM sediment require long-term O&M activities, including surface and/or groundwater monitoring; restrictions on access, use, or power plant operations; and maintenance of constructed caps and covers. Therefore, 50 years was chosen as the period of analysis, rather than the standard assumption of 30 years.

For all alternatives, the net present value was calculated using the real discount rate found in Appendix C of Office of Management and Budget Circular A-94 (Office of Management and Budget, 2004). In that guidance document, the real discount rate based on the economic assumptions from the 2005 budget for programs with durations of 30 years or longer is 3.5 percent. A summary of the capital cost, annual O&M cost, and 50-year present value for each alternative is shown in Table 15.

TABLE 15
Cost Summary of Remedial Alternatives
Iron Mountain Mine Record of Decision 5, Shasta County, California

Alternative	Capital Cost ($)	Annual O&M Cost ($)	50-Year Present Value ($)
1 – No Action	0	0	0
2 – In situ Subaqueous Cap			
2A – Cap Full Extent of Spring Creek Arm	11,300,000	280,000	17,900,000
2B – Cap Sediment Piles A, B, and C	8,210,000	195,000	12,800,000
3 – Full Dredge with Disposal in Upland Dewatering/ Disposal Cell			
3A – Disposal Cell Adjacent to Spring Creek Reservoir	26,000,000	123,000	28,900,000
3B – Disposal Cell Adjacent to Iron Mountain Road	26,300,000	119,000	29,100,000
4 – Partial Dredge with Disposal in Upland Dewatering/Disposal Cell			
4A – Disposal Cell Adjacent to Spring Creek Reservoir	18,600,000	106,000	21,100,000
4B – Disposal Cell Adjacent to Iron Mountain Road	18,400,000	102,000	20,800,000
5 – Partial Dredge with In situ Subaqueous Sediment Cap for Pile C			
5A – Disposal Cell Adjacent to Spring Creek Reservoir	20,800,000	160,000	24,500,000
5B – Disposal Cell Adjacent to Iron Mountain Road	20,600,000	156,000	24,200,000

Notes:

Detailed cost estimates and cost estimate assumptions are presented in Appendix B and Appendix C of the Sediment FS (EPA, 2004).

Fifty-year present value was calculated using a discount rate of 3.5 percent (Office of Management and Budget, 2004).

The No-action Alternative would require no new capital or operating costs, because no change would be made to existing conditions. Of the alternatives involving active remediation, Alternatives 3A and 3B would be the most expensive remedial alternatives. The most expensive costs incurred during implementation of Alternative 3 would be costs of hydraulic dredging and construction of the dewatering/disposal cell. Alternatives 4 and 5 would be less expensive than Alternative 3 because they include partial rather than full dredging of contaminated sediment in the Spring Creek Arm. Alternative 5 includes placement of an in situ subaqueous cap over sediment remaining in Pile C, which increases the burdened construction costs by $2.2 million and increases the net present value by $3.4 million in comparison to Alternative 4.

In general, construction costs associated with capping under Alternative 2 would be less expensive than costs of sediment removal and disposal; however, annual maintenance costs would be more expensive. The net present value of Alternative 2B, which includes capping of the sediment piles only, is the least expensive remedial alternative evaluated, with a net present value of approximately half the cost of alternatives involving sediment removal.

State Acceptance

State acceptance refers to the State's position and key concerns related to the preferred alternative and other alternatives.

The State has expressed its support for the preferred alternative presented in the Proposed Plan, Alternative 4, Partial Dredge with Disposal in Upland Dewatering/Disposal Cell. Letters expressing concurrence with the preferred alternative were submitted by DTSC and CDFG during the public comment period. These letters are included in Appendix A of this ROD. RWQCB, CDFG, Reclamation, and DTSC verbally expressed their support for the preferred alternative during the presentation made at the 2004 Proposed Plan public meeting on August 25, 2004. The Administrative Record includes a transcript of the public meeting.

Prior to the release of the Proposed Plan, the State raised concerns about the need for adequate sediment containment safeguards (i.e., resuspension management) during sediment removal operations. In response to these concerns, EPA will implement several specific measures to ensure close coordination with State agencies during remedial design and construction, and to assure that contaminated sediments will be contained during dredging operations. These measures include collection of additional data on sediment engineering properties during remedial design, developing and implementing a monitoring program to provide early detection of potential problems, and implementing a phased dredging approach. Given these measures, and in conjunction with compliance with ARARs for dredging operations, the State has stated that the preferred alternative should not significantly impact water quality.

The State does not believe that Alternative 1, the no-action alternative, provides adequate protection of the environment. In the September 3, 2004, letter to Rick Sugarek/EPA, Donald Koch/CDFG stated "we [CDFG] believe the no-action alternative constitutes significant risk to the environment and that the proposed project needs to be completed." This letter is included in Appendix A of this ROD.

On page three of the CDFG May 14, 2004, letter to EPA, Mr. Koch expressed concerns with Alternative 2, In Situ Subaqueous Capping. The letter presented concerns regarding the durability and maintenance of the cap material, and concerns that absent monitoring and maintenance of the cap, the sediment might be subject to erosion or resuspension. The same letter expressed concerns regarding technical challenges with implementation of Alternative 5, specifically with the construction of the partial cap over sediment remaining in Pile C. This letter was submitted prior to the public comment period during the development of the remedial alternatives, and is included in the Administrative Record at EPA Records Center in San Francisco, California.

Community Acceptance

This criterion refers to the community's stated preferences through oral and written comments on EPA's Proposed Plan regarding which components of the alternatives interested persons in the community support, have reservations about, or oppose.

The public meeting held in connection with the August 2004 Proposed Plan was attended by approximately 40 people. EPA presented its preferred alternative, Alternative 4,

Partial Dredge with Disposal in Upland Dewatering/Disposal Cell. During the public meeting, the majority of interested persons expressed their support for the preferred alternative presented in the Proposed Plan. One community member stated that the preferred alternative was cost-effective and would support improvements being made to Winter-run Chinook salmon habitat in the Sacramento River.

However, several community members expressed concerns regarding dredging and onsite disposal. These include:

- Potential impacts to adjacent land value
- Potential for release of toxic sediments and impacts to water quality during dredging
- Long-term monitoring requirements for the disposal cell

The City of Redding, Redding Municipal Utilities, expressed similar concerns regarding potential impacts to water quality in the Sacramento River during dredging operations and possible effects on the City of Redding's domestic water supply and wastewater treatment plant discharges. EPA believes that these concerns can be properly addressed, and has provided detailed responses to these concerns in the responsiveness summary, Part 3 of this ROD.

As discussed under the short-term effectiveness criterion, EPA will implement multiple controls during in-water work to mitigate risks to the environment by minimizing the disturbance and resuspension of sediment and/or the migration of suspended sediment. In-water work will primarily be limited to periods when SCPP is not operating and no flow is being released from SCDD. This will facilitate construction, allow easier anchoring and movement of equipment, and limit migration of suspended sediment. Dredging will be implemented in a conservative, phased approach that allows lower production rates during the first year. Other methods to limit suspension and migration of contaminated sediment might include best management practices, engineering design, and sediment curtain barriers. Monitoring will be performed during remedial action to determine effectiveness of resuspension management and provide early warning of potential problems. Using these controls, EPA believes the preferred alternative will be implemented safely, effectively, and in compliance with ARARs.

A few community members proposed additional alternatives that they felt would be more protective than the preferred alternative. These alternatives involve technologies that were screened out in the Sediment FS based on technical implementability, effectiveness, and/or cost. EPA determined that alternatives proposed by community members would be technically challenging and very costly compared to the alternatives developed and evaluated in the Sediment FS.

2.10.2 Comparative Analysis of Potential Disposal Locations in Alternatives 3A, 3B, 4A, 4B, 5A, and 5B

This section presents a comparative analysis of the two disposal locations evaluated under Alternatives 3, 4, and 5. Alternatives 3A, 4A, and 5A evaluate conveyance and disposal of dredged material in an upland disposal cell adjacent to Spring Creek Reservoir. Alternatives 3B, 4B, and 5B include conveyance and disposal in a cell adjacent to Iron Mountain Road.

Overall Protection of Human Health and the Environment

Overall protection of human health and the environment would be similar between the two disposal locations. The disposal cell would be constructed and maintained to minimize long-term potential of contaminant releases to surface water or groundwater and would require long-term maintenance and management in the form of cover maintenance, collection and disposal of filtrate, monitoring, inspections, and institutional controls.

Compliance with Applicable or Relevant and Appropriate Requirements

CERCLA §121(e), 42 USC §9621(e), states that no federal, state, or local permits are required for remedial actions conducted entirely onsite. Onsite refers to the areal extent of contamination and all suitable areas in proximity to the contamination necessary for implementation of the response action (EPA, 1988). Both potential disposal sites are onsite in accordance with this definition. Therefore, neither permits nor a permit equivalency process would be required, but project elements must meet any ARAR substantive requirements.

Construction and maintenance of the disposal cell at either location would comply with location- and action-specific ARARs. Construction, monitoring, and maintenance of the upland disposal cell would comply with the appropriate and relevant substantive provisions of State of California Water Code §13172 and regulations promulgated thereunder (27 CCR) for a mining waste management unit. The embankment structure of the dewatering/disposal cell would meet criteria to be considered a Jurisdictional Dam by the California Division of Safety of Dams, and as such, would comply with substantive requirements of the Dam Safety Act and Division 3 of the California Water Code. Location- and action-specific ARARs require compliance with the substantive requirements in Section 404 of the Clean Water Act for placement of fill within jurisdictional wetlands, sediment removal, discharge of filtrate and overflow from a dewatering/disposal cell, and surface water diversions. Discharge of filtrate and overflow from the dewatering/disposal cell would also comply with substantive requirements of the NPDES permit program.

Long-term Effectiveness and Permanence

The disposal cell would be constructed and maintained to prevent contaminant releases to surface water or groundwater. The disposal cell would require long-term maintenance and management in the form of cover maintenance, collection and disposal of filtrate, monitoring, and inspections.

The Spring Creek Reservoir site is located within the impacted Spring Creek watershed behind SCDD. This disposal location has reduced risks of contaminant migration in the unlikely event of a contaminant release from the onsite disposal cell. A contaminant release would flow into the Spring Creek Reservoir and would be contained and managed by current Reclamation operations. In contrast, the Iron Mountain Road location is located in an environmentally sensitive area outside of the impacted Spring Creek watershed, and would be subject to more stringent construction and/or long-term monitoring requirements.

Reduction of Toxicity, Mobility, or Volume through Treatment

Dewatering and disposal of dredge discharge in either disposal location would provide a similar reduction of mobility and volume of contamination.

Short-term Effectiveness

Short-term risks to the community during remedial action would be greater for disposal in a cell adjacent to Iron Mountain Road than disposal in a cell adjacent to Spring Creek Reservoir. The Iron Mountain Road disposal site would be located adjacent to areas that are easily and regularly accessed by the public. Restrictions to limit trespassing, including fencing or other controls, would be much more difficult to enforce for this location. Public access to the Spring Creek Reservoir site could be more easily restricted during implementation of the remedial action. The proposed site is remote and less accessible. This proposed site is within an area that is currently fenced, has signs posted and that is patrolled by Reclamation security.

Disturbed seasonal wetlands, as well as willow and willow/cottonwood riparian habitats, have been identified in the vicinity of both disposal locations. Wetland impacts would occur as a result of disposal site construction at either site, and mitigation would be required. Biological resource information presented in the Sediment FS indicates construction of the Spring Creek Reservoir disposal cell would result in fewer significant impacts to biological resources than the Iron Mountain Road disposal site. The Iron Mountain Road site supports a sensitive vegetation type (vernal pools). The species composition at the Iron Mountain Road site is more diverse in all habitats, the hydrologic function appears to be relatively intact, and the vegetation cover is generally more dense.

Based on the density and composition of site vegetation, the Iron Mountain Road site would be expected to support a more diverse assemblage of wildlife species. The habitat value of wetlands at the Iron Mountain Road site is therefore ranked higher than those at the Spring Creek Reservoir site. As a result, the Spring Creek Reservoir disposal site is considered the biologically preferred alternative for disposal of dredged sediment under Alternatives 3, 4, and 5.

Both proposed disposal sites have undergone substantial disturbance, and the likelihood of special-status species occurrence is low. However, surveys should be conducted for special-status plant and wildlife species during the remedial design phase to confirm their presence and/or absence.

Implementability

Technical Feasibility. Construction of an upland dewatering/disposal cell at either location would be readily implementable. The following discussion highlights specific technical issues related to the construction, access, and conveyance for the disposal cell at both locations.

The Iron Mountain Road disposal site requires more earthwork and ground preparation than the Spring Creek Reservoir disposal site. Current conceptual design of the Iron Mountain Road disposal cell includes construction of a center berm that allows Iron Mountain Road to continue on its existing alignment through the center of the disposal cell. Construction of a dewatering/disposal cell at the Iron Mountain Road location would

require traffic control, including rerouting of Iron Mountain Road during construction. The Iron Mountain Road disposal location would cover two of three existing informal shooting ranges. Lead-contamination in the surface soils would need to be addressed during design and construction of the disposal cell at the Iron Mountain Road location.

Access would be much more limited for the Spring Creek Reservoir site than the Iron Mountain Road site. Seasonal access would be available adjacent to the Spring Creek Reservoir. The former access road would need to be rebuilt, and low areas would need to be filled. Access for construction equipment would need to be obtained on the existing road over SCDD. The access road to the Spring Creek Reservoir location could be under water during portions of the year between mid-December through late May. During periods when the access road is flooded, boat and barge access to the disposal site would be required for monitoring and any unanticipated maintenance, and a boat ramp would need to be constructed. Significant long-term maintenance of the access road would be required due to flooding and potential washout. In contrast, year-round road access would be readily available to the disposal site adjacent to Iron Mountain Road.

Dredge discharge would need to be pumped a greater distance, with a greater change in elevation, to the Spring Creek Reservoir disposal site than to the Iron Mountain Road disposal site. However, return water could be gravity-fed from the Spring Creek Reservoir disposal location over a shorter distance than that required for the Iron Mountain Road location. For the Iron Mountain Road disposal location, a return-water pump station and pipeline would be needed to convey return water from the disposal cell to Spring Creek Reservoir. Pipeline routing and placement would be more difficult for the Iron Mountain Road disposal location and would need to be incorporated into the new and existing design of the road and adjacent drainage ditches. The return-water pump station at the Iron Mountain Road disposal location and the return-water pipeline from either disposal location would require long-term maintenance and operation to convey any filtrate that is generated over time.

Administrative Feasibility. Construction and operation of a dewatering/disposal cell at the Spring Creek Reservoir location would be readily implemented from an administrative perspective. Some administrative challenges would exist for construction of an upland disposal cell along Iron Mountain Road.

Both potential disposal locations are on the IMM CERCLA site, and neither permits nor a permit equivalency process would be required, but project elements must meet the ARAR substantive requirements.

Disturbed seasonal wetlands, as well as willow and willow/cottonwood riparian habitats, have been identified in the vicinity of both disposal locations and might require special-status species surveys, wetlands mitigation, or other compensatory actions according to location-specific ARARs. Mitigation options could include the creation of wetland mitigation in an approved offsite location, or the purchase of mitigation credits. The potential for onsite mitigation is limited, but would be investigated further during remedial design. The Iron Mountain Road disposal site supports a sensitive vegetation type (vernal pools) that could impact mitigation requirements and ratios.

Cost

Overall, the costs associated with dewatering and disposal of dredge discharge are similar for both disposal locations evaluated. The preliminary cost estimate indicates the burdened construction costs are within $250,000, and the 50-year present value is within $300,000 for the two disposal locations. The difference in costs is well within the range of error of the cost estimates.

State Acceptance

The State has expressed its support for the disposal cell location adjacent to Spring Creek Reservoir. The State prefers this location because it is in a watershed that has already been impacted by mining operations and public access could be more easily restricted. For these reasons, the State believes the disposal cell location adjacent to Spring Creek Reservoir presents lower risks to human health and the environment than the location adjacent to Iron Mountain Road.

Specifically, in the June 28, 2004, letter to Rick Sugarek/EPA re *Comments on CH2M HILL's Agency Review Draft for the Iron Mountain Mine Sediment Feasibility Study for the Iron Mountain Mine Superfund Site, Redding, California*, Don Mandel/DTSC stated the following:

> DTSC believes that if a remedy involving disposal is chosen the disposal cell should be located in the area behind Spring Creek Debris Dam. DTSC thinks the location for a disposal cell behind Spring Creek Debris Dam is superior to a location along Iron Mountain Road based on environmental data, security, long term-effectiveness, future operation and maintenance (O&M) costs and implementability.

Similarly, on page three of the May 14, 2004, letter to Rick Sugarek/EPA, Donald Koch/CDFG stated the following:

> We prefer the disposal cell located in the Spring Creek watershed. This location poses fewer consequences to resources due to the degraded nature of the watershed from previous mine operations. It will also be easier to protect the public from wastes in the disposal cell when compared to the Iron Mountain Road location.

Finally, in the June 2, 2004 letter to Rick Sugarek/EPA re *Agency Review Draft, Iron Mountain Mine Sediment Feasibility Study, Redding California*, Phil Woodward/ RWQCB stated the following:

> The disposal of contaminated sediment behind SCDD keeps the material within the Spring Creek Drainage and behind SCDD where severe water quality impacts already exist. In the unlikely event of a discharge of wastes from the facility, the potential for impacting downstream waters is significantly reduced.

These letters were submitted during the development of remedial alternatives prior to the public comment period, and are included in the Administrative Record at EPA Records Center in San Francisco, California.

Community Acceptance

During the public meeting, the community expressed its support for the disposal location adjacent to Spring Creek Reservoir. One community member expressed concerns regarding the potential disposal location along Iron Mountain Road. These concerns include potential impacts to residents in the Flat Creek watershed area and impacts to recreational uses of the area.

2.11 Principal Threat Waste

AMD generated at the IMM Site is considered to be a principal threat waste because it is highly toxic and presents significant risk to human health and the environment should exposure occur. Completed and ongoing remedial actions to control the sources of AMD through collection and treatment at the IMM treatment plant have significantly reduced the acidity and metals content in surface water from IMM. However, EPA has not selected a remedy that treats the source in a manner that prevents the formation of AMD because EPA is not currently aware of such an approach that could be effectively implemented at IMM. EPA encourages the continued development and evaluation of alternatives that may partially satisfy the preference for treatment as a principal element, and this issue will be addressed in the final decision document for the Site.

The contaminated sediment within the Spring Creek Arm is not considered to constitute a principal threat waste because the contaminated sediment can be contained in a reliable manner through the implementation of the selected remedy. The selected remedy uses ex situ physical and chemical treatment of dredge discharge as a significant portion of the remedy.

EPA has determined that the selected interim remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a practicable manner for the contaminated sediment in the Spring Creek Arm of Keswick Reservoir. EPA has determined the selected remedy represents the best balance of trade-offs in terms of the five balancing criteria, while also considering the statutory preference for treatment as a principal element, bias against offsite treatment and disposal, and considering State and community acceptance.

2.12 Selected Remedy

The EPA has selected Alternative 4A – Partial Dredge with Disposal in Upland Dewatering/Disposal Cell as described in the June 2004 Sediment FS (EPA, 2004). The major components of the selected remedy include:

- Removal of contaminated sediment to an elevation that minimizes contaminated sediment loss during most operational scenarios of SCPP, SCDD, and Keswick Reservoir
- Operational controls to restrict Keswick Reservoir operating levels during releases from SCPP and SCDD that could scour sediment remaining at greater depths in Pile C

- Continued restrictions on the release schedule and criteria for the discharge of water from SCDD to the Spring Creek Arm
- Limited management of residual sediment in Pile A, Pile B, or the main channel of the Spring Creek Arm that is technically infeasible to dredge and is susceptible to erosion; implemented as needed, and ranging from monitored natural recovery to capping
- Short-term monitoring and resuspension management during implementation of the remedial action
- Conveyance of dredge discharge from the Spring Creek Arm to the dewatering/ disposal cell
- Ex situ physical and chemical treatment of dredge discharge to separate solids and liquids for disposal and achieve ARARs for discharge of filtrate and overflow
- Disposal of dewatered solids in an engineered upland disposal cell located adjacent to Spring Creek Reservoir
- Conveyance and discharge of return water from the disposal cell to Spring Creek Reservoir
- Long-term monitoring, disposal cell maintenance and institutional controls

2.12.1 Summary of Rationale for Selected Remedy

The selected remedy protects the environment from the exposure pathways that are being addressed in this interim action and achieves RAOs. The selected remedy removes contaminated sediment that would be susceptible to erosion under all operational scenarios of SCPP, SCDD, and Keswick Reservoir except under storm event and operational conditions that are extremely rare and very unlikely to occur. Partial dredging and disposal of dredge discharge in an engineered upland disposal cell will minimize the potential for mobilization of sediment from the Spring Creek Arm except under rare and unlikely conditions when the combined discharge from SCPP and SCDD approaches historical maximum releases and Keswick Reservoir is below an elevation of 578 feet msl. Operational restrictions for the SCPP, SCDD and Keswick Reservoir will be implemented to mitigate this risk scenario during rare discharge events.

The selected remedy minimizes the amount of sediment that requires dredging, dewatering, and disposal and is more technically feasible than other alternatives evaluated. Although full removal of sediment under Alternative 3 or partial removal and capping of sediment under Alternative 5 would provide a small increment of additional protection, these alternatives are more expensive and less implementable than the selected remedy, and the additional actions are not necessary to achieve RAOs.

The selected disposal cell location adjacent to Spring Creek Reservoir will be more protective of human health and the environment than the potential disposal cell location adjacent to Iron Mountain Road. The selected disposal location is within the impacted Spring Creek watershed behind SCDD. Therefore, this disposal location will have

reduced long-term risks of contaminant migration in the unlikely event of a contaminant release from the engineered disposal cell. Public access to the selected disposal location will be restricted during remedial action, reducing short-term risks to human health. Construction of a disposal cell at either location is technically feasible and the estimated construction and maintenance costs are similar.

2.12.2 Description of Selected Remedy

The engineering components of the selected remedy are shown on Figure 7. The components of the selected remedy are discussed below. The selected remedy may change somewhat from what is described in this ROD as a result of the remedial design and construction processes. Changes to the remedy described in this ROD may be documented using a technical memorandum in the Administrative Record, an Explanation of Significant Differences, or a ROD Amendment, depending on the scope, performance, and costs associated with the modification.

Sediment Removal – Dredging

Sediment will be removed by dredging to an elevation determined to meet RAOs by minimizing contaminated sediment loss under most operational scenarios of SCPP, SCDD, and Keswick Reservoir. The Sediment FS conceptual design estimates that removal of sediment in the Spring Creek Arm to 560 feet msl will minimize erosion of sediment under the following condition:

- Combined release from SCDD and SCPP below 6,600 cfs and Keswick Reservoir elevation above 574 feet msl. Combined release of 6,600 cfs is equivalent to the upper end of SCPP capacity (4,900 cfs) plus the historical maximum discharge from SCDD (1,700 cfs).

Dredging of contaminated sediment to 560 feet msl is estimated to remove approximately 55 percent of the volume of contaminated sediment in the Spring Creek Arm (158,000 cy). Dredging to an elevation of 560 feet msl will remove Pile A, Pile B, sediment in the main channel of the Arm, and approximately one-third of Pile C. Approximately 126,000 cy of fine-grained sediment will remain in Pile C following dredging to an elevation of 560 feet msl. The removal elevation will be further evaluated during the remedial design.

Dredging will primarily occur when SCPP is not operating and no flow is being released from SCDD. Dredging when SCPP is not operating will allow easier anchoring and movement of the dredge and limit transport of suspended sediment during in-water work. The timing and duration when in-water work can occur without discharge from SCPP or SCDD will require further evaluation and consultation with Reclamation during remedial design.

Dredging in the Spring Creek Arm will be performed using a phased approach: Phase I (during the first year) and Phase II (performed the following years). The phased approach will allow determination of settling and dewatering characteristics of dredged material, production efficiencies, an evaluation of the environmental constraints, and implementability while dredging at lower rates during Phase I.

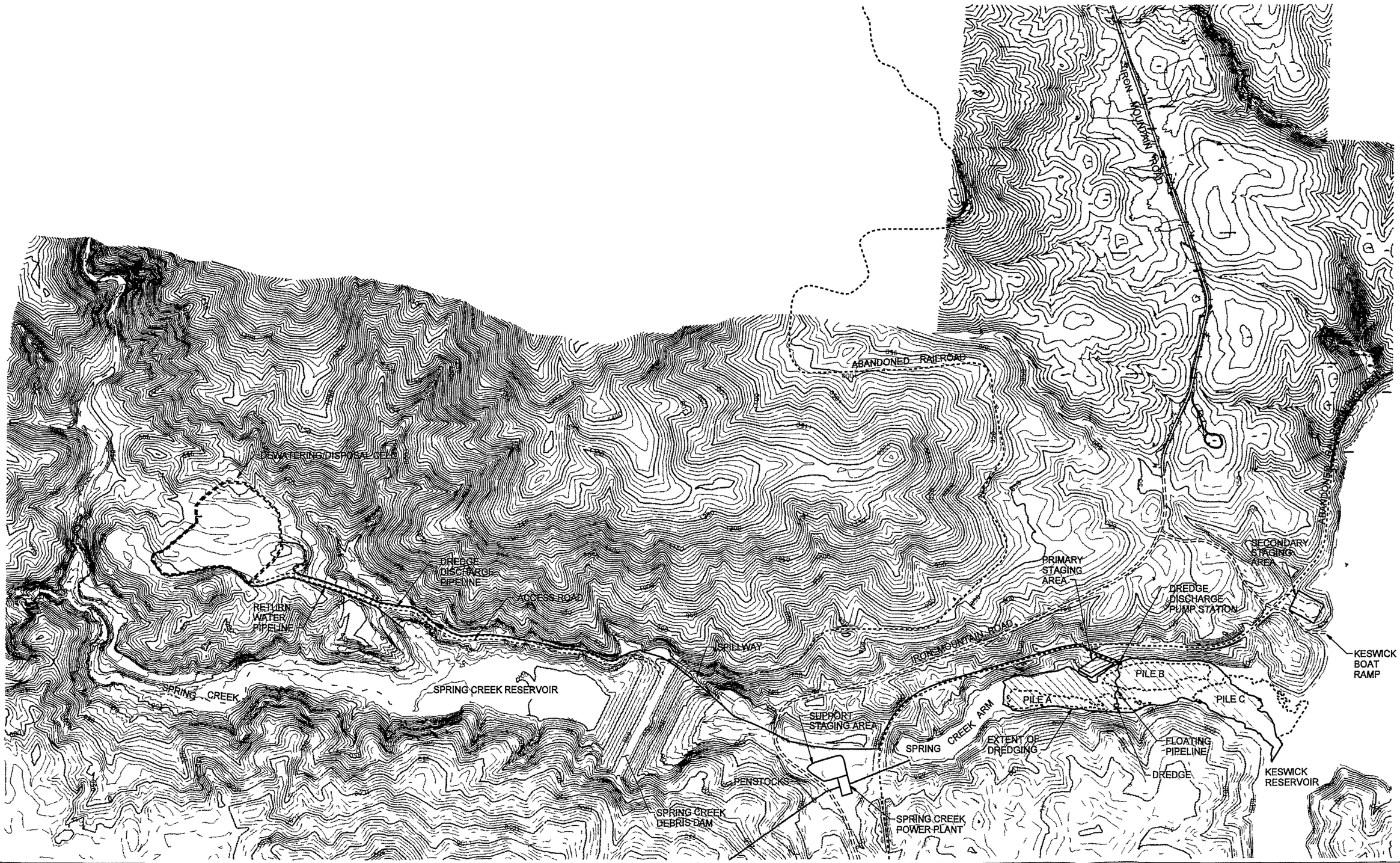


FIGURE 7
SELECTED REMEDY, PARTIAL DREDGE WITH DISPOSAL IN UPLAND DEWATERING/DISPOSAL CELL
RECORD OF DECISION
IRON MOUNTAIN MINE SHASTA COUNTY CALIFORNIA

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Information obtained during Phase I will assist in planning for Phase II. Performance of additional sampling and geotechnical testing during the design will assist in planning the phased approach. A pilot-scale dredging and dewatering study could be performed, if necessary, in conjunction with the phased dredging.

Operational and Institutional Controls

Continued use of existing operational/institutional controls and new operational or institutional controls will be implemented to meet the following performance goals:

1. Current operational controls pursuant to the Operations Criteria and Plan (OCAP) that require Reclamation to restrict Keswick Reservoir elevations during release events from SCPP and SCDD to minimize the potential for erosion of sediment in the Spring Creek Arm will be revised. Operational restrictions would be removed except for periods during rare storm events where continued operational restrictions are necessary to assure that remaining sediments do not erode into the environment.

2. Current OCAP operational controls will be continued that require Reclamation to operate SCDD releases to comply with water quality ARARs in the Sacramento River downstream of Keswick Dam, and to continue low-flow releases from SCPP as necessary to flush Spring Creek Reservoir water through the Spring Creek Arm.

3. A new institutional control will be required to restrict access to, and future use of, the portion of federal lands that will be used for the onsite disposal cell location in order to prevent potential human exposure to contaminants. The institutional control will restrict land use at and in the immediate vicinity of the disposal cell by prohibiting residential use (and related uses) and by prohibiting intrusive activities that could damage the integrity of the cell.

Evaluations conducted by EPA as part of the Sediment FS indicate limited restrictions to maintain Keswick Reservoir pool elevation above 578 feet msl, when the combined discharge from SCPP and SCDD approaches or exceeds 6,600 cfs, will prevent erosion of contaminated sediment remaining after dredging. However, the actual restrictions will be further defined following completion of the dredging operations. Once the final sediment contours are known for sediment that will remain in place, detailed engineering analyses can be performed to determine the actual restriction that would be necessary.

The operational controls selected by this ROD and discussed above may be implemented through re-negotiation of the 1980 MOU (and related documents), or by means of a separate agreement between EPA, Reclamation and the State of California.

Limited Residual Management

Following dredging, a small percentage of sediment may remain in Pile A, Pile B, or the main channel of the Spring Creek Arm because it is infeasible to remove for reasons such as underwater obstructions. Residual sediment in Pile A, Pile B, or the main channel of Spring Creek Arm that is infeasible to dredge and is potentially eroded under the restricted operational scenarios described above will be managed to prevent scouring. Residual management options allowed by the ROD will range from monitored natural recovery to limited capping efforts. The extent of residual management will be determined in the

remedial design and following dredging. The extent of residual management required will be determined using methods such as bathymetric and geophysical surveys and detailed hydraulic modeling. The Sediment FS conceptual design estimates that 10 percent (1.5 acres) of the dredging footprint around Piles A and B may require a subaqueous cap to manage residual sediment. Residual management does not include management of sediment remaining in Pile C below the dredge elevation. This sediment will be managed using limited operational restrictions, as described above.

Short-term Monitoring and Resuspension Management during In-water Work

During implementation of the selected remedy, surface water will be monitored within and downstream of the Spring Creek Arm, and the discharge from the disposal cell will be monitored. Water quality monitoring criteria in Keswick Reservoir will be selected to demonstrate compliance with water quality ARARs at the point of compliance during implementation of the selected remedy. The monitoring program will be designed to provide early warning of potential problems. Water generated during dewatering of dredged sediment will comply with the substantive requirements of the NPDES permit program.

Resuspension management will include the use of multiple controls to minimize the resuspension of sediment and/or the migration or resuspended sediment. Resuspension management will be employed to meet water quality ARARs (most notably the turbidity standards in the RWQCB Basin Plan during dredging operations). Controls for resuspension management will be further defined in the remedial design stage and may include:

- **Best Management Practices (BMPs) to minimize resuspension.** BMPs used during dredging may include keeping the intake head of the dredge below the surface of the sediment being removed at all possible times; minimizing reverse purging of intake lines; and keeping intake lines at a depth to minimize erosion and resuspension if reverse purging is necessary. BMPs may also include limiting power to props, using caution when moving floating vessels and anchors, and using above-water deadhead anchor points.

- **Engineering design and in-water construction methods to minimize resuspension and events such as slope failures.** Engineering controls during dredging may include limiting the number of passes by the dredge, controlling the height and slope of the working face, and selecting appropriate dredging equipment. Dredging plans will consider sediment strength, and dredging will be designed to create stable slopes less than a predetermined horizontal:vertical ratio. Use of other methods to promote slope stability during dredging will be considered during design.

- **Use of a sediment curtain barrier to minimize migration of suspended sediment.** Both permeable and impermeable silt curtains will be considered and further evaluated in the remedial design.

Also, as discussed above, dredging will occur when the SCPP is not operating, and dredging will be implemented using a phased dredging approach. If potential problems are identified during Phase 1 dredging based upon water quality monitoring, a response action will be implemented and might include additional resuspension management

controls, reduced dredging rates, or shutting down operations until the issues can be resolved.

Conveyance of Dredge Discharge

Dredge discharge will be transported by pipeline to the disposal location adjacent to Spring Creek Reservoir. Dredge discharge will be pumped approximately 350 vertical feet and a distance of 8,700 feet to the dewatering/disposal cell.

Ex situ Physical and Chemical Treatment of Dredge Discharge

Solids in the dredge discharge will be separated from liquid during dewatering. Results from the 2003 Treatability Study (CH2M HILL, 2004a) were used to develop the conceptual design for ex situ physical and chemical treatment of dredge discharge.

Lime and polymer will be added to the dredge discharge prior to dewatering. Lime will be added for pH adjustment and to improve overflow and filtrate water quality through metals precipitation. Polymer will be added as necessary for particle aggregation to aid in the settling of solids.

Treatability study results indicate overflow and filtrate water quality will meet Effluent Limitation Guidelines following adjustment of the pH of the dredge discharge to 9.0. The Sediment FS conceptual design assumed further clarification of filtration or overflow will not be required. Process control during dewatering will accommodate variable flow rates and changing ratios of top material to bottom material, resulting in variable polymer and lime requirements.

Filtrate and overflow from the dewatering/disposal cell will be collected and discharged to Spring Creek Reservoir. Treatability study results indicate one-stage gravity settling, in combination with polymer and lime addition, will achieve adequate settling and dewatering of dredge discharge. As part of a one-stage treatment process, dredge discharge will be pumped directly into the ultimate dewatering/disposal cell, and no intermediate settling pond will be designed. Using consolidation rates measured in the Treatability Study column tests, the design volume for the disposal cell is 195,000 cy, with 2 feet of additional freeboard elevation. This volume represents the volume requirements on the last day of dredging, and includes the volume of dewatered solids and the return water that will remain from the final 20 days of dredging. The one-stage treatment approach may be modified based on additional information that may be collected during remedial design; during pilot testing, if conducted; or during the Phase I operations.

Disposal in Engineered Upland Disposal Cell Adjacent to Spring Creek Reservoir

The disposal cell will be designed to comply with action-specific ARARs. The disposal cell will comply with appropriate and relevant construction, monitoring, and closure and post-closure maintenance requirements for new mining waste units under the State of California Water Code §13172 for California Title 27 Group B mining wastes. These requirements include the following:

- Flood protection – protected from 100-year peak streamflow
- Construction standards – underlain with an impermeable liner system (permeability equal to or less than 1 x 10^{-6} centimeters per second) and a blanket-type leachate collection and removal system
- Precipitation and drainage controls – designed for one 10-year, 24-hour storm; precipitation that is not diverted shall be collected and managed through the required leachate control and removal system, unless the collected fluid does not contain indicator parameters or waste constituents in excess of applicable water quality standards
- Monitoring – comply with conditions of 27 CCR §§20385-20430
- Closure - close in accordance with 27 CCR §21090 (a), (b), and (c)

The Sediment FS design estimates the top-of-berm elevation of the disposal cell to be 934 feet msl, which accommodates the design volume of 195,000 cy plus 2 feet of freeboard. The cell's area will be approximately 11.5 acres. Construction of the cell will require ground preparation to create a uniform slope for filtrate collection and to increase the available disposal volume of the cell. Fill will be required to construct the perimeter berm.

Road access to the Spring Creek Reservoir disposal location is limited by the steep topography of the surrounding area. Seasonal access will be available adjacent to the Spring Creek Reservoir in the location of the former access road used during construction of SCDD. The former access road will be rebuilt, and access for construction equipment will need to be obtained on the existing road over SCDD. A boat ramp may need to be constructed to provide boat and barge access for monitoring and emergency maintenance during periods when the access road is flooded.

Disturbed seasonal wetlands and willow riparian habitats have been identified in the vicinity of the Spring Creek Reservoir disposal location. Construction of the disposal cell will impact these wetlands, and special-status species surveys, wetlands mitigation, or other compensatory actions will be required as detailed during the remedial design.

Return-water Conveyance and Discharge to Spring Creek Reservoir

Water generated during dewatering of sediment will be collected as overflow and filtrate from the dewatering/disposal cell. A gravity return-water pipeline, or other conveyance structure, will convey return water (i.e., overflow and filtrate) approximately 3,000 feet from the disposal cell to the Spring Creek Reservoir.

Long-term Monitoring and Disposal Cell Maintenance

As part of the remedial design and remedial action for the disposal cell, a water quality monitoring and response program will be prepared and submitted for review by RWQCB in compliance with the substantive relevant and appropriate requirements of 27 CCR §§20385 through 20430. EPA will seek RWQCB comments on this monitoring program. Long-term monitoring will also include surface water quality monitoring to determine the continued effectiveness of the remedial action. The disposal cell will be closed and main-

tained in compliance with the substantive relevant and appropriate requirements of 27 CCR §21090 (a), (b), and (c).

2.12.3 Summary of Estimated Costs of Selected Remedy

Table 16 contains a summary of the estimated costs for components of the selected remedy. Details regarding the assumptions and cost estimation methods are presented in Appendixes B and C of the Sediment FS (EPA, 2004).

TABLE 16
Cost Estimate Summary for Selected Remedy
Iron Mountain Mine Record of Decision 5, Shasta County, California

Description	Cost ($)
Construction Costs, Phase 1	
Mobilize	165,000
Staging Area off Railroad Grade/ Bike Trail	357,000
Secondary Staging Area at Boat Ramp	198,000
Phase I Dredge Discharge Pump Station	137,000
Lime/Polymer Feed Equipment	406,000
Develop Disposal Cell / Pipeline Access Road	286,000
Install Phase I Dredge Discharge Pipeline	457,000
Develop Dewatering, Disposal Cell	1,984,000
Install Return Water Pipeline	138,000
Install Sediment Curtains	40,000
Phase I Dredging	851,000
O&M during Remedial Action	307,000
Residual Management (Subaqueous Cap)	136,000
Monitoring during Remedial Action	110,000
Remove / Store Sediment Curtains	10,000
Demobilize / Secure Site End of Phase 1	100,000
Total Phase 1	5,682,000
Construction Costs, Phase 2	
Remobilize	144,000
Phase II Dredge Discharge Pump Station	234,000
Install Phase II Dredge Discharge Pipeline	659,000
Repair/Reinstall Sediment Curtains	113,000
Phase II Dredging	1,994,000
O&M During Remedial Action	615,000
Residual Management (Subaqueous Cap)	172,000
Reclaim Primary Staging Area	117,000
Reclaim Secondary Staging Area	23,000
Place Cover on Disposal Cell	638,000
Demobilize Dredge Equipment	70,000
Remove Pump Station	25,000
Remove Dredge Discharge Pipeline	35,000

TABLE 16
Cost Estimate Summary for Selected Remedy
Iron Mountain Mine Record of Decision 5, Shasta County, California

Description	Cost ($)
Remove K Rail	6,000
Reclaim Dredge Discharge Pipeline Route	16,000
Monitoring during Remedial Action	61,000
Remove Sediment Curtains	26,000
Total Phase 2	4,948,000
Discounted Phase 2 (3.5% Discount Rate)	4,781,000
Total Estimated Construction Cost 2004 Dollars	10,463,000
Indirect Costs	
Field Detail Allowance (2.5%)	262,000
Bonds/Insurance (5.0%)	523,000
Contractors' Overhead and Profit	included above
Remedial Design Investigation (8.0%)	837,000
Engineering (12.0%)	1,255,000
Construction Management (7.5%)	785,000
License/Legal (2.0%)	209,000
Subtotal	14,334,000
Surveys and Reporting	
Bathymetric and Geophysical Survey	55,000
Agency Coordination /Documentation	40,000
Special Status Species Surveys and Reporting	60,000
Wetlands Delineation and Reporting	40,000
Wetlands Mitigation and Monitoring Plan	55,000
Wetlands Mitigation	300,000
Cultural Resources Survey	15,000
Subtotal	14,899,000
Contingency	
Contingency (25%)	3,725,000
Subtotal	18,624,000
Annual O&M Costs	
Monitoring	27,000
Institutional Controls	5,000
Residual Management Cap Maintenance	15,000
Disposal Cell Maintenance	52,000
Pump and Pipeline Maintenance and Repairs	7,000
Annual Total	106,000
Annual O&M 50 Year NPV (3.5% Discount Rate)	2,488,000
Total Estimated Cost	21,112,000

Notes:
O&M = operations and maintenance
NPV = net present value

As discussed under Section 2.10.1, the net present value allows costs for remedial alternatives to be compared by discounting all costs to the year that the alternative is implemented. Fifty years was chosen as the period of analysis. For all alternatives, the net present value was calculated using the real discount rate found in Appendix C of Office of Management and Budget Circular A-94 (Office of Management and Budget, 2004). In that guidance document, the real discount rate based on the economic assumptions from the 2005 budget for programs with durations of 30 years or longer is 3.5 percent. The cost estimate for the selected remedy assumes a constant average annual cost for the duration of the project.

The cost estimate for the selected remedy is an order-of-magnitude engineering cost estimate with an expected accuracy range of –30 to +50 percent of the actual project cost. In the remedial design phase, changes may be made to the processes or approach used to implement the components of the selected remedy. Major changes to the processes or approach may be documented in the form of a memorandum to the Administrative Record file, an Explanation of Significant Difference, or a ROD Amendment.

The present value of O&M costs was calculated using the following formula:

$$PV_{O\&M} = \sum_{t=1}^{t=n} \frac{1}{(1+i)^t} * x_t = \frac{(1+i)^n - 1}{i(1+i)^n} * x_t$$

where:

$PV_{O\&M}$	=	present value of O&M costs
i	=	discount rate (3.5%)
t	=	year
n	=	total years (50)
x_t	=	constant annual cost

The cost estimate has been prepared for guidance in the evaluation of alternatives and remedy selection from the information available at the time of the estimate. The actual cost that would be incurred for each alternative would depend on a number of factors including additional data that would become available during design and construction, actual labor and material costs, competitive market conditions, actual site conditions, final project scope, implementation schedule, continuity of personnel and engineering, and other variable factors. As a result, actual project costs are expected to vary from the estimate presented in Table 16.

2.12.4 Performance Criteria and Water Quality ARARs

The applicable numeric chemical-specific water quality standards promulgated in the National Toxics Rule (NTR), CTR, and RWQCB Basin Plan are selected as ARARs (as set out in Table 17) for the remedial actions selected in this ROD. ARAR determinations in this ROD do not alter or amend ARAR determinations in prior EPA RODs for this Site, including but not limited to ROD4 (1997).

The performance criteria for the dredging operations during implementation of the interim remedial action will include the following:

- Discharges of sediment from the Spring Creek Arm shall not cause exceedances of the chemical-specific ARARs (Table 17) at the compliance point, which will be located upstream of the drinking water intakes for the City of Redding.

  The applicable numeric standards are presented in Table 17.

TABLE 17

Basin Plan and California Toxics Rule Water Quality Criteria for the Sacramento River below Keswick Dam

Iron Mountain Mine Record of Decision 5, Shasta County, California

Parameter	Basin Plan Maximum Concentration (µg/L)[a]	California Toxics Rule Continuous Concentration (4-day Average) (µg/L)[a]
Arsenic	10	150
Cadmium	0.22[b]	1.1[b]
Copper	5.6[b]	4.1[b]
Iron	300	--
Zinc	16[b]	54[b]

[a] Expressed as dissolved concentrations.
[b] Concentration is dependent on hardness. Objectives presented assume a hardness of 40 mg/L.
-- = no standard

- RWQCB Basin Plan turbidity standards at the point of compliance during dredging operations.

- Return water discharged from the disposal cell shall not exceed the relevant and appropriate Effluent Limitation Guidelines established for existing point sources at copper and zinc mines in 40 CFR §§440.102(a) and 440.103(a). The effluent limitations are:

  - Cadmium - 0.10 mg/L maximum for any one day; 0.05 mg/L average of daily values/30 consecutive days
  - Copper - 0.30 mg/L maximum for any one day; 0.15 mg/L average of daily values/30 consecutive days
  - Lead - 0.6 mg/L maximum for any one day; 0.3 mg/L average of daily values/ 30 consecutive days
  - Zinc - 1.5 mg/L maximum for any one day; 0.75 mg/L average of daily values/ 30 consecutive days
  - pH - within the range of 6.0 and 9.0 at all times
  - Total Suspended Solids (TSS) - 30 mg/L maximum for any one day; 20 mg/L average of daily values for 30 consecutive days

- Sediment that is susceptible to erosion shall be removed (or contained through residual management) to 560 feet msl or to an elevation determined by further analysis to prevent erosion under the following operational condition:

- Combined release from SCDD and SCPP up to 6,600 cfs and Keswick Reservoir elevation of 574 feet msl or greater. Combined release of 6,600 cfs is equivalent to the upper end of SCPP capacity (4,900 cfs) plus the historical maximum discharge from SCDD (1,700 cfs).

By meeting these performance criteria, the remedy will also achieve RAOs. When determining compliance with water quality ARARs in the Sacramento River downstream of Keswick Dam, metals concentrations will also be evaluated in upstream sources, including water released from SCDD and Shasta Dam. Monitoring data will be used to determine when or if exceedances of water quality criteria are caused by upstream sources rather than releases of sediment from the Spring Creek Arm.

However, the action selected in this ROD is an interim action that leaves some releases of hazardous substances unabated. EPA is relying on the ARARs waiver for "interim measures" (CERCLA §121(d)(4)(A); 40 CFR § 300.430(f)(1)(ii)(C)(1)) for this remedial action. In particular, EPA anticipates that the remedy will improve water quality in the Spring Creek Arm and main body of Keswick Reservoir, but EPA does not anticipate that this remedy, in conjunction with the other remedies implemented to date, will be sufficient to ensure compliance with (1) the numeric, chemical-specific standards contained in the NTR, CTR and Basin Plan for copper, cadmium, or zinc, and (2) California Fish and Game Code § 5650 (which prohibits discharge of contaminants "deleterious to fish, plant life, or bird life"). The EPA is therefore waiving compliance with those standards (following construction completion) for the interim remedial action to the extent those standards cannot be achieved by the remedy selected in this ROD in conjunction with the remedies implemented under prior RODs.

EPA is continuing to study the feasibility of implementing additional controls on the metal discharges from the Boulder Creek watershed at IMM, Operable Unit 6, and the down gradient impacts of these continuing discharges. EPA expects to be able to reach a cleanup decision, that could include a no further action alternative, for these contaminant sources by September 2006. EPA further expects that this decision would be the final decision for EPA's IMM Superfund cleanup. The final ROD for the IMM site would address all issues related to compliance of EPA's remedial action with water quality ARARs on a sitewide basis.

2.12.5 Expected Outcomes of Selected Remedy

The selected remedy is anticipated to require to 2 to 3 years to implement. The schedule of the remedy is dependent on the timing and duration when in-water work can be performed without operation of SCPP and without discharge from SCDD. This section discusses expected outcomes following implementation of the selected remedy.

Removal of contaminated sediment in the Spring Creek Arm that is most susceptible to erosion, and disposal of dredged sediment in an upland disposal cell, will mitigate the risk for release events of contaminated sediment. Implementation of the selected remedy will protect important fishery spawning habitats in the Sacramento River ecosystem from the release of toxic metals associated with contaminated sediment in the Spring Creek Arm. The selected remedy will comply with water quality ARARs that are established to

prevent toxicity in the Sacramento River ecosystem during implementation of the remedial action.

2.13 Statutory Determinations

Under CERCLA §121 and the NCP, EPA must select remedies that are protective of human health and the environment and comply with ARARs (unless a statutory waiver is justified). The selected remedy must also be cost-effective and use permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA includes a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of hazardous wastes as a principal element and a bias against offsite disposal of untreated wastes. The following sections discuss how the selected remedy meets these statutory requirements.

2.13.1 Protection of Human Health and the Environment

The selected remedy protects the environment from the exposure pathways that are being addressed by this remedial action. Risk evaluations conducted by EPA indicate that contaminated sediment and surface water in the Spring Creek Arm do not pose a current or future unacceptable risk to human health and welfare. Therefore, the selected remedy is aimed at protection of the environment.

The fishery resources and other sensitive aquatic species in the Sacramento River below Keswick Dam are the primary natural resources at risk from the mobilization of contaminated sediment from the Spring Creek Arm. The Sacramento River provides high-quality habitat for spawning and rearing fish, including the Sacramento River Winter-run Chinook salmon (listed as endangered by the State of California), and the Sacramento River Spring-run Chinook salmon (listed as threatened). Removal of contaminated sediment from the Spring Creek Arm that is most susceptible to erosion, and disposal of dredged sediment in an upland disposal cell, will mitigate the risk for release events of contaminated sediment. The selected remedy will reduce the metal loads and suspended solids associated with contaminated sediment discharged from the Spring Creek Arm and will comply with water quality during implementation of the remedial action.

Metal contamination in IMM discharges and deposited sediment has resulted in ecologically significant impacts to benthic and aquatic communities in the Spring Creek Arm, including significant toxicity to invertebrates, plants, and amphibians. It is uncertain whether a benthic community will be re-established in the Spring Creek Arm following implementation of the selected remedy, or under any of the alternatives evaluated in the Sediment FS. Copper concentrations in SCDD discharge will be reduced to 5 percent of the pre-1994 concentrations once remedies under ROD 4 are operational; however, continued releases of dissolved copper from Spring Creek Reservoir may still limit growth of aquatic plants following remedial action. Historical smelting activities conducted in the Spring Creek watershed have contaminated portions of the alluvial material below the fine-grained sediment and collodial HMO precipitates. Metals concentrations associated with the bottom material may still inhibit establishment of a benthic community following partial dredging. The selected remedy is expected to indirectly improve aquatic

habitat in Keswick Reservoir by limiting future mobilization of contaminated sediment and redeposition into Keswick Reservoir.

Implementation of the selected remedy will pose short-term risks to the environment. Short-term risks to the environment during remediation include the potential for resuspension and movement of contaminated sediment during dredging. Multiple controls will be used to mitigate this risk by minimizing the resuspension of sediment and/or the migration of resuspended sediment. Resuspension management will be employed to meet water quality ARARs in the Sacramento River downstream of Keswick Dam during in-water work in the Spring Creek Arm. Controls for resuspension management will be further defined in the remedial design stage and may include:

- Conducting in-water work when SCPP is not operating to limit migration of suspended sediment
- A conservative, phased dredging approach to determine settling and dewatering characteristics of dredged material, production efficiencies, implementability, and effectiveness of resuspension management, while dredging at lower rates
- Best Management Practices (BMPs) during dredging, anchoring, and vessel operation to minimize resuspension
- Engineering design and in-water construction methods to minimize resuspension and events such as slope failures
- Use of a sediment curtain barrier to minimize migration of suspended sediment
- Monitoring of sediment resuspension and surface water quality during remedial action to provide early detection of potential problems

Public access to the selected disposal location adjacent to Spring Creek Reservoir will be restricted during remedial action to reduce potential exposure to contaminants. The disposal cell will be constructed and maintained to prevent contaminant releases to surface water or groundwater. The selected disposal location is within the impacted Spring Creek watershed behind SCDD, resulting in reduced long-term risks of contaminant migration in the unlikely event of a contaminant release from the engineered disposal cell.

2.13.2 Compliance with ARARs

The selected remedy will be designed to comply with ARARs in the manner described in the following sections.

Compliance with Chemical-specific ARARs

Chemical-specific ARARs for the selected remedy are listed in Table 17 and 18.

The selected remedy is expected to meet state and federal maximum contaminant levels at the point of compliance for Site related contaminants. The selected remedy is also expected to meet the RWQCB Basin Plan turbidity standard at the point of compliance during dredging operations.

TABLE 18

Chemical-specific ARARs for Selected Remedy

Iron Mountain Mine Record of Decision 5, Shasta County, California

Remedy Components	Standard, Requirement, Criterion, or Limitation	ARAR Status	Description	Comment
Performance criteria for Sacramento River near City of Redding's intake	National Drinking Water Standards (maximum contaminant levels [MCLs]) 40 CFR 300.430(e)(2)(I)(B) Safe Drinking Water Act	Relevant and appropriate	Establishes national primary drinking water standards to protect the quality of water in public water systems. MCLs represent the maximum concentrations of contaminants permissible in a water system delivered to the public. MCLs are generally relevant and appropriate when determining acceptable exposure limits for current or potential sources of drinking water.	National primary drinking water standards are health-based standards for public water systems (MCLs). The National Contingency Plan (NCP) defines MCLs as relevant and appropriate for water determined to be a current or a potential source of drinking water in cases where maximum contaminant level goals (MCLGs) are not ARARs. MCLs are enforced at the point where water is delivered to the public. For the IMM Site, the only location where MCLs are currently relevant and appropriate is the Sacramento River near the City of Redding's Jewel Creek intake.
	California Safe Drinking Water Standards (MCLs) State MCLs found in 22 CCR §64435 and §64444.5	Relevant and Appropriate	Establishes primary MCLs for contaminants that can not be exceeded in public water systems. In some cases the California drinking water standards are more stringent than the federal MCLs.	Like federal MCLs, state MCLs are applicable as cleanup goals for waters determined to be a current or a potential source of drinking water. State MCLs are referenced in the Basin Plan as the minimum standards for waters with a beneficial use of municipal or domestic supply.
Performance criteria for surface water at IMM Site	National Toxics Rule (NTR) and California Toxics Rule (CTR) 40 CFR Part 131	Applicable, but waived as discussed in text	Establishes numeric aquatic life criteria and human health criteria for priority toxic pollutants. This regulation is applicable to inland surface waters, bays, and estuaries in California.	This standard establishes criteria for surface water quality. Standards for Site related contaminants are applicable to surface waters at the IMM Site.

TABLE 18

Chemical-specific ARARs for Selected Remedy

Iron Mountain Mine Record of Decision 5, Shasta County, California

Remedy Components	Standard, Requirement, Criterion, or Limitation	ARAR Status	Description	Comment
Discharge from dewatering/ disposal cell	State Water Resources Control Board (SWRCB) Resolution 68-16	Applicable	This resolution requires the continued maintenance of high-quality water of the State. Water quality may not be degraded below what is necessary to protect the beneficial uses of the water source.	Remedial actions that involve discharges to surface water or surface water drainage courses must take into account the protection of beneficial uses and the maintenance of high-quality waters in the area.
Sediment removal and treatment of dredge discharge	SWRCB Resolution 92-49	Applicable, but waived as discussed in text	Section III.G of this resolution states in part that dischargers are required to clean up and abate the effects of discharges in a manner that promotes attainment of background water quality, or the best water quality that is reasonable if background levels cannot be restored.	Remedial alternatives evaluated must consider attainment of the highest water quality that is economically and technically achievable, and protects beneficial uses.
Performance criteria for protection of water quality	RWQCB's Water Quality Control Plan for the Sacramento River and San Joaquin River Basins (Basin Plan)	Applicable, but waived as discussed in text	The Basin Plan for the Sacramento and San Joaquin River Basins, dated December 9, 1994, establishes beneficial uses for groundwater and surface water, water quality objectives designed to protect those beneficial uses, and implementation plans to achieve water quality objectives.	The narrative water quality objectives and numerical standards for the Sacramento River described in the Basin Plan, for Site related contaminants, are considered ARARs.

The applicable numeric chemical specific water quality standards promulgated in the NTR, CTR and RWQCB Basin Plan, as set out in Table 17, are selected by this ROD as ARARs for the remedial actions selected in this ROD. ARAR determinations in this ROD do not amend or alter ARAR determinations in prior EPA RODs for this Site, including but not limited to ROD 4 (1997).

However, the remedial action selected in this ROD is an interim action that leaves some releases of hazardous substances unabated. EPA is utilizing the ARAR waiver for interim measures (42 U.S.C. Section 9621(d)(4)(A) and 40 C.F.R. Section 300.430(f)(1)(ii)(C)(1) as the basis to waive certain of the applicable numeric chemical specific water quality ARARs following construction completion. EPA expects that the remedy will meet these ARARs at the point of compliance during the construction of the remedial action. While EPA anticipates that the remedial action selected in this ROD will improve water quality in the Spring Creek Arm and Keswick Reservoir, EPA does not anticipate that this remedy, in conjunction with other remedies implemented to date, will be sufficient to ensure compliance with applicable numeric chemical specific ARARs for copper, cadmium and zinc. EPA anticipates that the final ROD for this Site will address compliance with these ARARs on a Sitewide basis. EPA is also employing the interim action waiver to waive compliance with provisions of SWRCB Resolution 92-49 and California Fish and Game Code Section 5650 (a narrative standard prohibiting discharge of contaminants "deleterious to fish, plant life, or bird life").

Location-specific ARARs

Location-specific ARARs for the selected remedy are listed in Table 19. Significant location-specific ARARs are those pertaining to the protection of endangered species, fisheries, wildlife habitat, and wetlands.

The selected remedy will be designed to prevent the release of metal-laden sediment so that such release no longer presents a threat of deleterious effects to fish life. However, EPA does not anticipate that this remedy will ensure compliance with California Fish and Game Code § 5650, which prohibits discharge of contaminants "deleterious to fish, plant life, or bird life." See the discussion of ARARs waivers in the preceding section.

Other releases from the IMM Site, such as releases from area sources in the Boulder Creek watershed and the existing sediments in Spring Creek Reservoir, may continue to result in the releas of deleterious substances (primarily metals) into the surface waters of Spring Creek and Keswick Reservoir. Justification for an interim action ARARs waiver is presented at the end of Section 2.13.2.

The selected remedy shall address and is expected to comply with all other location-specific ARARs listed in Table 19.

TABLE 19

Location-specific ARARs for Selected Remedy

Iron Mountain Mine Record of Decision 5, Shasta County, California

Location	Standard, Requirement, Criterion, or Limitation	ARAR Status	Description	Comment
Historic property managed or controlled by a federal agency	National Historic Preservation Act (16 USC 470 et seq.; 36 CFR Part 800; 40 CFR 6.301(b); Executive Order 11593); National Historic Landmarks Program (36 CFR Part 65); National Register of Historic Places (36 CFR Part 60)	Applicable	Federal agencies must identify possible effects of proposed remedial activities on historic properties (cultural resources). If historic properties or landmarks eligible for, or included in, the National Register of Historic Places exist within remediation areas, remediation activities must be designed to minimize the effect on such properties or landmarks.	If historic properties are identified and would be impacted during implementation of the remedial action, substantive requirements would be applicable.
Area where action may cause irreparable harm, loss, or destruction of significant artifacts	Archaeological and Historical Preservation Act (16 USC 469 et seq., 40 CFR 6.301(c))	Applicable	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. Presence or absence of such data on the site must be verified. If historical or archaeological artifacts are present in remediation areas, the remedial actions must be designed to minimize adverse effects on the artifacts.	The proposed remedial alternatives will not alter or destroy any known prehistoric or historic archaeological features at the IMM site. However, substantive mitigation measures to protect the area would be required if such a discovery were uncovered.
	Archaeological Resources Protection Act of 1979 (16 USC 470aa-ii; 43 CFR 7)	Applicable	Steps must be taken to protect archaeological resources and sites that are on public and Indian lands and to preserve data. Investigators of archaeological sites must fulfill professional requirements. Presence of archaeological sites is to be determined.	

TABLE 19

Location-specific ARARs for Selected Remedy

Iron Mountain Mine Record of Decision 5, Shasta County, California

Location	Standard, Requirement, Criterion, or Limitation	ARAR Status	Description	Comment
Critical habitat upon which endangered species or threatened species depend (Sacramento River)	Endangered Species Act, 16 USC 1531 et seq., 50 CFR 402; 40 CFR 6.302(h))	Applicable	Protects endangered or threatened species and their habitat. If endangered or threatened species are in the vicinity of remediation work, U.S. Fish and Wildlife Service (USFWS) must be consulted, and the remediation activities must be designed to conserve endangered or threatened species and habitats.	Winter-run Chinook salmon (listed as endangered) rely on spawning areas in the Sacramento River. Remedial actions must be sensitive to the regulations that protect listed species.
State waters that support non-game fish and wildlife (Keswick Reservoir and Sacramento River)	Fish and Wildlife Conservation Act (16 USC 2901 et seq.; 50 CFR 83)	Applicable	Federal departments and agencies required to use their statutory and administrative authority to conserve and promote conservation of non-game fish and wildlife and their habitats. Non-game fish and wildlife are defined as fish and wildlife that are not taken for food or sport, that are not endangered or threatened, and that are not domesticated.	Federal departments and agencies are required to use their authority to conserve and promote non-game fish and their habitats.
Stream or water body that will be modified (Spring Creek Arm)	Fish and Wildlife Coordination Act (16 USC 661 et seq.; 40 CFR 6.302(g))	Applicable	Requires adequate provisions for protection of fish and wildlife resources. Certain remedies may result in the temporary or permanent modification of naturally occurring water bodies and may require the construction of mitigated wetlands in other areas.	Remedial actions resulting in modifications to the Spring Creek Arm require compliance with substantive provisions for protection of fish and wildlife resources.
Designated waters (Sacramento River)	Fish and Game Code Section 1505	Applicable	Requirements for the management, control, and protection of spawning areas which occupy state-owned lands, to protect fish life in these areas.	Designates the State lands of the Sacramento River from Keswick to Squaw Hill Bridge (near Vina) as prime salmon and steelhead-spawning areas which are used by salmon species listed as threatened and endangered. Substantive requirements for the management, control, and protection of spawning areas are applicable.

TABLE 19

Location-specific ARARs for Selected Remedy

Iron Mountain Mine Record of Decision 5, Shasta County, California

Location	Standard, Requirement, Criterion, or Limitation	ARAR Status	Description	Comment
	Fish and Game Code Sections 1600 and 1603	Applicable	Requirements for construction by, or on behalf of, any State or local agency or public utility that will change the natural flow or use material from the beds or result in disposal into designated waters.	Substantive requirements are applicable.
Critical habitat upon which endangered species or threatened species depend (Sacramento River)	Fish and Game Code Section 2081	Relevant and appropriate	Permits CDFG to authorize taking of endangered, threatened, or candidate species under specific circumstances, including when the authorized take is for scientific, educational, or management purposes, or when the impacts of the authorized take shall be minimized and fully mitigated.	Substantive requirements related to taking of endangered, threatened, or candidate species are applicable to the Chinook salmon in the Sacramento River.
Waters of the Untied States (Spring Creek Reservoir, Keswick Reservoir, and Sacramento River)	Clean Water Act (CWA)(Section 404) - Dredge or Fill Requirements (33 USC 1251-1376; 40 CFR 230)	Applicable	Establishes requirements that limit the discharge of dredged or fill material into waters of the United States. EPA guidelines for discharge of dredged or fill materials in 40 CFR 230 specify consideration of alternatives that have fewer adverse impacts and prohibit discharges that would result in exceedance of surface water quality standards, exceedance of toxic effluent standards, and jeopardy of threatened or endangered species. Special consideration is required for "special aquatic sites," defined to include wetlands.	Substantive requirements are applicable to road construction, sediment removal, sediment disposal and dewatering, placement of capping material for residual management, and surface-water diversions.
Areas within 100-year floodplain	Protection of Floodplains (Executive Order 11988; 40 CFR 6.302(b); 40 CFR Part 6, Appendix A)	Applicable	Requires federal agencies to evaluate the potential effects of action they may take in a floodplain to avoid the adverse impacts associated with direct and indirect development of a floodplain.	Requirements are potentially applicable if remedial actions affect the floodplain at the site.

TABLE 19

Location-specific ARARs for Selected Remedy

Iron Mountain Mine Record of Decision 5, Shasta County, California

Location	Standard, Requirement, Criterion, or Limitation	ARAR Status	Description	Comment
Wetlands	Protection of Wetlands (Executive Order 11990; 40 CFR 6.302(a); 40 CFR Part 6, Appendix A)	Applicable	Requires federal agencies to take action to avoid adversely affecting wetlands, to minimize wetlands destruction, and to preserve the value of wetlands.	Disturbed seasonal wetlands and willow riparian habitats were identified during a field reconnaissance survey in the disposal cell location adjacent to the Spring Creek Reservoir. Wetlands protection and mitigation requirements are applicable to remedial actions that impact existing wetlands.

Notes:
ARAR – applicable or relevant and appropriate requirement
CFR – Code of Federal Regulations
CDFG – California Department of Fish and Game
USFWS – U.S. Fish and Wildlife Service
USC – U.S. Code

Areas that will be unavoidably impacted by the selected remedy include disturbed seasonal wetlands and willow riparian habitats in the disposal cell location. The EPA will consult with USFWS and the U.S. Army Corps of Engineers to develop appropriate mitigation measures.

Action-specific ARARs

The selected remedy shall address, and is expected to comply with, all action-specific ARARs. Action-specific ARARs for the selected remedy are listed in Table 20. Significant action-specific ARARs include those relating to construction, monitoring, and maintenance of the upland disposal cell.

Construction, monitoring, and maintenance of the upland disposal cell will comply with substantive appropriate and relevant portions of the State of California Water Code §13172 and the substantive appropriate and relevant portions of regulations promulgated thereunder (27 CCR) for a mining waste management unit.

The embankment structure of the dewatering/disposal cell will meet the criteria for a Jurisdictional Dam by the California Division of Safety of Dams. As such, substantive requirements of the Dam Safety Act and Division 3 of the California Water Code are appropriate and relevant ARARs for the construction of the disposal cell embankment.

New discharges of treated water to surface waters must comply with the substantive appropriate and relevant portions of the National Pollutant Discharge Elimination System (NPDES) permit program. Because the discharge of return water from the dewatering/disposal cell will occur onsite, no permit will be required.

There are no technology-based effluent limitations specifically identified for inactive copper or pyrite mines. There are technology-based limitations for active coal, iron, copper, and zinc mines. Because the discharges of acid mine drainage from the underground mining at IMM are similar to the discharges from active open pit and underground copper mines, EPA has selected the effluent limitations for such copper mines as relevant and appropriate at the IMM Site for the discharge of return water from the dewatering system to the Spring Creek Reservoir.

The best practicable control technology (BPT) and best available technology economically achievable (BAT) limits on discharges from existing point sources at copper and zinc mines are the following effluent limitations (40 C.F.R. SS440.102(a) and 440.103(a)), which will be met at the point of discharge:

TABLE 20

Action-specific ARARs for Selected Remedy
Iron Mountain Mine Record of Decision 5, Shasta County, California

Remedy Components	Standard, Requirement, Criterion, or Limitation	ARAR Status	Description	Comment
Contaminated sediment dredge discharge	RCRA Bevill Exclusion – RCRA Section 3001(b)(3)(A)(ii), 42 USC 6921(a)(3)(A)(ii), 40 CFR 261.4(b)(7)		The Bevill exclusion, codified in 40 CFR §261.4(b)(7), provides that "[s]olid waste from the extraction, beneficiation and processing of ores and minerals (including coal), including phosphate rock and overburden from the mining of uranium ore" are not hazardous wastes.	Sediment in the Spring Creek Arm, and waste associated with removal of such sediment, may be excluded from hazardous waste designation because they are the result of historical mineral extraction or beneficiation at the Site.
Remedy components that could generate air contaminants	Shasta County Air Quality Management District (AQMD) Rules 3-2 and 3-16.	Applicable	Rule 3-2: Prohibits discharges of air contaminants above specific concentrations for any single source. Rule 3-16: Substantive requirements are those of Health and Safety Code Sections 41700 and 41701. No person shall discharge from any source whatsoever such quantities of air contaminants or other material which cause injury, detriment, nuisance, or annoyance to any considerable number of persons or to the public, or which endanger the comfort, repose, health, or safety of any such persons or the public, or which cause, or have a natural tendency to cause, injury or damage to business or property.	Requirements are applicable to remedial activities that could generate air contaminants, including construction of the onsite disposal cell, access road and staging area construction, and dewatering and treatment of dredge discharge.

TABLE 20

Action-specific ARARs for Selected Remedy
Iron Mountain Mine Record of Decision 5, Shasta County, California

Remedy Components	Standard, Requirement, Criterion, or Limitation	ARAR Status	Description	Comment
Access and land use restrictions for the onsite disposal cell	Land Use Covenants Regulations	Relevant and appropriate		Regulations will be relevant and appropriate for access and land use restrictions for the onsite disposal cell.
	CCR, title 22, Section 67391.1(a)		Requires imposition of appropriate limitations on land use by recorded land use covenant when hazardous substances remain on the property at levels that are not suitable for unrestricted use of the land.	
	CCR, title 22, Section 67391.1(b)		Requires that cleanup decision document contains an implementation and enforcement plan for land use limitations.	
	CCR, title 22, Section 67391.1(d)		Requires that land use covenant be recorded in the county where the land is located.	
	CCR, title 22, Section 67391.1(i)		Definitions	
	CA Civil Code, Section 1471(a)&(b)		Specifies requirements for land use covenants to apply to successors in title to the land.	
	CA Health & Safety Code, Section 25222.1			

TABLE 20

Action-specific ARARs for Selected Remedy
Iron Mountain Mine Record of Decision 5, Shasta County, California

Remedy Components	Standard, Requirement, Criterion, or Limitation	ARAR Status	Description	Comment
Disposal cell	Water Code §13172 and regulations promulgated thereunder [27 CCR 22480(b)]	Relevant and Appropriate	Establishes three groups of mining wastes: Group A – Mining wastes that must be managed as hazardous waste pursuant to Title 22, provided the RWQCB finds that such mining wastes pose a significant threat to water quality. Group B – Mining wastes that consist of or contain hazardous wastes, that qualify for a variance under Title 22, provided that the RWQCB finds that such mining wastes pose a low risk to water quality; and 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. Group C - Mining wastes from which any discharge would be in compliance with the applicable water quality control, including water quality objectives, other than turbidity.	EPA has determined that these wastes will be managed as Group B mining wastes.

TABLE 20

Action-specific ARARs for Selected Remedy
Iron Mountain Mine Record of Decision 5, Shasta County, California

Remedy Components	Standard, Requirement, Criterion, or Limitation	ARAR Status	Description	Comment
Disposal cell (continued)	Mining closure requirements under Water Code §13172	Applicable	Group A and B waste piles – close in accordance with 27 CCR §21090 (a), (b), and (c). Group A and B surface impoundments – close in accordance with 23 CCR 21400(a) and (b)(1); some surface impoundments with clay liners may be closed in place. Group A and B tailings ponds – close in a accordance with §21090(a), (b), and (c) and 21400(a) Group C units – close "in a manner that will minimize erosion and the threat of water quality degradation from sedimentation."	It is expected that dewatered dredge discharge will be classified as Group B mining wastes. Therefore, regulations for new Group B waste piles are applicable to the upland disposal cell.
Discharges to surface water from disposal cell	National Pollutant Discharge Elimination System (40 CFR Part 122)	Applicable	The National Pollutant Discharge Elimination System (NPDES) permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States.	Substantive requirements are applicable to discharge from the disposal cell. Onsite CERCLA actions do not require a permit. Substantive discharge requirements that are relevant and appropriate to discharges resulting from management of mining wastes are the National Effluent Limitations Guidelines for copper and zinc mining operations at 40 CFR §§440.102(a) and 440.103(a).
Disposal cell embankment	The National Dam Safety Act	Relevant and Appropriate	Substantive provisions of the Act encourage acceptable engineering policies and procedures to be used for dam site investigation, design, construction, operation and maintenance, and emergency preparedness.	The disposal cell will require construction of an embankment structure. The embankment will meet criteria to be considered a jurisdictional dam. Substantive requirements are applicable for construction of the disposal cell

TABLE 20

Action-specific ARARs for Selected Remedy
Iron Mountain Mine Record of Decision 5, Shasta County, California

Remedy Components	Standard, Requirement, Criterion, or Limitation	ARAR Status	Description	Comment
	Water Code §§6000 through 6501 and regulations promulgated thereunder [23 CCR 301-333]	Relevant and Appropriate	Establishes authority of the State to requires that a dam shall at all times be designed, constructed, operated and maintained so that it shall not or would not constitute a danger to life or property.	embankment.

Notes:

ARAR – applicable or relevant and appropriate requirement
CCR – California Code of Regulations
CFR – Code of Federal Regulations
EPA – U.S. Environmental Protection Agency
RCRA – Resource Conservation and Recovery Act

The concentration of pollutants discharged in mine drainage from mines that produce copper or zinc...from open-pit or underground operations other than placer deposits shall not exceed:

- Cadmium - 0.10 mg/L maximum for any one day; 0.05 mg/L average of daily values/30 consecutive days
- Copper - 0.30 mg/L maximum for any one day; 0.15 mg/L average of daily values/30 consecutive days
- Lead - 0.6 mg/L maximum for any one day; 0.3 mg/L average of daily values/ 30 consecutive days
- Zinc - 1.5 mg/L maximum for any one day; 0.75 mg/L average of daily values/ 30 consecutive days
- pH - within the range of 6.0 and 9.0 at all times
- Total Suspended Solids (TSS) - 30 mg/L maximum for any one day; 20 mg/L average of daily values for 30 consecutive days

Overflow and filtrate from the dewatering/disposal cell will be designed to meet the technology-based effluent limitations for copper and zinc mines.

2.13.3 Cost

In EPA's judgment, the selected remedy provides the best balance of cost and effectiveness in meeting NCP criteria for remedy selection for the alternatives that were developed and evaluated to assure the protection of human health and the environment. In making this determination, the following definition was used: "A remedy shall be cost-effective if its costs are proportional to its overall effectiveness." (NCP §300.430(f)(1)(ii)(D)). This was accomplished by evaluating the "overall effectiveness" of those alternatives that satisfied the threshold criteria (i.e., were both protective of the environment and ARAR-compliant). Overall effectiveness was evaluated by assessing three of the five balancing criteria in combination (long-term effectiveness and permanence; reduction in toxicity, mobility, and volume through treatment; and short-term effectiveness). Overall effectiveness was then compared to costs to determine cost-effectiveness. The relationship of the overall effectiveness of the selected remedy was determined to be proportional to its costs, and hence the selected remedy represents a reasonable value for the money to be spent.

The estimated 50-year present worth cost of the selected remedy (using a 3.5 percent interest rate) is $21,100,000. Although Alternative 2A is $3,200,000 less expensive than the selected remedy and Alternative 2B is $8,300,000 less expensive, these alternatives rely solely on containment to prevent mobilization of contaminated sediment in the Spring Creek Arm. Under Alternatives 2A and 2B, containment would be achieved by placing a subaqueous cap designed to withstand the greatest anticipated discharges from SCPP and SCDD. Capping is expected to be less effective in containing the sediments because placement of the cap on the fine grained sediments presents difficult engineering challenges. Some portion of the contaminated sediments, particularly the unconsolidated

upper sediments, would be expected to be resuspended during cap placement. Capping is a less permanent action than removal and disposal in an engineered upland cell. The long-term effectiveness of capping is entirely dependent on the adequacy of maintenance of capping components and land use restrictions to prevent dredging or construction activities that could damage the integrity of the cap. In addition, Alternatives 2A and 2B do not employ treatment technologies to reduce the toxicity, mobility, or volume of contaminated sediment. For these reasons, EPA believes the selected alternative achieves a greater overall protectiveness than Alternative 2 and is cost-effective. EPA also believes that partial removal, combined with limited restrictions on Keswick Reservoir operations under the selected remedy, will provide an overall level of protection comparable to Alternative 3 (full removal) and Alternative 5 (partial removal with capping) at a significantly lower cost ($3,100,000 to $8,000,000 less expensive).

Construction and maintenance costs are similar for a disposal cell at the selected location adjacent to Spring Creek Reservoir and a disposal cell located adjacent to Iron Mountain Road. The estimated costs are within $250,000, and the 50-year present value is within $300,000 for the two disposal locations. The cost difference is well within the expected accuracy range of the estimates. The selected disposal cell location adjacent to Spring Creek Reservoir will provide greater long-term protection of the environment and greater short-term protection of human health than the disposal cell location adjacent to Iron Mountain Road.

2.13.4 Utilization of Permanent Solutions and Alternative Treatment Technologies to Maximum Extent Practicable

EPA has determined that the selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a practicable manner for the interim remedial action. The selected remedial action is not designed or expected to be final, but EPA has determined the selected remedy represents the best balance of trade-offs among alternatives with respect to pertinent criteria, given the limited scope of the action. The selected remedy provides the best balance of trade-offs in terms of the five balancing criteria, while also considering the statutory preference for treatment as a principal element, bias against off-site treatment and disposal, and considering State and community acceptance.

The selected remedy satisfies the criteria for long-term effectiveness by removing contaminated sediment that is most susceptible to erosion, treating and dewatering dredge discharge, and disposing of solids in an onsite upland disposal cell. Limited restrictions on Keswick Reservoir operating levels during rare hydrologic events will be sufficient to prevent the migration of sediment remaining in the Spring Creek Arm after dredging. Ex situ chemical and physical treatment of dredge discharge will reduce the volume of contaminated material requiring onsite disposal and will reduce the mobility of heavy metals. Dredge discharge will be disposed onsite within a watershed that has already been impacted by discharge of AMD from the IMM Site. Short-term risks to the environment during remediation include the potential for resuspension and movement of contaminated sediment during dredging. A combination of controls will be used to mitigate this risk, and the selected remedy does not present different or more significant short-term risks than other alternatives. The selected remedy is more technically feasible to implement with

fewer anticipated difficulties and fewer uncertainties compared to other alternatives. The cost of the selected remedy is in the middle of the range of alternatives evaluated.

The State agencies expressed support for the selected remedy. However, the State indicated the need to implement adequate sediment containment safeguards (i.e., resuspension management) during sediment removal operations. In response, EPA will implement several specific measures to assure close coordination with State agencies and to ensure that contaminated sediments will be contained during dredging operations. These measures include:

- EPA will acquire additional data during the design phase to further characterize sediment engineering properties;
- EPA will work closely with State agencies to develop and implement a well designed monitoring program to provide early detection of potential problems;
- EPA will closely coordinate with State agencies during the phased implementation of the dredging operations;
- EPA will involve the State agencies in the evaluation of the performance of sediment containment measures and consult with the State agencies regarding the potential need for additional sediment containment safeguards during the sediment removal program.

In the letter dated September 13, 2004, to Rick Sugarek/EPA re *Concurrence with EPA's Proposed Plan to Cleanup Contaminated Sediments in the Spring Creek Arm of Keswick Reservoir for the Iron Mountain Mine Superfund Site, Redding, California*, James Tjosvold/DTSC stated that:

> The State feels that EPA has responded to our concerns, and in conjunction with following the State's substantive requirements for dredging operations that will be transmitted to EPA at a later date, the project should not significantly impact water quality. EPA, in coordination with the State, will continue to develop safeguards presented in the technical memorandum [CH2M HILL, re *Iron Mountain Mine: Design Concepts in Remediation Approach*, August 18, 2004] and incorporate them into the project design.

A copy of this letter is included in Appendix A of this ROD.

During the public meeting on August 25, 2004, the majority of interested persons expressed their support for the preferred alternative. Several community members and the City of Redding (Redding Municipal Utilities) expressed concerns regarding the potential for release of contaminated sediments during dredging and resultant impacts on water quality, human health, and aquatic life. EPA will implement multiple controls during in-water work to mitigate risks. As discussed above, EPA will implement specific measures to assure close coordination with State agencies in developing, implementing, and evaluating a monitoring program and phased dredging approach.

2.13.5 Preference for Treatment as a Principal Element

The largest environmental risk from metal contamination in the Spring Creek Arm is the potential for a significant release of contaminated sediment into the Sacramento River ecosystem. Technology screening performed as part of the Sediment FS determined that in situ treatment technologies to reduce the toxicity, mobility, or volume of metal contamination in sediment are technically infeasible, are prohibitively expensive, and/or have not been used and proven for commercial or full-scale applications. The selected remedy therefore relies on removal and ex situ treatment to mitigate the environmental risks at the site. By using ex situ physical and chemical treatment of dredge discharge as a significant portion of the remedy, the statutory preference for remedies that employ treatment as a principal element is supported.

Metal loads discharged from the IMM Site, the source for formation of metal-laden sediment, have been drastically reduced as a result of completed and ongoing remedial actions under RODs 1 through 4. The HDS neutralization treatment process is very effective in removing heavy metals from collected AMD. Treatment of AMD flows from the IMM Site will result in a total reduction of copper, cadmium, and zinc discharged from SCDD to approximately 5 percent of the pre-1994 discharge. EPA is not selecting a remedy that treats the source in a manner that prevents the formation of AMD because EPA is not currently aware of such an approach that could be effectively implemented at IMM. EPA encourages the continued development and evaluation of alternatives that may partially satisfy the preference for treatment as a principal element, and this issue will be addressed in the final decision document for the Site.

2.13.6 Five-year Review Requirements

The selected remedy will result in hazardous substances, pollutants, or contaminants remaining onsite above levels that allow for unlimited use and unrestricted exposure. Contaminated sediment that is susceptible to erosion only under rare discharge events will remain in deeper portions of the Spring Creek Arm in Pile C. Sediment that will be dredged from the Spring Creek Arm will be dewatered and disposed in an engineered, upland disposal cell located adjacent to Spring Creek Reservoir. This disposal location is located on the IMM CERCLA site. Section 121(c) of CERCLA and the NCP at §300.430(f)(5)(iii)(C) therefore require EPA to conduct a statutory review no less often than each 5 years after initiation of remedial action to ensure that the remedy is protective of human health and the environment.

2.14 Documentation of Significant Changes from Preferred Alternative of Proposed Plan

The Proposed Plan to address environmental threats posed by contaminated sediment in the Spring Creek Arm of Keswick Reservoir was released for public comment in August 2004. The Proposed Plan identified Alternative 4A as the preferred alternative for remediation of contaminated sediment in the Spring Creek Arm. EPA reviewed all written and verbal comments submitted during the public comment period. It was determined that no

significant changes to the remedy, as originally identified in the Proposed Plan, were necessary or appropriate.

2.15 References

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PART 3: THE RESPONSIVENESS SUMMARY

EPA provided a public comment period from August 11, 2004, to September 13, 2004, for the proposed remedial action described in the Proposed Plan for contaminated sediment in the Spring Creek Arm of Keswick Reservoir. The Proposed Plan, Sediment FS, Sediment RI, and other documents in the Administrative Record file were available to the public in the Iron Mountain Mine Administrative Record maintained at the EPA Records Center in San Francisco, California, and information repositories maintained at the Shasta County Library in Redding, California, and Meriam Library, California State University-Chico, in Chico, California.

In addition to providing an opportunity to the public to provide written comments, a public meeting was held at the Red Lion Hotel in Redding, California, on August 25, 2004, to present EPA's Proposed Plan, to answer questions, and to receive verbal public comments. The August 25, 2004, public meeting was recorded, in its entirety, by a certified shorthand reporter. The transcript of the public meeting is part of the Administrative Record, maintained at the EPA Records Center in San Francisco.

Details of EPA's community relations activities for the IMM Site are presented in Section 2.3 of the Decision Summary. See also the Response to Comment CM-p59-2 in Section 3.4.1 below.

This Responsiveness Summary summarizes information about the views of State support agencies, interested community members, and local government agencies regarding both the remedial alternatives and general concerns about the site submitted during the public comment period. It also documents how public comments were integrated into the decision-making process. Because State Acceptance and Community Acceptance of cleanup alternatives are separate criteria in EPA's nine criteria established in the NCP, State comments and community comments are addressed separately below. A point-by-point, detailed response to comments follows the summary.

3.1 Summary of State Support Agency Comments and EPA Responses

The State has expressed its support for the preferred alternative presented in the Proposed Plan, Alternative 4 – Partial Dredge with Disposal in Upland Dewatering/Disposal Cell. Letters expressing concurrence with the preferred alternative were submitted by DTSC and CDFG during the public comment period. These letters are included in Appendix A of this ROD. RWQCB, CDFG, Reclamation, and DTSC verbally expressed their support for the preferred alternative during the presentation made at the 2004 Proposed Plan public meeting on August 25, 2004.

The State had previously raised some concerns about the need for sediment containment safeguards (i.e., resuspension management) during sediment removal operations. In response to these concerns, EPA will implement several specific measures during the design

and implementation of the remedial action to ensure close coordination with State agencies and to ensure that contaminated sediments will be contained during dredging operations. These measures include:

- EPA will acquire additional data during the design phase to further characterize sediment engineering properties;
- EPA will work closely with State agencies to develop and implement a well designed monitoring program to provide early detection of potential problems;
- EPA will closely coordinate with State agencies during the phased implementation of the dredging operations; and
- EPA will involve the State agencies in the evaluation of the performance of sediment containment measures and consult with the State agencies regarding the potential need for additional sediment containment safeguards during the sediment removal program.

Given these measures, and in conjunction with compliance with ARARs for dredging operations, the State believes that the preferred alternative should not significantly impact water quality (September 13, 2004, letter to Rick Sugarek/EPA re *Concurrence with EPA's Proposed Plan to Cleanup Contaminated Sediments in the Spring Creek Arm of Keswick Reservoir for the Iron Mountain Mine Superfund Site, Redding, California,* James Tjosvold/DTSC).

The State has also expressed its support for the disposal cell location adjacent to Spring Creek Reservoir. The State prefers this location because it is in a watershed that has already been impacted by historic mining operations and public access can be more easily restricted. For these reasons, the State believes the disposal cell location adjacent to Spring Creek presents lower risks to human health and the environment than the location adjacent to Iron Mountain Road.

3.2 Summary of Community Comments and EPA Responses

The public meeting held in Redding in connection with the August 2004 Proposed Plan was attended by approximately 40 people. During the public meeting, the majority of interested persons expressed their support for the preferred alternative presented in the Proposed Plan. One community member stated that the preferred alternative was cost-effective and will support improvements being made to winter-run Chinook salmon habitat in the Sacramento River. During the public meeting, the community also expressed its support for the disposal location adjacent to Spring Creek Reservoir. One community member expressed concerns regarding the potential disposal location along Iron Mountain Road. These concerns include potential impacts to residents in the Flat Creek watershed area and impacts to recreational uses of the area.

Several community members expressed concerns regarding dredging and onsite disposal. These include:

(1) Potential impacts to land value;

(2) Potential for release of toxic sediments and impacts to water quality during dredging; and

(3) Long-term monitoring requirements for the disposal cell

Detailed comments are provided in Sections 3.4.1 and 3.4.2 of this Responsiveness Summary. The responses are summarized below:

1. EPA does not expect the selected remedy to have any negative impact on private property values. The engineered disposal cell will be located on public lands behind Spring Creek Debris Dam managed by Reclamation in a watershed already impacted by historic mining activities. The disposal cell would be located at a distance of approximately 1.5 miles from the town of Keswick. Construction activities are expected to require 2 to 3 years to implement. Short-term impacts to public lands from construction activities (e.g., construction of staging areas, mobilizing dredging equipment, and installing pipelines) will be mitigated, and impacted land will be restored to the existing or an improved condition.

2. As discussed in Section 2.13.1 of the Decision Summary, EPA will implement multiple controls during dredging to mitigate risks to the environment by minimizing the disturbance and resuspension of sediment and/or the migration of suspended sediment. In-water work will primarily be limited to periods when SCPP is not operating and no flow is being released from SCDD. This will facilitate construction, allow easier anchoring and movement of equipment, and limit migration of suspended sediment. Other methods to limit suspension and migration of contaminated sediment might include best management practices, engineering design, and sediment curtain barriers. Monitoring will be performed during remedial action to determine effectiveness of resuspension management. As discussed above, EPA will implement specific measures to ensure close coordination with State agencies in developing and implementing a monitoring program and implementing and evaluating the phased dredging approach.

   EPA will also implement a conservative, phased dredging program. Phase I will be implemented during the first working year of the project. Phase I will begin at the upstream sediment pile (Pile A), and production rates will be low to allow more controlled conditions. EPA will collect data and evaluate the ongoing performance of Phase I dredging operations. Should problems arise during Phase I dredging, EPA will work with State agencies to implement additional controls, reduce dredging rates, or shut down equipment until issues can be resolved.

3. As part of the remedial design for the disposal cell, EPA will prepare a water quality monitoring and response program and submit the program for review by RWQCB. The upland disposal cell adjacent to Spring Creek Reservoir will comply with the substantive portions of the regulations for a mining waste management unit (State of California Water Code § 13172 and 27 CCR promulgated thereunder). Subsection "Action-specific ARARs" under Section 2.13.2 provides additional detail. EPA will implement surface water monitoring under the selected remedy to determine the continued effectiveness of the remedy. And as mandated by Superfund law (CERCLA and its reauthorizations), EPA will conduct statutory reviews every 5 years after initiation of remedial action to ensure that the remedy is protective of human health and the environment (see Section 2.13.6 of the Decision Summary).

A few community members proposed additional alternatives they felt would be more protective than the preferred alternative. These alternatives involve technologies that were screened out in the Sediment FS based on technical implementability, effectiveness, and/or cost. EPA determined that the alternatives proposed by community members would be technically challenging and very costly compared to the alternatives developed and evaluated in the Sediment FS.

3.3 Summary of Local Government Agency Comments and EPA Responses

Letters were received from two local government agencies: Redding Municipal Utilities and Shasta County Air Quality Management District. Detailed comments are provided in Section 3.4.4 of this Responsiveness Summary. The responses are summarized below.

Redding Municipal Utilities

Redding Municipal Utilities stated that the removal of sediments in the Spring Creek Arm of Keswick Reservoir is a worthwhile endeavor for the long-term health of the Sacramento River. However, the Wastewater and Water Utilities expressed concerns regarding short-term impacts on water quality in the Sacramento River during dredging operations and potential effects on Redding's domestic water supply and wastewater treatment plant discharges.

As discussed in the responses to State support agency and community comments, EPA will implement several specific measures and closely coordinate with State agencies to ensure that contaminated sediments will be contained during dredging operations. The dredging program will be designed and implemented to provide adequate sediment containment safeguards to meet the substantive requirements of the RWQCB and other ARARs. The discharge of water from the Spring Creek Arm of Keswick Reservoir into the Sacramento River will meet applicable water quality requirements.

The dredging operations will be designed to meet water quality objectives at the point of compliance upstream of the City of Redding drinking water intakes. EPA will work with the RWQCB to ensure that the monitoring plan addresses issues presented by the City. EPA will involve the State agencies in the evaluation of the performance of dredging operations and sediment containment measures, and EPA will consult with the State agencies regarding the potential need for additional safeguards.

Shasta County Air Quality Management District

Shasta County Air Quality Management District submitted a comment that air emission permits may be required. Under CERCLA §121(e), 42 USC §9621(e), EPA is not required to obtain permits nor undergo a permit equivalency process for the selected remedial action. However, EPA will work closely with Shasta County Air Quality Management District to comply with the substantive requirements of the applicable portions of the Air Quality Management District's regulations, and will abide by all ARARs during dredging and construction. During the design process, EPA will consult with Shasta County to ensure that

plans, specifications, and the subcontract documents identify and require compliance with the ARARs and that appropriate monitoring is conducted during construction.

3.4 Detailed Response to Comments

The purpose of this section is to provide EPA's responses to the comments received from the public and State support agencies on EPA's Proposed Plan and Administrative Record for the Iron Mountain Mine Superfund Site, OU5, Spring Creek Arm of Keswick Reservoir.

EPA received written comments during the public comment period and formal verbal comments at EPA's public meeting. EPA is required by law to consider and address only those comments that are pertinent and significant to the remedial action being selected. EPA is not required to address comments that pertain to the allocation of liability for the remedial action, nor potential enforcement actions to implement the remedial action, as these are independent of the selection of the remedial action and EPA's Proposed Plan. EPA does have the discretion to address comments with limited pertinence if doing so would nonetheless address the concern of a significant segment of the public.

Written comments submitted to EPA are included in the Administrative Record. To protect the privacy of individual community members, only written comments from State support and local government agencies are reproduced in Appendix A to this ROD.

This section will present detailed responses in the following order:

- Comments received during the public meeting held August 25, 2004
- Written comments received by EPA from community members
- Written comments received by EPA from State support agencies
- Written comments received by EPA from local government agencies

3.4.1 Comments Received at Public Meeting and EPA Responses

Comments in this section are indexed for convenience. An example for a verbal comment received during the public meeting is "CM-p58-1." The "CM" designation indicates "Community Meeting," "p58" indicates the page number of the transcript of the August 25, 2004, public meeting where the comment was recorded, and the comments are consecutively numbered to account for multiple comments on a page.

Comment CM-p58-1

MS. HORNER: I am Terry Horner, I live in downtown Keswick. I'm curious to find out if this is going to affect our land that's right there. I'm an owner of land that comes right up to the edge of it, and I want to know how that's going to affect our land value wise.

Response CM-p58-1

EPA does not expect the selected remedy to have any negative impact on property values.

The engineered disposal cell for dredged sediment will be located on public lands managed by Reclamation, behind Spring Creek Debris Dam, in a watershed already impacted by historical mining activities. The disposal cell will be located approximately 1.5 miles from the town of Keswick. The disposal cell will not be visible from county or state roads. And

unlike a municipal landfill, this disposal cell will not release any unpleasant odors during long-term operation.

Dredging and construction activities are expected to require 2 to 3 years to implement. In-water work will be limited to 2 to 3 months per year. Short-term impacts from construction activities may occur, including clearing of vegetation to create land staging areas, installing pipelines to convey discharge from the dredge to the disposal cell, increased truck traffic on Iron Mountain Road, and noise associated with operating dredging equipment, generators, and pump stations. Boat access and recreational use of the Spring Creek Arm will be limited during in-water work. Short-term impacts from construction activities will be minimized to the extent possible, and impacted land will be restored to the existing or an improved condition.

Comment CM-p59-1

MS. RARDIN: Annette Rardin, R-a-r-d-i-n. I support the preferred alternative. I do have concerns how far, if the disposal site were to be on Iron Mountain Road at the ad hoc gun range, concerns for Flat Creek watershed area of residents as well as the off-highway vehicle area and the various other recreational uses out that way.

Response CM-p59-1

EPA has selected the disposal cell location adjacent to Spring Creek Reservoir instead of the location adjacent to Iron Mountain Road because of reduced risks to human health and the environment and in response to opinions expressed by the State and community.

Negative aspects of locating the disposal cell along Iron Mountain Road include potential short-term impacts to the local community and increased risks to the environment. The Iron Mountain Road disposal site would be readily accessible to public, and restrictions to limit trespassing would be much more difficult to enforce for this location. Dredging and construction activities are expected to require 2 to 3 years to implement. During this time period, residents in the Flat Creek watershed area would experience increased truck traffic on Iron Mountain Road, construction and traffic diversions, noise associated with construction equipment and pump stations, and the three ad hoc gun shooting ranges would likely be closed.

A comparison of the two disposal locations is presented in Section 2.10.2 of the Decision Summary, and the rationale for selecting the disposal location adjacent to the Spring Creek Reservoir is presented in Section 2.12.1.

Comment CM-p59-2

MR. KLESEEN: My name is Ted Kleseen, K-1-e-s-e-e-n. I have been here quite a while. This area came to my notice when I was working on the soil map of the county. I took some pH samples just upstream from this and got what you said, pH 3 in the soil, which is kind of unheard of. Nowhere else will you get that, except in a laboratory with straight sulfur, whatever it is. Anyway, sulphuric acid.

My question is, why can't the sign on Spring Creek Debris Dam be changed to read Spring Creek Temporary Storage -- Spring Creek Toxic Waste Dam, Temporary Storage Dam -- I'm sorry, Toxic Waste Temporary Storage Dam.

Response CM-p59-2

EPA agrees that the public needs to be informed regarding the nature and extent of contamination and associated risks. However, Spring Creek Debris Dam is managed by the U.S. Bureau of Reclamation, and any change to the name of Spring Creek Debris Dam would need to be made by Reclamation.

Public involvement is an important aspect of EPA's efforts at Iron Mountain Mine, and is in fact mandated by the Superfund law (CERCLA and its reauthorizations). To inform and involve the public, EPA holds community meetings, conducts interviews with media representatives, and produces fact sheets. EPA has recently undertaken the following actions to involve the public in the decisionmaking process for this site:

- Published and distributed a Proposed Plan for the Spring Creek Arm of Keswick Reservoir Operable Unit
- Conducted a 30-day public comment period on the Proposed Plan (August 11, 2004, to September 13, 2004) and announced this in the local newspaper
- Made the supporting studies, files, and documents ("Administrative Record") available for public review in the Shasta County Library and in the Meriam Library at California State University-Chico
- Conducted a public meeting in Redding on August 25, 2004, to hear and transcribe comments from all interested parties
- Considered and responded to all written comments submitted to EPA during the public comment period and all verbal comments made at the public meeting

Comment CM-p60-1

MS. AMES: Marcia Ames, A-m-e-s. I work for the City of Redding and we will be filing some official comments in writing at a later date when we've had a little more opportunity to review the official document. A couple of things.

First of all, the document you guys sent to the Shasta County Library was all on CD-ROM and you had to print each individual page because they all came through as .tif files.

You need to take a look what you're putting out before you put it out. It was very difficult to review. We do now have a hard copy that we received from CH2M HILL earlier today.

Response CM-p60-1

CH2M HILL, on behalf of EPA, delivered a hard copy of the Sediment Feasibility Study and Sediment Remedial Investigation to the Shasta County Library before the beginning of the public comment period. Doris Powers with CH2M HILL called Shasta County Library after the public meeting and confirmed that the library still had the hard copy available and asked that this be given to interested parties for their review instead of the CD-ROM. EPA and CH2M HILL apologize for the inconvenience.

Comment CM-p61-1

MS. AMES: But one of our concerns is that we have a water treatment plant downstream. We have been assured we shouldn't have any issues with water quality for human health criteria. We also have two wastewater treatment plants downstream that have discharge criteria that are orders of magnitude lower than what we're looking at here. Copper discharge standard is 12 micrograms per liter.

And so we want some assurance we're not going to end up getting fined for these problems because obviously our taxpayer dollars are, you know, being used to clean up the sediments. We don't want to have to pass any more fees onto the users of City of Redding Waste Water Treatment. Thanks.

Response CM- p61-1

Please see the response to written comments provided by Richard Elliott, Wastewater Utility Supervisor for Industrial Waste, Redding Municipal Utilities. These comments are numbered RMU-1 through RMU-3 in Section 3.4.4.

Comment CM-p61-2

MR. RARDIN: Robert Rardin. Is there a debris pile where Flat Creek dumps into Keswick Lake? Because it was a very polluted creek for quite a while, too.

Response CM-p61-2

Sediment within the Flat Creek drainage has not been officially investigated. The creek channel does not have adequate volume or geometry for sediment to settle and deposit in large piles as has occurred in the Spring Creek Arm of Keswick Reservoir. A smaller delta of sediment has been observed at the outlet of Flat Creek. However, EPA expects that the majority of sediment that was deposited from historical discharges was flushed into Keswick Reservoir during rain events and high water levels.

Currently, clean water is diverted around the Iron Mountain Mine Superfund Site in Flat Creek. Since 1991, approximately 6 square miles (40 percent) of the Upper Spring Creek is diverted into the Flat Creek drainage to avoid mining-related impacts from Iron Mountain Mine. Continuing low-level metal loads in Flat Creek are primarily attributed to the Stowell mine rather than Iron Mountain Mine.

Water quality in the lower reaches of Flat Creek (at Keswick Reservoir) was monitored during the wet seasons of 1995 through 2000. Over the period of record, dissolved copper ranged from 1.1 to 24.6 parts per billion (ppb), dissolved zinc ranged from non-detect to 168 ppb, and pH was near-neutral (ranging from 6.92 to 7.73). For comparison, copper and zinc concentrations were up to two orders of magnitude greater in the discharge from Spring Creek Debris Dam (as evidenced by samples collected at the Spring Creek weir). Over this same time period, dissolved copper ranged from 251 to 2,840 ppb, dissolved zinc ranged from 296 to 3,390 ppb, and the pH was acidic (ranging from 3.44 to 5.04) in the discharge from Spring Creek Debris Dam.

Comment CM-p62-1

MR. CALLOWAY: Jamie Calloway, C-a-1-1-o-w-a-y. I work at a fish hatchery and I'm interested in water treatment. I think that, you know, for what they're going to spend for this, it's minuscule compared to what we spent on Shasta Dam on the temperature control device trying to improve just the temperature of the water in the river.

So, you know, this would only help that. So I'm behind it all the way. We have winter run in the river. We're trying to improve that. We're spending money trying to improve the habitat and, you know, this is just another part of that. Thank you.

Response CM-p62-1

EPA agrees with the comment. The fishery resources and sensitive aquatic species in the Sacramento River below Keswick Dam are the primary natural resources at risk from releases of toxic metals from the Spring Creek Arm of Keswick Reservoir. The selected remedy will be designed to prevent migration of contaminated sediment from the Arm into the Sacramento River by removing sediment that is most susceptible to erosion.

Comment CM-p62-2

MS. O'GRADY: My name is Mary O'Grady. I'm a Redding resident. I want to add this comment about afterwards. You spoke about the monitoring, you know, if it was in one area, stepped up in the other area, not so stepped up. I would like to put it on record that for no matter what happens afterwards, I would like it to be closely monitored still because too many times have things been cleaned up and then afterwards there's a worse problem. That's all. Thank you.

Response CM-p62-2

The disposal cell will be constructed and maintained to prevent releases of contamination to surface water or groundwater. The cell will undergo long-term maintenance and management, including: cover maintenance, collection and disposal of filtrate (i.e., water that drains out of the cell), and inspections. EPA will prepare a water quality monitoring and response program for the disposal cell and submit the program for review by the Regional Water Quality Control Board. At a minimum, surface water quality monitoring will be performed to determine the continued effectiveness of the remedy, and as mandated by Superfund law (CERCLA and its reauthorizations), EPA will conduct statutory reviews every 5 years to ensure that the remedy remains protective of human health and the environment.

Comment CM-p63-1

MR. STEPHENS: My name is Ryan Stephens, S-t-e-p-h-e-n-s. There's been a lot of concern I've heard about the salmon, fish, but I don't know if there's been any research towards the agriculture, the plants soaking up any kinds of materials coming out of the sediment pool in the dredging.

Response CM-p63-1

EPA believes that dredging activities will not impact the quality of Sacramento River water for irrigation. EPA will work with the State agencies to implement a phased dredging approach and monitoring program that meets water quality goals that are protective of human health and aquatic life. Recommended water quality goals for agriculture are less

stringent than goals for the protection of human health or aquatic life. Recommended water quality goals for agriculture were developed in *Water Quality for Agriculture*, Food and Agriculture Organization of the United Nations, Irrigation and Drainage Paper No. 29, Revision 1, 1985. These guidelines are also included in a compilation of water quality goals by John Marshack with Central Valley Regional Water Quality Control Board. Table 1 presents a comparison of agriculture water quality goals with water quality goals that will be applicable to the dredging operation. For the metals of primary concern (arsenic, copper, cadmium, and zinc), the recommended goals for agriculture are up to two orders of magnitude greater than goals for protection of human health and aquatic life.

TABLE 1
Comparison of Water Quality Goals for Agriculture and for Protection of Human Health and Aquatic Life
Responsive Summary, Iron Mountain Mine Record of Decision 5, Shasta County, California

Metal	Agricultural Water Quality Goal [a] (ppb)	Water Quality Goal for Protection of Human Health or Aquatic Life (ppb)	
Arsenic	100	10	Drinking water standard Federal MCL and Basin Plan [b]
Copper	200	4.1	Protection of aquatic life California Toxics Rule Continuous Concentration
Cadmium	10	0.22	Protection of beneficial uses Basin Plan [b]
Zinc	2,000	16	Protection of beneficial uses Basin Plan [b]

Notes:
[a] Source: *Water Quality for Agriculture*, Food and Agriculture Organization of the United Nations, Irrigation and Drainage Paper No. 29, Revision 1, 1985
[b] Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins

ppb = parts per billion
MCL = maximum contaminant level

Comment CM-p63-2

MS. HORNER: Yeah. I'm concerned about you guys stirring up everything that's been sitting for so long. It seems to me -- I live there and I see the creek and it looks really clear and clean all the way up to the first tunnel before you get to the dam itself.

I don't feel like you guys have even -- I think it's fine. I mean, it's been clean, plants are coming back. I see fish now in the water up there. I mean, is there something going on that's not helping the environment? Because to me, if you start stirring things up, it will make it worse. I don't know.

Response CM-p63-2

Cleanup actions at Iron Mountain Mine have significantly improved the quality of water released from Spring Creek Debris Dam into Keswick Reservoir. EPA now controls and treats 95 percent of historic copper, cadmium, and zinc discharged from the mine site. However, contaminated sediment in the Spring Creek Arm that formed from historical discharges still poses a major threat to the downstream Sacramento River ecosystem. The

sediments are toxic to aquatic life, and in the event of a major storm, these sediments could erode, move, and redeposit in important fish spawning habitat of the Sacramento River downstream of Keswick Dam.

EPA expects that there will be short-term increases in turbidity in the Spring Creek Arm as sediment is stirred up during dredging. However, EPA will work with the State agencies to implement multiple controls to limit the amount of sediment that is stirred up and prevent sediment from moving downstream into lower Keswick Reservoir and the Sacramento River. These controls are discussed in Comment CW-2A in Section 3.4.2. The controls will be designed to meet water quality criteria in the Sacramento River that are protective of human health and the environment.

Comment CM-p64-1

MR. KLESEEN: I wonder if everybody here, for instance, is aware why the smelters closed in Keswick? Has that been covered?

They closed because the farmers in Happy Valley were losing their barbwire fences. This is pretty hard to believe when you think of how unknown ecology was back that far back, but the lawyers were able to convince -- the farmers sued the mill to stop it and they won.

There was so much sulfur fumes going that far clear down to Happy Valley, 20 miles from here, it melted barbwire fences.

Response CM-p64-1

Mr. Kleseen is correct that the historical copper smelters in Shasta County were shut down because of environmental impacts. Mining in Shasta County historically supported five copper smelters. The smelters were shut down over a 3-year period between 1919 and 1922. The smelters were closed due to economics and pressure from farm interests because of fume damages to orchard crops. (Regional Water Quality Control Board, Central Valley Region, Draft Final Staff Report *Amendments to the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins for Beneficial Uses at West Squaw Creek, Shasta County*, June 2004)

3.4.2 Written Comments Received from Community Members

Comments appearing in this section are given a "CW" designation, indicating "Community Written comment" and numbered consecutively by the date they were written. If multiple comments are provided in a single letter or email, they are designated as "A," "B," etc. An example for a written comment received from a community member is "CW-2A."

Comment CW-1A

CHARLES GRIFFIN: Sir, I live in Keswick, and I was wondering why not dam the Spring Creek Arm where it enters Keswick Reservoir and fill in the upper portion by the power plant and build a canal from there to Keswick Reservoir via a filter plant ??

Response CW-1A

EPA received this comment by e-mail and responded to Mr. Griffin by e-mail. The following text was extracted from EPA's e-mail:

Thank you for your interest in EPA's cleanup proposal for the contaminated sediments located in the Spring Creek arm of Keswick Reservoir.

The approach that you have proposed would be very difficult to build and very costly. The dam would have to be constructed while water continues to flow from Shasta Lake through Keswick Reservoir into the Sacramento River. Although the water level in Keswick Reservoir could be lowered somewhat, you could not empty Keswick Reservoir. You would probably have to drive sheet piling and construct the dam in some amount of water. It would be difficult to control the quality of the construction, and costly. There are additional complications related to the presence of an old railway trestle, 50 feet underwater, across the mouth of the arm.

We looked at placing the water discharges from the power house and the spillway releases into a channel to by-pass the arm. Constructing a channel large enough to handle large storm flows, itself, is costly.

It turns out that there are less costly, but effective approaches to cleanup the sediments. These approaches involve removing the sediments by dredging them and disposing of them in an upland disposal cell, capping them in-place, or a combination of the two approaches. These alternatives are outlined in our proposed plan.

Comment CW-2A

MARION SCHMITZ: My comments concern Alternatives 3 and 4. I am concerned about dredging operations stirring up and releasing toxins into the waterway unless something more secure than sediment curtains are employed.

Response CW-2A

EPA believes the selected cleanup action can be completed safely and effectively, in compliance with water quality goals for protection of human health and the environment. EPA evaluated a number of alternatives and technologies for cleaning up the sediments. The selected cleanup action, Partial Dredging and Disposal in a Disposal Cell, minimizes the amount of sediment that requires dredging, dewatering, and disposal; is the most technically feasible alternative; and contains fewer uncertainties than other alternatives evaluated.

EPA will use multiple controls to limit the amount of sediment that is stirred up and prevent sediment from moving downstream into lower Keswick Reservoir and the Sacramento River. These include:

- Dredging when Spring Creek Power Plant is not operating and there is no water flowing through the Arm
- Using best management practices and engineering design to limit the amount of sediment that is stirred up during dredging, anchoring, and vessel operation
- Using sediment curtains to contain suspended sediment within the Arm
- Monitoring surface water quality to provide early warning of potential problems

EPA will implement a conservative, phased dredging program. Phase I will be completed during the first working year of the project. Phase I will begin at the upstream sediment pile

(Pile A), and production rates will be low to allow more controlled dredging conditions. EPA will collect data and evaluate the ongoing performance of Phase I dredging operations before beginning Phase II. Should problems arise during Phase I dredging, EPA will work with State agencies to implement additional controls, reduce dredging rates, or shut down equipment until issues can be resolved.

Comment CW-2B

MARION SCHMITZ: On the other hand in discussions with Dave Poore, BOR chief maintenance engineer at the Spring Creek power station, he stated that the unit can be shut down for a three-month period in the winter during which no water would be discharged.

To me this is almost an invitation to erect a cofferdam at pile C and go in with large earthmovers to remove piles A and B. I would think with proper planning, equipment, logistics, and resources you could remove one hell of a lot of pile A and pile B sediment in three months.

Response CW-2B

EPA has spoken with Dave Poore and other Reclamation employees in Central Valley Operations about shutting down Spring Creek Power Plant during in-water work (e.g., dredging or capping of contaminated sediment). EPA and Reclamation discussed that up to 60 days could be arranged when Spring Creek Power Plant could be shut down. All of the cleanup alternatives developed in the Feasibility Study and Proposed Plan assume that in-water work will be performed over several years during periods when the power plant could be shut down.

In Section 3 of the Sediment Feasibility Study, EPA did evaluate using structural control barriers such as sheet piling, berms, or embankments to isolate areas to be dredged or excavated. EPA determined that the construction of these barriers would be very difficult and costly. The dam or barrier would be constructed either along the mouth of the Spring Creek Arm or along the edges of the individual piles. Keswick Reservoir could only be lowered by 10 to 15 feet during construction because of design restrictions of Keswick Dam. Water would continue to flow from Shasta Lake through Keswick Reservoir to the Sacramento River during construction activities. The presence of an old railway trestle, 50 feet underwater, across the mouth of the Arm would cause further complications. These factors would make construction of a structurally stable wall difficult. To allow earthmoving equipment on the sediment, the sediment within the Arm would need to be further dewatered. Keeping the Spring Creek Arm in a dewatered condition during excavation would be difficult, and differences in water levels between the contained area and Keswick Reservoir might cause structural failures of a temporary barrier.

EPA believes that the preferred cleanup option is a more feasible, less costly, and effective approach.

Comment CW-3A

JOY LOUISE NEWCOM: The alternatives for the Iron Mt. Mine Superfund Site seem unprotective and inadequate for fragile beings like toddlers, the injured, the sick, the elderly, endangered species, coho salmon, frogs, butterflies, wildflowers, etc. Please consider California's POPULATION GROWTH!

Response CW-3A

EPA evaluated whether sediments or surface water in the Spring Creek Arm of Keswick Reservoir pose unacceptable risk to human health or the environment under current and reasonably anticipated future site use conditions. Results are summarized in Section 2.7 of the Decision Summary and Appendix E of the Sediment Feasibility Study. The Sediment FS is available in the information repositories at the EPA Records Center, the Shasta County Public Library, and the Meriam Library at California State University-Chico.

The risk evaluations indicate that surface water and sediment in the Spring Creek Arm do not pose a current or future unacceptable risk to human health. This evaluation considered children who might accidentally swallow or come into skin contact with surface water or sediment while using the Arm for recreation (e.g., swimming).

The evaluation concluded that metal contaminants in the sediment are toxic to aquatic life in the Spring Creek Arm. The pollutants are particularly toxic to organisms and habitat at the bottom of the creek and fish in early life stages. EPA can not guarantee that a cleanup action will improve the aquatic habitat in the Spring Creek Arm. Even if all the sediment were removed, sand and gravel at the bottom of the original creek bed is also likely contaminated by historical copper smelting adjacent to Keswick Reservoir. Instead, the cleanup actions presented in the Proposed Plan are designed to prevent a release of contaminated sediment from the Spring Creek Arm into the Sacramento River ecosystem downstream of Keswick Dam. A large release could occur during major storm events when high flows are released from the Spring Creek Power Plant. During such an event, Sacramento River water quality would be expected to be highly toxic to aquatic life. It is also expected that toxic sediments would deposit in the gravels of the important Sacramento River spawning grounds. These sediments would threaten the early life stages of endangered and threatened species of salmon, and could threaten entire populations of the salmon.

There is no expectation for the future use of the land adjacent to the Spring Creek Arm to change. The Shasta County General Plan Map indicates the majority of the land surrounding the Spring Creek Arm is public lands and will not be developed for residential, commercial, or industrial use. In developing and evaluating the selected cleanup action, EPA has considered that Keswick Reservoir is used for recreational activities (e.g., fishing and boating). The cleanup action will not impact these recreational uses.

Comment CW-3B

JOY LOUISE NEWCOM: Would it be possible to dam all pollutants from the Sacramento River, do a full and complete dredge, haul the pollutants by truck and railroad to the largest barges and freight ship or tug to the deepest part of the ocean; sink it to the bottom of the ocean with anchors and weights, so saltwater can dissolve it???

Response CW-3B

No, EPA does not believe the proposed approach would be feasible. In the Sediment Feasibility Study (Section 3.2.6), EPA did evaluate construction of a dam or barrier at the mouth of the Spring Creek Arm, excavating (or "dry dredging") the sediments, and transporting the sediment by truck to a disposal location. EPA also evaluated an option where flow into the Spring Creek Arm would be diverted into a new channel and the sediments would be

capped in place. EPA decided these approaches would be very difficult to implement and costly due to a number of factors.

Construction of a dam or barrier at the mouth of the Arm would be very difficult. Keswick Reservoir cannot be emptied; the reservoir could only be lowered by a maximum of 10 to 15 feet. The dam would need to be constructed as water continues to flow from Shasta Lake through Keswick Reservoir to the Sacramento River. Response CW-2B provides additional detail on difficulties with building a dam or barrier to isolate the Spring Creek Arm and excavating sediment.

Approximately 10,000 to 25,000 truckloads of excavated sediment would be transported to the ultimate disposal location. This would result in increased truck traffic for local residents and potentially greater risk of exposure of workers and residents to contaminated dust. Disposing of excavated or dredged sediment in the ocean would present greater risks to the environment than disposing of contaminated sediment in an onsite disposal cell. Sinking the sediment to the bottom of the ocean would spread the contamination into an unimpacted and less controlled environment. Ocean disposal would also be prohibited under applicable provisions of the Clean Water Act.

EPA believes the selected remedy meets remedial action objectives established to protect human health and the environment. EPA believes that the selected cleanup action will be easier to implement and less costly than the comment's proposed cleanup option.

Comment CW-3C

JOY LOUISE NEWCOM: Do you have a chemist and biologist overseeing this project? (Life scientist have an interdependent perspective that engineers don't seem to have.)

Response CW-3C

Yes. A number of chemists and biologists are providing technical support and review for this project. Scientists specializing in chemistry, metallurgy, botany, wetlands ecology, environmental toxicology, and risk assessment have worked on this project under EPA's contractor, CH2M HILL. Several of the engineers working on the project also possess degrees and experience in environmental science.

EPA has worked closely with State support agencies and Natural Resource Trustees on the Iron Mountain Mine project. Scientists from the California Department of Fish and Game, Department of Toxic Substances Control, and Central Valley Regional Water Quality Control Board have reviewed and commented on studies and decision documents for the Spring Creek Arm of Keswick Reservoir. In addition, representatives from the following agencies have participated in meetings regarding the proposed cleanup options: US Bureau of Reclamation, US Fish and Wildlife Service, US Geological Survey, US Corps of Engineers, Bureau of Land Management, and the National Oceanic and Atmospheric Administration.

Comment CW-3D

JOY LOUISE NEWCOM: The owner of Iron Mt. Mine needs to be taken back to court, again! He thinks the state, not him, is responsible. The ability to respond needs to be taught to everyone!!!

Response CW-3D

EPA's cost recovery litigation is continuing with respect to the liability of IMMI and Mr. T. W. Arman.

Comment CW-4A

RYAN STEPHENS: On behalf of Northern California, and people around the world who will be affected by a proposed dredging operation near Iron Mountain Mine, I believe it is not in our best interest to proceed with the proposed dredging operation.

I believe there will be much difficulty controlling or monitoring the amount of deadly toxins that will undoubtedly be stirred into the water that flows into the Sacramento River and subsequently into our drinking water, agriculture, and onto unsuspecting wildlife, causing catastrophic results.....I beg of you, you MUST ask yourself... Can we risk the contamination of drinking water in one of California's fastest growing cities? Can we risk poisoning the river that feeds the majority of our precious California crops? Can we risk poisoning our wildlife?

Response CW-4A

EPA believes the selected cleanup action can be completed safely and effectively, in compliance with water quality goals for protection of human health and the environment. EPA evaluated a number of alternatives and technologies for cleaning up the sediments. The selected cleanup action, Partial Dredging and Disposal in a Disposal Cell, minimizes the amount of sediment that requires dredging, dewatering, and disposal; is the most technically feasible alternative; and contains fewer uncertainties than other alternatives evaluated.

EPA has worked closely with State support agencies and Natural Resource Trustees on the Iron Mountain Mine project. Scientists from the California Department of Fish and Game, Department of Toxic Substances Control, and Central Valley Regional Water Quality Control Board have reviewed and commented on the studies and decision documents for the Spring Creek Arm of Keswick Reservoir. EPA will continue to closely coordinate with State agencies throughout the project to ensure protection of natural resources.

EPA will work closely with the Central Valley Regional Water Quality Control Board to develop and implement a monitoring program that provides early warning of water quality problems. It is the Regional Board's mission to "preserve, enhance and restore the quality of California's water resources, and ensure their proper allocation and efficient use for the benefit of present and future generations."

EPA will use multiple controls to limit the amount of disturbance of sediment and prevent the migration of suspended sediment. In-water work will primarily be limited to periods when the Spring Creek Power Plant will be shut down and there is no flow through the Arm. This will allow easier anchoring and movement of dredging equipment and will prevent large amounts of suspended sediment from moving out of the Arm. Other methods to limit suspension and migration of contaminated sediment might include best management practices, engineering design, and flexible sediment curtain barriers.

EPA will implement a conservative, phased dredging program. Phase I will be completed during the first working year of the project. Phase I will begin at the upstream sediment pile

(Pile A) , and production rates will be low to allow more controlled dredging conditions. EPA will collect data and evaluate the ongoing performance of Phase I dredging operations before beginning Phase II. Should problems arise during Phase I dredging, EPA will work with State agencies to implement additional controls, reduce dredging rates, or shut down equipment until issues can be resolved.

Comment CW-4B

RYAN STEPHENS: ....However, I do not believe this matter should simply be left alone. As we have seen in the past, a large rain fall has the potential to dislodge toxic material, and send them downstream.

I believe, in conjunction with a sustainable plan to remove contaminants before entering water ways, one possible alternative, not listed in the EPA's plan, would be to cut off all water flow through the toxic sediment areas, leading to the excavation of materials in a "dry" environment. Such an action would guarantee the safety of the community, the integrity of our precious agriculture, and the health of our wildlife. Shutting down the water flow would lead to a temporary loss of electricity generation, but if we must stop the generation of electricity, so be it, we can not put a price on the welfare of our city.

Response CW-4B

In the Sediment Feasibility Study (Section 3.2.6), EPA did evaluate using excavation (or "dry dredging") to remove contaminated sediment from the Spring Creek Arm. EPA also looked at diverting water discharged from the power plant and debris dam into a new channel and capping the sediments in place. EPA decided these approaches would be very difficult to implement and costly due to a number of factors.

To create a dry environment, Keswick Reservoir would be lowered, a structural control barrier (e.g., sheet piling, berm, or embankment) would be constructed at the mouth of the Spring Creek Arm, and sediment within the Arm would need to be dewatered. Several factors would make construction of a structurally stable wall and maintaining a dewatered condition difficult. Keswick Reservoir cannot be emptied; the reservoir could only be lowered by a maximum of 10 to 15 feet. The dam would need to be constructed as water continues to flow from Shasta Lake through Keswick Reservoir to the Sacramento River. Response CW-2B provides additional detail on difficulties with building a dam or barrier to isolate the Spring Creek Arm.

Once the sediment in the Arm is dewatered, land excavators would remove sediment and place excavated material into trucks to be transported to a disposal area. The excavated sediment might need to be handled several times by an assembly line of excavators before being placed into trucks. Depending on the size of the trucks and how much water can be removed from the sediment, approximately 10,000 to 25,000 truckloads of excavated sediment would be transported to the ultimate disposal location or to a rail line. This would result in increased truck traffic for local residents. Careful measures would need to be used to prevent exposure to dust during excavation and transport of contaminated sediment.

EPA believes the selected remedy meets remedial action objectives established to protect human health and the environment. EPA believes that the selected cleanup action will be easier to implement and less costly than the proposed cleanup option.

3.4.3 Written Comments Received from State Support Agencies

This section contains responses to comments received by EPA from state support agencies. These comments are designated by the acronym for the agency (e.g. "DTSC" for Department of Toxic Substances Control) and numbered consecutively.

James L. Tjosvold, Department of Toxic Substances Control, California Environmental Protection Agency

Comment DTSC-1

The Department of Toxic Substances Controls (DTSC) has reviewed the Proposed Plan to Cleanup Sediments in the Spring Creek Arm of Keswick Reservoir as part of the remediation of the Iron Mountain Mine Superfund Site, Redding, California. DTSC, as lead agency for the State for the remediation of the Iron Mountain Mine Superfund Site, has conferred with the Central Valley Regional Water Quality Control Board (CVRWQCB) and the Department of Fish and Game (DFG) regarding the Proposed Plan. The State Agencies concur with the selected remedy identified in the Proposed Plan, the partial removal of sediment from the Spring Creek Arm of Keswick Reservoir, and will work with the Environmental Protection Agency (EPA) to implement the remedy.

Previous concerns voiced by the State regarding the adequacy of sediment containment safeguards during implementation of the remedy were discussed and solutions proposed in CH2M HILL's technical memorandum entitled "Iron Mountain Mine: Design Concepts In Remediation Approach" and a conference call between the State and EPA. The State feels that EPA has responded to our concerns and, in conjunction with following the State's substantive requirements for dredging operations that will be transmitted to EPA at a later date, the project should not significantly impact water quality. EPA, in coordination with the State, will continue to develop the safeguards presented in the technical memorandum and incorporate them into the project design.

Response DTSC-1

EPA agrees with this comment. EPA will closely coordinate with the State during design, implementation, and evaluation of the dredging program. During remedial design, EPA will work with the State to continue development of safeguards that minimize the resuspension of sediment and prevent the migration of sediment. The project will comply with applicable or relevant and appropriate requirements for dredging operations.

Donald B. Koch, California Department of Fish and Game

Comment CDFG-1

The Department of Fish and Game has reviewed the proposed plan to clean up the contaminated sediment which has been deposited in the Spring Creek arm of Keswick Reservoir from the Iron Mountain Mine Superfund site in Redding, California.

The Department supports the proposed action. We believe the no-action alternative constitutes significant risk to the environment and that the proposed project needs to be completed. A dramatic example of the extent of the risk of leaving the sediment in place was the brief discharge of the metal precipitates which occurred on May 25, 1988,when the reservoir was drawn down and the powerhouse discharged over the exposed metal sludge. Even

though the fluvial erosion was brief and mobilized a minute portion of the waste piles, the small amount of sediment caused a 30-mile long plume that traveled down the river to Hamilton City and deposited contaminated sediment in important spawning areas.

Response CDFG-1

EPA agrees with this comment.

Comment CDFG-2

We believe the dredging proposed to remove the sediment is a manageable operation; certainly one that will have less environmental consequence and be more controllable than what occurred in May 1988. Very brief events of sediment mobilization are capable of exposing sensitive life stages of listed species of salmon throughout the entire Sacramento River prime spawning area. This area is designated as one of the State's most important salmon and steelhead spawning areas (Fish and Game Code Section 1505).

We look forward to working with the Environmental Protection Agency on the development of the details of the dredging operation. The phased approach of dredging along with project monitoring should allow the operation to be managed to attain the basin plan water qualify objectives for the Sacramento River. The dredging project will also meet the goal of preventing future movement of contaminated sediment into important spawning habitats in the Sacramento River.

Response CDFG-2

EPA agrees with this comment. EPA will work with the State to implement a conservative, phased dredging approach and monitoring plan designed to provide early detection of potential problems. The dredging operation will be designed and implemented to meet applicable water quality criteria for the Sacramento River.

3.4.4 Written Comments Received from Local Government Agencies

This section contains responses to comments received by EPA from local government agencies. These comments are designated by the acronym for the agency (e.g. "RMU" for Redding Municipal Utilities) and numbered consecutively.

Richard Elliott, Redding Municipal Utilities

Comment RMU-1

The City feels the removal of sediments in the Spring Creek Arm of Keswick Reservoir is a worthwhile endeavor for the long-term health of the Sacramento River. However, the Wastewater and Water Utilities have some concerns about water quality conditions in the river during dredging operations and their possible effects on our domestic water supply and our wastewater treatment plant discharges.

1. Reasonable assurances are made in the Administrative Records that water quality criteria will not be exceeded during the dredging operations, and it is our hope this comes to fruition. Be advised one of our large domestic water supply pump stations for the Foothill Water Treatment Plant (FWTP) is located approximately 2 miles downstream of Keswick Dam on the southwest side of the Sacramento River, and it is imperative

human health criteria are maintained at the pump intake. The FWTP supplies approximately 50% of the City's drinking water supply.

Response RMU-1

EPA will implement several specific measures to ensure close coordination with State agencies and to ensure that contaminated sediments will be contained during dredging operations. During design, EPA will work closely with the Regional Water Quality Control Board to develop a Water Quality Management and Monitoring Plan. The monitoring program will allow an early warning detection system and will be designed to meet water quality objectives at the point of compliance upstream of the Jewel Creek and Bella Vista drinking water intakes. Maximum contaminant levels (MCLs) for the primary contaminants of concern (COCs) (arsenic, copper, cadmium, and zinc) are equal to or less stringent than water quality standards that are applicable or relevant and appropriate to dredging operations and are established to protect aquatic life and beneficial uses. EPA will work with the RWQCB to ensure that the monitoring plan addresses issues presented by the City.

EPA will implement multiple controls during dredging to minimize the disturbance and resuspension of sediment and/or the migration of suspended sediment. Controls will include dredging when Spring Creek Power Plant is not operating to minimize flow through the Arm, using Best Management Practices and engineering design to minimize sediment resuspension, and using sediment containment barriers (i.e., silt screens or silt curtains). EPA will also implement a conservative, phased dredging program. Phase I will be implemented during the first working year of the project. Phase I will begin at the upstream sediment pile (Pile A), and production rates will be low to allow more controlled conditions. EPA will collect data and evaluate the ongoing performance of Phase I dredging operations. Should problems arise during Phase I dredging, EPA will work with State agencies to implement additional controls, reduce dredging rates, or shut down equipment until issues can be resolved.

Comment RMU-2

2. Additionally, flocculated water treatment solids from the FWTP are discharged to our Clear Creek Wastewater Treatment Plant (CCWWTP) which has NPDES monthly average discharge limits of 12 μg/L (0.88 lbs/day) copper and 81 μg/L (5.9 lbs/day) zinc. Any additional load to the FWTP will be transferred to the CCWWTP; effluent violations are now subject to mandatory fines under California SB709 and we therefore require assurance this operation will not cause or contribute to effluent violations at this facility. At the very least, if this operation were to cause or contribute to effluent violations, EPA should provide assurances or relief to affected downstream NPDES Permit holders by authorizing temporary waivers of specific parameters affected or by direct payment of mandatory fines imposed. The CCWWTP NPDES permit charges us with monthly monitoring for low level metals at Caldwell Park to ensure acceptable background conditions exist for additional downstream inputs. Any exceedance of water quality criteria during the dredging operations would potentially have a negative effect and impact to ongoing municipal monitoring program requirements.

Response RMU-2

As discussed in Response RMU-1, EPA will work closely with State agencies, including the RWQCB, to design and implement a conservative phased dredging program and a monitoring program that provides early warning of potential problems. The dredging program will be designed and implemented to ensure adequate sediment containment safeguards to meet the substantive requirements of the RWQCB as well as other applicable or relevant and appropriate requirements. The discharge of water from the Spring Creek Arm of Keswick Reservoir into the Sacramento River will meet applicable water quality criteria.

EPA will work with the RWQCB to ensure that the monitoring plan addresses issues presented by the City. EPA will involve the State agencies in the evaluation of the performance of dredging operations and sediment containment measures, and EPA will consult with the State agencies regarding the potential need for additional safeguards.

Comment RMU-3

3. While we have been verbally assured mercury is not an issue in the Spring Creek sediments, we feel it is prudent for EPA to perform a mercury discharge loading evaluation for this operation. Mercury was commonly used in the Shasta Mining District; TMDL's for mercury are currently being developed for the Sacramento River watershed including the San Francisco Bay and Sacramento/San Joaquin River Deltas which are both downstream of the Project.

Response RMU-3

EPA does not believe mercury is of concern either in the Spring Creek Arm sediments or with respect to Sacramento River water quality during dredging operations. Samples collected from the mine portals and seeps indicate the acid mine drainage is not a significant source of mercury contamination. Data from the Spring Creek Arm indicate that mercury is not present at elevated concentrations in sediment or reservoir water. Mercury data for the mine drainage and Spring Creek Arm surface water and sediment are summarized in the paragraphs below.

As part of the Remedial Investigation in 1983 and 1984, surface water samples and samples of mine drainage were collected within the Boulder Creek, Slickrock Creek, Spring Creek, and Flat Creek drainages. The average concentration of total mercury was below the MCL of 2 µg/L for all major sources of acid mine drainage. Using samples collected between December 30, 1983, and May 16, 1984, the average mercury concentration was calculated as 1.4 µg/L for the Richmond portal and below 0.2 µg/L for remaining sources of acid mine drainage (Lawson portal, Old/No.8 Mine Seep, Big Seep, and Brick Flat Pit). Within Spring Creek, mercury was detected at concentrations up to 5.7 µg/L in September 1983, but mercury was not detected (detection limit of 0.2 µg/L) in December 1983. Mercury was also analyzed in the Sacramento River downstream of Keswick Dam biweekly between January and June 1984. Mercury was detected in one sampling event at a concentration of 0.2 µg/L, which is marginally above the detection limit of 0.1 µg/L. Otherwise mercury was not detected. These data are presented in EPA's *Final Remedial Investigation Report, Iron Mountain Mine near Redding, California,* prepared by CH2M HILL in August 1985.

Samples of acid mine drainage from the Richmond and Lawson portals and Old/No. 8 Mine Seep were also collected in June 1993 to support the pilot-scale high density sludge treatability study. Concentrations of total mercury ranged from non-detect (detection limit of 0.2 µg/L) to 2.6 µg/L and concentrations of dissolved mercury ranged from non-detect (detection limit of 0.2 µg/L) to 0.7 µg/L. These data are presented in EPA's *High Density Sludge Treatability Study, Iron Mountain Mine, California,* prepared by CH2M HILL in October 1993.

During treatability testing in 2003, mercury was analyzed in composite sediment samples collected of the top half and bottom half of the sediment piles in the Spring Creek Arm of Keswick Reservoir. Mercury was detected at concentrations of 1.0 mg/kg in the top composite and 0.51 mg/kg in the bottom composite sediment sample. These concentrations are well below the wet weight total threshold limit concentration (TTLC) of 20 mg/kg and the EPA Region IX preliminary remedial goal for a residential exposure of 23 mg/kg for total mercury and 6.1 mg/kg for methyl mercury. Total and dissolved mercury were not detected in Spring Creek Arm water collected at a depth of approximately 6 feet, and dissolved mercury was not detected in sediment slurries of 5 and 7 percent solids (reporting limit of 0.1 µg/L). No data are available for mercury concentrations in pore water. These data indicate that mercury is not present at elevated concentrations in sediment or Spring Creek Arm water.

The dredging operations will not be regulated in the total maximum daily loads (TMDLs) for the Sacramento River watershed. TMDLs are the sum of allocated loads of pollutants set at a level necessary to implement the applicable water quality standards. TMDLs include load allocations from point sources, nonpoint sources, and natural background conditions. These load allocations are developed for ongoing point and nonpoint source pollutants; however, the dredging operations are short-term efforts. The dredging operations will be designed to meet applicable or relevant and appropriate requirements, including water quality objectives.

EPA will work closely with the Regional Water Quality Control Board during development and implementation of the dredging project and monitoring and reporting program. EPA will acquire additional data during the design phase to further characterize sediment engineering properties. During this sampling event, EPA will also collect additional mercury data for the sediment in the Spring Creek Arm.

Ross Bell, Shasta County Air Quality Management District, Department of Resource Management

Comment SCAQMD-1

Thank you for the opportunity to comment on the proposed plan to clean up contaminated sediments in the Spring Creek Arm of Keswick Reservoir. If the selected alternative involves a large dredging and construction project, then air emission permits may be required.

The Shasta County Air Quality Management District requires that portable equipment operated at a location within the District for more than six months be permitted. If the equipment is operating in the District for less than one year, then permitting under the California Statewide Portable Equipment Registration Program is adequate. If the equipment is oper-

ated for more than one year, then a District issued Authority to Construct and Permit to Operate will be required.

Equipment covered under the permitting requirement includes engines powering dredges, cranes, pumps, drill rigs, compressors, and generators. Sand and gravel screens, rock crushers, and tub grinders also require air emissions permits. All diesel-powered equipment would be subject to engine exhaust limits contained either in the State Portable Equipment Registry Program or the Airborne Toxic Control Measure for Stationary Compression Ignition Engines.

We would like to request that EPA notify any contractor selected for this construction work that air district permitting needs to be addressed.

Response SCAQMD-1

CERCLA §121(e), 42 USC §9621(e), states that no federal, state, or local permits are required for remedial actions conducted onsite. Onsite refers to the areal extent of contamination and all suitable areas in proximity to the contamination necessary for implementation of the response action. However, EPA will work closely with Shasta County Air Quality Management District to comply with the substantive requirements of the applicable Air Quality Management district's regulations and will abide by all applicable or relevant and appropriate requirements (ARARs) during dredging and construction. During the design process, EPA will consult with Shasta County to ensure that plans, specifications, and the subcontract documents identify and require compliance with the ARARs and that appropriate monitoring is planned and conducted during construction.

Appendix A

APPENDIX A

State and Municipal Written Comments Received by EPA

Following are copies of the written comments received by EPA on the Proposed Plan. Included are letters from the following commenters:

James L. Tjosvold, PE, Chief, Northern California-Central Cleanup Operations Branch, Department of Toxic Substances Control

Donald B. Koch, Regional Manger, California Department of Fish and Game

Ross Bell, Air Quality District Manager, Shasta County Department of Resource Management

Richard Elliott, Wastewater Utility Supervisor, Industrial Waste, Redding Municipal Utilities

2033842

Department of Toxic Substances Control

Terry Tamminen
Agency Secretary
Cal/EPA

8800 Cal Center Drive
Sacramento, California 95826-3200

Arnold Schwarzenegger
Governor

September 13, 2004

Mr. Rick Sugarek
Remedial Project Manager – Iron Mountain Mine
Superfund Enforcement Branch
U.S. Environmental Protection Agency, Region IX
75 Hawthorne Street
San Francisco, California 94105-3901

CONCURRENCE WITH EPA'S PROPOSED PLAN TO CLEANUP CONTAMINATED SEDIMENTS IN THE SPRING CREEK ARM OF KESWICK RESERVOIR FOR THE IRON MOUNTAIN MINE SUPERFUND SITE, REDDING, CALIFORNIA

Dear Mr. Sugarek:

The Department of Toxic Substances Controls (DTSC) has reviewed the Proposed Plan to Cleanup Sediments in the Spring Creek Arm of Keswick Reservoir as part of the remediation of the Iron Mountain Mine Superfund Site, Redding, California. DTSC, as lead agency for the State for the remediation of the Iron Mountain Mine Superfund Site, has conferred with the Central Valley Regional Water Quality Control Board (CVRWQCB) and the Department of Fish and Game (DFG) regarding the Proposed Plan. The State Agencies concur with the selected remedy identified in the Proposed Plan, the partial removal of sediments from the Spring Creek Arm of Keswick Reservoir, and will work with the Environmental Protection Agency (EPA) to implement the remedy.

Previous concerns voiced by the State regarding the adequacy of sediment containment safeguards during implementation of the remedy were discussed and solutions proposed in CH2M Hill's technical memorandum entitled "Iron Mountain Mine: Design Concepts in Remediation Approach" and a conference call between the State and EPA. The State feels that EPA has responded to our concerns and, in conjunction with following the State's substantive requirements for dredging operations that will be transmitted to EPA at a later date, the project should not significantly impact water quality. EPA, in coordination with the State, will continue to develop the safeguards presented in the technical memorandum and incorporate them into the project design.

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If you have any questions, please feel free to contact DTSC's project manager, Mr. Don Mandel, at (916) 255-3667.

Sincerely,

James L. Tjosvold, P.E., Chief
Northern California-Central Cleanup Operations Branch

cc: Mr. Dave Bunte
CH2M Hill, Inc.
2525 Airpark Drive
Redding, California 96049

Mr. Phil Woodward
CVRWQCB
415 Knollcrest Drive, Suite 100
Redding, California 96002

Ms. Jane Vorpagel
Department of Fish and Game
601 Locust Street
Redding, California 96001

State of California - The Resources Agency
ARNOLD SCHWARZENEGGER, Governor
DEPARTMENT OF FISH AND GAME
http://www.dfg.ca.gov
Northern California-North Coast Region
601 Locust Street
Redding, CA 96001
(530) 225-2300

2033840

September 3, 2004

Mr. Rick Sugarek
Environmental Protection Agency
75 Hawthorne Street
Mail Code SFD-7-2
San Francisco, California 94105-3901

Dear Mr. Sugarek:

The Department of Fish and Game has reviewed the proposed plan to clean up the contaminated sediment which has been deposited in the Spring Creek arm of Keswick Reservoir from the Iron Mountain Mine Superfund site in Redding, California.

The Department supports the proposed action. We believe the no-action alternative constitutes significant risk to the environment and that the proposed project needs to be completed. A dramatic example of the extent of the risk of leaving the sediment in place was the brief discharge of the metal precipitates which occurred on May 25, 1988, when the reservoir was drawn down and the powerhouse discharged over the exposed metal sludge. Even though the fluvial erosion was brief and mobilized a minute portion of the waste piles, the small amount of sediment caused a 30-mile long plume that traveled down the river to Hamilton City and deposited contaminated sediment in important spawning areas.

We believe the dredging proposed to remove the sediment is a manageable operation; certainly one that will have less environmental consequence and be more controllable than what occurred in May 1988. Very brief events of sediment mobilization are capable of exposing sensitive life stages of listed species of salmon throughout the entire Sacramento River prime spawning area. This area is designated as one of the State's most important salmon and steelhead spawning areas (Fish and Game Code Section 1505).

We look forward to working with the Environmental Protection Agency on the development of the details of the dredging operation. The phased approach of dredging along with project monitoring should allow the operation to be managed to attain the basin plan water quality objectives for the Sacramento River. The dredging project will also meet the goal of preventing future movement of contaminated sediment into important spawning habitats in the Sacramento River.

Thank you for the opportunity to comment on the proposed plan. If you have any questions regarding these comments, please contact Environmental Scientist Jane Vorpagel at (530) 225-2124.

Sincerely,

for **DONALD B. KOCH**
Regional Manager

cc: Mr. Jim Pedri
Central Valley Regional Water
Quality Control Board
415 Knollcrest Drive, Suite 100
Redding, California 96002

Department of Toxic Substances Control
4250 Power Inn Road
Sacramento, California 95826

U.S. Fish and Wildlife Service
2800 Cottage Way, Room W-2605
Sacramento, California 95825-1846

Mr. Mike Tucker
NOAA Fisheries
650 Capitol Mall, Suite 8-300
Sacramento, California 95814

ec: Ms. Jane Vorpagel
Mr. Harry Rectenwald
Northern California-North Coast Region
Department of Fish and Game
601 Locust Street
Redding, California 96001

SHASTA COUNTY

DEPARTMENT OF RESOURCE MANAGEMENT
1855 Placer Street, Redding, CA 96001

Russ Mull, R.E.H.S., A.I.C.P.
Director
Richard D. Barnum
Assistant Director

August 23, 2004

Rick Sugarek (SFD-7-2)
Remedial Project Manager
U.S. EPA
75 Hawthorne Street
San Francisco, CA 94105

Iron Mountain Mine Superfund Site

Dear Mr. Sugarek:

Thank you for the opportunity to comment on the proposed plan to clean up contaminated sediments in the Spring Creek Arm of Keswick Reservoir. If the selected alternative involves a large dredging and construction project, then air emission permits may be required.

The Shasta County Air Quality Management District requires that portable equipment operated at a location within the District for more than six months be permitted. If the equipment is operating in the District for less than one year, then permitting under the California Statewide Portable Equipment Registration Program is adequate. If the equipment is operated for more than one year, then a District issued Authority to Construct and Permit to Operate will be required.

Equipment covered under the permitting requirement includes engines powering dredges, cranes, pumps, drill rigs, compressors and generators. Sand and gravel screens, rock crushers and tub grinders also require air emissions permits. All diesel-powered equipment would be subject to engine exhaust limits contained either in the State Portable Equipment Registry Program or the Airborne Toxic Control Measure for Stationary Compression Ignition Engines.

We would like to request that EPA notify any contractor selected for this construction work that air district permitting needs to be addressed.

Please feel free to contact the District at 530-225-5674 if you have questions regarding this matter.

Sincerely,

Ross Bell
Air Quality District Manager

RB/eg

☒ *Suite 101*
AIR QUALITY MANAGEMENT DISTRICT
(530) 225-5674
FAX: (530) 225-5237

☐ *Suite 102*
BUILDING DIVISION
(530) 225-5761
FAX: (530) 245-6468

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PLANNING DIVISION
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Toll Free Access Within Shasta County 1-800-528-2850

REDDING
MUNICIPAL UTILITIES

P.O. BOX 496071
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Working together to improve our community

September 13, 2004
W0101-000-000

Mr. Rick Sugarek (SFD-7-2)
Remedial Project Manager
USEPA
75 Hawthorne Street
San Francisco, CA 94105

Dear Mr. Sugarek:

SUBJECT: Iron Mountain Mine - Public Comment on Proposed Plan to Clean up Contaminated Sediments at the Spring Creek Arm of Keswick Reservoir

The City feels the removal of sediments in the Spring Creek Arm of Keswick Reservoir is a worthwhile endeavor for the long-term health of the Sacramento River. However, the Wastewater and Water Utilities have some concerns about water quality conditions in the river during dredging operations and their possible effects on our domestic water supply and our wastewater treatment plant discharges.

1) Reasonable assurances are made in the Administrative Records that water quality criteria will not be exceeded during the dredging operations, and it is our hope this comes to fruition. Be advised one of our large domestic water supply pump stations for the Foothill Water Treatment Plant (FWTP) is located approximately 2 miles downstream of Keswick Dam on the southwest side of the Sacramento River, and it is imperative human health criteria are maintained at the pump intake. The FWTP supplies approximately 50% of the City's drinking water supply.

2) Additionally, flocculated water treatment solids from the FWTP are discharged to our Clear Creek Wastewater Treatment Plant (CCWWTP) which has NPDES monthly average discharge limits of 12 µg/l (0.88 lbs/day) copper and 81 µg/l (5.9 lbs/day) zinc. Any additional load to the FWTP will be transferred to the CCWWTP; effluent violations are now subject to mandatory fines under California SB709 and we therefore require assurance this operation will not cause or contribute to effluent violations at this facility. At the very least, if this operation were to cause or contribute to effluent violations, USEPA should provide assurances or relief to affected downstream NPDES Permit holders by authorizing temporary waivers of specific parameters affected or by direct payment of mandatory fines imposed. The CCWWTP NPDES Permit charges us with monthly monitoring for low level metals at Caldwell Park to ensure acceptable background conditions exist for additional downstream inputs. Any exceedance of water quality criteria during the dredging operations would potentially have a negative effect and impact to ongoing municipal monitoring program requirements.

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3) While we have been verbally assured mercury is not an issue in the Spring Creek sediments, we feel it is prudent for USEPA to perform a mercury discharge loading evaluation for this operation. Mercury was commonly used in the Shasta Mining District; TMDL's for mercury are currently being developed for the Sacramento River watershed including the San Francisco Bay and Sacramento/San Joaquin River Deltas which are both downstream of the Project.

Thank you for the opportunity to comment.

Sincerely,

Richard Elliott
Wastewater Utility Supervisor - Industrial Waste

RE/jh
c: Stephen J. Craig, Wastewater Utility Manager
Mike Robertson, Water Utility Manager
IMM 904