AR2768

SDMS# 56145

Record of Decision
Boulder Creek Operable Unit
Iron Mountain Mine
Shasta County, California

Boulder Creek is OU2

September 30, 1992

U.S. Environmental Protection Agency
Region IX
75 Hawthorne Street
San Francisco, California 94105

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IRON MOUNTAIN MINE
SHASTA COUNTY, CALIFORNIA

THE DECLARATION

I. SITE NAME AND LOCATION

Iron Mountain Mine
Shasta County, California (near Redding, California)

II. STATEMENT OF BASIS AND PURPOSE

This decision document presents the selected interim remedial action for hazardous substance sources in the Boulder Creek Operable Unit at the Iron Mountain Mine site, which is located in Shasta County, California, near the City of Redding. The selected interim remedial action is to collect and treat the acid mine drainage (AMD) discharges from the Richmond and Lawson portals and to excavate, consolidate onsite, and cap seven waste piles that have been identified as actively eroding and discharging hazardous substances to Boulder Creek. The selected interim remedial action was chosen in accordance with CERCLA, as amended by SARA, and, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This decision is based upon the administrative record for this site.

The State of California concurs with the selected interim remedial action for the Boulder Creek Operable Unit at the Iron Mountain Mine Superfund site.

III. ASSESSMENT OF THE SITE

Heavy metal-laden acid mine drainage is released from several and possibly all of the inactive mine workings at Iron Mountain and from the numerous waste piles on the mine property. The acid mine drainage discharges to surface waters (which include Boulder, Slickrock, and Spring Creeks, the Spring Creek Reservoir, Keswick Reservoir, and the Sacramento River) causing severe environmental impacts and posing a potential threat to human health. The Sacramento River is a major fishery and source of drinking water for Redding. The National Oceanic and Atmospheric Administration (NOAA) has identified the affected area as the most important salmon habitat in the State. Under the Clean Water Act § 304(l) inventory of impaired water bodies and the toxic point sources affecting the water bodies, EPA identified Iron Mountain Mine as the largest such discharger of toxic metals in the United States.

EPA has identified control of acid mine drainage sources in the Boulder Creek Operable Unit as a major step in the ultimate control of discharges of contamination from Iron Mountain Mine. Two of the sources in the Boulder Creek drainage, the

Richmond and Lawson portals, are the two largest sources of acid mine drainage at the site. Actual or threatened releases of hazardous substances from this site, if not addressed by implementing the response action selected in the Record of Decision (ROD), may present an imminent and substantial endangerment to public health, welfare, or the environment.

IV. DESCRIPTION OF THE SELECTED REMEDY

The Boulder Creek Operable Unit (OU) addresses the AMD discharges from the mine workings and waste piles at Iron Mountain Mine (IMM) that discharge to Boulder Creek. The mine workings and associated mineralization related to the AMD discharges from the Richmond and Lawson portals are the two largest sources of hazardous substances at the site, comprising as much as 40 percent of the copper and 80 percent of the cadmium and zinc discharged from IMM. Several waste piles that are characterized as consisting largely of pyritic materials containing heavy metal constituents are currently located on steep slopes at IMM and are actively eroding and discharging to Boulder Creek.

The discharge of AMD from the Richmond and Lawson portals containing high concentrations of copper, cadmium, and zinc to surface waters draining Iron Mountain Mines is the primary exposure pathway. The principal threat posed by these releases is the creation of conditions toxic to aquatic life in the receiving waters, most importantly, the Sacramento River. The Sacramento River supports a valuable fishery that includes four species of chinook salmon, steelhead, and resident trout. The winter-run Chinook salmon has been designated as a threatened species under the Endangered Species Act.

This OU is the second ROD for the IMM site. The first OU, contained in a Record of Decision signed in October, 1986, provided limited source control actions to begin lessening the AMD discharges and provided water management capability to manage the ongoing AMD releases to surface waters. Under the first ROD, the AMD releases are managed to minimize their impacts on the fishery and the environment and to reduce the potential threat to human health arising from the hazardous substance discharge to the Sacramento River, used by the City of Redding as a source of drinking water. Specific activities authorized by the 1986 ROD include the Slickrock diversion, Upper Spring Creek diversion and a partial cap of Brick Flat Pit. All of these projects have been completed. The 1986 ROD also authorized the enlargement of Spring Creek Debris Dam. Last week, the United States Bureau of Reclamation entered a Memorandum of Agreement with the EPA, pursuant to which the United States Bureau of Reclamation will design the enlarged dam.

In addition to these activities, EPA is moving forward with two more Operable Units. A third OU will address the AMD discharges from the Old Mine/No. 8 mine workings and associated mineralization which discharges to Slickrock Creek. To achieve the remedial action objectives of the Superfund action at IMM, EPA expects to require a further study or studies for the sources in the Boulder Creek drainage not addressed in today's Record of Decision; other sources in the Slickrock Creek drainage; sediments in

Slickrock Creek, Spring Creek, Spring Creek Reservoir, Keswick Reservoir, and the Sacramento River; contaminated groundwater and other sources of contamination. The additional study will also assess potential water management options, including the need to coordinate releases of acidic waters with Central Valley Project water releases. Any further study will also consider resource recovery and source control. EPA is currently developing a work plan for this additional RI/FS activity and this study will consider all ARARs for the actions, including any underground injection requirements.

Because of the environmental impacts of the sources not addressed in this FS, EPA anticipates that the Boulder Creek OU remedial action will not provide for compliance with all ARARs at all times, and consequently EPA is relying on the ARARs waiver for "interim measures" (40 C.F.R. § 300.430(f)(1)(ii)(C)(1)) for remedy selection with respect to sources in the Boulder Creek Operable Unit. As discussed more fully below, this ARARs waiver does not affect all ARARs.

The remedy selected in this decision document addresses the principal threat posed by contaminant releases from sources within the Boulder Creek watershed at Iron Mountain through collecting and treating the Richmond and Lawson portal discharges. The excavation, consolidation, and capping of seven identified waste piles will further reduce hazardous substance discharges that contribute to the site problems.

The major components of the selected remedy include:

- Maintenance of the Richmond and Lawson adits to allow the mine workings to continue to function as efficient collectors of the AMD.

- Construction of necessary structures, pipelines, pumping stations, and equalization to provide for delivery of all AMD flows from the Richmond and Lawson adits to the treatment facility for treatment.

- Treatment facilities to perform chemical neutralization/precipitation treatment of all of the Richmond and Lawson AMD flows utilizing the lime/sulfide High Density Sludge treatment process option to meet the performance standards of 40 C.F.R. Part 440 which have been determined to be relevant and appropriate to this application. If the discharge is to the Boulder Creek or Slickrock drainage, the discharge shall comply with the effluent limitations of 40 C.F.R. §§ 440.102(a) and 440.103(a), except for the limitation on pH and TSS. If the discharge is to Flat Creek, the discharge shall also comply with the pH and TSS requirements of 40 C.F.R. § 440.102(a).

- Disposal of treatment residuals onsite in the inactive open pit mine, Brick Flat Pit. The design of the improvements to Brick Flat Pit to function as a disposal facility shall comply with the requirements of the Toxic Pits Control Act and California requirements for disposal of mining wastes.

- Seven waste piles (identified as WR-2, WR-12, WR-13, WR-14, WR-17, WR-18, and WR-19 in the Boulder Creek OUFS) shall be excavated, consolidated, and capped onsite in accordance with California requirements for disposal of mining wastes.

V. STATUTORY DETERMINATIONS

This interim action is protective of human health and the environment. The selected remedy essentially eliminates the potential exposure and the resultant threats to human health and the environment from the sources and pathways addressed in this interim action. The Boulder Creek OU provides for an interim action that is not expected to be final and does not address all of the sources of discharges from the site. The selected remedy, therefore, cannot be expected to be fully protective of human health and the environment. Further remedial actions are required.

This interim action complies with (or waives) Federal and State applicable or relevant and appropriate requirements (ARARs) for this limited-scope action. The selected remedy is expected to comply with most chemical, action and location-specific ARARs. The selected remedy does not address all sources of contaminant discharges at the site and cannot provide for compliance with the chemical-specific ARARs of the Central Valley Regional Quality Control Basin Plan water quality objectives and for compliance with Fish and Game Code Section 5650 which prohibits discharge of contaminants "deleterious to fish, plant life, or bird life." EPA is invoking the CERCLA Section 121(d)(4)(A) waiver for "interim measures."

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

EPA has determined that the selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized for the interim remedial action for the Boulder Creek OU at Iron Mountain Mine. Alternatives that might reduce or eliminate the AMD forming reactions have been developed and evaluated, but EPA has concluded that significant additional development and evaluation of these approaches is required. EPA encourages the continued development of these alternatives that could reduce or eliminate the AMD forming reactions for consideration in a subsequent action for IMM. Treatment of the discharges will effectively eliminate the contaminant discharges and is a component of all alternatives developed to date. Treatment, therefore, is consistent with any anticipated subsequent actions. By selecting HDS instead of Simple Mix, EPA is using treatment to reduce toxicity, mobility and volume to the maximum extent feasible in the Boulder Creek Operable Unit at this time.

Because this action does not constitute the final remedy for the Iron Mountain Mine site, the statutory preference for remedies that employ treatment that reduces toxicity, mobility, or volume as a principal element will be further addressed by the final response action. Subsequent actions are planned to address fully the threats posed by the conditions at this site. Because this remedy will result in hazardous substances remaining on site above health-based levels, a review will be conducted to ensure that the remedy continues to provide adequate protection of human health and the environment within five years after commencement of the remedial action. Because this is an interim action ROD, review of this site and of this remedy will be continuing as EPA continues to develop final remedial alternatives for the site.

John Wise
Daniel W. McGovern for
Regional Administrator

9.30.92
Date

RECORD OF DECISION
IRON MOUNTAIN MINE
SHASTA COUNTY, CALIFORNIA

THE DECISION SUMMARY

I. SITE NAME, LOCATION, AND DESCRIPTION

I.1 Site Name

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

I.2 Site Location

The Iron Mountain Mine Superfund site is defined pursuant to CERCLA to include the inactive mines on Iron Mountain and areas where hazardous substances released from the mines are now located. The Iron Mountain (IMM) site includes the approximate 4,400 acres of land that includes the mining property on the topographic feature known as Iron Mountain, the several inactive underground and open pit mines, numerous waste piles, abandoned mining facilities, mine drainage treatment facilities, and the downstream reaches of Boulder Creek, Slickrock Creek, Spring Creek, Spring Creek Reservoir, Keswick Reservoir, and the Sacramento River affected by drainage from Iron Mountain Mine.

I.3 Site Description

The summit of Iron Mountain is 3,583 feet above mean sea level and is approximately 3,000 feet above the Sacramento River, 3 miles to the east. The terrain is very steep, with slopes dropping 1 to 2 feet for every 2 feet horizontally, or steeper. The mountain is predominantly forested with some areas of brush and numerous unpaved roads leading to various work locations.

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. The largest sources of AMD are located within the Iron Mountain Mine property. The largest source of AMD is the Richmond Mine and the second largest is the Hornet Mine both of which drain into Boulder Creek.

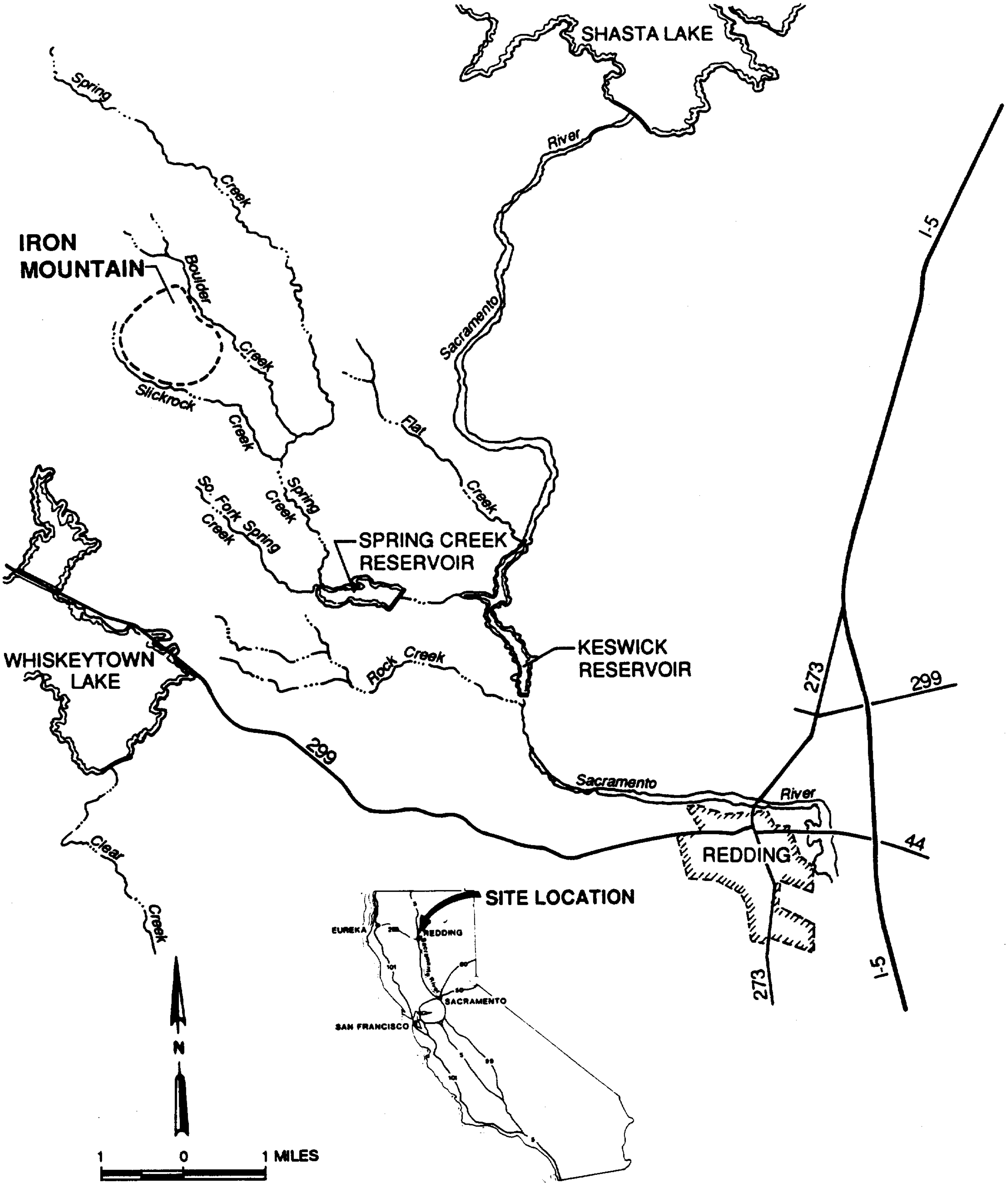

FIGURE 1
LOCATION OF
IRON MOUNTAIN SITE
IRON MOUNTAIN MINE ROD

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EPA has identified control of the AMD sources in the Boulder Creek drainage basin as a major step in the ultimate control of the contaminant discharges from Iron Mountain. EPA has designated the Boulder Creek basin as an Operable Unit for a Feasibility Study of pollution sources and alternative approaches for AMD control. This study has included the Richmond and Hornet Mines, waste piles, seeps, and sulfide-rich sediments within the basin.

Iron Mountain contains a very large mass of nearly pure sulfide (massive deposit), several small massive sulfide deposits, several zones of disseminated sulfides, and a large gossan. The gossan is a zone of rock from which disseminated sulfides have been almost completely removed by natural solution leaving a residue of iron and other metals. The gossan has been mined by open pit for residual metals. The disseminated and massive sulfides have been mined in open pit and underground openings for copper, cadmium and zinc and for pyrite. The country rock at Iron Mountain is rhyolite.

Commercial mining at Iron Mountain started in 1879 and continued with a few interruptions until 1963. In the early twentieth century, the site was one of the largest copper mines in the United States. Mineral extraction objectives and methods varied widely. In recent years, metal recovery activity at the site has been limited to extracting copper from the AMD using copper cementation.

I.4 Adjacent Land Uses

The adjacent land is largely undeveloped wilderness property that is currently infrequently visited because of the rugged topography and few roads. Offroad vehicles have been known to visit these areas and the U.S. Bureau of Land Management has notified EPA with regard to potential acquisition of adjacent lands for preservation as wilderness and enhancement for recreational use.

I.5 Natural Resources Uses

The natural resources on the mining property and in the surface waters which flow on or adjacent to the mining property at one time included mature stands of timber, fish, and aquatic populations and sulfide minerals. The natural resources in the downgradient Sacramento River include the valuable Sacramento River fishery, recreational use of the river and Keswick Reservoir, and the valuable water resources which are a major component of the U.S. Bureau of Reclamation's water distribution system for the State.

The timber on the IMM property has today been largely removed for timber sales. The timber stands were also extensively damaged by historic smelter operations in the early 1900s. The portions of Boulder Creek, Slickrock Creek, and Spring Creek impacted by AMD from IMM are essentially lifeless. A major portion of the sulfide minerals remain in the mines and in undeveloped areas. The sulfide minerals have not been attractive in recent years, and there is no verified proposal to mine these deposits in the near future.

Spring Creek Reservoir was constructed in part as a mitigation measure for the AMD discharges and does not support aquatic life. It is not used for any recreational purpose.
The portion of Keswick Reservoir impacted by IMM AMD has reduced recreational value, and the resident trout fishery is impacted by the heavy metal contaminants in the water column in the mixing zones, and the heavy sediment loadings due to the precipitation of iron and coprecipitation of heavy metals.

The upper Sacramento River salmon fishery is the most important fishery in the State and has experienced large population declines over the past 20 years due to a number of factors, including IMM AMD impacts. The Sacramento River also supports a major steelhead trout and resident trout fishery.

The water resources held in Shasta Lake by the U.S. Bureau of Reclamation (USBR) as part of its Central Valley Project (CVP) are an important component of the water distribution system to a growing California's municipal and agricultural interests. CVP operations are today often constrained by the IMM AMD discharges in order that water quality conditions in the Sacramento River can be maintained within safe bounds for fishery protection. On occasion, the USBR has released water from Shasta to dilute AMD which would otherwise have been used for beneficial purposes.

I.6 Location and Distance of Human Populations

Iron Mountain Mine is mainly remote from human populations because of the rugged terrain and the single access roadway. The mine owner has provided heavy metal gates which are locked at most times to discourage casual entry to the site. Human contact with the flows from Iron Mountain are mainly limited to the waters downstream of Spring Creek Debris Dam which includes Keswick Reservoir and the Sacramento River below Keswick Dam.

The closest community is Keswick located just east of the site. Several isolated residences are between Keswick and the mine property. The City of Redding has a population of approximately 70,000 people and is located approximately 9 miles from the site.

I.7 General Surface-Water and Groundwater Resources

Local surface drainage includes Boulder Creek, located northeast of the mountain, and Slickrock Creek, located to the southwest. Boulder Creek and Slickrock Creek flow into Spring Creek. Spring Creek flows south and east to the Spring Creek Debris Dam (SCDD), from which the U.S. Bureau of Reclamation (USBR) releases flow into the Sacramento River. Flat Creek drains an area to the east of Iron Mountain and enters the Sacramento River approximately 0.8 mile north of Spring Creek. Flat Creek also receives water from upper Spring Creek, as a result of a water diversion project constructed in 1990 as part of the CERCLA response at Iron Mountain.

The Boulder Creek watershed encompasses 2.7 square miles. The headwaters of Boulder Creek begin at approximately 3,400 feet msl, and flow 3.7 miles to the confluence with Spring Creek at 1,400 feet msl. Boulder Creek receives water from several small tributaries, groundwater seeps, and discharges from the Richmond and Lawson Adits which drain the Richmond and Hornet mines. The estimated average daily flow at Boulder Creek's confluence with Spring Creek is 8.8 cubic feet per second (cfs) (4,000 gpm). Boulder Creek flows vary from essentially a trickle in the upper reaches of the creek during late summer to several hundred cubic feet per second during storm events.

Approximately 60 percent (2.2 miles) of Boulder Creek is affected by past mine activities located in the lower Boulder Creek watershed (Figure 2). All identified AMD sources within the Boulder Creek Operable Unit are located in this area. The upper portion of Boulder Creek (1.5 miles) is not significantly affected by mining activities.

The rainfall-runoff responsiveness of the Boulder Creek Operable Unit may vary significantly throughout storm events. The amount of runoff is dependent on antecedent moisture conditions, storm intensity, the vegetative cover, ground slope, length of distributing area, and geology. Surface runoff is transported from the basin to Spring Creek. Channel-invert slopes are often greater than 20 percent with well-defined creekbeds. Major storm events may cause a rapid rise in the water levels in Boulder Creek.

The rhyolite country rock is a dense rock with two to three sets of joints and a number of faults. The rock blocks generally lack significant porosity and the low porosity of the rock mass is due to the joint/fault discontinuities. The presence of groundwater and its movement within the rock is largely controlled by the discontinuities.

The massive sulfide deposits were largely isolated from the groundwater before mining because the joints generally do not extend from the country rock into the mineralized zone. Groundwater was present in the disseminated zones. Mine openings and cracking caused by ground movements induced by mining have opened large volume of massive sulfide to groundwater and increased groundwater access to the disseminated sulfide mineralization. The additional groundwater movement and increased circulation of air within the rockmass has greatly accelerated the process of sulfide dissolution and the formation of metal-rich acid drainage

Surface water and groundwater at Iron Mountain were previously used for mining operations and to provide water supply to the mine staff and their families. These resources are essentially unused today due to contamination from AMD.

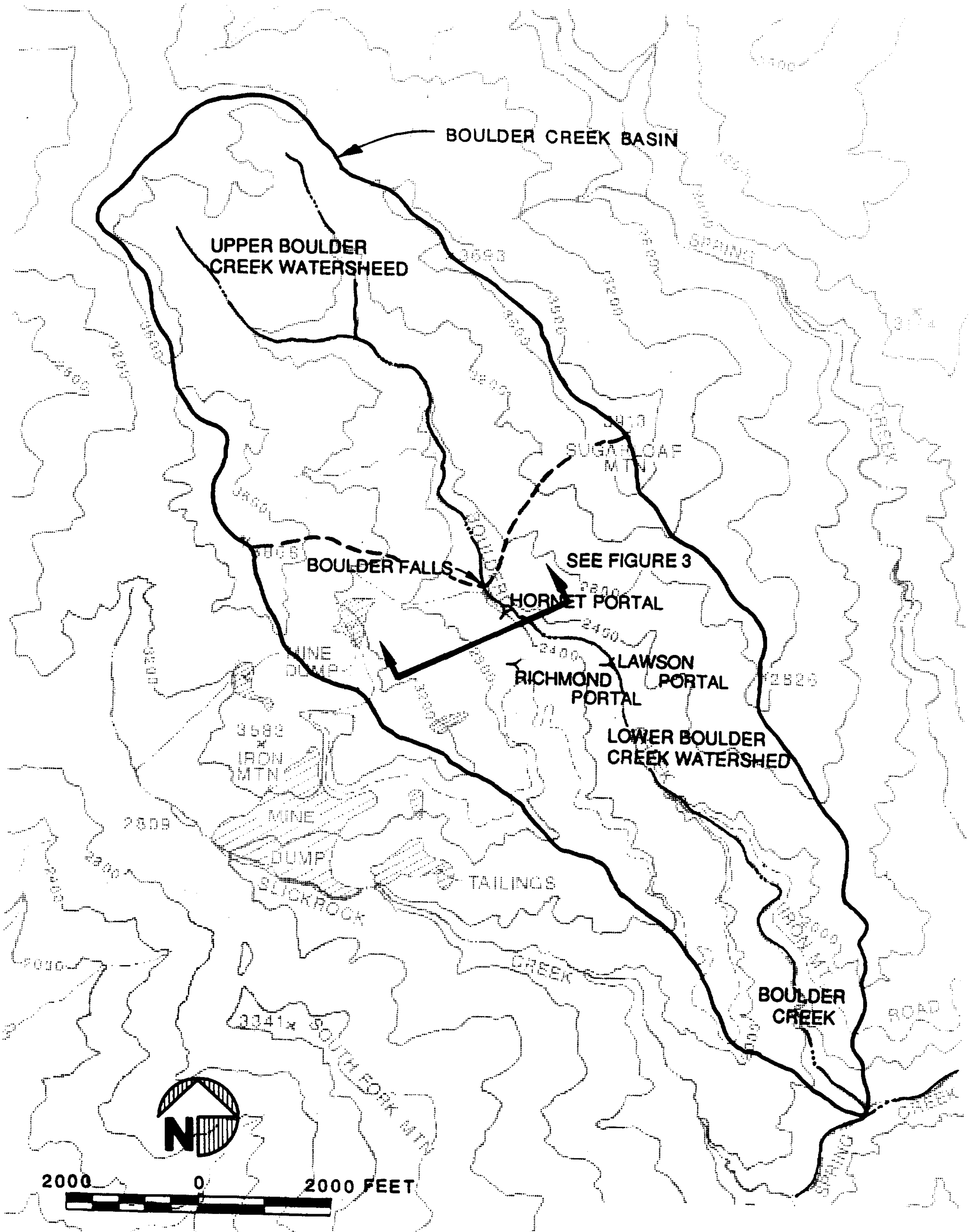

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FIGURE 2
BOULDER CREEK BASIN
IRON MOUNTAIN MINE ROD

I.8 Surface and Subsurface Features

An open pit mine at Brick Flat, underground workings at Old Mine, No. 8, and the Confidence-Complex on the southern flank of the mountain, and the Richmond and Hornet Mines on the northern flank are the large mines on Iron Mountain. The mines on the north flank are shown schematically in Figure 3. The Richmond and Hornet Mines clearly affect water quality in the Boulder Creek valley and are of primary interest in this operable unit. Brick Flat Pit, the Confidence-Complex Mine and the Mattie Mine may also affect this operable unit in certain potential actions to control metals releases in the Boulder Creek valley.

The Hornet Mine was accessed by the Lawson adit, which at its closest point runs almost directly below Boulder Creek, with the adit at approximately 2,200 feet elevation and Boulder Creek at approximately 2,285 feet elevation (Figure 4). The Lawson adit is currently inaccessible due to partial collapse.

The Richmond Mine was accessed by two adits, an extension of the Lawson adit from the Hornet Mine workings, and later by the Richmond adit. The Lawson extension runs northeast approximately 400 feet below the floor of the Richmond Mine into the Lawson adit below the Hornet Mine, and then turns southeast parallel with Boulder Creek for approximately 2,000 feet. The Richmond adit runs from the haulageway level at the base of the Richmond Mine workings east at an elevation of approximately 2,600 feet. A third connection to the Richmond Mine is through the Confidence-Complex adit, which exits the south side of the mountain above Slickrock Creek. Two 400-foot-high raises from the Richmond Mine workings intercept the Confidence-Complex adit at Elevation 3007.

The Richmond Mine workings consist of 23 large and several smaller mined-out areas within the Richmond mineralized zone. Most of these openings are stopes as they were mined from the bottom by roof caving. In the innermost portions of the mine, the ore was excavated using a room-and-pillar configuration instead of large stopes. Most of the larger stopes have apparently collapsed. The 10- to 15-acre surface area above the Richmond Mine contains several subsidence areas, totaling about 1 acre, resulting from the collapse of stopes within the underground mine workings. The total volume of the Richmond workings has been estimated at approximately 20 million cubic feet (460 acre-feet).

The Hornet and Richmond mineralized zones are separated by the Scott Fault which caused the Hornet zone to drop approximately 200 feet relative to the Richmond zone. The bottom of the Richmond mineralized zone is about 100 feet above and 170 feet offset from the top of the Hornet mineralized zone.

[illegible] SEPTEMBER [illegible]

NOTE
INNER MINE WORKINGS IN THE RICHMOND, HORNET, MATTIE, AND CONFIDENCE MINES ARE NOT SHOWN FOR CLARITY.

FIGURE 3
SCHEMATIC OF SULFIDE DEPOSITS IN BOULDER CREEK OPERABLE UNIT
[illegible]

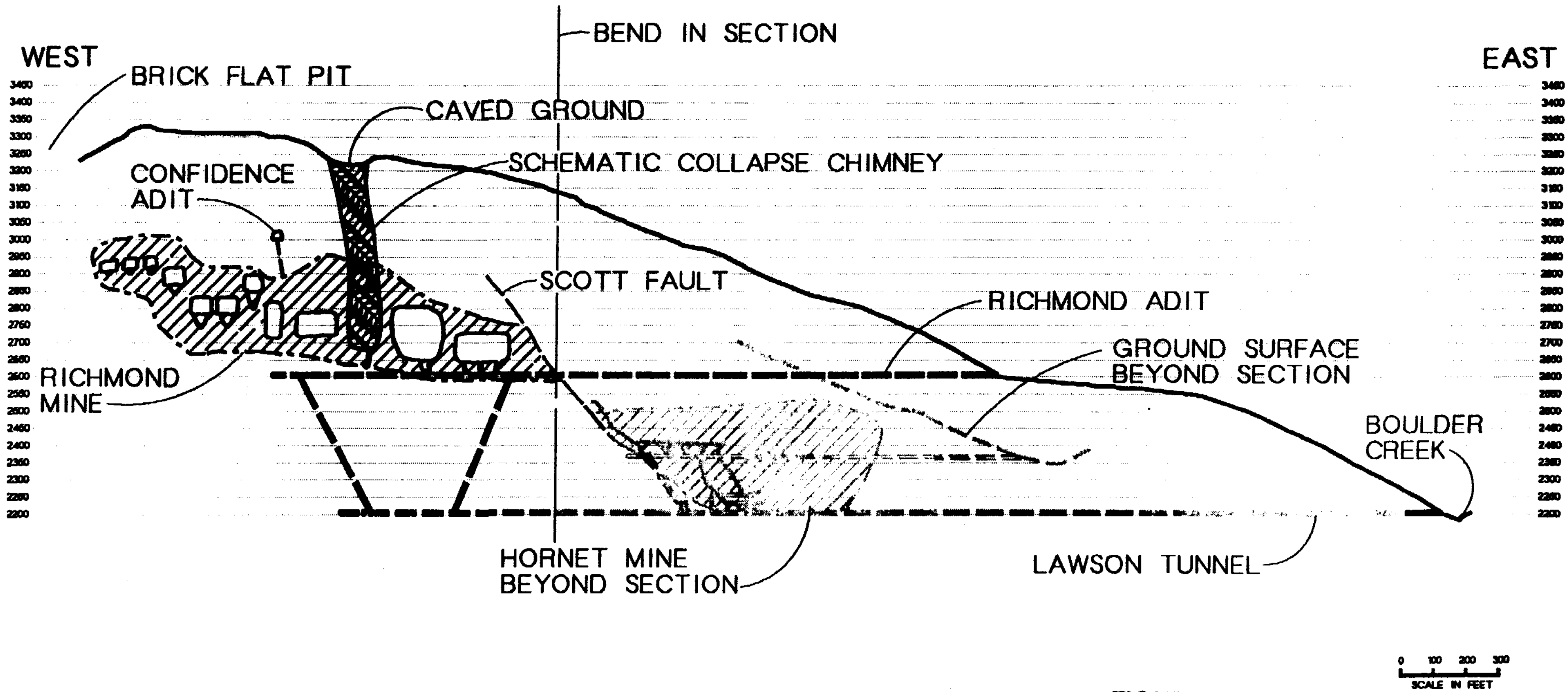

FIGURE 4
SECTION A-A THROUGH RICHMOND AND HORNET MINES
IRON MOUNTAIN MINE ROD

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II. SITE HISTORY AND ENFORCEMENT ACTIVITIES

II.1 History of Site Activities that Led to Current Problem

Iron Mountain Mine was first secured for mining purposes in 1865 and various individuals held the property and conducted limited mining for the recovery of silver from the gossan cap 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 probably dumped into ravines and eventually washed into the creeks.

Beginning in late 1894, Mountain Mining Co., Ltd., began operation of the mine. In approximately 1896, Mountain Copper Co., Ltd. assumed ownership of the mine. Under Mountain Copper, Ltd.'s operation of the mines, Iron Mountain became the largest producer of copper in California and the sixth largest producer in the country during the first quarter of the 20th century. The high-grade copper ore in Old Mine was mined 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, Brick Flat Pit from 1929 and 1942, and 1955 to 1962.

In 1968, Stauffer Chemical Co. acquired Mountain Copper Co., Ltd., and thereby acquired beneficial ownership of Iron Mountain Mine. Stauffer transferred record ownership of most of the parcels comprising Iron Mountain Mine from its wholly owned subsidiary to itself in 1969. Stauffer operated the copper cementation plant during its ownership of the site and continued to investigate the commercial mining potential of the property. In November 1976, the California Regional Water Quality Control Board issued Stauffer an order requiring the abatement of the continuing pollution from the mountain.

In December 1976, Stauffer transferred ownership of 31 parcels on Iron Mountain to Iron Mountain Mines, Inc. (IMMI); and in December 1980, five additional parcels were transferred to IMMI. IMMI, a California corporation, is the current owner of Iron Mountain. 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.

II.2 Impacts of Mining Activity at Iron Mountain

Mountain Copper employed stoping, block caving, and room and pillar techniques in the underground mines; side-hill and open-pit techniques were used at the ground surface. These mining activities and subsequent collapse of underground mine workings have fractured the bedrock overlying the sulfide mineralization, rubblizing significant quantities of in-place sulfides, and increasing the ability of groundwater to flow through the previously low permeability sulfide zones.

The engineered mine openings and the partially collapsed mineralized zones resulting from the mining activity now function as effective groundwater drains, drawing groundwater to and through the sulfide mineralization. The sulfides that were once largely below the water table are now largely within the unsaturated zone, and oxygen is available for reaction. The exothermic oxidation of the sulfide elevates the overall temperature in the sulfide mineralized zone, induces convective air flow, and likely induces evaporation of some subsurface mine waters. These processes contribute to the intensity and pattern of acidic discharges.

These mining-related characteristics, in combination with the natural occurrence at Iron Mountain of nearly pure massive sulfide deposits surrounded by bedrock with very little neutralizing capacity, result in a unique hydrogeochemical reactor that is nearly optimal for maximum production of acid mine waters (Nordstrom and Alpers, 1990). Iron Mountain produces mine waters that are among the most acidic in the world, containing extremely elevated concentrations of copper, cadmium, zinc, and other metals known to be toxic to aquatic life.

Mining activities at Iron Mountain have also resulted in deposition of large quantities of waste rock and lesser quantities of pyrite tailings on the exposed ground surface at Iron Mountain. Rain and surface flows contact the waste rock and pyrite, which forms AMD and transports contaminants to surface water and sediments. These sources, though secondary in relationship to the quantity and quality of contaminant discharges from the mine workings, are significant, particularly in storm events.

The waste rock dumps, mine tailings, unstable excavated areas, and denuded slopes of the watershed contribute to sedimentation in the various drainages. In addition, oxidation of waste materials and portal discharges contribute AMD into Spring Creek, which collects drainage from both Boulder Creek and Slickrock Creek.

II.3 Central Valley Project Related Impacts

The increasing use of Sacramento River water to serve a growing California has also increased the significance of Iron Mountain AMD impacts in the Sacramento River. The U.S. Bureau of Reclamation (USBR) constructed Shasta Dam in 1943 to control Sacramento River flows; Keswick Dam, located downstream of Shasta Dam, was completed in 1950. Spring Creek and Sacramento River flows mix in the lower third of Keswick Reservoir. Prior to the USBR's construction of these dams on the Sacramento River, the AMD was often diluted by large flows of water from farther upstream on the Sacramento River.

Although fish kills and toxicity problems were documented prior to the completion of Shasta Dam in 1943, the dam compounded the toxicity problems by reducing the availability of dilution flows (CVRWQCB, 1976; Wilson, 1977; Finlayson and Wilson, 1989).

Keswick Dam and Reservoir were completed in 1950. This dam restricted the salmon and steelhead to spawning grounds in downstream areas. This restricted the naturally spawning salmon and their early life stages to that area of the Sacramento River with the greatest exposure to AMD discharges from Iron Mountain.

After construction of Keswick Dam in 1950, the sediment load from Spring Creek, which previously had been flushed downstream, caused a delta to form in the Spring Creek arm of Keswick Reservoir.

In response to the problems at Spring Creek, the USBR constructed the SCDD in 1963 to control the toxic releases from Spring Creek and to prevent sediment from forming a delta in the vicinity of the Spring Creek Powerplant tailrace.

The SCDD allows for the storage and controlled release of water from the Spring Creek basin. Optimally, releases from Spring Creek Reservoir are timed to coincide with releases from Shasta Reservoir to meet interim water quality criteria in the Sacramento River. However, because of the relatively limited capacity of Spring Creek Reservoir with respect to peak discharges from the Spring Creek watershed, there have been uncontrolled spills from the reservoir. Although the debris dam has helped to reduce the incidence and severity of major fish kills, it has not eliminated them. In addition, the gradual release of Iron Mountain AMD from SCDD increases the duration of exposure of fish in the Sacramento River to chronic toxicity resulting from Iron Mountain AMD (EPA, 1992b).

II.4 History of Federal and State Site Investigations

Remedial Investigation activities at Iron Mountain began in September 1983, when Iron Mountain was placed on the National Priorities List of the nation's most contaminated sites. In conjunction with EPA's Record of Decision for the first operable unit at Iron Mountain, EPA issued an RI report in 1985 (EPA, 1985a). That report characterizes the entire Iron Mountain site with respect to the nature and extent of contamination from information available at that time. Site characterization studies have continued within the Boulder Creek watershed, and EPA has prepared a second RI report (EPA, 1992a) to present information developed in these additional studies. An Endangerment Assessment (EA) has been prepared to characterize and evaluate the current and potential threats to the environment that may be posed by Iron Mountain contaminants migrating to the groundwater, surface water, and air (EPA, 1992b), and EPA's public health risk assessment (EPA, 1991) has been updated.

The Boulder Creek OUFS considers remedial alternatives for (1) the two largest sources of acidity and metals contamination at Iron Mountain, the Richmond portal discharge and the Lawson portal discharge; and (2) the numerous waste rock piles, tailing piles, seeps, and contaminated sediments that also affect contaminant levels in Boulder Creek.

The Boulder Creek OUFS began as an investigation of the feasibility of the use of low-density cellular concrete (LDCC) to stop the AMD formation, a study required by the 1986 ROD. Concurrent with implementing selected remedial actions from the 1986 ROD, EPA continued its RI/FS activities, including efforts to enter the Richmond Mine workings to investigate groundwater and potential source control alternatives as called for in the 1986 ROD. Based on this further study, the potential use of LDCC has been rejected.

Subsequent to these initial investigations, on June 20, 1990, EPA conferred with California support agencies for the Iron Mountain site to determine the sequence of actions necessary to address outstanding site problems. This conference with the State support agencies led to the Boulder Creek OU approach as the next major step towards site cleanup.

Since that date, EPA continued to develop additional relevant site information through site investigation programs. EPA has also worked cooperatively with ICI Americas, Inc., (ICIA)(who represent Rhone-Poulenc Basic Chemicals Co., the current name for Stauffer Chemical Co.). ICIA has also performed site investigation activities.

The following tasks were performed mainly or entirely for the purpose of developing information on the existing conditions within the Boulder Creek Operable Unit.

> Review of mine records to identify the possible extent of mine workings and the most recent record of the conditions of the workings. The mine records currently available to EPA are limited to an unorganized group of mine drawings and profiles, published articles about the mine, and recollections of several former mine staff.
>
> Geologic reconnaissance and mapping in the Boulder Creek basin to document the soils, bedrock, waste rock and tailings materials, springs, and other metal sources. Limited areas containing evidence of surface subsidence, landsliding, thermal activity, or acid mine drainage (AMD) were documented.
>
> Aerial and ground surface thermal infrared imaging over the Richmond Mine to identify areas of elevated temperatures. Anomalous areas with elevated temperature were documented, including areas with open cracks and "steam" venting and areas with no apparent surface indication of thermal activity.
>
> Review and assessment of Richmond portal and Lawson portal flow and water quality data.
>
> Review of EPA and ICIA groundwater data to identify general groundwater levels and groundwater movement.
>
> Underground reconnaissance in the Richmond Mine to identify access, mine conditions, and AMD sources. About 1 percent of the mine volume and

5 percent of the passages (drifts) were accessible and have been preliminarily explored.

Geochemical reconnaissance in the Richmond Mine to identify the composition of observed streams of AMD and acid salts and to obtain information on the distribution and formation of AMD.

Review of available Hornet Mine records. Reconnaissance of the Hornet Mine was not possible because access adits are blocked.

Review of available information and AMD flow records for the Lawson adit. An effort was made to relate the Lawson and Richmond AMD flows and to allocate the source of the Lawson flow between the Hornet Mine and the Richmond Mine.

Study of Boulder Creek hydrology to assess the quantity and quality of contributing flows and overall site flows.

Review of the operation of the Boulder Creek copper cementation plant and ICIA's interim Richmond Mine AMD treatment plant.

II.5 History of CERCLA Enforcement Activities and Remedial Action

EPA's Superfund program became involved with 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 Stauffer Chemical Co. 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 Iron Mountain Mine site was listed on the National Priorities List in 1983. From 1983 through 1985, EPA conducted a remedial investigation/feasibility study of the site and published its report in 1985. After public comment and publication of a Feasibility Study Addendum, EPA signed the first Iron Mountain Mine Record of Decision in October, 1986. That ROD selected a partial remedy at the site, 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 diversion in Slickrock Creek to avoid an AMD generating slide; 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 Spring Creek Debris Dam, the exact size of which would be determined after implementation of other remedies.

During 1987 and 1988, EPA sued the property owner to gain 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 utilized tailings materials from the Minnesota Flat area, as well as selected other tailings piles that contained relatively high concentrations of copper, cadmium, and zinc. EPA completed construction of the partial cap in July 1989.

EPA, through the USBR, began construction of the Slickrock Creek diversion in July 1989 and completed construction in January 1990.

Under an EPA Order, ICIA, on behalf of Stauffer Chemical Company/ Rhone-Poulenc Basic Chemicals Co., began construction of the upper Spring Creek diversion in July 1990. Construction was substantially completed in December 1990.

In addition to the activities implemented pursuant to the ROD, EPA recognized the need for additional actions in light of the drought conditions prevailing in California during the late 1980's. In the winter of 1988-1989, EPA operated an emergency treatment plant at the site to reduce the toxicity of the acid mine drainage releases.

The following fall, in part due to continuing drought conditions, the winter-run chinook were listed as a threatened species under the Endangered Species Act. In August 1989, EPA issued an order requiring that potentially responsible parties operate an emergency treatment plant at the site to reduce the toxicity of the AMD discharges for the upcoming 1989-1990 winter wet season and to provide for metals removal for future years until such time as 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, ICI Americas, Inc., on behalf of Rhone-Poulenc Basic Chemicals constructed the treatment plant and has operated this treatment plant during the 1989-1990, 1990-1991, and 1991-1992 wet seasons. Because of the continuing drought in California and the critical fishery conditions, EPA issued an order on September 2, 1992, for the 1992-1993 wet season requiring that additional emergency measures be implemented, including increasing capacity of the treatment plant.

EPA has also issued an order requiring the PRPs to operate and maintain all EPA-constructed remedial actions as well as the actions taken by the PRPs under other orders.

EPA has identified the following persons as potentially responsible parties (PRPs), parties who may be liable pursuant to CERCLA, for the clean up of the site: the former owner and operator, Rhone-Poulenc Basic Chemicals (successor to Mountain Copper, Ltd., and Stauffer Chemical Company), and the current owner and operator, Iron Mountain Mines, Inc., and its President and primary owner, T. W. Arman. EPA has filed a civil action for recovery of costs and a judgment of liability for future costs against these PRPs. The defendants have denied liability. The defendants have filed cross-claims and have filed counterclaims against the United States (based on alleged U.S. Bureau of Reclamation involvement at the site) and the State of California.

III. HIGHLIGHTS OF COMMUNITY PARTICIPATION

III.A. Community Participation

EPA issued its first Record of Decision for the Iron Mountain Mine site in October 1986. 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). EPA also updated its Community Relations Plan, which was finalized in May, 1990.

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 local media coverage. Although the community has maintained interest in the progress of cleanup at the site, community involvement had been moderate until the winter wet seasons of 1991-1992. Due to the drought conditions facing California and the occurrence of a March 1992 storm which required the special release of 95,000 acre-feet of valuable water resources from Shasta Lake, community interest and involvement in the Boulder Creek OUFS and Proposed Plan was significant. Federal, State, and County elected officials expressed interest and concern regarding cleanup progress and remedy selection.

EPA issued the RI/FS, the Environmental Endangerment Assessment, an updated public health Risk Assessment, the Administrative Record, and the Boulder Creek OU Proposed Plan for public review on May 20, 1992. To fulfill the requirements of CERCLA Section 113(k)(2)(B)(i-v) and Section 117, EPA made these documents available to the public both at the EPA Records Center in San Francisco, California, and at the official information repository at the Shasta County Library in Redding, California. EPA also made the above documents and the large majority of the Administrative Record available to the public at the Meriam Library of the California State University at Chico, California. The notice of availability for these documents was published in the Redding *Record Searchlight* on May 20, 1992. A public comment period was held from May 20, 1992, through July 20, 1992. In addition, a public meeting attended by 200 people was held in Redding, California, at the Red Lion Hotel on June 11, 1992. At this meeting, representatives from EPA and the California Regional Water Quality Control Board, Department of Toxic Substances Control, and Department of Fish and Game made presentations regarding the remedial alternatives under consideration. EPA answered questions regarding the remedial alternatives under consideration and problems at the site. EPA received 19 formal oral comments at the meeting.

EPA received approximately 100 comment letters from the public during the public comment period. A response to comments received during this period is included in the Responsiveness Summary, which is part of this Record of Decision. The Responsiveness Summary includes a transcript of the public meeting. There is also a brief review of principal comments below.

III.B Review of Principal Comments

This section summarizes significant comments received during the public comment period and provides a brief discussion of EPA's response to these comments. Comments addressed in this summary include comments made by members of the general public, the responsible parties, and other goverment agencies. Responses to all of the comments made on the record are included in the Response to Comments.

III.B.1 Comments from the General Public

There was strong public sentiment in favor of taking action to abate the acid mine drainage as soon as possible to protect the fishery and water resources which were being damaged by the IMM discharges. Approximately half of the public comments favored implementation of a treatment plant. Many persons in favor of treatment supported the proposed Simple Mix plant as proven and effective. Several members of the public favored the HDS plant, for reasons such as improved leachability and reduced sludge volume. Many members of the public favored doing more than was proposed by EPA, including many persons who supported implementing the ICI plugging proposal in addition to construction of the external treatment plant.

In selecting the HDS treatment plant as an interim remedy, EPA is selecting a remedy that is consistent with the interests expressed in the public comments. The HDS treatment plant can be installed next year, consistent with the public interest in prompt action. Use of HDS instead of Simple Mix should yield a smaller volume, less toxic sludge, which was a matter of concern raised in several comments. Finally, by selecting the HDS treatment as an interim remedy, EPA does not foreclose the further action sought by those commenters who wished to achieve a more permanent solution.

III.B.2. Comments of Government Agencies

EPA received substantial comments from several government agencies, including regulatory agencies such as the California Department of Toxic Substances Control (DTSC) and the Regional Water Quality Control Board (RWQCB), and natural resource trustees, including the National Oceanic and Atmospheric Administration (NOAA), the California Department of Fish and Game (DFG), the National Marine Fisheries Service (NMFS), and the Department of Interior.

The natural resource trustees submitted a joint letter which stated that the IMM site is "one of the most significant Superfund sites in terms of its impact on natural resources" and "concurred with EPA's selected interim remedy to treat the portal effluent without plugging and flooding of the mine (Alternative No. P-1A) and cleanup of seven pyrite bearing waste piles within the Boulder Creek drainage." The trustees stated that "the storage of alkaline sludge from neutralization processes does not appear to result in significant environmental risk" and supported use of a liner in Brick Flat Pit, the proposed disposal location. The trustees also identified several important concerns with respect to the plugging option and stated that the trustees "also concur with the

EPA's decision not to implement any alternatives that would flood the mine by plugging, at least at this time." In addition, the trustees identified a number of conditions which EPA should consider before implementing any higher risk alternative such as plugging. These conditions included the end of drought conditions, completion of remedial actions, reversal in a decline of salmon and an end to fishing restrictions. The trustees also accurately stated that Basin Plan standards supersede nationwide criteria which were listed for comparative purposes in the FS. The trustees also identified several analytical approaches for future work at the site and requested that the contamination in Keswick Reservoir be considered in a future operable unit. EPA agrees with these comments. EPA's final decision differs with the trustee concurrence in only one minor respect, which is the selection of the HDS as the principal treatment method rather than Simple Mix. As is explained elsewhere in this document, this small change should result in a sludge which has less volume and is less toxic.

DTSC and the RWQCB also submitted a joint letter which stated that "We support and recommend the implementation of Alternative P1, Neutralization Treatment of Richmond/Lawson Flow." DTSC and RWQCB also concurred in EPA's approach of selecting treatment as an interim remedy. Due to materials, transport and sludge disposal requirements, DTSC and RWQCB agreed that "there should be a continued effort towards actions which would reduce or eliminate the long-term burden of neutralization treatment." DTSC and RWQCB also concurred "with the design of a neutralization treatment plant with an approximate capacity of 100 gpm average annual flow and 1,000 gpm daily peak flow." DTSC and RWQCB also identified several design parameters for Brick Flat Pit. EPA agrees that these design parameters should be included in the design evaluation.

DTSC and RWQCB also favored limiting the interim remedial action to five years, and stated that they would support a Richmond mine sealing project subject to several contingencies, including a 600-700 gpm neutralization treatment plant. DTSC and RWQCB stated that it would be necessary to develop an agreement between the responsible parties and the regulatory agencies which would define the precise scope of the program, specify contingencies, and allow for phased implementation. EPA generally concurs that any plugging experiment would need to be subject to carefully developed controls.

EPA disagrees with DTSC and RWQCB in one minor respect; EPA does not agree that the interim remedy needs to be limited to five years. If it is possible to develop another equally effective alternative in the next five years, the selection of that alternative would supersede the current remedy selection. If a term is placed on the remedial action, it could lead to an interruption in treatment at the end of the five year period. CERCLA already requires that EPA review remedial actions every five years. For these reasons, EPA does not believe it would be necessary or appropriate to place a limit on the interim remedy selected today. EPA does agree, however, that "[e]fforts to investigate, select and implement alternatives to reduce the treatment requirements" should continue.

EPA also received comments from the City of Sacramento, the City of Redding and Shasta County Supervisor Molly Wilson. These comments supported the EPA treatment option and strongly encouraged EPA to continue to investigate and implement further remedial actions.

III.B.3 Comments of Potentially Responsible Parties

EPA received comments from Stauffer/ICI and Iron Mountain Mines, Inc. This section principally discusses the extensive comments submitted on behalf of Stauffer/ICI.

Stauffer/ICI, which favors adoption of a plugging alternative, submitted extensive documents during the public comment period, to supplement the considerable amount of information and opinion it had shared with EPA over the past several years. These comments focused on several points, some of which were critical of EPA's proposal to treat the AMD and others which differed with EPA's analysis of the Stauffer/ICI plugging proposal. In large part, these comments repeated points made in earlier submittals or discussions with EPA, or provided additional detail on the evolving Stauffer/ICI proposal.

Stauffer/ICI's comments raised several issues with respect to their opportunity for comment and to present their case to the community. These process concerns are addressed in the response to comments. Stauffer/ICI's substantive comments dealt principally with their criticism of treatment as a final remedy and their disagreement with EPA over the current state of knowledge with respect to the viability of plugging.

With respect to treatment, although Stauffer/ICI agrees that treatment will work, Stauffer/ICI was critical of the sludge disposal problem over the long term. Stauffer/ICI repeatedly emphasized that treatment would be required for over three thousand years if no other remedy were subsequently selected. In selecting HDS treatment, with its smaller sludge volume, EPA is being responsive to the concerns regarding sludge disposal capacity. In addition, by selecting treatment as an interim remedy, EPA is not foreclosing implementation of another option as soon as it is proven to be technically viable and environmentally sound. EPA does not agree with the criticisms of treatment based solely on the amount of time the acid will continue to be generated. Because the treatment plant is only an interim remedy, the focus of concern with sludge disposal and other operational issues should be over the near term, prior to selection of a more permanent remedy. Sludge disposal, for example, does not become a significant constraint over the next decades or even the next century.

Stauffer/ICI also criticized treatment because it would require long term operation and maintenance and argued that in this respect it compared unfavorably with plugging. Although EPA agrees that the level of operation and maintenance would likely be greater under treatment than it would under a completely successful plugging regime, the differences should not be exagerrated. Even if the Richmond mine could be successfully plugged, EPA has concluded that the Hornet mine, the second largest AMD source at IMM, would still be generating acid mine drainage which would need to be handled in some manner, either through treatment or injecting it into the Richmond where it could be treated to some degree within the mountain.

EPA and Stauffer/ICI differ as to how large a problem the AMD generation in the Hornet would be. At times, Stauffer/ICI has minimized the role of the Hornet as a producer of acid mine drainage or has argued that releases from the Hornet/Lawson are principally leakage from the Richmond mine. EPA, however, believes that the Hornet mine is a major source of AMD. The Hornet Portal is the second largest point source of AMD at the site and the Hornet has all the ingredients needed for AMD generation, including sulfides, fractures, and passages for air and water. The water chemistry of Hornet effluent differs from Richmond AMD, suggesting different reactions are responsible for the two flows. Finally, EPA conducted a chemical mass balance study which demonstrated that at most, only a small percentage (1% to 2%) of the Hornet AMD was generated in the Richmond mine. Based upon these studies, EPA believes that even if the Richmond mine could be successfully plugged, the Hornet would continue to generate AMD.

Stauffer/ICI's comments on plugging dealt with numerous specific areas of technical debate between Stauffer/ICI and EPA. Principal areas of disagreement concerned whether the mountain would leak elsewhere where it would be difficult or impossible to contain, whether any leakage would be of good or poor quality, and how well it will be possible to engineer solutions to the identified problems.

Perhaps the most important EPA concern about plugging is whether the AMD will leak out elsewhere. (Stauffer, which now supports plugging with ICI, opposed plugging for just this reason six years ago.) At present, the Richmond and Lawson flows exit the mountain in a location where they can be collected and treated. If these avenues are plugged off, and the mountain does not act as a perfect seal, the AMD will leak out elsewhere, quite possibly in locations in the rugged terrain that are relatively inaccessible or where it is not possible to isolate and treat the flows.

EPA and Stauffer/ICI's differences on the ability of the Richmond mine to hold the mine pool are based upon their different views of the state of our knowledge of the mine. Stauffer/ICI, based in large part on mine maps which have not been provided to EPA, have argued that the mine maps provide a complete picture of all engineered passageways in the mine so that any possible paths for leakage can be identified. EPA believes that our knowledge of the inside of the mine is imperfect and that not only might there be engineered passageways which are unknown to us, but that the manner of mining and the severe collapse of the mine over the last century may have led to additional unknown passageways for AMD release.

What is known about the interior of the mine is based on surface examination, study of mine maps, reconnaisance in the limited portion of the mine which is accessible, and bore holes. EPA believes this currently available information is insufficient to allow it any confidence that the mine will not leak and instead, tends to support the conclusion that the AMD could find other passageways once the Richmond mine is plugged. No one has been able to fully explore the interior of the mine so no one has first hand knowledge regarding the deep interior of the mine. Based upon limited exploration and historical records, EPA and Stauffer/ICI know that huge areas inside the mine were completely mined out and that Mountain Copper did extensive drilling in efforts to locate new deposits. It is also clear from an examination of the surface that there has been considerable settling of the mountain, resulting in collapsing inside the mountain. In the limited areas in the mine where EPA has been able to compare mine maps with the actual mine, the mine maps have been deficient. For example, during the Engineers International Phase III reconnaisance two substopes were encountered. One of these substopes does not appear in any available mine map, and the other is shown incorrectly on the mine maps. The most recent date on available mine maps is 1953, but underground mining continued past that date.

Finally, Stauffer/ICI have relied upon the structural integrity of a geologic formation between the Richmond and Hornet mines to act as a wall to hold in the Richmond mine pool. However, tests of this wall have shown it to be permeable.

The other significant area of debate between Stauffer/ICI and EPA has to do with the quality of any leakage. Stauffer/ICI, in large part relying upon the experience of a dissimilar mine in Norway, believes that the mine pool will stratify or can be made to stratify, or can be made to be neutralized throughout by the injection of neutralizing agents. Because a mine pool of neutral pH will still contain high concentrations of metals, Stauffer/ICI have argued that it would then be possible to introduce biologic agents to induce the precipitation of the metals in the mine pool.

EPA believes that there are significant unresolved issues with respect to this approach. First, it is unclear whether the complex nature of the IMM interior will allow for good neutralization. As is discussed in greater detail in the Response to Comments, EPA has serious reservations about the use of the Lokken mine as a model for IMM, given the many dissimilarities between the two. Secondly, the use of biologic agents in the manner proposed is an innovative approach that requires further study before EPA is willing to commit to an approach that may require their use to be effective.

Stauffer/ICI has also criticized the treatment approach because it will (in 3400 years) result in depletion of the mineral resource. Stauffer/ICI asserts that the plugging proposal preserves the mineral resource. EPA does not agree. The plugging proposal will prevent the use of in situ mining techniques, like those favored by the current mine owner, and it will create sludge within the mine which will create additional problems for persons who attempt to either drain the mine or strip mine it. Construction and operation of the treatment plant, however, is not inconsistent with in situ mining operations or other innovative resource recovery methods which may become available in the near future.

IV. SCOPE AND ROLE OF THE OPERABLE UNIT WITHIN SITE STRATEGY

IV.1 Role of the Remedial Action

In accordance with the program management principles identified in the NCP and 40 C.F.R. § 300.430(a)(1)(ii)(A) and (B), EPA has designated all of the sources of metal and acidity contamination within the Boulder Creek drainage basin at Iron Mountain as an operable unit. The physical boundaries and features of the Boulder Creek basin that define the Operable Unit are shown in Figure 5.

EPA has determined, in conference with the California support agencies, that the designation of the Boulder Creek Operable Unit will allow the EPA to focus its RI/FS efforts at this large and complex Superfund site to more quickly achieve a significant risk reduction and ultimately expedite the total site cleanup. To achieve the greatest risk reduction in an expeditious manner, however, it has been necessary to focus the FS further to take into account the following observations:

- The Richmond and Lawson portal AMD discharges have been identified by EPA's RI efforts as the two largest sources of metal contamination on Iron Mountain. These portals discharge an estimated 40 percent of the copper and 80 percent of the cadmium and zinc reaching the Sacramento River. Remediation of these sources would provide an immediate significant reduction in acid water and heavy metals loading to the environment.

- The Richmond and Lawson portal AMD discharges are the source of an estimated 80 to 98 percent of the heavy metals in Boulder Creek (EPA, 1992a; dry period sampling). The unusual concentration of AMD from the two point sources suggests that complete remediation of the portal flows and effective control of miscellaneous sources within the Boulder Creek basin might restore Boulder Creek surface-water quality to premining natural background levels. However, existing information suggests that this goal may be technologically impracticable because of inability to completely control both large and small sources.

- A phased analysis and response is necessary and appropriate at IMM. Detailed information regarding specific sources (e.g., the specific Richmond Mine geometry, mineralization, and condition) is required to appropriately evaluate remedial alternatives for each source.

- Results from implementation of remedial actions for sources in the Boulder Creek Operable Unit will be important considerations in setting remedial action objectives for an overall final site remedy. If, as expected, water management capabilities remain a component of the final site cleanup plan, the degree of success in halting or reducing the

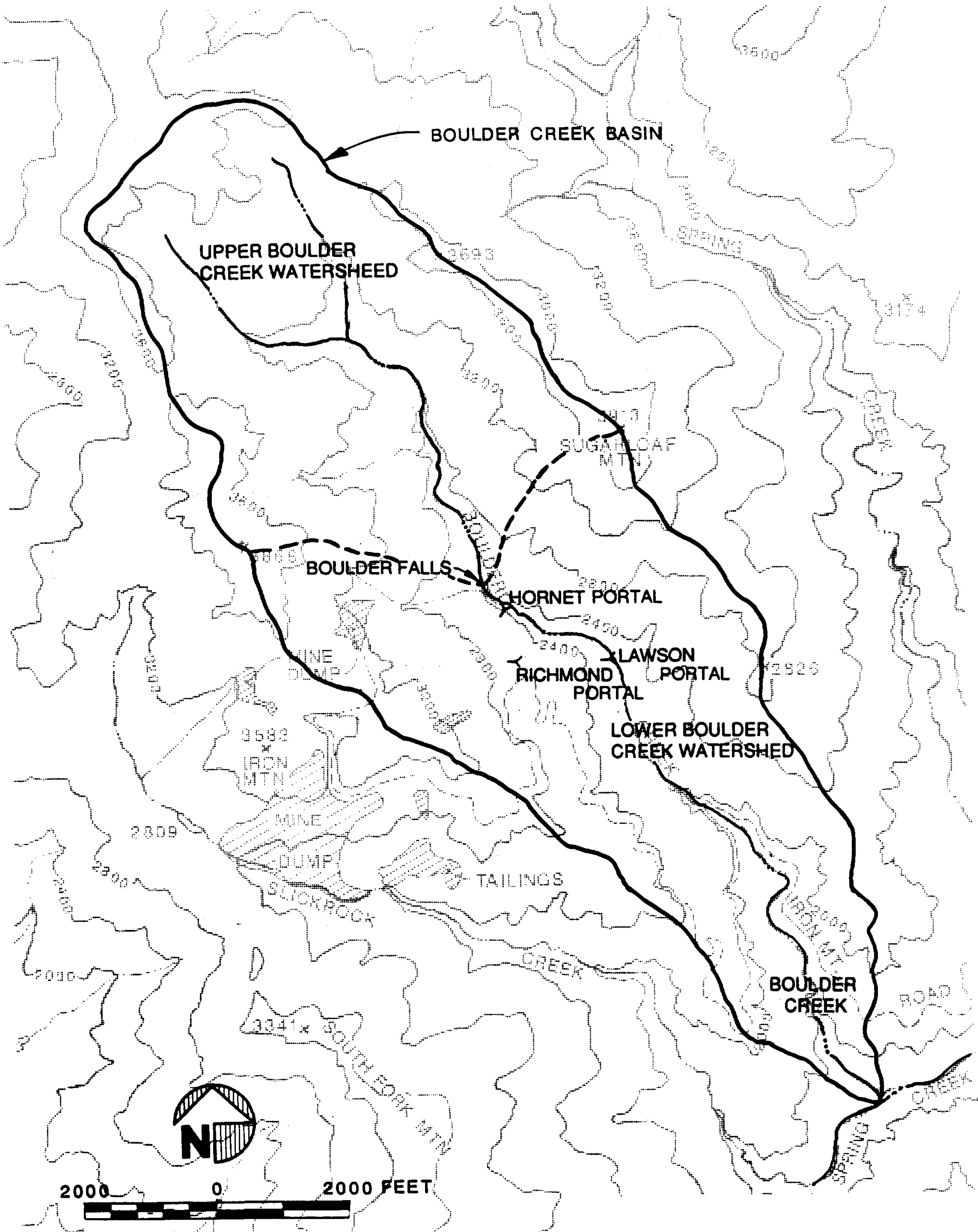

FIGURE 5
BOULDER CREEK BASIN
IRON MOUNTAIN MINE ROD

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AMD discharge will affect the ultimate design and cost of the water management system.

IV.2 Scope of the Problem Addressed by the Remedial Action Selected

The Boulder Creek OUFS considers remedial alternatives for (1) the two largest sources of acidity and metals contamination at IMM, the Richmond portal discharge and the Lawson portal discharge; and (2) the numerous waste rock piles, tailing piles, seeps, and contaminated sediments that also affect contaminant levels in Boulder Creek. Because this FS represents only an interim remedy for a portion of the site, consideration of alternatives for these sources takes into account the need to be consistent with future remedial action and the need to reduce significant risks as soon as possible.

EPA expects to require an additional study of the sources in the Slickrock Creek drainage; sediments in Slickrock Creek, Spring Creek, Spring Creek Reservoir, Keswick Reservoir, and the Sacramento River; and other impacted areas and sources of contamination. The additional study will also assess potential water management options, including the need to coordinate releases of acidic waters with Central Valley Project water releases. EPA is currently developing a work plan for this additional RI/FS activity.

V. SITE CHARACTERISTICS

V.1 Known or Suspected Sources of Contamination

The Richmond and Lawson portal AMD discharges have been identified by EPA's RI efforts as the two largest sources of metal contamination on Iron Mountain. These portals discharge an estimated 40 percent of the copper and 80 percent of the cadmium and zinc reaching the Sacramento River. The Richmond and Lawson portal AMD discharges are the source of an estimated 80 to 98 percent of the heavy metals in Boulder Creek (EPA, 1992a; dry period sampling).

Piles of overburden from open pit mining, muck from underground mining, and tailings from ore beneficiation have been mapped in the Boulder Creek OU. Some of these waste piles have been classified as secondary AMD sources on the basis of chemical testing of grab samples, inspection and classification by a geologist, presence of AMD discharges from the piles, and/or active erosion of the pile. These waste piles contribute to the site discharges of AMD, particularly during storm events.

V.2 Contamination

Acidic water appears to be forming at any location on the site where sulfides, water, air, and microbial activity are present. It appears to be coming from all parts of the Richmond Mine. Flows have been observed from the three haulage drifts, in the shafts, many orechutes, and in various parts of the Richmond adit. Acid water also enters the Richmond adit from the Mattie Mine. Acidic water in the Lawson adit appears to be largely the result of chemical activity in the Hornet Mine. Acidic drainage has also been observed from the Confidence adit, the Old Mine, and No. 8 Mine on the Slickrock Creek side of Iron Mountain. Finally, there is evidence of acidic drainage from mine tailings and waste rock on both the Boulder Creek and Slickrock Creek sides of Iron Mountain.

AMD flows year-round from the Richmond portal. This flow has been monitored for flow rate and water quality on a regular basis since 1983, and the flow rate has been monitored continuously in the wet season since 1978 (Table 2-5). The flow normally increases within a few hours to several days of the start of a major storm. The relationship between the storm intensity and the peak portal flow appears complex, possibly reflecting the volume of water in storage in the mine and surrounding ground and the geometry of the mine. The observed flows have ranged from 8 to 800 gpm with a mean rate of 70 gpm. The quality of the AMD also varies in a complex fashion with the season and storm intensity. The pH is commonly less than 1, and the mean metals loadings in mg/l is 250 for copper, 1,600 for zinc, and 12 for cadmium flows year-round from the Lawson adit.

Table 2-5
Summary of Water Quality and Flow Data for Richmond and Lawson Portals from 1983 through 1990

	Richmond Portal				Lawson Portal			
	No. of Samples	Mean[a]	Minimum	Maximum	No. of Samples	Mean	Minimum	Maximum
Flow (gpm)	143	70	8.1	800	140	40	13	236
pH	106	0.78	0.02	1.52	101	1.61	0.55	2.8
Copper, total (mg/l)	142	250.1	118	648	139	87.7	47.3	147
Zinc, total (mg/l)	144	1,599	695	2,620	139	512	284	836
Cadmium, total (mg/l)	142	11.9	3.5	19.2	138	3.5	1.9	7.6
Copper load (lb/day)	141	260	17	5,575	139	43	11	335
Zinc load (lb/day)	143	1,117	158	10,958	139	218	97	920
Cadmium load (lb/day)	141	8.6	1.2	79	138	1.5	0.6	5.8

[a]Mean average calculated as sum of samples divided by number of samples.

The Lawson portal AMD flow rates are less than the Richmond portal flows, and the water quality is generally better than the Richmond portal flows. The flow rates range from 18 to 236 gpm with a mean rate of 40 gpm. The pH is commonly about 1.65, while mean metals loading values in mg/l are 88 for copper, 512 for zinc, and 4 for cadmium.

The literature reveals that the AMD from the Richmond Mine is among the most acidic and contains among the highest metals content of any characterized mine drainage in the world, and the AMD from the Lawson adit apparently ranks in the worst 10 percent of the reported cases with respect to pH and metals loading. In terms of copper and zinc discharges, Iron Mountain Mine discharges 2 to 3 times the total combined discharges from California's other 37 largest inactive mines.

Reconnaissance of the 2600 and 2650 levels in the Richmond Mine revealed an unexpectedly large volume of resident solid and liquid acid, each with high metals content. Solid acid is found encrusting the walls of tunnels and other mine openings and forming small and large pendants and columns like the dripstone of a limestone cave. Small pools of exceptionally concentrated acid were also noted in several areas. Some of the solid acid deposits showed evidence of erosion during partial mine flooding, apparently during and after large storms. Many of the solid deposits appear to be growing and may include materials deposited 50 years ago. Relatively large dripstone features have developed in the Richmond adit in less than 2 years.

The volume of resident acid is unknown but is large if the deposits in the accessible openings are a reliable indication of the conditions in all of the openings caused by the mining. The accessible mine openings have 1 to 5 percent resident solid acid salts by volume. If the mine has an average of 5 percent resident acid salts by volume, flooding of the mine to stop further acid production is expected to dissolve the solid acid salts and dilute the acid pools. The solution of about 25 acre-feet of acid salts would create about 500 acre-feet of typical Richmond portal AMD, or about 4 years of average flow from the Richmond portal.

Secondary sources of AMD discharges containing acidity and high concentrations of copper, cadmium, and zinc are the numerous waste piles located in the Boulder Creek OU. Many of these piles are composed completely of pyritic minerals or contain pyritic minerals in high concentrations. These minerals react with oxygen and water to create sulfuric acid and similarly to release metals from the mineralization. Storm events can quickly wash the metals and acidity into surface waters and, as is often the case, erode the pyritic materials off of the steep slopes into the surface waters. The waste piles vary in volume with some overburden piles containing as much as 100,000 cubic yards of material each, while seven waste piles identified for remediation are composed almost completely of pyritic materials and have a total volume estimated to be less than 50,000 to 70,000 cubic yards.

V.3 Location of Contamination and Known or Potential Migration Routes

As discussed above, analytical data collected over 40 years indicate that Iron Mountain is releasing large quantities of contaminants to the environment (primarily surface water) via AMD. The AMD is characterized by low pH (1 to 3) and very high concentrations of heavy metals.

The water quality parameters of concern from a public health exposure perspective are pH, cadmium, copper, and zinc. These parameters are selected because of potential dermal contact effects caused by low pH and potential consumption of AMD (with these three metals being of greatest concern from a water consumption perspective).

The contaminants of concern from the perspective of fisheries (salmon and steelhead trout) exposure are pH, cadmium, zinc, copper, and aluminum. These parameters are selected because of their toxicity, primarily to salmonids, at low pH levels and concentrations ranging from 1 μg/l for cadmium to 100 μg/l for aluminum (copper toxicity levels are in the range of 10 μg/l, and zinc toxicity levels are in the range of 50 μg/l). For comparison 1 μg/l equals 0.001 mg/l.

The contaminants of concern with respect to terrestrial wildlife include arsenic as well as those listed above for aquatic species.

The major mechanism for onsite and offsite transport of contaminants is surface water. The AMD enters Boulder and Slickrock Creeks, and these two creeks discharge into Spring Creek, which flows to the Sacramento River at Keswick Reservoir.

The major processes that appear to affect the fate of transported copper, cadmium, and zinc are coprecipitation with iron hydroxides or precipitation as carbonates. Metals concentrations are further reduced and surface-water pH is raised by dilution as Spring Creek discharges into the main body of Keswick Reservoir (Figure 1).

AMD from the Richmond and Lawson portals is physically transported by a system of open-topped flumes to a copper cementation plant located along lower Boulder Creek. The flume system traverses steep slopes and frequently spills its contents when the flume overflows or collapses. Also, regularly spaced leaks of AMD occur at joints in the flume. Spilled or leaked AMD acidifies the receiving soil and deposits highly concentrated metal salts into the terrestrial wildlife habitats. The degree of consumption of these salts by deer and other animals is not presently known.

The contaminants of concern can be biologically transported through the aquatic food chain. For example, the initial uptake of contaminants would be by phytoplankton, periphyton, and other aquatic vegetation. These food sources would be ingested by benthic invertebrates and/or zooplankton. The plankton and benthos would be ingested by fish at subsequently higher trophic levels and ultimately consumed by birds, animals, and humans.

VI. SUMMARY OF SITE RISKS

VI.1 General

Iron Mountain Superfund site was placed on the National Priorities List on September 8, 1983. The site was listed because of the impacts of metals-laden AMD discharges on the Sacramento River, a major fishery and source of drinking water for the City of Redding and other domestic water supplies. The Iron Mountain site has been associated with water quality degradation and impacts on aquatic resources in nearby drainages during much of its history. Impacts include numerous fish kills in the upper Sacramento River (39 documented fish kills since 1940), the primary salmon-producing river in California (CDWR, 1985; CDFG, 1990). In addition, those portions of

Boulder Creek, Slickrock Creek, and Spring Creek that receive AMD from Iron Mountain are essentially devoid of aquatic life.

The rationale for the Boulder Creek Operable Unit is to address elevated metals emanating from Boulder Creek into Spring Creek and subsequently entering the Sacramento River. From the results of the RI, the endangerment assessment, and the ARARs analysis, the following problem areas are identified for remedial action.

The Richmond portal discharge is the largest source of AMD and metals in the Boulder Creek Operable Unit and in the United States. This discharge is the result of year-round geochemical reactions in the mine workings involving infiltrating water, air, bacteria, and elevated temperatures. The Richmond portal AMD has the potential to cause environmental damage because the flows are permanent, they continue at a significant rate year-round, and the metals loading is uniquely high.

The Lawson portal discharge is the second largest source of AMD and metals in the Boulder Creek Operable Unit. The Lawson portal AMD flow rate is about 50 percent of the Richmond portal, and the metals loading is about 20 percent of the Richmond portal. The Lawson portal AMD is also one of the largest sources of AMD in the United States. The Lawson portal appears to be a separate and a permanent source of AMD.

Waste piles include tailings from beneficiation activities at the mine, the dumping of mine cars with sulfide contents below processing facilities, and rock wasted during mining operations. Collectively, these piles are the third largest source of AMD, contributing an estimated 3 to 20 percent of the metals to Boulder Creek. The piles have widely varied potential for AMD generation. Piles with high sulfide content and a potential for future erosion have been identified and characterized for possible future remediation.

VI.2 Human Health Risks

The potential for direct human exposure to AMD is relatively small. The property owner has posted the property to discourage trespassers who might become exposed, although the property is located between two heavily used national forests, and direct exposure cannot be ruled out as a possibility.

Persons who might come into direct contact or consume concentrated AMD at Iron Mountain could be at risk. Such persons include people working, living, or hiking at the site. Individuals who enter the Iron Mountain site are at risk if they have direct contact with or ingest the AMD. The risk of such exposure is limited by controlled access to the minesite.

Persons who might come into direct contact with surface water downstream from Iron Mountain include people working, living, hiking, or swimming near the site. Individuals who come in direct contact with water or sediments from the main body of Keswick Reservoir or Sacramento River are not currently at risk.

Persons who might consume surface water downstream from Iron Mountain include people working, living, or hiking near the site. Persons who might consume fish taken from the Sacramento River downstream from Iron Mountain includes the general population in the upper Sacramento River Valley. Individuals who consume fish from the main body of Keswick Reservoir or Sacramento River may currently be at some risk; the uncertainties associated with this scenario are great and likely would result in the risk being overestimated.

Children are at somewhat greater risk than adults, when considering noncancer toxicity resulting from incidental ingestion of creek water downstream from Iron Mountain.

VI.3 Environmental Risks

The principal risks posed by the runoff of metals-bearing AMD from Iron Mountain are the associated impacts on aquatic life in the Spring Creek drainage, Keswick Reservoir, and the Sacramento River downstream of Keswick Dam. Among these natural resources, the most important are the fishery resources in the Sacramento River downstream of Keswick Dam. Migratory populations of chinook salmon, steelhead trout, resident trout, and numerous other aquatic and terrestrial species can be or are affected by AMD from Iron Mountain (EPA, 1992b).

The salmon and steelhead trout populations have high commercial and/or recreational value to the region (USFWS and USBR, 1984; USFWS and CDFG, 1987). The susceptibility of these populations to contaminants originating from Iron Mountain has been documented (Wilson, 1982). One of the chinook salmon runs, the winter run, is a species listed by the Federal Government as threatened with extinction and listed by the State of California as a species endangered with extinction.

Pollution from Iron Mountain is considered to be a major factor causing the decline in Sacramento River fishery resources, and an impediment in achieving fishery resource restoration goals. Other major factors contributing to the decline include loss of spawning habitat, predation, habitat degradation, mortality at dams and diversions, overfishing, and natural disasters (such as drought) (Vogel, 1989). Fish migrating into the uppermost river reach of the Sacramento River risk being killed by AMD from Iron Mountain; offspring of adult fish spawning in that reach have reduced chances of survival due to the Iron Mountain AMD (Finlayson and Wilson, 1979). There is an indication that AMD from Iron Mountain has reduced the suitability of available spawning grounds for salmon in the uppermost reaches of the Sacramento River and that fish population reductions have occurred following uncontrolled spillage of Iron Mountain AMD (Finlayson, 1979). The greatest decline in salmon-spawning populations has occurred within the uppermost river reach from Balls Ferry upstream to Redding, a distance of approximately 26 river miles (NOAA, 1989).

Since the late 1960s, when fish counts were initiated at Red Bluff Diversion Dam (RBDD), each of the anadromous salmonid runs has suffered major declines. A more extensive data base is available specifically for fall-run chinook. This data base demonstrates that recent levels of spawning escapement to the upper Sacramento River are only about 50 percent of levels observed during the late 1950s. The greatest decline among the salmon runs has occurred for the winter run, which has been reduced to less than 5 percent of run sizes during the late 1960s. This serious decline prompted the 1989 listing of this fish as a threatened species by the Federal Government (NMFS, 1989) and an endangered species by the State of California (CDFG, 1989).

The primary potential exposed fisheries populations are the salmonids and steelhead trout present in the Sacramento River; Boulder Creek and Spring Creek are devoid of fisheries and aquatic invertebrates below the mine drainage area. The upper Sacramento River chinook salmon runs, steelhead trout run, and resident populations of rainbow trout have life history characteristics that make them vulnerable to potential adverse effects from AMD originating from Iron Mountain. The probability and magnitude of potential exposure depends on the releases of contaminated water from Spring Creek Debris Dam (SCDD), the releases of water from Shasta Dam, and the life stages present within the zone of impact.

For spring- and fall-run chinook salmon, in a worst-case scenario, approximately half of an entire year's fall spawning production could be at risk from contaminants released from Iron Mountain. The impact of the release depends in large part on the pattern of releases from Shasta Dam relative to when releases occur from IMM. For example, if flood control releases from Shasta Dam could cause most of the year's production to migrate downstream of the affected water quality zone, thereby reducing the AMD's impact.

Winter-run chinook salmon could be at higher risk compared to other runs. They are most likely to seek cooler water areas closest to Keswick Dam due to potentially lethal water temperatures in lower reaches of the Sacramento River. Under drought-type conditions, these fish are the most important to future runs because eggs laid farther downstream are more likely to be adversely affected by lethal warm water temperatures. However, these same drought conditions are more likely to create conditions (uncontrolled AMD release and low dilution in the Sacramento River) where AMD from Iron Mountain could pose a high risk to juvenile rearing in the uppermost reach of the river.

The steelhead trout and resident rainbow trout populations that are potentially at risk are not well defined or understood. However, both the adult and yearling life phases are potentially at risk because both are present in the river when fish kills have historically occurred.

At present, a memorandum of understanding commits the U.S. Bureau of Reclamation (USBR) to operate SCDD in a manner that (when considering releases of dilution water from Shasta Dam) will protect aquatic life in the Sacramento River downstream of Keswick Dam. The USBR must also operate Shasta Dam to provide electric power, irrigation water, and flood control. The USBR estimated that during an average year it may lose between $16 million and $168 million, depending on the level of protection required in the Sacramento River, by supplying water to dilute Spring Creek flows. There is the potential that USBR's ability to supply adequate dilution water will be further reduced due to conflicting priorities for water use, thereby increasing the potential risk to the aquatic community.

It is extremely difficult to quantify fish mortality in the Sacramento River as a result of contamination from Iron Mountain. This is due to a variety of factors, including the general size of the Sacramento River downstream of Keswick Reservoir and difficulty of visually observing dying or dead fish during periods when the water is turbid. However, there have been 39 documented fish kills near Redding since 1940, and there have been observations of adult steelhead mortalities near Redding attributable to metal contamination from Iron Mountain since installation of the SCDD.

Boulder and Spring Creeks, downstream from Iron Mountain discharges, do not support aquatic populations, and the creeks may remain sterile following remediation at Iron Mountain. Aquatic populations, water column and benthic, in Keswick Reservoir downstream of Spring Creek are at risk because of sediment contamination, as well as water column contamination. Below Keswick Dam, contaminant concentrations occasionally exceed toxic concentrations for sensitive life stages and frequently exceed both EPA and State of California criteria to protect aquatic life, indicating that these populations are also at risk.

Any terrestrial wildlife onsite has the potential for direct exposure to AMD, such as deer drinking from contaminated creeks or licking metals-laden salts along the flume system, or consuming contaminated plants, fish or other organisms. More than 300 species of amphibians, reptiles, birds, and mammals can be expected to occur in the Boulder Creek basin and downstream areas that may be directly exposed to AMD.

VII. DESCRIPTION OF ALTERNATIVES

VII.1 General

The general response actions, technologies, and options for portal discharge and the results of this screening process are summarized for each general response action in Figures 6 and 7. This section also discusses the alternatives for the waste piles.

The technologies and options that have been screened out as infeasible are shown by boxes with cross-hatching. These options have been judged to be infeasible because of known technical limitations. It is unlikely that new information about the Iron Mountain Mine site or applications elsewhere would justify further consideration of these options.

GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
No Action	None	None	No Action.	Retained per the NCP.
Containment	Mine Sealing	Low-Density Cellular Concrete	Cement grout is placed in the mine workings to seal the pyrite from groundwater.	Questionable overall effectiveness, difficulty in implementing, and high cost. Not retained.
	Plugging	Classical Plugging	Cement plugs are placed in strategic locations to flood the mine workings, halting the generation of AMD. No efforts are made to manage the mine pool	Due to uncertainty associated with containment and mine pool quality, this option is perceived to have an unacceptably high risk. This option is the least favored plugging option and is screened out. Not retained.
		Plugging with Mine Pool Management	Same as classical plugging except efforts are made to manage the mine pool quality and overflow.	If effective, potential risk is reduced when compared with classical plugging, by mine pool conditioning, contingent containment upgrade by grouting, and monitoring. Retained.
	Air Sealing	Air Doors	Air seals are placed in mine workings to limit air flow, decreasing the generation of AMD.	Control mine atmospheric replenishment. Limited precedence and varied success. Retained. Ghosted.
		Inert Gas Blanket	Inert gas blanket is pumped into workings to eliminate oxygen in the mine atmosphere.	Potential innovative approach to reduce the oxidation of pyrite. May be used in conjunction with air doors. Retained. Ghosted.
	Groundwater Control	Vertical Barrier	Grout is injected into the bedrock to decrease its inherent permeability.	Potentially applicable in conjunction with capping or plugging to decrease groundwater flow into or out of the mine. Retained.
		Wells	Wells are drilled from surface to intercept groundwater prior to interaction with pyrite.	High capital and operating costs and uncertain effectiveness. Not retained.
		Tunnels	Gravity drainage into drifts using boreholes drilled upwards into bedrock to intercept groundwater.	High capital and moderate operating costs and uncertain effectiveness. Retained. Ghosted.
	Capping	Clay	Clay is used to limit surface infiltration above mine workings.	Clay sources uncertain and performance uncertain. Not retained.
		Shotcrete	Pneumatically placed concrete is used to limit surface infiltration above mine workings.	Effective at reducing infiltration and therefore reducing the amount of AMD that is generated inside the mine workings. Resistant to erosion. Retained.
		Synthetic Membranes	Flexible membrane liner is constructed above mine workings infiltration. Placed on prepared soil base, anchored and protected from surface damage.	Similar to shotcrete. May be less implementable in rugged terrain. Retained.
Treatment of AMD	Physical-Chemical/ Resource Recovery	Neutralization	These are the primary treatment technologies for AMD. Caustic soda or a high-density sludge process using lime and sulfide polishing are two viable methods.	Both methods are implementable and effective in removing metals. High-density sludge may be able to produce a nonhazardous sludge. Retained.
		Precipitation		
		Cementation	Copper-bearing AMD is passed over scrap iron, plating out copper.	Proven and reliable. Currently used at IMM. Copper is efficiently removed. Retained.
		Membrane Processes	These are associated with innovative resource recovery process or secondary treatment processes.	The implementability and effectiveness of the resource recovery options are less well defined than the retained processes. EPA retains these options because they potentially offer lower costs than traditional treatment, and they meet the intent of the NCP to use innovative technologies. Future bench-scale testing may provide insight to the applicability of resource recovery. Retained. Ghosted.
		Crystallization		
		Liquid-Liquid Extraction		
		Ion Exchange		
	Biological	Wetlands	Constructed wetlands are used to remove metals from water. This is viable only as a secondary treatment step.	Current strength AMD from portals is too acidic and high in metals for wetlands. Large land requirements are difficult to accommodate at the site. May become viable if current quality of AMD is improved by implementing other technologies. Retained. Ghosted
	Passive	Evaporation Ponds	Ponds are used to evaporate AMD.	Limited space and high rainfall at mine site make this difficult to implement. Not retained
Disposal of Sludge	Fixation/Stabilization	Pozzolanic Agents	Materials are added to "hazardous" sludge so that it can be disposed of according to regulatory requirements.	The need for fixation/stabilization is not known; technology is implementable and effective. Retained.
		Encapsulation		
	Landfill	RCRA landfill	Hazardous sludge can be disposed of offsite (380 miles away) or onsite.	A large volume of sludge could be generated; all options are retained, except the use of the mine workings, which cannot practicably be rehabilitated to comply with RCRA
		Non-RCRA Landfill	Nonhazardous sludge can be disposed of offsite (10 miles away) or onsite.	A large volume of sludge could be generated, all options are retained
Discharge of Treated Water	Dilution By Surface Water	Outfall	Treated water can be discharged onsite (Boulder Creek) or offsite (Sacramento River).	The onsite option is retained because it offers equivalent effectiveness and is easier to implement. Retained
	Injection	Wells	Treated water can be injected back into the flooded mine workings (also could be preadjusted to aid in buffering of the mine pool).	Potentially viable if plugging is selected for portal flow source control. Retained

NOTES

1. TECHNOLOGIES AND PROCESS OPTIONS SCREENED OUT (NOT RETAINED) ARE SHOWN WITH HATCHING.
2. DASHED BOXES REPRESENT OPTIONS THAT ARE NOT USED IN THIS OUFS BUT ARE NOT SCREENED OUT. THESE MAY BE USED AT THE SITE IN FUTURE REMEDIAL ACTIVITIES.

FIGURE 6
SCREENING OF REMEDIAL TECHNOLOGIES FOR MINE PORTALS
IRON MOUNTAIN MINE ROD

GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
No Action	None	None	No action.	Retained per the NCP.
Containment	Capping	Shotcrete	Pneumatically applied concrete is used to limit surface infiltration on waste piles.	Effective at preventing or reducing erosion of the waste pile. Reduces potential for generation of AMD by reducing infiltration. Implementability depends on location of waste pile. Not retained.
		Clay	Clay is used to limit surface infiltration on waste piles.	Similar to shotcrete, but less resistant to erosion, and subject to desiccation cracking. Not retained.
		Geosynthetic membrane*	Geosynthetic cap is constructed on waste piles.	Similar to shotcrete, but may require less maintenance. Not retained.
	Surface Controls	Grading	Mechanical equipment is used to reshape piles to limit surface water run-on.	Not effective unless combined with diversion systems. Not retained.
		Diversion Systems	Ditches or berms are used to limit surface water run-on to the piles.	Should be effective at controlling erosion; is most effective in combination with capping. Retained.
Removal	Excavation	Backhoes & bulldozers	Mechanical equipment is used to remove the piles.	Commonly used; effective and implementable. Retained.
Treatment	Stabilization	Pozzolanic Agents	Materials are added to meet regulatory requirements for disposal.	The need for stabilization is not yet known; the technology is implementable and effective. Retained.
	Resource Recovery/ Physical-Chemical	Flotation	Resource recovery treatment processes may be able to recover metals, plus generate a nonhazardous waste product. Some of these techniques were used previously to process ore at IMM.	The implementability and effectiveness of resource recovery is unknown, although removal efficiencies probably will be low. Not retained.
		Soil Washing		
		Neutralization		
Disposal	Landfill	RCRA Landfill	Hazardous material can be disposed of offsite (380 miles away) or at a new facility onsite.	All options are retained, except the use of the mine workings, which cannot practicably be rehabilitated to comply with RCRA.
		Non-RCRA Landfill	Nonhazardous material can be disposed of offsite (10 miles away) or at a new facility onsite.	All options are retained.

NOTES

1. TECHNOLOGIES AND PROCESS OPTIONS SCREENED OUT ARE SHOWN WITH HATCHING.
2. * SELECTED REPRESENTATIVE PROCESS OPTIONS FOR ALTERNATIVE DEVELOPMENT.

FIGURE 7
SCREENING OF REMEDIAL TECHNOLOGIES FOR WASTE PILES
IRON MOUNTAIN MINE ROD

The technologies and options that have been screened out because of inadequate precedent or inadequate information about their application to the Iron Mountain Mine site are shown by boxes with dashed lines. This screening is based largely upon a judgment that existing information does not provide a strong or complete case for successful application of this option. There is a possibility that additional information about the site or other applications may justify a future reexamination of these options and possibly their inclusion as part of adopted remedial alternatives.

The Feasibility Study addressed four basic alternatives for control of the portal AMD. They are P0—No-Action, a mandated base-line alternative, P1—Treat Portal Flows (with Simple Mix and HDS subalternatives), P2—Plug Mine, Internal Pool Treatment and Treat Residual Flows, P5—Plug Mine, External/Internal Pool Treatment and Treat Residual Flows, and P6—Cap and Treat Portal Flows (with Simple Mix and HDS subalternatives). The main elements of these alternatives are described below.

VII.2 Alternative P0—No-Action

The "no-action" alternative, P0, is developed and evaluated as required by the NCP in 40 C.F.R. § 300.430(e)(6).

The no-action alternative is commonly used as a baseline alternative against which other alternatives are judged. As the name implies, this alternative does not include any additional remediation activities. The no-action alternative would include provisions for limited monitoring, operation, and maintenance of the copper cementation plants and operation and maintenance of the projects constructed pursuant to EPA's 1986 ROD.

Without further remediation, the AMD production and discharge at Iron Mountain is expected to continue for centuries until such time as the sulfide-rich mineralization is completely depleted. This geochemical process is expected to continue with the same or similar pattern and intensity of the current discharges for the foreseeable future.

VII.3 Alternative P1—Treatment of Flows from Portals

The treatment alternative mitigates the effects of AMD discharges by collecting and treating the AMD as it flows out of the Richmond and Lawson portals. The purpose of treating the AMD is to neutralize the acidity and cause the heavy metals to precipitate out of solution. The heavy metals-laden sludge derived from treatment plant operations would require disposal and long-term management consistent with applicable or relevant and appropriate regulations.

The treatment technology is well developed in general. At Iron Mountain, ICIA has operated a simple-mix treatment plant and demonstrated capability of neutralizing Richmond portal AMD flows and removing greater than 99 percent of the copper, cadmium, and zinc. Treatment plants can be designed to meet various discharge standards including stringent standards. Collection and treatment of AMD would not compromise the current nature of the AMD discharges as point source discharges.

The treatment alternative consists of the following components:

A system for collecting AMD flows from the Richmond and Lawson portals, which includes the adits and facilities to physically collect the flows, prior to the delivery system

Pumping stations and pipelines or gravity drainage pipelines to deliver the AMD to the treatment plant

Equalization systems to provide for flow equalization and equalization of chemical constituents in the AMD

Treatment plant facilities

Sludge handling and disposal facilities

Monitoring

VII.4 Identified Treatment Options

A detailed evaluation of water treatment technologies that might be applicable for the Iron Mountain site was performed. That evaluation identified three treatment technologies that are considered to be viable options:

Simple mix precipitation using calcium hydroxide
Lime/sulfide high-density sludge (HDS) precipitation
Caustic precipitation

For purposes of evaluation, the peak design capacity of the treatment plant is assumed to be 1,050 gpm. This anticipates simultaneous peak flows from the Richmond and Lawson portals of 800 and 250 gpm, respectively. Annual average flow is assumed to be 94 gpm, based on measured Richmond and Lawson portal flows.

Based on the available information, it is estimated the sludge from the lime/sulfide HDS treatment process may result in a sludge of 50 percent solids with a bulk density of nearly 95 pounds/cubic foot. Under these assumptions, approximately 30,000 cubic yards of sludge would be produced annually and require disposal. Under the Simple Mix treatment method outlined in the Proposed Plan, it is estimated that approximately 110,000 cubic yards of sludge would be produced annually and require disposal.

Brick Flat Pit will be modified for sludge disposal as a non-RCRA landfill, including a landfill engineered to comply with California regulations governing mining waste disposal. Conditions in Brick Flat Pit are expected to meet or surpass non-RCRA landfill requirements and may approach or approximate RCRA requirements with a moderate level of modifications.

VII.5 Alternative P2—ICIA Plugging Alternative

The plug and treat approach developed for consideration by ICIA relies upon improvements to the mine facilities to assure containment and injection of neutralizing agents into the mine workings to control the chemistry of the mine pool as it is formed. The ICIA approach would also involve establishing a colony of microbes to aid in reducing metal concentrations and oxygen content of the water in the mine pool. Table 4-3 from EPA's Feasibility Study provides a comparison of components of the various plugging approaches considered. Figure 8 provides a simplified graphical depiction of the mine workings and some of the key physical features related to plugging approaches.

Table 4-3
Components of the Plugging Alternatives

Component	P2 Mine Plugging With Internal Treatment (ICIA Alternative)	P3 Mine Plugging With Internal Treatment	P4 Mine Plugging With External Treatment	P5 Mine Plugging With External-Internal Treatment
Rehabilitate Mine				
A-Drift	★	•	•	•
B-Drift	•	•	•	•
C-Drift	○	•	•	•
2550 Substope	•	•	•	•
2650 Grizzly	•	○	○	○
Lawson Tunnel	○	•	•	•
Confidence Decline	○	•	•	•
Alternative Access to Lawson Decline Plugs	★	★	★	★
Backfill				
D-Drift	•	•	•	•
Scott Platform	•	•	•	•
Abandoned Mine Borings	○	•	•	•
Grouting				
Pillar Exploration and Grouting Test	○	•	•	•
Grout Curtain	★	★	★	★
Injection Wells	19	50	25	40
Lime Stowage	•	•	○	○
Pumping Systems				
Lawson—Brick Flat Pit	•	•	•	•
Richmond—Brick Flat Pit	•	•	•	•
Boulder Creek—Brick Flat Pit	•	•	•	•
Slickrock Creek—Brick Flat Pit	★	★	•	•
Confidence—Brick Flat Pit	★	★	★	★
Brick Flat Pit Treatment Plant	•	•	•	•
Brick Flat Pit Improvements				
Containment Embankment	★	•	•	•
Saddle Dike	★	★	★	★
Leachate Drainage System	★	•	•	•
Monitoring Wells				

Table 4-3 Components of the Plugging Alternatives				
Component	**P2 Mine Plugging With Internal Treatment (ICIA Alternative)**	**P3 Mine Plugging With Internal Treatment**	**P4 Mine Plugging With External Treatment**	**P5 Mine Plugging With External-Internal Treatment**
Pool	4	30	30	30
Pillar	6	30	30	30
Slope/Streams	4	7	7	7
Grout, Plug, and Pressure Test				
Richmond Adit	•	•	•	•
Four Declines to Lawson Tunnel	•	•	•	•
Second Richmond Plug	○	★	★	★
Slope Monitoring	•	•	•	•
Stage Mine Filling	•	•	•	•
• = included ○ = not included ★ = contingency				

VII.6 Alternative P2—ICIA Plugging Alternative

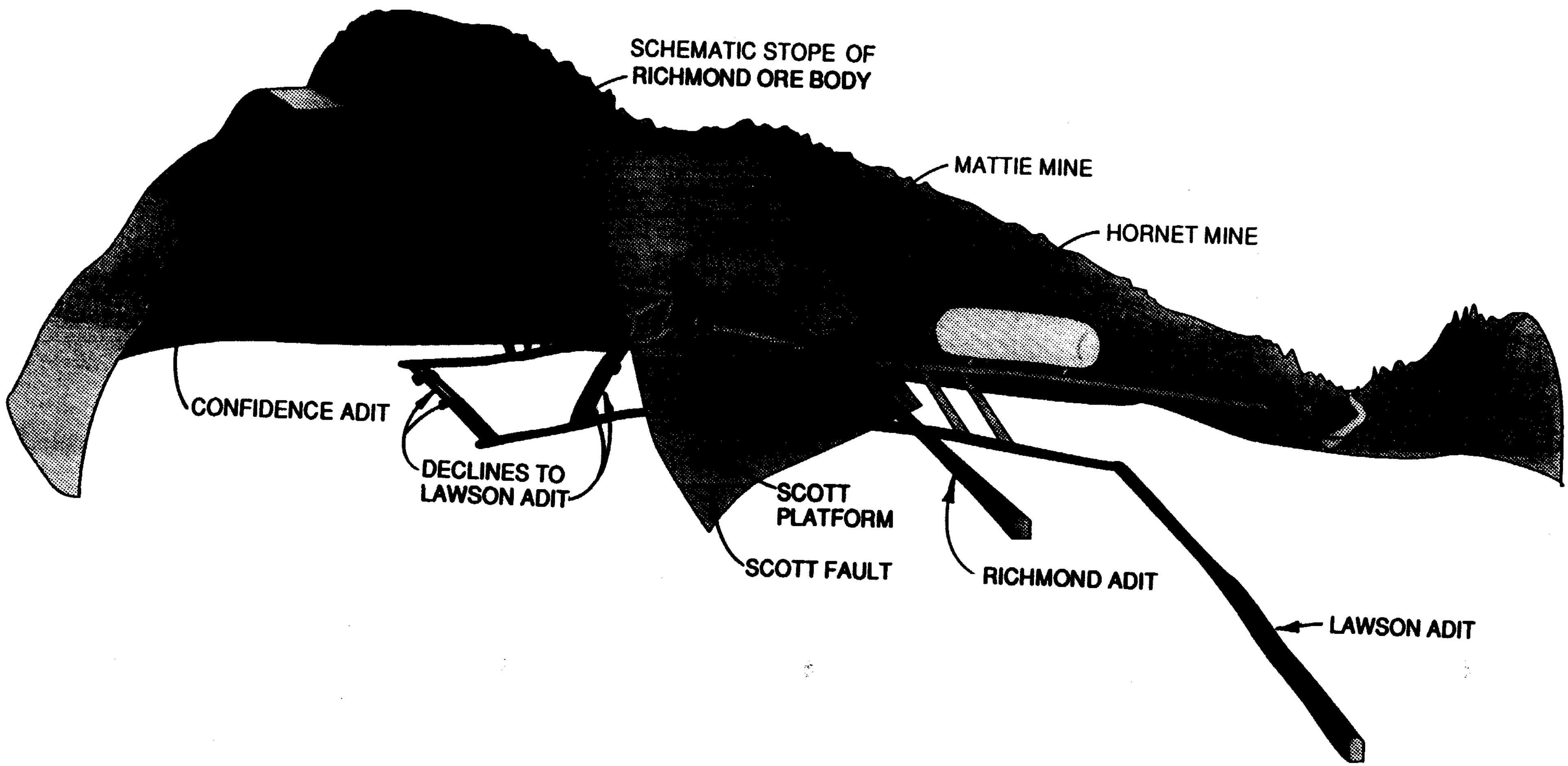
Weston, 1991a, describes the ICIA proposal as follows:

> An initial dose of lime would be placed in the accessible passageways on the 2,600 and 2,650 levels to ensure that during the initial stages of filling, the mine pool would not be at an extremely low pH. Also, where redissolved salts contribute ferric and ferrous iron to the mine pool, contact with lime will cause the iron to precipitate as an insoluble sludge, inhibiting the increased production of AMD. In addition, during mine filling, a neutralizing agent (e.g., lime slurry, soda ash, caustic) would be injected into the major stope areas to provide in situ neutralization of the mine pool. Finally, a liquid high in organic carbon would be injected to enhance the in situ microbial reduction of ferric iron and dissolved oxygen, thereby preventing the production of AMD. This enhanced microbial activity could also result in the precipitation of highly insoluble metal sulfide sludge. Metals precipitated would include ferric and ferrous iron, copper, cadmium and zinc.

This reference (updated pursuant to ICIA comments during the public comment period and its April, 1992 Remedial Implementation Plan) provides the following additional information on the details of the ICIA proposal implementation and operation:

> Each of the decline plugs will be a pair of concrete plugs, which will be hydrostatically tested.

> The initial lime dose will be manually or mechanically placed to a depth of several feet.



LEGEND

● PLUG LOCATION

FIGURE 8
PLUG LOCATIONS FOR THE PLUGGING ALTERNATIVES (ALTERNATIVES P3, P4, & P5)
IRON MOUNTAIN MINE ROD

An outside neutralization plant will be on "standby status" and "treatment of mine discharges is not anticipated as part of this alternative."

A series of 21 injection wells will be installed to deliver neutralizing agent, Boulder Creek water and AMD into the mine pool . . . . through the same injection system in cycles.

The Weston 1991b report provides some additional details of the ICIA proposal. The key additional information includes:

A total of approximately 22,000 tons of lime will be placed in the drifts and blown into nine stopes that are assumed to be uncollapsed.

Phase 1—22 percent pool, Elevation 2750, 6 months
Phase 2—50 percent pool, Elevation 2850, 18 months
Phase 3—100 percent pool, Elevation 3000, 24 months
Phase 4—Pool maintenance

The injection solutions will include soda ash and lime in the following estimated quantities—1,500 and 3,000 tons, respectively, in Phase 1; 5,400 and 7,500 tons, respectively, in Phase 2; and 8,500 tons of lime in Phase 3.

VII.7 Alternative P5—Plug and External-Internal Treatment

EPA has developed the external-internal treatment alternative in response to technical limitations that became apparent in the evaluation of plugging alternatives limited to internal treatment or external treatment. Alternative P5 provides staged mine pool filling, both external and internal treatment, and an operational flexibility to use these methods sequentially and concurrently to achieve the best level of mine pool water quality and to achieve the lowest level of environmental risk. The base plan, developed to provide a basis for cost estimating, assumes initial use of only external treatment and later concurrent external and internal treatment. The fully developed work plan would have extensive field monitoring of the mine pool and seepage from the pool, a well-developed set of guidelines for action during mine pool development and cleanup, and operator flexibility to deal with both better-than-expected and worse-than-expected developments. Lawson adit flows are treated by the external treatment plant.

Alternative P5 combines the attributes of Alternative P3, Plug and Internal Treatment, and Alternative P4, Plug and External Treatment. The combination of treatment by both external and internal (in situ) plant treatment provides the maximum opportunity to attain good pool water quality early in the operation.

Alternative P5, Plug and External-Internal Treatment, is summarized as follows:

Richmond adit plug and four Richmond/Lawson decline plugs with appropriate site testing and site improvements

AMD conveyance system from Richmond and Lawson portals

Rehabilitation of the Richmond level including B-drift, C-drift, and possibly A-drift

Backfill or partial backfill of the Richmond substopes, D-drift, and Scott platform

Rehabilitation of the Confidence adit and Confidence/Richmond declines

Backfill of other mine openings and borings that could compromise the containment

Exploratory drilling and testing of the Richmond/Hornet pillar, and installing minimum pillar grout curtain indicated by these tests

Pool and pillar monitoring wells

Slope inclinometer installations

Injection wells in the stopes, room and pillar, and drifts

Pumping wells for select removal of mine pool water for external treatment

Clean water supply system from Boulder Creek and Slickrock Creek

680-gpm treatment plant

System to prepare and circulate injection streams of clean water, recycled AMD, and neutralizing solutions

Alternative P5 consists of plugging the mine to flood the workings above the Richmond portal to the Confidence adit elevation. Filling is estimated to take approximately 5 years based on an average net fill rate of 60 gpm and a mine void volume of 480 acre-feet. Clean water would be continuously injected into the mine pool and removed for treatment at a rate sufficient to maintain a dilution factor of approximately 10:1 within the pool as it fills to the 2875-foot elevation. It is anticipated that when the pool has reached this elevation, sufficient control of the mine pool chemistry will have been achieved to allow internal treatment using lime and soda ash to continue until the mine is flooded to the Confidence adit (Elevation 3000). This scenario would maintain a relatively dilute mine pool at all times during mine flooding, thus reducing risks associated with leakage or plug failure.

VII.8 Alternative P6—Cap and Treatment

Alternative P6 consists of placing a low permeability cap over the Richmond Mine and providing treatment of the residual flows from the Richmond and Lawson portals. The cap would cover the footprint of the mine and extend several hundred feet outside that footprint to maximize capture of infiltration to the groundwater sink. The planimetric area of the considered cap is about 23 acres with an estimated slope area of about 30 acres. The cap would range in elevation from 3440 feet to 3290 feet. It has been concluded that a similar cap is not constructible over the Hornet Mine.

The existing terrain would be prepared for capping by clearing and grubbing the existing vegetation, removing loose overburden soils, compacting and fine grading of exposed soil base materials, installing erosion control measures, and excavating a series of access benches. The average depth of excavation exclusive of bench construction is estimated to be 2 feet, and the exposed base material is expected to be lightly to moderately weathered rock in 65 percent of the area and saprolite, landslide debris, or fill in the remaining 35 percent. Benches are excavated at vertical intervals of about 50 feet over the cap area and have a steep cut slope of 1:1 to 2:1 (horizontal to vertical). The benches would be aligned on the slope to provide access to all areas of the slope and to direct runoff from the slopes to a central downslope drainage system.

The cap material may be shotcrete on a rock base and overlapping or "shingled" geosynthetic on soil base, or 65 percent shotcrete and 35 percent geosynthetic.

VII.9 Waste Pile Alternatives

The waste piles which will be addressed by these alternatives include WR-2, WR-12, WR-13, WR-14, WR-17, WR-18, and WR-19. The alternatives considered in the Feasibility Study were:

WO - No action. The waste piles would remain in place and would continue to release hazardous substances.
W1 - Capping the wastes in place. Under this alternative, the waste piles would be capped in place. They would not be consolidated.
W2 - Disposal in an off-site landfill. Under this alternative, the waste piles owuld be excavated, transported to a landfill off-site, treated to fixate the waste materials, and disposed of. The total volume of these wastes has been estimated to be approximately 30,000 to 50,000 cubic yards.
W3 - Disposal in an on-site landfill. Under this alternative, the wastes would be consolidated and capped in an on-site location. Surface and groundwater flows would be diverted from the landfill.

VIII. Summary of Comparative Analysis of Alternatives

The remedial alternatives developed in the Boulder Creek OUFS were analyzed in detail for the Richmond and Lawson portal AMD discharges and the seven identified waste piles using the nine evaluation criteria specified by the NCP in 40 C.F.R. § 300.430(e)(9). The resulting strengths and weaknesses of the alternatives were then weighed to identify the alternative for the portal AMD discharges and waste piles providing the best balance among the nine criteria. These criteria are (1) overall protection of human health and the environment; (2) compliance with applicable or relevant and appropriate requirements (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; (9) community acceptance. Each of these criteria are described below.

VIII.1 Criterion 1 – Overall Protection of Human Health and the Environment

Overall protection of human health and the environment 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.

The Boulder Creek OU provides for an interim action that is not expected to be final, and will not address all of the sources of contaminant discharges from the site. Consequently, even though the remedial action will provide significant environmental benefit, it is not expected to be fully protective of human health and the environment. The remedial actions will address the two largest discharges at the site, the Richmond and Lawson AMD discharges, and the discharges from seven waste piles, and will provide a significant contribution toward the final site cleanup. The remedial actions considered are intended to provide protection of human health and the environment from the exposure pathway or threat being addressed by the Boulder Creek OU and from the waste material being managed. The comparative analysis of the alternatives is made on this basis and on the basis of their contribution toward meeting the final cleanup goal.

Treatment of the acid mine drainage should contribute to protection of human health, although this is not considered a major issue for either the No-Action or the action alternatives. It is not considered a major issue because the concentrated acidic waters are mainly limited to remote and uninhabited areas, these source areas have restricted entry, and human exposure to the dilute waters is limited (Table 5-27).

VIII.1.1 Portal AMD Discharges

The level of environmental protection among the alternatives considered ranges from limited to good. The No Action alternative provides only a continuation of the controls now in place, namely the cementation plants, partial cap, and the Spring Creek and Slickrock Creek Diversions. Effluent from the cementation plants will continue with undiminished zinc and cadmium, significantly reduced amounts of copper, and a low pH. The treatment alternatives, P1 and P6, provide at least 99 percent removal of all the metals and pH control. The plug-and-treat alternatives, P2 and P5, provide at least good short-term protection from both metals and low pH waters, but the longer range value of the plug-and-treat alternatives will depend on the control of mine pool chemistry and the effectiveness of the containment. Alternative P5 has a better chance to provide good overall environmental protection.

In summary, the No-Action alternative provides inadequate environmental protection; the plug-and-treat alternatives, P2 and P5, provide uncertain protection; and the treatment alternatives, P1-A, P1-B, and P6, provide for a significant improvement in protection for aquatic resources. The treatment only alternatives provide similar risks, but Alternative P1-B generates sludge which is physically and chemically more stable than the Alternative P1-A sludge. The cap of Alternative P6 will have a new visual impact which will change in detail the skyline visible from the north side of Redding.

VIII.1.2 Waste Piles

The no-action alternative provides only a continuation of the controls now in place and inadequate protection. The waste piles will continue to discharge AMD and to erode into surface waters. Both action Alternatives W2, Removal, Treatment, and Disposal, and W3, Excavation, Consolidation and Capping, will provide for protection of human health and the environment from this exposure pathway by essentially eliminating the discharge. Alternative W2 would provide for additional protection resulting from treatment of the waste piles prior to disposal, but this additional protection may not be significant relative to that provided by Alternative W3.

Table 5-27
Summary of Overall Protection of Human Health and the Environment

P0	No-Action	• Human health risk likely to be low. • Present environmental impacts are likely to continue and may increase in severity with prolonged exposure to contaminated water and increased volume of contaminated sediments. • Cementation removes about 95 percent of the copper, but does not remove other metals or reduce acidity.
P1-A	Treat Portal Flows Simple Mix	• Human health risk likely to be low. • Significant reduction in environmental impacts with greater than 99 percent reduction in metals and the acidity of portal flows. • Sludge from treatment requires containment to avoid new exposure.
P1-B	Treat Portal Flows HDS	• Similar to Alternative P1-A.
P2	Plug Mine Internal Pool Treatment Treat Residual Flows	• Human health risk likely to be low. • Level of environmental protection may be good or poor depending on the effectiveness of mine pool chemistry controls and the effectiveness of rock containment.

P5	Plug Mine External/Internal Pool Treatment Treat Residual Flows	• Human health risk likely to be low. • Level of environmental protection may be good or poor depending on the effectiveness of controls of mine pool chemistry and the effectiveness of rock containment. • Risk of poor protection with P5 is less than P2 because of better pool conditioning and a specific plan to limit or drain the mine pool.
P6	Cap and Treat Portal Flows	• Human health risk likely to be low. • Significant reduction in environmental impacts with greater than 99 percent reduction in metals and the acidity of portal flows. • Sludge from treatment requires containment to avoid new exposure.

Table 5-36
Summary of Overall Protection of Human Health and the Environment

Alternatives	Overall Protection of Human Health and the Environment
W0 No-Action	• Human health risk likely to be low. • Present environmental impacts are likely to continue and may increase in severity with prolonged exposure to contaminated water and increased volume of contaminated sediments.
W2 Waste Pile Removal, Treatment, and Disposal	• Human health risk likely to be low. • Significant reduction in environmental impacts with up to 99 percent reduction in metals and the acidity of portal flows. • Sludge from treatment requires containment to avoid new exposure.
W3 Consolidating and Capping Waste Piles Onsite	• Similar to Alternative W3.

VIII.2 Criterion 2—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.

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.

The Boulder Creek OU provides for an interim action that it is not expected to be final and does not address all of the sources of discharges from the site. Therefore, it is not expected to fully comply with all ARARs with respect to water quality standards for metals concentrations in surface waters and State Fish and Game standards. Although the remedial actions evaluated in the Boulder Creek OUFS provide for significant improvement by essentially eliminating the two largest discharges from the site, EPA is relying upon the ARAR waiver for "Interim Measures" (40 C.F.R. § 300.430 (f)(1)(ii)(C)(i) for remedy selection with respect to the Boulder Creek OU and therefore is waiving the the Regional Board Basin Plan water quality objectives and the Fish and Game § 5650 standards which would necessitate elimination of all releases as ARARs for this operable unit. EPA's overall goal at the site remains achieving these water quality objectives and Fish and Game standards. The alternatives for this Operable Unit otherwise will comply with ARARs, including ARARs for sludge disposal.

VIII.2.1 Portal AMD Discharges

The treatment and cap and treat alternatives will make a significant contribution in the goal of complying with water quality standards. The plug-and-treat alternatives, P2 and P5, are less certain and they may or may not make a significant contribution depending on the development of nonpoint source leaks and the water quality in these leaks. If fully effective, the plug-and-treat alternatives would provide comparable compliance with ARARs.

Table 5-28 Summary of Compliance with ARARs		
P0	No-Action	• Will not meet ARARs.
P1-A	Treat Portal Flows Simple Mix	• This interim action will not provide full compliance with ARARs. • The large anticipated reduction in metals in the discharges is a significant contribution to final cleanup standards for the site.
P1-B	Treat Portal Flows HDS	• Similar to Alternative P1-A. • Improved sludge characteristics over P1-A may facilitate compliance with disposal ARARs.
P2	Plug Mine Internal Pool Treatment Treat Residual Flows	• This interim action will not provide full compliance with ARARs. • May have a small or large reduction in metals and no contribution or a significant contribution to final cleanup standards for the site.
P5	Plug Mine External/Internal Pool Treatment Treat Residual Flows	• This interim action will not provide full compliance with ARARs. • May have a small or large reduction in metals and no contribution or a significant contribution to final cleanup standards for the site.
P6	Cap and Treat Portal Flows	• This interim action will not provide full compliance with ARARs. • The large anticipated reduction in metals in the discharges is a significant contribution to final cleanup standards for the site.

ARARs are discussed in greater detail in the Feasibility Study for the Operable Unit. Except for the no-action alternative, which generally fails to comply with ARARs, the Feasibility Study did not demonstrate any important differences in compliance with ARARs among the various alternatives. It is anticipated that the lower leachability of the HDS treatment sludges over the Simple Mix treatment will make it easier to comply with Regional Board regulations governing disposal of mining waste.

VIII.2.2 Waste Piles

All of the alternatives for waste piles will fall short of meeting ARARs in the receiving waters because of the Boulder Creek Operable Unit does not contain all of the contaminant sources and these alternatives address only a part of the sources in the Boulder Creek Operable Unit (Table 5-37). The action alternatives are interim measures with a best case expectation of making a significant contribution toward final cleanup.

Table 5-37 Summary of Compliance with ARARs	
Alternatives	**Compliance with ARARs**
W0 No-Action	• Will not meet ARARS.
W2 Waste Pile Removal, Treatment, and Disposal	• This interim action will not provide full compliance with ARARs. • The small anticipated reduction in metal discharges is a significant contribution to final cleanup standards on the site.
W3 Consolidating and Capping Waste Piles Onsite	• This interim action will not provide full compliance with ARARs. • The small anticipated reduction in metal discharges is a significant contribution to final cleanup standards on the site.

VIII.3 Criterion 3—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 and the adequacy and reliability of controls.

VIII.3.1 Portal AMD Discharges

The plug-and-treat alternatives, P2 and P5, are the only options with the potential to slow or halt the geochemical reactions forming AMD (Table 5-30). However, their long-term effectiveness is uncertain because their success depends on certain natural conditions (e.g., low rock permeability) being optimal, and these natural conditions are only partly known. In addition, some aspects of the proposed activities have few precedents. Although both are uncertain, the potential for success of plug-and-treat is judged to be higher for P5 than for P2 because of operational flexibility of the former option.

Based upon current knowledge of mine conditions, the potential for complete control of AMD formation in the Richmond Mine is judged to be low for both P5 and P2. Furthermore, even if partially effective, AMD generation may resume if the mine pool is lowered or drained at some future date. The plug-and-treat alternatives may lead to leakage into the Hornet Mine but are unlikely to affect the ongoing AMD generation. It is expected that Lawson adit flows will impose an ongoing and potentially permanent treatment requirement irrespective of the success or failure of plug-and-flood in the Richmond Mine.

The treatment options, P1-A and P1-B, control the contaminated flows and have no effect on the geochemical reactions. They provide a dynamic balance which can be effective as long as treatment and sludge disposal resources are provided. The cap and

STATE OF CALIFORNIA—THE RESOURCES AGENCY PETE WILSON, Governor

DEPARTMENT OF FISH AND GAME
1416 NINTH STREET
P.O. BOX 944209
SACRAMENTO, CA 94244-2090
(916) 653-4875

September 30, 1992

Mr. Jeffery Zelikson, Director
Hazardous Waste Management Division
U.S. Environmental Protection Agency
Mail Code H1
75 Hawthorne Boulevard
San Francisco, California 94105

Dear Mr. Zelikson:

The Department of Fish and Game has reviewed the draft Record of Decision for the Iron Mountain Mine Superfund Site. This site has a long history of damaging some of the State's most important fishery and water resources. The chinook salmon spawning area in the upper Sacramento River (above the confluence with the Feather River) currently supports the most valuable salmon fishery in the State. The Iron Mountain Mine Superfund Site impacts the most valuable portion of this salmon spawning area as well as other important biological resources.

We support the decision to install a proven treatment technology on the portal effluent without flooding the mine pool and the cleanup of selected pyrite bearing waste piles. We believe that it is important to avoid flooding the mine pool when the water and fishery resources are in such critically poor condition and other remedial actions require completion. The performance of the plug and flood alternative is uncertain and there is a risk that the mine pool fluids will leak out where they cannot be immediately collected and treated.

In the future the treatment remedy may be replaced by another source control technology or a resource recovery action. We understand that the Environmental Protection Agency (EPA) will evaluate alternative replacement technologies using a new feasibility study and record of decision process along with endangered species consultation. Prior to implementing replacement remedies that have higher risk, we recommend EPA consider not replacing proven technologies with higher risk alternatives until the drought conditions end, Shasta Reservoir storage returns to normal, declines of the salmon stocks are reversed, salmon fishery restrictions return to normal and the other necessary remedial actions are completed at the site.

We would like to thank you for selecting a reliable remedy for this complex site. We look forward to working with your staff on the remaining necessary remedial actions at the site, including discharges to Slickrock Creek, mobilization of metal sludge from Keswick Reservoir to the river and the final dilution manipulation system for operating the Spring Creek Reservoir.

Sincerely,

John Turner, Acting Chief
Environmental Services Division

cc: E. C. Fullerton, Regional Director
National Marine Fisheries Services
Long Beach, California

Mr. Don Dievert
Department of Toxic Substances
Rancho Cordova, California

Mr. Jim Pedri
Central Valley Regional Water
Quality Control Board
Redding, California

Ms. Sarah Russell
California Attorney General's Office
Oakland, California

Mr. Rick Sugarek
U.S. Environmental Protection Agency
San Francisco, California

STATE OF CALIFORNIA — ENVIRONMENTAL PROTECTION AGENCY

PETE WILSON, Governor

DEPARTMENT OF TOXIC SUBSTANCES CONTROL
10151 CROYDON WAY, SUITE 3
SACRAMENTO, CA 95827-2106

September 30, 1992

Mr. David B. Jones
U.S. Environmental Protection Agency
Region IX
75 Hawthorne Street
San Francisco, California 94105

IRON MOUNTAIN MINE SUPERFUND SITE, COMMENTS ON DRAFT RECORD OF DECISION

Dear Mr. Jones:

Thank you for providing us with a copy of the Draft Record of Decision ("DROD") for the Boulder Creek Operable Unit of the Iron Mountain Mine Superfund Site.

After our review of the document and telephone communications between the Department of Toxic Substances Control (DTSC) and the U.S. Environmental Protection Agency (EPA) staff, we understand that the ROD will reflect the following:

1. The State does not consider AMD to be exempt from the California Hazardous Waste Control Laws, Chapter 6.5, California Health and Safety Code Section 25100 et. seq. The State acknowledges that treatment of AMD and disposal of the resultant sludge may be subject to a variance pursuant to California Health and Safety Code Section 25143.

2. The scope of the expected "final" remedial alternatives for the Boulder Creek Operable Unit will be based upon further investigations of waste rock piles, creek sediments, seeps and the feasibility of source control or resource recovery at the Richmond Mine workings.

3. The proposed CERCLA Section 121(d)(4)(A) Waiver of Compliance with the Regional Boards's Basin Plan Water Quality Objectives will not be invoked for discharges to Flat Creek.

Based on the above modifications of the DROD, we conclude that the DROD is acceptable. We look forward to working together with EPA in the development of the remedial design parameters for the Boulder Creek Operable Unit and the implementation of future actions at the site.

If you have any questions concerning this letter or if we can assist you in any way, please contact Duncan Austin at (916) 855-7861.

Sincerely,

Anthony J. Landis, P.E., Chief	James C. Pedri, P.E.
Site Mitigation Branch	Supervising Engineer
Department of Toxic Substances Control	Regional Water Quality Control Board

cc: Mr. Rick Sugarek
U.S. Environmental Protection Agency
Region IX
75 Hawthorne Street
San Francisco, California 94105

Mr. Ramon Perez
Department of Toxic Substances Control
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Sacramento, California 95812-0806

Mr. Gary Stacey
California Department of Fish and Game
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Ms. Lisa Trankley-Sato
Department of Justice
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United States Department of the Interior

OFFICE OF THE SECRETARY
Office of Environmental Affairs
600 Harrison Street, Suite 515
San Francisco, California 94107-1376

IN REPLY REFER TO:

September 30, 1992

Mr. Rick Sugarek
U.S. EPA - Region IX
75 Hawthorne Street - H-6-2
San Francisco, CA 94105

Dear Mr. Sugarek,

We are writing as natural resource trustees concerning two issues involving Iron Mountain Mine, Shasta County, California. First, with regard to the draft Record of Decision, as we noted in our comments on the draft plan, we agree with the selection of treatment for an interim remedial action. By selection of alternative P1-B, the High Density Sludge Process, EPA is selecting an alternative to produce maximum reduction of waste volume. If the HDS plant is designed to provide capacity to treat sustained elevated flows, concerns regarding the ability of the selected alternative to respond to emergency high flow levels are met.

Secondly, we are aware that ICI Americas has indicated by letter that they believe that Judge Schwartz's September 21, 1992 ruling in <u>United States of America v. Iron Mountain Mines, Inc., et al.</u> makes EPA Administrative Order No. 92-96 invalid. Naturally, we are concerned, as the sixth year of drought has made this a critical year for survival of the Federally threatened winter-run Chinook salmon. As the species may not survive the impact of untreated discharge through the season, we are supportive of EPA's intent to implement the requirements of the administrative orders utilizing Superfund, with cost recovery later.

If you wish to meet with the natural resource trustees for Iron Mountain Mine concerning our comments, please contact me at (415) 744-4090.

Sincerely,

William C. Allan
Regional Environmental Assistant

Concur:

Denise Klimas
National Oceanic and Atmospheric Administration

treat alternative, P6, includes a cap to control infiltration, which is a major source of the water to form new AMD, and a treatment program to deal with continued Richmond portal flows and the Lawson portal flows. The cap is expected to have value to reduce peak flows from the Richmond portal and to reduce the average Richmond portal flow by between 50 and 80 percent. The effectiveness of the P6 plant should be equal to and perhaps a little better than P1-A and P1-B, as the former plant does not have to deal with peak flows.

A prediction of the long-term effectiveness of the plugging alternatives must rest on an informed judgment based upon what is reliably known about the site conditions and what can be learned from other plugged mines with similar geology. Many of the technical factors related to successful implementation of the various plugging approaches require further development through bench-scale and large-scale studies, field studies and field testing. Rehabilitation of portions of the mine workings is required. EPA considers that this information is required to provide reliable information that is not presently available and related to key technical considerations. EPA has reviewed other plugging actions (including those at the Eagle Mine in Colorado and the Lokken Mine in Norway) and has concluded that site specific factors related to geology, geochemistry and hydrology are central to success in mine plugging as a remedial approach.

The treatment alternatives, P1-A, P1-B, and P6, will be effective as long as treatment is maintained. Because P1-A and P1-B do not reduce or eliminate the AMD-forming reactions, they cannot be expected to improve the quality of the discharges. Alternative P6 may be combined with additional controls or itself may impact the chemistry of the discharge by its alteration of the hydrologic regime in quantity of flows or their peak nature. The differences between these alternatives may be significant with respect to cost but are not large with respect to effectiveness. Alternative P6 may offer opportunities to implement further source control technologies for the Richmond Mine. Alternative P5 is a source control for an "ultimate solution" experiment for the Richmond Mine but does not appear to be the solution for the Lawson portal flows.

The conclusion that Alternative P5 will require a treatment plant for the Lawson portal flows should be balanced against its potential for stopping Richmond portal flows.

Table 5-30
Summary of Long-Term Effectiveness

P0	No-Action	• Not effective long-term or short-term. • Metals releases and current risks may continue for thousands of years.
P1-A	Treat Portal Flows Simple Mix	• Effective in short-term and long-term for a wide range of flow quality. • Expect 99 percent reduction in metals from portal flows. • Little uncertainty about results. • Treatment is a dynamic mitigation controlling the contaminant stream but not the source geochemical reactions. • Sludge disposal becomes a major cost consideration in 60 to 100 years.
P1-B	Treat Portal Flows HDS	• Same as Alternative P1-A except sludge disposal would not become a major cost consideration until approximately 120 to 200 years.
P2	Plug Mine Internal Pool Treatment Treat Residual Flows	• Effectiveness depends on (1) successfully flooding the mine, (2) permanent mine pool neutralization, (3) mine pool uncontaminated by metals-laden infiltration, (4) mine pool exfiltration is uncontaminated, and (5) Lawson flows cease or are metals-free. • There is uncertainty about the results, but the potential for success is judged to be low. • Success would provide source control. • Acid generation may resume if mine pool is lowered or drained.
P5	Plug Mine External/Internal Pool Treatment Treat Residual Flows	• Effectiveness depends on (1) successfully flooding the mine, (2) permanent mine pool neutralization, (3) mine pool uncontaminated by metals-laden infiltration, (4) mine pool exfiltration is uncontaminated, and (5) Lawson flows cease or are metals-free. • Result uncertain, but potential for success is judged to be low. • Success would provide source control. • Acid generation may resume if mine pool is lowered or drained.
P6	Cap and Treat Portal Flows	• Effective indefinitely provided cap maintained and treatment provided. • Expect portal flows to be reduced by 50 to 80 percent. • Treatment is dynamic mitigation, which controls contaminant streams and not the source geochemical reactions. • Sludge disposal in Brick Flat Pit becomes a major cost factor in approximately 120 to 200 years (Simple Mix) or approximately 240 to 400 years (HDS). • Capping is expected to be only partially successful at controlling the AMD-forming reactions.

VIII.3.2 Waste Piles

Alternative W2 is ranked slightly higher than Alternative W3 because the waste rock would be physically removed from the OU and would have no chance of contaminating

Boulder Creek in the future. EPA expects that the disposal of the waste piles in accordance with Alternative W2 would result in essentially permanent storage of the metals in a capped and well-maintained offsite landfill. However, EPA also expects that a capped and well maintained on-site landfill would also provide essentially permanent storage of the metals in Alternative W2. See Table 5-38.

Table 5-38
Summary of Long-Term Effectiveness and Permanence

Alternatives	Long-Term Effectiveness and Permanence
W0 No-Action	• Not effective long-term or short-term.
W2 Waste Pile Removal, Treatment, and Disposal	• Effective in short-term and long-term. • Anticipate that the treated waste will have high stability. • Anticipate a well-maintained landfill site will provide essentially permanent storage.
W3 Consolidating and Capping Waste Piles Onsite	• Effective in short-term and long-term. • Anticipate a well-maintained landfill site will provide essentially permanent storage with a somewhat higher risk of future contamination to Boulder Creek than Alternative W3.

VIII.4 Criterion 4—Reduction of Toxicity, Mobility, or Volume through Treatment

Reduction of toxicity, mobility, or volume through treatment refers to the preference for a remedy that uses treatment to reduce health hazards, contaminant migration, or the quantity of contaminants at the site.

VIII.4.1 Portal AMD Discharges

Alternative P0, the No-Action alternative, is not expected to provide a reduction in toxicity, mobility, or volume because the source geochemical reactions in the Richmond Mine and Hornet Mine are likely to continue for hundreds and perhaps thousands of years (Table 5-31).

The treatment alternatives, P1-A, P1-B, and P6, will decrease the toxicity and volume of the discharges and will reduce the mobility by separating and binding the metals in sludge and storing the sludge in a landfill to limit future remobilization. Alternatives P1-B and P6-B with lime/sulfide HDS treatment are somewhat superior to the other treatment alternatives because they produce a smaller volume of less leachable sludge.

The plug-and-treat alternatives can, in the best case, provide the ultimate reduction of toxicity and volume by permanently stopping the production of metals-laden AMD in the Richmond Mine but not the Hornet Mine. The potential for such a favorable result for either P2 or P5 is judged to be low. If the best case is realized, the remaining issues are the mobility of acid water and metals trapped within the mine and the continued treatment of Lawson portal flows. Alternative P5 offers the possibility that the trapped metals may not be significant. If the plug-and-treat alternatives in the Richmond Mine are not completely successful, the issues are likely to be treatment of the Lawson portal flows, treatment of Richmond Mine pool, and collection and treatment of exfiltrating waters in the mine pillars. The new mobility of potentially acid and metals-bearing water and the possibility that monitoring systems and control systems may be inadequate to control the new condition are serious risks inherent in the plug-and-treat alternatives.

Table 5-31
Summary of Reduction of Toxicity, Mobility, or Volume

P0	No-Action	• Cannot expect reduction in toxicity or volume in the near future. • Increased environmental impacts may result from the same discharges because of prolonged exposure and increased sediment accumulations.
P1-A	Treat Portal Flows Simple Mix	• Treatment and good containment of sludge can reduce metal discharges from portals by 99 percent. • Metals releases from sludge landfill are controlled by the sludge alkalinity and site underdrain system.
P1-B	Treat Portal Flows HDS	• Similar to Alternative P1-A, except that treatment method will result in lower volume and toxicity sludge.
P2	Plug Mine Internal Pool Treatment Treat Residual Flows	• Reduction in toxicity and volume depends upon the effectiveness of well injections. • In situ neutralization and metal precipitation are likely to be less efficient and effective than in a treatment plant, and pool quality is difficult to monitor. • Mobility of mine pool metals is greater than in sludge or portal flows. • In-mine sludge storage may be less secure than storage in landfill.
P5	Plug Mine External/Internal Pool Treatment Treat Residual Flows	• Reduction in toxicity and volume depends upon the effectiveness of external and internal treatment. • Neutralization and metals removal likely to be better than Alternative P2. • In-mine sludge storage may be less secure than sludge storage in landfill, but this risk is likely to be lower than with Alternative P2.
P6	Cap and Treat Portal Flows	• Treatment and good containment of sludge can reduce metal discharges by 99 percent. • Metals releases from sludge landfill are controlled by the sludge alkalinity and site underdrain system.

VIII.4.2 Waste Piles

Alternative, WO—No-Action, is not expected to provide a reduction in toxicity, mobility, or volume because field observations suggest that the waste rock piles have a large amount of unreacted sulfides. Alternatives W2 and W3 are expected to be very similar with respect to reducing mobility. The fixation treatment process of Alternative W2 will increase the volume of waste material but leave the volume of metals and the toxicity unchanged. Alternative W3 will not affect the toxicity or volume of metals. See Table 5-39.

Table 5-39
Summary of Reduction of Toxicity, Mobility, or Volume

Alternatives	Reduction of Toxicity, Mobility, or Volume
W0 No-Action	• Cannot expect reduction in toxicity or volume in the near future. • Increased environmental impacts may result from the same discharges because of prolonged exposure and increased sediment accumulations.
W2 Waste Pile Removal, Treatment, and Disposal	• Toxicity will remain unchanged. • Mobility to Boulder Creek is eliminated, while fixation and landfilling makes the risk of future mobility unlikely. • The volume of waste material is increased, but the quantity of metals is unchanged.
W3 Consolidating and Capping Waste Piles Onsite	• Toxicity will remain unchanged. • Mobility of the waste rock in landfill will be significantly lower than the existing condition but greater than Alternative W2. • The volume of waste rock and metals is unchanged.

VIII.5 Criterion 5—Short-Term Effectiveness

Short-term effectiveness refers to the period of time needed to complete the remedy and any adverse impacts on human health and the environment that may be posed during the construction and implementation of the remedy.

VIII.5.1 Portal AMD Discharges

Alternative P0, the No-Action alternative, does not meet the remedial action objectives and does not mitigate the present environmental risks as noted in Table 5-32.

The treatment alternatives, P1-A, P1-B, and P6, and the plug-and-treat alternatives, P2 and P5, all have a high potential short-term effectiveness because the treatment alternatives treat all Richmond portal and Lawson portal flows while the plug-and-treat alternatives capture all Richmond portal flows and treat Lawson portal flows. The plug-and-treat alternatives may be viewed as even slightly better than the treatment alternatives because they do not require the treated water, with very small quantities of residual metals, to be discharged into Boulder Creek.

The treatment alternatives share the common short-term advantage that the process can be readily changed to take advantage of improvements in treatment technology or changed economic conditions which may in the future favor resource recovery processes. The treatment plant for the plug-and-treat alternatives could likewise be changed, but the large investment in preparing the mine for flooding and changes to the mine during flooding could delay or eliminate modifications attractive under the treatment only alternatives.

The chief short-term concerns for the plug-and-treat alternatives are continued AMD production which complicates or compromises mine pool conditioning and poor containment which allow excessive exfiltration and the risk of contaminated, nonpoint source discharges in Boulder Creek or Slickrock Creek valleys. The pool chemistry and containment risks will be uncertainties until operational experience is developed with at least a partly filled mine. In addition, both plug-and-treat alternatives involve underground construction for mine rehabilitation and therefore pose some risk of injury due to caving ground, contact with highly acidic water, and exposure to potentially toxic or harmful gas.

Table 5-32
Summary of Short-Term Effectiveness

P0	No-Action	• Does not meet remedial action objectives. • Does not mitigate risks.
P1-A	Treat Portal Flows Simple Mix	• Provides an immediate 99 percent reduction in metals discharge from portals. • Provides significant reduction in metals to the Sacramento River. • No unusual worker or environmental risks during construction.
P1-B	Treat Portal Flows HDS	• Similar to Alternative P1-A.
P2	Plug Mine Internal Pool Treatment Treat Residual Flows	• Provides an immediate 100 percent reduction in metals discharge from portals. • Provides significant reduction in metals to the Sacramento River. • Metals may reappear in small or large quantities as nonpoint sources if mine pool chemistry is not controlled, or containment is poor, or both adverse conditions are encountered. • No practical controls for nonpoint sources have been identified. • Mine rehabilitation may involve unusual risk to workers.

Table 5-32 Summary of Short-Term Effectiveness		
P5	Plug Mine External/Internal Pool Treatment Treat Residual Flows	• Provides an immediate 100 percent reduction in metals discharge from portals. • Provides significant reduction in metals to the Sacramento River. • Metals may reappear in small or large quantities as nonpoint sources if mine pool chemistry is not controlled, or containment is poor, or both adverse conditions are encountered; risk is lower than Alternative P2, but may be significant. • No practical controls for nonpoint sources have been identified. • Mine rehabilitation may involve unusual risk to workers.
P6	Cap and Treat Portal Flows	• Provides an immediate 99 percent reduction in metals discharge from portals. • Provides significant reduction in metals to the Sacramento River. • No unusual worker or environmental risks during construction.

VIII.5.2 Waste Piles

Alternative W0, the No-Action alternative, does not meet the remedial action objectives and does not mitigate the present environmental risks (Table 5-40).

Alternative W2 is ranked slightly higher than Alternative W3 because the waste rock would be physically removed from the OU and would have no chance of contaminating Boulder Creek in the future. Expect the short-term effectiveness of the two alternatives to be essentially identical. The construction operations for both alternatives would involve some risk of worker exposure. Alternative W2 has the additional small risk of public exposure to the waste rock in transit through populated areas of Shasta County.

Table 5-40
Summary of Short-Term Effectiveness

Alternatives	Short-Term Effectiveness
W0 No-Action	• Does not meet remedial action objectives. • Does not mitigate risks.
W2 Waste Pile Removal, Treatment, and Disposal	• Limited traffic impacts on the community and risk to workers during construction. • Will provide, at least by the next rainy season, an estimated 1 to 10 percent reduction in metals loading to Boulder Creek.
W3 Consolidating and Capping Waste Piles Onsite	• Limited risk to workers during construction. • Will provide, at least by the next rainy season, an estimated 1 to 10 percent reduction in metals loading to Boulder Creek. • Small risk of future leaching of metals from the onsite landfill.

VIII.6 Criterion 6—Implementability

Implementability refers to the technical and administrative feasibility of a remedy, including the availability of materials and services needed to implement the chosen solution. It also includes coordination of Federal, State, and local governments to clean up the site.

VIII.6.1 Portal AMD Discharges

The No-Action alternative, Alternative P0, requires the least effort and is readily implementable (Table 5-33).

The treatment alternatives, P1-A and P1-B, are readily implementable because they involve only flow control, treatment, and sludge disposal facilities. All of these facilities involve well established technologies with known costs, effectiveness, and reliability.

The cap and treat alternative, P6, has similar treatment and sludge control requirements and, in addition, the construction and maintenance of a cap. The proposed shotcrete cap involves an established technology used to protect slopes. The proposed shotcrete cap is an unusual application of this technology with respect to both the size of the cap and its purpose of reducing infiltration. Alternative P6 has the same high implementability as P1-A and P1-B because it provides complete treatment of portal discharges. The enhancement of providing a cap to reduce the Richmond portal flow is a secondary aspect which trades increased capital investment to potentially achieve an even greater reduction in operational costs.

The plug-and-treat alternatives, P2 and P5, have moderate to high risk of problems which can affect their successful implementation. Although plug-and-flood is a conventional approach with mixed success in AMD remediation in a variety of geologic settings, the proposed plug-and-flood alternatives with mine pool conditioning are an experimental approach with no apparent precedent. These proposals also have a number of known technical problems, and pose the risk of creating new sources of contamination. The areas which may affect success include containment, control of mine pool chemistry, construction and operation of deep injection wells in caved and otherwise disturbed ground above the mine, and problems associated with the administration of a plug and mine-flooding activity. It is unlikely that a complete implementation plan can be developed ahead of the work including all the control and contingencies necessary to safeguard the environment. A rigid plan for a plug-and-treat alternative is very likely to be unsuccessful. The best opportunity for success is to develop a flexible base plan, implement controls and contingencies as verified by field observation and testing, and provide a management plan with the authority to make appropriate changes and even the authority to cancel plug and treat and move to another option.

Table 5-33 Summary of Implementability		
P0	No-Action	• Readily implementable.
P1-A	Treat Portal Flows Simple Mix	• Readily implemented as it uses established technologies with known costs, effectiveness, and reliability. • Onsite sludge disposal appears practical for as long as 100 years. • Action is reversible and does not preclude implementation of other alternatives or resource recovery. • Maintains point source nature of the discharge.
P1-B	Treat Portal Flows HDS	• Readily implemented like Alternative P1-A but with newer technology. • Produces smaller amount of less leachable sludge than Alternative P1-A. • Like Alternative P1-A, reversible and maintains point source nature of the discharge.
P2	Plug Mine Internal Pool Treatment Treat Residual Flows	• Moderate to high risk of implementation problems. • Technical concerns with containment, chemical control of mine pool, construction and operation of injection wells, and control of Lawson portal discharges. • Administrative concerns with monitoring and performance standards. • May create a nonpoint discharge. • Extends the life of onsite sludge disposal by factor of 3 or more. • Mine plugging by sludge may preclude future resource recovery.
P5	Plug Mine External/Internal Pool Treatment Treat Residual Flows	• Moderate to high risk of implementation problems. • Technical concerns with containment, chemical control of the mine pool and injection wells; chemical control is more likely with P5 than with P2. • May create a nonpoint discharge. • Extends the life of onsite sludge disposal by factor of 3 or more.
P6	Cap and Treat Portal Flows	• Low risk of cap implementation problems due to slopes and subsidence. • Cap will have some small impact on skyline views from the north side of Redding. • Treatment is readily implementable. • Extends the life of onsite sludge disposal by factor of 2 or more.

VIII.6.2 Waste Piles

Alternative W0, the No-Action alternative, requires no specific future action (Table 5-41).

Alternatives W2 and W3 are considered implementable as the required work of excavation, transportation, and landfill construction for each alternative and waste rock treatment in the case of Alternative W2 uses well established technologies. Steep terrain and poor access will make some of the excavation work challenging and it is possible that some part of the waste rock will be left in place because of construction limitations. Alternatives W2 or W3 will be successful if the major part of the waste rock is removed.

Table 5-41
Summary of Implementability

Alternatives	Implementability
W0 No-Action	• Not applicable.
W2 Waste Pile Removal, Treatment, and Disposal	• Excavation can be performed with existing technology but steep slopes and limited access will make some of the work challenging. • Transport and landfilling are well established activities. • May adopt a relative new treatment method but bench testing should remove most uncertainties respecting implementation.
W3 Consolidating and Capping Waste Piles Onsite	• Excavation can be performed with existing technology but steep slopes and limited access will make some of the work challenging. • Transport and landfilling are well established activities.

VIII.7 Criterion 7—Cost

This criterion examines the estimated costs for each remedial alternative. For comparison, capital and annual O&M costs are used to calculate a 30-year present worth cost for each alternative.

VIII.7.1 Portal AMD Discharges

Table 5-34 presents estimates of the 30-year present worth for the alternatives. The table shows the present worth of the initial capital investment, 30 years of operation and the total 30-year cost. The 30-years' basis is selected merely to compare the early costs of all alternatives. All of the alternatives are expected to have costs beyond 30 years because present information shows that contaminated Lawson portal flows will continue beyond 30 years. In most, if not all alternatives, contaminated Richmond portal flows will also continue beyond 30 years, adding to the treatment burden.

The total present worth costs range from $40.4 million for P1-A, Treat Portal Flows, to $61.6 million for Alternative P5. Alternatives P1-B, P2, and P6-A are in the middle of this cost range, and Alternative P6-B is near the top of the cost range. It should be noted that all of these cost estimates are the product of "order of magnitude" estimating procedures based upon conceptual layouts and preliminary cost information. Estimates of this nature are subject to large changes with more detailed engineering and cost information. It is commonly assumed that actual cost may vary from the stated amounts by as much as plus 50 percent and minus 30 percent. With this level of uncertainty in the cost estimates and given the similarity in the estimating results, it appears that cost is not a dominating criterion in ranking the alternatives.

EPA has revised its proposed plan cost estimates in response to two general issues identified in public comments:

> Commenters identified work items for which they felt EPA's estimates were too low. Upon review, EPA identified two specific items for which EPA agrees that the original cost estimates were too low. These two items are roadway improvements and supply of electricity to the treatment facility. EPA has recalculated the costs for these work items.
>
> Commenters identified reliable operation of the treatment plant as a concern. EPA reviewed factors associated with assuring reliable performance and concluded that modifications to the proposed pipeline routing and pump specifications were necessary with respect to assuring reliable performance. EPA recalculated the associated costs.

The revised treatment cost estimates impact each of the alternatives under consideration because they all rely on treatment in some capacity. The relative costs of the alternatives have remained consistent.

Table 5-34
Summary of Costs

		Present Worth Basis		
Alternatives		**Capital Costs ($)**	**Operating Costs ($)**	**Total Costs ($)**
P0	No-Action		462,000	462,000
P1-A	Treat Portal Flows Simple Mix	18,798,000	21,552,000	40,350,000
P1-B	Treat Portal Flows HDS	23,133,000	27,855,000	50,988,000
P2	Plug Mine Internal Pool Treatment Treat Residual Flows	27,301,000	19,622,000	46,923,000
P5	Plug Mine External/Internal Pool Treatment Treat Residual Flows	38,985,000	22,592,000	61,577,000
P6-A	Cap and Treat Portal Flows Simple Mix	31,123,000	18,401,000	49,524,000
P6-B	Cap and Treat Portal Flows HDS	34,166,000	23,808,000	57,974,000

VIII.7.2 Waste Piles

Table 5-42 presents the capital, operating and total costs for each of the Waste rock Alternatives on the basis of 30-year present worth. Alternative W2 with offsite treatment and landfilling of the waste rock is nearly twice the cost of onsite landfilling of untreated waste rock. This cost difference is far more significant than the cost difference noted hereinbefore for the Portal Alternatives. The benefit gained in Alternative W2 by treatment and offsite landfilling at the price of doubling the total cost, is an important consideration in selection of a Waste Rock Alternative.

Table 5-42
Summary of Costs

Alternatives	Initial Cost ($)	O&M Cost ($/year)	30-Year Present Worth Value ($)
W0 No-Action	0	0	0
W2 Waste Pile Removal, Treatment, and Disposal	5,918,000	0	5,918,000
W3 Consolidating and Capping Waste Piles Onsite	2,810,000	10,000	2,970,000

VIII.8 Criterion 8—State Acceptance

State acceptance refers to the State's position and key concerns related to the preferred alternative and other alternatives, and State comments on ARARs or the proposed use of waivers.

EPA has worked closely throughout the Boulder Creek OU with the California Department of Toxic Substances Control (DTSC) (the State lead agency), the Regional Water Quality Control Board (RWQCB), and the Department of Fish and Game. All three agencies support the selection of EPA's preferred alternative, treatment of the Richmond and Lawson portal AMD flows.

In a July 20, 1992, letter signed by DTSC and the RWQCB, these two agencies supported the selection and implementation of treatment as soon as possible. They view treatment as an interim remedy and encourage the further development and consideration of an alternative that could reduce or eliminate the need for treatment at the site, including capping, plugging, and resource recovery approaches. These agencies expressed concerns that designs for the disposal facility for the treatment residuals meet requirements of the Toxic Pits Control Act and the California Code of Regulations, Chapter 15. EPA has agreed that the disposal facility must meet these criteria.

The Department of Fish and Game signed a July 20, 1992, letter along with the other Natural Resource Trustees for the site, supporting the selection of treatment of the Richmond and Lawson portal AMD flows and cleanup of the seven waste piles. These agencies recommend that any further follow-up actions to remediate these sources that might result in some increased risk to the fishery be delayed until such time as the current criterical water supply and fishery conditions improve and all other remedial actions at the site are completed.

VIII.9 Criterion 9—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.

There was significant community interest in EPA's proposed plan for the Boulder Creek OU at IMM. EPA's public meeting was attended by over 200 people. EPA received 19 oral comments at the meeting. EPA received over 100 letters commenting on the Proposed Plan. In general, the community expressed interest in selecting a remedy that would safely protect the water and fishery resources, that could be implemented quickly, and that could remediate permanently the long-standing site problems. Community interest was heightened by the critical water supply and fishery conditions and the significance of this decision to the overall cleanup strategy for the site.

There was overwhelming support from the community to take immediate action at the site and overwhelming support to either treat the acid mine drainage discharges, or take another remedial approach with treatment of the discharges as a component or contingency action. There was considerable divergence within the community regarding whether an approach other than EPA's preferred alternative of treatment could or should be implemented at this time. All commenters supported the use of the inactive open pit mine, Brick Flat Pit, for sludge disposal.

Approximately 50 letters supported EPA's proposed plan to implement treatment of the Richmond and Lawson portal AMD discharges with the Simple Mix System (Alternative P1-A, FS). They urged EPA to implement the remedy as soon as possible because of the critical fishery and water supply conditions. They supported treatment as the only proven and effective alternative available. Many of the letters endorsed the "interim" nature of the proposed action and EPA's intended efforts to develop and evaluate a source control approach that could reduce or eliminate the long-term reliance upon treatment at the site for these sources. Several of the letters urged EPA to drop consideration of the plug-and-flood alternatives because these alternatives posed too great a risk to the fishery and water supply and because they are too speculative. Several letters urged EPA to select the P1-B treatment alternative, the High-Density Sludge process, to minimize sludge volumes produced and thus extend the life of available onsite disposal of sludge in Brick Flat Pit. Some letters encouraged EPA to select the capping alternative (P6) with the P1-B treatment option to further extend disposal capacity.

Approximately 50 letters supported the plug-and-flood alternative proposed by ICI Americas, Inc., on behalf of Rhone-Poulenc Basic Chemicals, a potentially responsible party for the site. Many letters cited support for the ICIA approach on the basis that it could, if successful, provide for a permanent solution to the acid mine drainage problem that would not require treatment in the long term. Many felt that it would be a lower-cost approach. Many commenters supported the ICIA approach on the basis that a treatment plant would be built as a safeguard and that necessary contingency measures were integral to the proposal.

Several commenters also supported selecting alternatives that favored approaches that could benefit the local economy, such as relying on treatment with locally available neutralizing agents (limestone, fly ash), alternatives that ensure protection of the fishery and water supply, resource recovery options, and options that could achieve cleanup in combination with strategies to reopen mining operations at Iron Mountain.

ICIA, on behalf of Rhone-Poulenc Basic Chemicals, submitted detailed comments in support of their conclusion that P2, the ICIA plug-and-flood alternative, could be safely implemented, would be effective, and the lowest-cost option.

Responses to the above comments are presented in the attached Responsiveness Summary.

IX. THE SELECTED REMEDY

EPA is selecting collection and treatment of the Richmond and Lawson acid mine drainage (AMD) flows. Treatment sludges will be disposed of on-site in the inactive open pit mine, Brick Flat Pit. EPA also is selecting consolidation and capping of seven waste piles on-site.

The selected remedy differs in one respect from the preferred alternative in EPA's May 20, 1992 Proposed Plan. EPA is selecting the same technology of the proposed plan, treatment by chemical neutralization/precipitation, but is selecting the lime/sulfide High Density Sludge (HDS) process option rather than the Simple Mix System as proposed. The reasons for selecting the HDS process option are more fully discussed later in this section.

The major components of the selected remedy include:

- Maintenance of the Richmond and Lawson adits to allow the mine workings to continue to function as effective collectors of AMD.

- Collection structures, pipelines and equalization to provide for delivery of all AMD flows collected by the Richmond and Lawson adits to the treatment facility for treatment.

- Treatment facilities to perform chemical neutralization/precipitation treatment of the Richmond and Lawson AMD flows. The treatment shall meet the effluent limitations of 40 C.F.R. §§ 440.102(a) and 440.103(a). Except for pH and TSS levels for discharges into Boulder Creek or Slickrock Creek, EPA has determined that these standards are relevant and appropriate in this application. If the discharge is made to one of these two creeks it will not be necessary to adjust the pH due to the expected acidity in the creeks. Treatment for TSS levels would not be practicable due to the high levels of TSS already in the creeks. If the discharge is made to Flat Creek, which is not expected to be acidic from other sources, the pH and TSS standards would be relevant and appropriate.

EPA has selected treatment alternative P1-B, the lime/sulfide High Density Sludge (HDS) process option as the required treatment technology option. The HDS process option, as discussed in the Boulder Creek OUFS, relies upon simple mix treatment and equalization for peak flows beyond the capacity of the HDS plant. The HDS plant shall be designed to provide capacity to treat sustained elevated flows from the Richmond and Lawson portals.

- Disposal of treatment residuals on-site in the inactive open pit mine, Brick Flat Pit. Brick Flat Pit shall be modified to comply with the applicable requirements of the Toxic Pits Control Act, Health and Safety Code § 25208, et seq., and California requirements for disposal of mining wastes promulgated under Water Code § 13172.

- The seven waste piles (identified as WR-2, WR-12, WR-13, WR-14, WR-17, WR-18, and WR-19 in the Boulder Creek OUFS) shall be consolidated on-site and capped in accordance with applicable California requirements for disposal of mining wastes, promulgated under Water Code § 13172.

The collection and conveyance systems shall provide for delivery of all base, sustained and peak AMD discharges from the Richmond and Lawson adits. The treatment plant shall provide equalization capacity, treatment capacity or combination of both to ensure that all of the AMD flows are treated in compliance with the performance standards. The conveyance and treatment facility design shall provide for excess capacity and redundancy of elements necessary to assure reliability of performance.

The routing of pipelines and siting of tankage and treatment facilities is expected to have minimal impacts on the undisturbed habitat. The historic mining related disturbance is significant due to collapse of the underground workings surface mining and establishment of roadways on cleared work areas. Pipeline routing and design and siting of facilities shall minimize impacts on undisturbed habitat by use of existing cleared work areas and roadways to the maximum extent practicable by avoidance of siting of any facilities in areas of riparian or wetland habitat. Specifically, Boulder Creek clean water supplies required for lime slaking shall be drawn from below Boulder Creek falls for protection of the upgradient wetlands habitat. Any facilities necessary for collection and conveyance of Lawson portal AMD flows shall be located away from riparian habitat and shall provide for protection of the riparian habitat in areas adjacent to the Lawson Portal.

EPA is selecting the lime/sulfide HDS process option (P1-B) for the following reasons:

- The lime/sulfide HDS process produces treatment sludges with superior characteristics with respect to dewatering and leachability. The smaller volumes of more dense sludge are expected to significantly increase the life of Brick Flat Pit for use as an on-site sludge disposal facility. The superior leaching characteristics may allow for reduced regulatory requirements on the design of the modifications to Brick Flat Pit for sludge disposal.

- The Simple Mix System relies upon Brick Flat Pit to function as a sludge dewatering facility as well as a disposal facility. The sludge from an lime/sulfide HDS plant would be placed in Brick Flat Pit dry. Although Brick Flat Pit modification designs must address several significant issues such as storm runoff, the design for placement of HDS sludges is significantly less complicated and its operation is more within conventional engineering practice.

- EPA intends to investigate the possibility of siting the HDS treatment plant downgradient of the Richmond and Lawson portal AMD discharges during detailed engineering design.

Siting the treatment plant adjacent to Brick Flat Pit, at the top of Iron Mountain, as is considered in EPA's FS, presents numerous logistical challenges. EPA has concluded that although these challenges can be met with proper engineering and can assure reliable operations, alternate siting at a downgradient location could be more easily engineered to assure reliable operations. The use of the HDS process option may make this alternative site cost-effective by significantly reducing the volumes of sludge that must be trucked to Brick Flat Pit for disposal.

More detailed design and cost information will be developed to fully evaluate the facility siting and reliability issues. The design studies will provide more precise and detailed costing relative to specific project components regarding siting and reliability. Many design details will receive further development and evaluation during the design of the operable unit (e.g., any necessary Brick Flat Pit modifications for sludge disposal and dewatering operations).

EPA has considered the siting of the HDS treatment plant adjacent to Brick Flat Pit at the top of Iron Mountain, adjacent to Boulder Creek at the site of the current Boulder Creek Copper Cementation Plant, and at Minnesota Flats.

For an HDS treatment plant located adjacent to Brick Flat Pit, the treatment plant could discharge to either Boulder Creek or Slickrock Creek and shall meet the relevant and appropriate requirements of 40 CFR § 440.102(a) and § 440.103(a). EPA is not requiring that the discharge meet the pH or TSS standards of 40 CFR § 440.102(a). Because these creeks do not meet the ambient water quality criteria pursuant to the remedial actions being performed in the Boulder Creek OU, EPA is invoking the ARAR waiver for "interim measures" provide by the NCP at 40 CFR § 300.430(f)(1)(ii)(C)(1). EPA is not requiring that the discharge from the treatment plant meet ambient water quality criteria in Boulder Creek or Slickrock Creek for this interim action.

For an HDS process treatment facility located at either the Boulder Creek Copper Cementation Plant site or at the Minnesota Flats site the treatment plant would discharge to Boulder Creek and shall meet the requirements of 40 CFR § 440.102(a) and § 440.103(a), except pH and TSS standards. Because Boulder Creek will not attain ambient water quality criteria pursuant to remedial actions being performed in the Boulder Creek OU, EPA is invoking the ARARs waiver for "interim measures" provided by the NCP at 40 CFR 300.430(f)(1)(ii)(C)(1). EPA is not requiring that the discharge from the treatment plant meet the ambient water quality criteria in Boulder Creek for this interim action.

For an HDS treatment facility located at the Boulder Creek site, sludge dewatering ponds would discharge to Boulder Creek and shall comply with the effluent limitations of 40 C.F.R. §§ 440.102(a) and 440.103(a), except for the limitation on pH and TSS. For an HDS treatment facility located at Minnesota Flats additional concerns are relevant regarding protection of the Flat Creek drainage, including meeting the effluent limitation for pH and TSS at 40 CFR § 440.102(a). Flat Creek does not currently meet all ambient water quality criteria (AWQC) and Basin Plan water quality standards due to a pollution source on Upper Spring Creek, the Stowell Mine. Once this source is remediated by the RWQCB, EPA expects that Flat Creek could meet AWQCs and water quality standards. Therefore, discharges from the dewatering of sludge that do not meet AWQCs must be prevented from entering Flat Creek. Proper design of the dewatering ponds may be an economically viable option to either mechanical dewatering or the Boulder Creek site. More detailed information which will be developed during design is required to enable making a decision on the suitability of this site.

For the HDS process option (P1-B), Brick Flat Pit must be modified to function as a safe, long-term disposal site for treatment plant sludges. The remedial design of the disposal facility in Brick Flat Pit shall address and comply with the requirements of the Toxic Pits Control Act and the California mining waste requirements. The discharge from Brick Flat Pit shall comply with California mining waste requirements. Because Boulder Creek and Slickrock Creek do not currently comply with ambient water quality criteria, and remediation of sources in the interim action pursuant to the Boulder Creek OU will not allow for compliance with these standards without further actions, EPA is relying upon a waiver for "interim measures" and is not requiring that the discharge meet ambient water quality criteria in surface waters receiving the discharge.

Seven waste piles have been identified for remediation. Available information has indicated that these largely pyritic waste piles are discharging AMD and/or are actively eroding into Boulder Creek. The waste piles have not been fully characterized to assure statistical representativeness of the sampling. However, additional data gathered during remedial design can be obtained to verify the extent to which the waste piles should be removed, consolidated and capped. At a minimum, all mining wastes in these waste piles which qualify as Group A or Group B wastes under 23 C.C.R. § 2571(b) shall be removed for proper disposal.

Some modifications and refinements may be made to the remedy during remedial design and construction. Such modifications or refinements, in general, would reflect the results of the engineering design process. Estimated cost for the remedy is $54.0 million. Details of the costs for the treatment component are shown in Table 5-8, PS and Table 5-9, FS for capital costs and O&M costs. Cost for the waste pile component of the selected remedy, W-3, is shown in Table 5-42, FS.

Table 5-8
Cost Summary for Alternative P1 ($ x 1,000)

	Alternative	
	P1-A Simple Mix	P1-B HDS
Site Preparation	1,683	1,683
AMD Conveyance System	3,623	4,241
Treatment Plants	2,333	4,674
Landfill Construction	2,283	1,614
Construction Subtotal	9,922	12,212
Bid Contingencies (10 percent)	992	1,221
Scope Contingencies (30 percent)	2,977	3,663
General Contingencies (8 percent)	794	977
Construction Total	14,685	18,073
Permitting and Legal (3 percent)	441	542
Services During Construction (10 percent)	1,469	1,807
Total Implementation Cost	16,595	20,422
Engineering Design Cost (15 percent of construction total)	2,203	2,711
Total Capital Cost	18,798	23,133
30-Year Present Worth of O&M Costs, interest equals 5 percent	21,552	27,855
Total 30-Year Present Worth, interest equals 5 percent	40,350	50,988

Table 5-9 Annual Operation and Maintenance Cost Summary of Alternative P1 ($ x 1,000)		
	Simple Mix	**HDS**
Site Preparation	62	62
AMD and Process Water Conveyance	104	112
Treatment Plant	1,186	1,588
Sludge Landfill at Brick Flat Pit	50	50
Total Yearly O&M	1,402	1,812
Total Present Worth of 30-Year O&M	21,552	27,855

Table 5-42 Summary of Costs			
Alternatives	**Initial Cost**	**O&M Cost ($/year)**	**30-Year Present Worth Value**
W0 No-Action	$0	$0	$0
W2 Waste Pile Removal, Treatment, and Disposal	$5,918,000	$0	$5,918,000
W3 Consolidating and Capping Waste Piles Onsite	$2,810,000	$10,000	$2,970,000

X. STATUTORY DETERMINATIONS

EPA's primary responsibility at Superfund sites is to select remedial actions that are protective of human health and the environment. CERCLA also requires that the selected remedial action for the site comply with applicable or relevant and appropriate environmental standards established under Federal and State environmental laws, unless a waiver is granted. The selected remedy must also be cost-effective and utilize permanent treatment technologies or resource recovery technologies to the maximum extent practicable. The statute also contains a preference for remedies that include treatment as a principal element. The following sections discuss how the selected remedy for the Boulder Creek OU at the Iron Mountain Mine site meets that statutory requirements.

X.1 Protection of Human Health and the Environment

The selected remedy protects human health and the environment from the exposure pathways that are being addressed in this interim action. The selected remedy addresses the AMD discharges from the Richmond and Lawson portals and the discharges from and erosion of seven largely pyritic waste piles. The human health threats posed by these sources are small and related to direct contact or ingestion of the AMD, which is unlikely due to the remote location, rugged topography, and restriction on access to the property. The environmental threats posed by these sources are the very significant releases of copper, cadmium, zinc, and acidity into surface waters. The selected remedy will essentially eliminate the discharges from the sources being addressed in this interim action. The adits and mine workings are very effective collectors of the AMD, and treatment of the discharges is expected to reduce the copper, cadmium, and zinc by greater than 99 percent. The consolidation and capping of the seven waste piles will essentially eliminate the current discharge with proper remedial design and maintenance.

The Boulder Creek OU provides for an interim action that is not expected to be final and does not address all of the sources of discharges from the site. The selected remedy therefore cannot be expected to be fully protective of the environment.

X.2 Compliance with ARARs

The selected remedy for the Boulder Creek OU provides for an interim remedial action for certain sources at the site. The selected remedy provides for significant progress towards meeting the objectives of the Superfund cleanup action at Iron Mountain Mine by providing for large reductions in the discharges of copper, cadmium, zinc, and acidity from the site. This section discusses the ARARs which the action shall meet and identifies the ARARs which are being waived.

X.2.1 Portal AMD Discharges

The components of the selected remedy to address portal AMD discharges is collection, treatment, and disposal of treatment residues onsite. This action shall comply with the following ARARs in the manner described:

X.2.1.1 Chemical-Specific ARARs - Summary. Chemical-specific ARARs for the treatment plant include the Clean Water Act effluent limitations for discharges of mine drainage from copper mines, exercise of best professional judgment under the Clean Water Act, Safe Drinking Water Act Maximum Contaminant Levels (MCLs) and non-zero Maximum Contaminant Level Goals (MCLGs) at the water intake to the City of Redding, and the Basin Plan water quality objectives.

California law controls the design of units that receive mining waste. Accordingly, the application of chemical-specific concentrations applicable to sludge disposal is addressed below in the context of action-specific ARARs, specifically the design, siting, and closure standards that apply to the disposal unit.

Chemical Specific ARARs - Water Quality in General. A primary adverse environmental impact from the IMM discharges is on surface waters and the species which live in those waters. CERCLA provisions respecting water quality criteria and the requirements of the Clean Water Act and California Water Code are ARARs for the Site.

In the final remedy, any discharge from the mine to surface waters should comply with the water quality objectives in the Central Valley Regional Water Quality Control Basin Plan. In determining the manner in which the mine discharges should be controlled to achieve these levels, EPA may use best professional judgment to determine the level of control. In addition to the use of best professional judgment to achieve the water quality objectives in the receiving waters, EPA may consider effluent limitations on related mining activities as potentially relevant and appropriate. Effluent limitations and best professional judgment are not limitations on the level of control, but simply represent components in a strategy to achieve the water quality criteria and water quality objectives.

CERCLA §121(d)(2)(A), 42 U.S.C. §9621(d)(2)(A), states that the remedy selected must "require a level or standard of control which at least attains...water quality criteria established under Section 304 or 303 of the Clean Water Act, where such...criteria are relevant and appropriate under the circumstances of the release or threatened release." The Act further provides that "[i]n determining whether or not any water quality criteria under the Clean Water Act is relevant and appropriate under the circumstances of the release, [EPA] shall consider the designated or potential use of the surface water or groundwater, the environmental media affected, the purposes for which such criteria were developed, and the latest information available." (42 U.S.C. §9621(d)(2)(B)(i).)

EPA guidance states that federal water quality criteria for specific pollutants should generally be identified as ARARs for surface water cleanup if circumstances exist at the site that water quality criteria were specifically designed to protect, unless the State has promulgated water quality standards for the specific pollutants and water body at the site. See "ARARs Q's and A's: Compliance with Federal Water Quality Criteria," Pub. No. 9234.2-09/FS, June 1990. For most of the hazardous substances released at the Site, the State has promulgated such water quality standards. Under the CWA, EPA has developed water quality criteria for the hazardous substances at the Site. Because the State has adopted specific State water quality objectives for the hazardous substances at IMM, EPA is selecting the more specific, more stringent State water quality standards as ARARs. However, as explained in Section X.2.3 below, these ARARs are being waived for this operable unit.

Chemical Specific ARARs - Effluent Limitations. The Clean Water Act regulates, among other matters, the discharge of pollutants from point sources into navigable waters of the United States. The discharge of metals-bearing acid mine drainage from mine adits into Boulder Creek, Spring Creek, and the Sacramento River is the discharge of pollutants from a point source or sources into navigable waters of the United States.

Clean Water Act controls are imposed on industries through National Pollutant Discharge Elimination System ("NPDES") permits, or Waste Discharge Requirements

("WDRs") which are permitted on a case by case basis. Because the discharges from IMM occur onsite, no permit will be required. However, absent an ARARs waiver, the discharge must meet the substantive requirements of such a discharge permit.

In establishing discharge limits, the permitting agency requires, at a minimum, that the discharger comply with the effluent limitations established under the Clean Water Act for the specific industrial category of the discharger. In the event there are no specific effluent limitations for the type of discharge at issue, the statute provides that the permit shall contain "such conditions as the Administrator determines are necessary to carry out the provisions of this chapter." CWA §402(a)(1)(B), 33 U.S.C. §1342(a)(1)(B). EPA uses "best professional judgement" to establish the effluent limitations if there is no regulation for the specific discharge category.

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 problems of acid mine drainage from the underground mining at IMM are similar to the problems of 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.

The Clean Water Act's system of technology-based effluent controls establishes effluent limitations according to whether the discharge is from a new or existing source and whether the pollutant is conventional, toxic, or a non-conventional, non-toxic pollutant. Existing sources of toxic discharges were initially required to achieve best practicable control technology ("BPT") and then later to achieve best available technology economically achievable ("BAT").

The BPT and BAT limits on discharges from existing point sources at copper and zinc mines are the following effluent limitations (40 C.F.R. §§440.102(a) and 440.103(a)):

> "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

Although potentially relevant and appropriate, the effluent limitations for coal and iron mines do not provide standards for hazardous substances of concern and employ the same standard of 6.0 to 9.0 for pH.

At this point in the design, it is possible that the discharge from the treatment plant could either be into Flat Creek or into Boulder or Slickrock Creeks. It is expected that the pH of the treatment effluent will be greater than the allowable range so that it would be necessary to increase the acidity to achieve the 6.0 to 9.0 range. Because Boulder Creek and Slickrock Creek will continue to have other acid sources, EPA has concluded that meeting this range would not be relevant and appropriate in these streams. Flat Creek, however, will not have acidity from other sources so that the pH of 6.0 to 9.0 will be relevant and appropriate for discharges into Flat Creek.

The treatment plant effluent is expected to contain TSS greater than the allowable range so that it would be necessary to provide for additional filtration to achieve the standard. Because Boulder Creek and Slickrock Creek are not likely to achieve this standard due to the numerous continuing discharges from the site, EPA has concluded that meeting the TSS standard would not be relevant and appropriate in these streams. Flat Creek, however, will not have these sources of suspended solids so that the TSS standard will be relevant and appropriate for discharges into Flat Creek.

Chemical Specific ARARs - Safe Drinking Water Act. The Safe Drinking Water Act, 42 U.S.C. §300f, et seq. provides limits on the concentrations of certain hazardous materials in drinking water "at the tap." CERCLA §121(d)(2)(B) provides that CERCLA response actions "shall require a level or standard of control which at least attains Maximum Contaminant Level Goals established under the Safe Drinking Water Act."

EPA has adopted MCLs or MCLGs for the following hazardous substances:

Substance	MCL	MCLG
Antimony*	0.006 mg/l	0.006 mg/l
Arsenic	0.050 mg/l	none
Cadmium	0.005 mg/l	0.005 mg/l
Copper	**	**
Lead	***	***
Mercury	0.002 mg/l	0.002 mg/l

Silver	0.1 mg/l (secondary)	none
Thallium*	0.002 mg/l	0.0005 mg/l
Zinc	5 mg/l (secondary)	none

*Effective January 1994.
**Required to employ treatment with an action level of 1.3 mg/l.
***Required to employ treatment with an action level of 0.015 mg/l.

These levels are relevant and appropriate with respect to any surface water bodies which are sources of drinking water. At this time, it appears this description would only apply to the area of the Sacramento River near Redding's Jewel Creek Intake. Although this response action is an interim remedial action and does not control all possible sources which lead to the intake, EPA expects that these standards will be met. Consequently there is no need to use an interim remedial action waiver for this ARAR.

Basin Plan Standards (Water Quality Objectives). This section discusses the water quality objectives/standards established by California in the Central Valley Basin Plan. Section 303 of the Clean Water Act, 33 U.S.C. §1313, provides for promulgation of water quality standards by the states. The standards consist of designated uses of water and water quality criteria based on the designated uses (40 C.F.R. §131.3(i)). The criteria are "elements of State water quality standards, expressed as constituent concentrations, levels, or narrative statements, representing a quality of water that supports a particular use." 40 C.F.R. §131.3(b). The Regional Board has identified these water quality standards in "The Water Quality Control Plan (Basin Plan) for the Central Valley Regional Water Quality Control Board (Region 5)" as "water quality objectives."

Table III-1 in the Basin Plan identifies water quality objectives for the Sacramento River and its tributaries above State Highway 32 bridge, an area which includes IMM and the relevant tributaries as follows:

- Antimony--none
- Arsenic--0.01 mg/l
- Cadmium--0.00022 mg/l
- Copper--0.0056 mg/l
- Lead--none
- Mercury--none
- Silver--0.01 mg/l
- Thallium--none
- Zinc--0.016 mg/l

The Basin Plan states that "The pH shall not be depressed below 6.5 nor raised above 8.5." Basin Plan at III-4.

The Basin Plan does not differentiate between those tributaries of the Sacramento River which are above Spring Creek and those water which are unaffected by the AMD. Accordingly, the water quality objectives apply to all such waters.

The Basin Plan makes several relevant comments regarding water quality objectives. For example, they do not need to be met at the point of discharge, but at the edge of the mixing zone if areas of dilution are defined. Basin Plan at III-1. Achievement of water quality objectives depend on applying them to "controllable water quality factors," which are defined as "those actions, conditions, or circumstances resulting from human activities that may influence the quality of the waters of the State, that are subject to the authority of the State Board or the Regional Board, and that may be reasonably controlled." Basin Plan at III-2.

The water quality standards for cadmium, copper, and zinc were established in 1985 and were intended to "fully protect the fishery from acute toxicity since the standards are based on short term bioassays on the critical life stage of a sensitive species." See EPA letter of August 7, 1985, from Judith Ayres, Regional Administrator, to Raymond Stone, Chairman, State Water Resources Control Board, Enclosure 1. As noted above, these values should vary depending on the hardness of the water. The Regional Board used a 40 mg/l water hardness.

On April 11, 1991, the State Water Resources Control Board adopted a California Inland Surface Waters Plan (91-13). This plan adopted water quality objectives to protect beneficial uses. The plan specifically retains the site-specific standards for cadmium, copper, and zinc discussed above.

To the extent practicable in the context of an interim remedial action, discharges resulting from the treatment plant shall also comply with the following requirements in the Basin Plan:

> **Sediment.** "The suspended sediment load and suspended sediment discharge rate of surface waters shall not be altered in such a manner as to cause nuisance or adversely affect beneficial uses." Basin Plan at III-6.
>
> **Toxics.** "All waters shall be maintained free of toxic substances in concentrations that produce detrimental physiological responses in human, plant, animal, or aquatic life." Basin Plan at III-7.
>
> **Guidelines on Mining Waste.** The mining guidance, included in the Basin Plan as Appendix 20, states that "Closure and reclamation plans for all operations will meet the minimum requirements of regulations in the Surface Mining and Reclamation Act of 1975 and will be coordinated with the State Board of Mining and Geology." The Guidance also attaches a diagram of "Best Management Practices Available for Control of AMD From Abandoned Mines."

In its letter of March 27, 1992, the Department of Fish and Game has noted that the State's water rights permits for the Shasta-Trinity unit of the Central Valley Project should also be considered applicable since these permits define the legally allowable minimum flows in the Sacramento River. As stated in the letter, "Since the contamination from this site cannot be totally controlled, streamflow conditions in the Sacramento River will be the determining factor for evaluating the risk to the health and environment. At present the only regulation for minimum Sacramento River flows below Keswick Dam exists in the terms and conditions of these water right permits pursuant to applicable Water Code sections." Calculations of water quality objectives must be considered in the context of the flows in the Sacramento River. The water rights permits define the minimum legally allowed flows.

Although compliance with the Basin Plan water quality objectives are considered ARARs for the site as a whole, they are being waived for this operable unit. This issue is discussed in section X.2.3 below.

X.2.1.2 Action-Specific ARARs - Summary. The selected remedy shall address and comply with all action-specific ARARs as provided herein. Significant action-specific ARARs include those relating to disposal of the treatment sludge and ARARs directing activity to protect affected fisheries and habitat.

Selection of this alternative is consistent with statutes such as the Federal and California Endangered Species Act and the Fish and Wildlife Coordination Acts, since the remedial alternative is being developed pursuant to a process of consultation like that required by the Acts. The alternative would also comply with Fish and Game Code Section 1505, since the improved water quality should result in greater protection of fishery habitat in the Sacramento River below Keswick Dam.

The disposal unit used for the treatment residue should comply with the applicable provisions of California Water Code Section 13172 and Health and Safety Code Section 25208, et seq. (Toxic Pits Control Act of "TPCA"). The Regional Board mining waste requirements are ARARs which are applicable to the disposal of the treatment residue. It is expected that chemical analysis of the treatment residues from the HDS plant will indicate that the wastes are properly categorized as Group B wastes. Although the HDS sludge will be less aqueous than the Simple Mix sludge, it may still contain free liquids subject to TPCA provisions.

Consequently, the unit must not be located in a Holocene fault; shall be located outside areas of rapid geologic change; shall require flood-plain protection from a 100-year peak streamflow; shall have liners and a filtrate collection system; shall have precipitation and drainage controls for a 10-year, 24-hour storm; and shall comply with specific monitoring requirements.

Insofar as the sludge contains free liquids, the disposal unit must also comply with TPCA, which prohibits discharge of free liquids into a surface impoundment unless the surface impoundment does not pollute or threaten to pollute the waters of the State.

If the treatment sludge contains free liquids, the design of the disposal unit must be such that the unit does not pose a threat to pollute the waters of the State.

Action Specific ARARs - Sludge Disposal. This section discusses the Federal and State laws regulating hazardous waste and mining waste. Based upon a consideration of these laws, EPA has concluded that it is not necessary to use a RCRA landfill for disposal of the sludge from the treatment plant. The HDS sludge is not a listed waste under federal law and is not expected to meet any federal characteristic of hazardous waste. EPA has also concluded that it is not necessary to use a State Hazardous Waste Control Law landfill for the sludge. Although the sludge will likely exceed some State characteristics, EPA believes that it would be appropriate to consider the sludge subject to 22 CCR § 66260.200 and 66260.210, which provide variances for non-RCRA wastes.

After a consideration of the Regional Board requirements for mining related waste, the probable groundwater quality, the remoteness of the facility location, and the institutional control of the site as a Superfund site, EPA has concluded that it is appropriate to employ a variance under State hazardous waste law to use applicable Toxic Pits Control Act and Regional Board mining waste requirements rather than the State hazardous waste control requirements for this non-RCRA waste. 22 CCR § 66260.200(f) provides for reclassification of a non-RCRA hazardous waste as non-hazardous if there are "mitigating physical or chemical characteristics." 22 CCR § 66260.210 provides for a variance from one or more of the requirements of the Hazardous Waste Control Law if either "[t]he hazardous waste or the hazardous waste management activity is insignificant or unimportant as a potential hazard to human health and safety, and the environment" or "[t]he handling, processing, or disposal of the hazardous waste, or the hazardous waste management activity, is regulated by another governmental agency in a manner that ensures it will not pose a substantial present or potential future hazard to human health and the environment." See Health and Safety Code § 25143(a)(2)(A and B). EPA notes that the Regional Board mining waste requirements contain adequate environmental safeguards such that the disposal of the non-RCRA sludge in Brick Flat Pit is "regulated by another governmental agency in a manner that ensures it will not pose a substantial present or potential future hazard...." In addition, EPA's oversight of the Site also assures that the activity is "regulated by another governmental agency."

The sludge is therefore to be regulated under the provisions of Water Code §13172 and those provisions of the Toxic Pits Control Act which govern mining waste. It is expected that the mining wastes (including treatment sludge and waste piles) are classified as Group B wastes.

Note on the Bevill Amendment. All of the wastes generated at the Site relate in some manner to the historic and current mining and mineral processing operations at the Site and therefore there has been an issue whether these wastes are subject to federal and State laws governing hazardous waste. As discussed in detail in Appendix A to the Feasibility Study, both federal and State law exempt certain "Bevill amendment" mining wastes from regulation as hazardous waste. Under RCRA §3001(b)(3)(A)(ii), 42 U.S.C. §6921(b)(3)(A)(ii) (also known as the "Bevill amendment"), EPA has exempted most mining wastes from regulation as hazardous waste. Exempted waste are identified in 40 C.F.R. §261.4(b)(7). In the Feasibility Study, EPA provided an analysis based on an assumption that the Bevill amendment was a broad exception that applied to all mining wastes. Pursuant to that analysis, the FS stated that it would be necessary for the mining waste and the sludge to be disposed of in accordance with applicable provisions of TPCA and the State regulations governing mining waste. As explained in the Feasibility Study, the State has stated that it does not believe the AMD is subject to the Bevill amendment.

In a recent District Court opinion regarding the Iron Mountain Mine site, the court stressed "the limited nature of the Bevill Amendment exclusion" and emphasized that "[n]ot all mining wastes are excluded by the regulation." This and other language in the opinion suggests that the court might not consider AMD and the treatment sludge within the scope of the Bevill amendment, as interpreted under federal law. EPA's Feasibility Study analysed the design of the treatment sludge landfill as if it were subject to the Bevill amendment. EPA expects this issue will be revisited in the litigation. However this issue is ultimately resolved, the Bevill status or not of the treatment sludge does not affect the design of the landfill since applicable provisions of TPCA and the State mining waste regulations remain ARARs under this ROD whether or not the sludge is subject to the Bevill amendment under State or federal law. Because the treatment sludge will not meet any federal RCRA characteristic, and EPA is employing a variance under the Health and Safety Code for the disposal of this non-RCRA waste, the requirements which the disposal location must meet will be the same whether or not the AMD and the sludge are subject to the Bevill amendment.

Mining wastes which are within the State's interpretation of Bevill would be subject to the requirements of the Toxic Pits Control Act (TPCA) and the requirements of Water Code §13172, detailed in 23 C.C.R. §§2571 et seq. See Health and Safety Code §25143.1(b)(1 & 2). EPA considers these provisions ARARs for this response action. Other State requirements applicable to mining waste are discussed below.

Design and Siting under Water Code Section 13172. Water Code §13172 and the regulations promulgated thereunder establish three groups of mining waste, Group A, B and C. It is expected that the mining wastes at the site will qualify as Group B wastes. These wastes are mining wastes that consist of or contain hazardous wastes, that qualify for a variance under Title 22, provided that the Regional Board 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. See 23 C.C.R. §2571(b).

Classification of the mining waste as hazardous under State law is used to determine which group designation is appropriate for regulation under Regional Board authority. Under 22 C.C.R. §66261.3, hazardous waste includes wastes which are hazardous under federal criteria, as well as wastes which meet criteria established under State law. In addition to the tests under Federal law, the State identifies as hazardous waste any waste which exceeds Soluble Threshold Limit Concentrations (STLC) or Total Threshold Limit Concentrations (TTLC). See 22 C.C.R. §66261.4(a)(2). The treatment sludge is not expected to exceed federal TCLP levels. Following are the STLC and TTLC limits for hazardous substances at IMM:

Substance	STLC (mg/l)	TTLC (mg/kg)
Antimony	15	500
Arsenic	5.0	500
Cadmium	1.0	100
Copper	25	2,500
Lead	5.0	1 g/kg
Mercury	0.2	20
Silver	5.0	500
Thallium	7.0	700
Zinc	250	5,000

California also identifies as hazardous those wastes which exceed certain parameters of toxicity. See 22 C.C.R. §66261.4(a)(3, 4, 5, and 6).

It is necessary to determine which wastes at the Site are hazardous under this State regulation to determine the group classification of the wastes under Water Code §13172. At this time, it is expected that any wastes which will be disposed of into new units would qualify as Group B wastes.

Under State regulations governing the design of mining waste disposal units, the Regional Board imposes specific requirements on siting, construction, monitoring, and closure and post-closure maintenance of existing and new units. Group B are subject to the following restrictions:

- New Group B Units:
  - -- Shall not be located on Holocene faults
  - -- Shall be outside areas of rapid geologic change, but may be located there if containment structures are designed and constructed to preclude failure
  - -- Flood protection--protect from 100-year peak streamflow

- Construction standards--for waste piles, the pile must be underlain with a single clay liner (at least 1 x 10^{-6} permeability); surface impoundments and tailings ponds must be underlain with a double liner, both layers of which have at least 1 x 10^{-6} permeability); a blanket-type leachate collection and removal system is required (the liner and leachate collection and removal system for tailings ponds must be able to withstand the ultimate weight of the wastes to be placed there)

- Precipitation and drainage controls--one 10-year, 24-hour storm; precipitation that is not diverted shall be collected and managed through the required LCRS, unless the collected fluid does not contain indicator parameters or waste constituents in excess of applicable water quality standards

- Monitoring--comply with conditions of 23 C.C.R. §§2551-2559

• Existing Group B Units:

  - Flood Protection--protect from 100-year peak streamflow

  - Construction standards--same as for new Group B units

  - Precipitation and drainage controls--one 10-year, 24-hour storm; precipitation that is not diverted shall be collected and managed through a required LCRS, unless the collected fluid does not contain indicator parameters or waste constituents in excess of applicable water quality standards

  - Monitoring--comply with conditions of 23 C.C.R. §§2551-2559

The remedial action shall comply with these requirements and any more detailed requirements, including specific requirements for installation of clay liners, are contained in 23 C.C.R. §2572, as necessary in design.

Under 23 C.C.R. §2570(c), Group B wastes may be exempt from liner and leachate collection and removal systems required if a comprehensive hydrogeologic investigation demonstrates that natural conditions or containment structures will prevent lateral hydraulic interconnection with natural geologic materials containing groundwater suitable for agricultural, domestic, or municipal use and (1) there are only minor amounts of groundwater underlying the area, or (2) the discharge is in compliance with the applicable water quality control plan. The unit would remain subject to requirements for siting, precipitation and drainage controls, and groundwater, unsaturated zone and surface water quality monitoring.

Under 23 C.C.R. §2570, the Regional Board may exempt a mining waste pile from the liner and LCRS requirement if leachate will not form in or escape the unit.

These requirements should be addressed during design of the units.

Any mining waste units must also comply with the closure requirements for new and existing mining units under Water Code §13172:

- Group B waste piles--close in accordance with 23 C.C.R. §2581(a), (b), and (c).
- Group B surface impoundments--close in accordance with 23 C.C.R. §2582(a) and (b)(1); some surface impoundments with clay liners may close in place.
- Group B tailings ponds--close in accordance with 23 C.C.R. §2581(a), (b) and (c) and 2582(a)

The action shall also comply with State requirements for seismic safety applicable to construction projects generally (see Department of Fish and Game letter of March 27, 1992), and the Dam Safety Act, in the event of any dam construction or enlargement (see DTSC and Regional Board letter of March 30, 1992).

Toxic Pits Control Act. Under Health and Safety Code §25143.1, Bevill-exempt wastes are exempt from all provisions of the Health and Safety Code except for the requirements of the Toxic Pits Control Act (TPCA), Health and Safety Code §25208, et seq. TPCA prohibits the discharge of liquid hazardous waste or hazardous wastes containing free liquid into a surface impoundment. See Health and Safety Code §25208.4(a). If the HDS treatment sludge contains free liquids the disposal facility shall comply with TPCA requirements, unless the facility is eligible for a variance. Health and Safety Code §25208.13, provides an exemption for a surface impoundment into which mining waste is discharged if the discharge is otherwise in compliance with the requirements for mining waste, and the surface impoundment does not pollute or threaten to pollute the waters of the state. A hydrogeologic assessment report should be reviewed if it is determined during design that an exemption is necessary.

Action-Specific ARARs - Protection of Natural Resources. A major concern at IMM is the impact of the discharges of the acid mine drainage on natural resources. The Sacramento River, into which the acid mine drainage ultimately discharges, contains a major fishery. The winter run chinook, a federally threatened and State-endangered species, spawn in the waters of the Sacramento River affected by the discharges. Because of the national significance of these resources, it is particularly important that EPA assure that any levels of control contained in natural resource protection laws be considered for the Site.

The remedial action at IMM should comply with the requirements of the natural resource protection laws discussed herein. Compliance with the applicable water quality objectives, which take into account the impacts on aquatic species, should also meet the substantive requirements of these ARARs to protect the species and their habitat. EPA is currently complying with the consultation requirements of the Endangered Species Act.

The federal natural resource ARARs include:

> The Endangered Species Act, 16 U.S.C. §1531, et seq.
>
> The Fish and Wildlife Coordination Act, 16 U.S.C. §§661-666

California natural resource ARARs include:

> Fish and Game Code § 1505, providing that State agencies are not to conduct action inconsistent with Department of Fish and Game's efforts to protect spawning grounds, including "Sacramento River between Keswick and Squaw Hill Bridge."
>
> Fish and Game Code § 3005 prohibits the taking of any mammal or bird with poison.
>
> Fish and Game Code §5650 which provides, among other prohibitions that "It is unlawful to deposit in, permit to pass into, or place into the waters of this State...substance or material deleterious to fish, plant life, or bird life." EPA's action is intended to prevent the continuing discharge of acid mine drainage so that it is no longer deleterious to fish life.
>
> Fish and Game Code §5651 which requires the Department of Fish and Game to cooperate with the Regional Board to correct "chronic water pollution."

Other requirements are contained in the following provisions of the California Fish and Game Code:

Fish and Game Code	**Subject**
2070	Establishment of lists of endangered species
2080	Prohibition on taking of endangered species

2090 Issuance of a jeopardy opinion if a project would jeopardize the continued existence of an endangered species or result in the destruction or adverse modification of habitat essential to the continued existence of the species

2091 Specify reasonable and prudent alternatives, subject to the requirements of Section 2092

2093 Informal consultation

2094 Opportunity for full participation in project consultation

2095 For candidate species

2096 Provides that the article remains in effect until January 1, 1994.

X.2.1.3 Location-Specific ARARs - Summary. The selected remedy shall address and is expected to comply with all location-specific ARARs. EPA has determined that the RCRA requirements for management of hazardous wastes, including siting and construction criteria, are not relevant and appropriate to the management and disposal of residuals from treatment of the acid mine drainage discharges or the waste piles. As discussed above, EPA is employing a variance from Hazardous Waste Control Law requirements for disposal of the non-RCRA waste. Accordingly, the selected remedy shall comply with requirements of the Toxic Pits Control Act and California requirements for management and disposal of mining wastes, including siting and technology requirements for disposal facilities.

The action shall comply with the following location-specific ARARs:

Archeological and Historic Preservation Act. The Archeological and Historic Preservation Act, 16 U.S.C. §469, establishes procedures to provide for preservation of historical and archeological data which might be destroyed through alteration of terrain as a result of a Federal construction project or a Federally licensed activity or program. If any response activities would cause irreparable loss or destruction of significant scientific, prehistorical, historical, or archeological data, it will be necessary to follow the procedures in the statute to provide for data recovery and preservation activities.

National Historic Preservation Act. The National Historic Preservation Act, 16 U.S.C. §470, requires Federal agencies to take into account the effect of any Federally assisted undertaking or licensing on any district, site, building, structure, or object that is included in or eligible for inclusion in the National Register of Historic Places. Criteria for evaluation are included in 36 C.F.R. § 60.4. Although it does not appear that the Site is of sufficient historic value to warrant inclusion in the National Register, in the event that an eligible structure will be adversely affected, the procedures for protection of historic properties are set forth in Executive Order 11,593 entitled "Protection and Enhancement of the Cultural Environment" and in 36 C.F.R. Part 800, 36 C.F.R. Part

63, and 40 C.F.R. §6.301(c). These procedures are relevant and appropriate for any action that might impact historic properties. At this time, it does not appear that any of the remedial alternatives under consideration would have any adverse impacts on historic structures.

Clean Water Act (Section 404). Section 404 of the Clean Water Act, 33 U.S.C. §1344, requires a permit for discharge of dredged or fill material into navigable waters. Section 502(7) of the Act defines "navigable waters" as "waters of the United States including the territorial seas." Boulder Creek and the Sacramento River are "waters of the United States." Components of the selected remedy, including removal of tailings, the surface-water diversions, road construction, and capping, are likely to affect Boulder Creek.

Selection of a CERCLA remedy falls within the definition of activities covered by the "nationwide permits" regulations. Under 33 C.F.R. §330.5, specified activities are permitted, provided that certain conditions are met. This provision covers "[s]tructures, work, and discharges for the containment and cleanup of oil and hazardous substances which are subject to the National Oil and Hazardous Substances Pollution Contingency Plan (40 C.F.R. Part 300)...." (33 C.F.R. §330.5(a)(20).) Under 33 C.F.R. §330.5(a)(20), a nationwide permit is available only if "the Regional Response Team which is activated under the [National Contingency] Plan concurs with the proposed containment and cleanup action." Substantive requirements are potentially applicable, including the substantive conditions set forth in 33 C.F.R. Section 330.5(b), the management practices outlined in 33 C.F.R. Section 330.6, and the requirements governing road construction activities in 33 C.F.R. Section 323.4(a)(6).

Executive Order on Floodplain Management. The action shall comply with the Executive Order on Floodplain Management, Executive Order No. 11,988, which requires Federal agencies to evaluate the potential effects of actions that may take place in a floodplain to avoid, to the extent possible, adverse effects associated with direct and indirect development of a floodplain. EPA's regulations to implement this Executive Order are set forth in 40 C.F.R. §6.302(b) and Appendix A. In addition, EPA has developed guidance entitled "Policy on Floodplains and Wetlands Assessments for CERCLA Actions," dated August 6, 1985. Some of the proposed remedial activities could affect the 100-year floodplain of Boulder Creek.

Executive Order on Protection of Wetlands. The remedial action shall comply with the Executive Order on Protection of Wetlands, Executive Order No. 11,990, which requires Federal agencies to avoid, to the extent possible, the adverse impacts associated with the destruction or loss of wetlands and to avoid support of new construction in wetlands if a practicable alternative exists. EPA's regulations to implement this Executive Order are set forth in 40 C.F.R. §6.302(a) and Appendix A. In addition, EPA has developed guidance entitled "Policy on Floodplains and Wetlands Assessments for CERCLA Actions," dated August 6, 1985.

A botanical survey in the Boulder Creek drainage at Iron Mountain Mine stated that "the ecological and environmental devastation to Boulder Creek below the Hornet Mine is so great that little time is needed to understand the problems and determine that in most of Boulder Creek much of the original flora is gone." The September 14, 1992 memorandum from Richard Lis and Harry Rectenwald of the California Department of Fish and Game documenting this survey concludes that the construction activities related to the proposed remedial action "would not result in any significant decrease in the existing riparian or wetland habitat. Instead it may actually increase the total riparian habitat along the creek. This increase would be significant because it would be within the most biologically healthy reach of the creek."

X.2.2 Waste Piles

The component of the selected remedy that addresses the AMD discharges from and erosion of waste piles to surface waters is expected to comply with the following ARARs:

X.2.2.1 Chemical-Specific ARARs. California law controls the design of units that receive mining waste. Accordingly, the application of chemical-specific concentrations applicable to sludge disposal is addressed below in the context of action-specific ARARs, specifically the design, siting, and closure standards that apply to the disposal unit.

As a portion of the Boulder Creek Operable Unit, the remediation of the waste piles will contribute to compliance with the chemical-specific ARARs discussed above for the treatment of AMD, including the Safe Drinking Water Act, and the Regional Board Basin Plan standards. As discussed above, however, it will be necessary to implement further response actions before full compliance with the Basin Plan standards can be achieved.

X.2.2.2 Action-Specific ARARs. The selected remedy shall address and comply with all action-specific ARARs identified in Appendix A to the Feasibility Study. Significant action-specific ARARs include those relating to disposal of the waste piles and ARARs directing activity to protect affected fisheries and habitat.

Selection of this alternative is consistent with statutes such as the Federal and California Endangered Species Act and the Fish and Wildlife Coordination Acts, since the remedial alternative is being developed pursuant to a process of consultation like that required by the Acts. The alternative would also comply with Fish and Game Code Section 1505, since the improved water quality should result in greater protection of fishery habitat in the Sacramento River below Keswick Dam.

The disposal unit used for the waste piles should comply with the provisions of California Water Code Section 13172 and Health and Safety Code Section 25208, et seq. (Toxic Pits Control Act of "TPCA"). These ARARs are applicable to the disposal of the treatment residue. It is expected that chemical analysis of the treatment residues will indicate that the wastes are properly categorized as Group B wastes. The requirements for disposal of Group B wastes are discussed in greater detail above in connection with disposal of the treatment sludge.

Consequently, the unit must not be located in a Holocene fault; shall be located outside areas of rapid geologic change; shall require flood-plain protection from a 100-year peak streamflow; shall have liners and a filtrate collection system; shall have precipitation and drainage controls for a 10-year, 24-hour storm; and shall comply with specific monitoring requirements.

The disposal unit must also comply with TPCA, which prohibits discharge of free liquids into a surface impoundment unless the surface impoundment does not pollute or threaten to pollute the waters of the State. Because the waste piles contain free liquids, the design of the disposal unit must be such that the unit does not pose a threat to pollute the waters of the State.

X.2.2.3 Location-Specific ARARs. The selected remedy shall address and is expected to comply with all location-specific ARARs discussed above.

X.2.3 ARAR Waivers For this Operable Unit

This section summarizes which ARARs are subject to ARAR waivers. Because the Boulder Creek Operable Unit is an interim remedy, it can qualify for the ARAR waiver for such actions.[*] CERCLA §121(d)(4)(A), 42 U.S.C. §9621(d)(4)(A), provides that ARARs may be waived if "the remedial action selected is only part of a total remedial action that will attain such level or standards of control when completed."

The ARARs which are being waived for purposes of this operable unit are:

> The Basin Plan water quality objectives, discussed in detail below. Because the treatment plant does not address all sources which are contributing to the exceedances of the water quality objectives, it is not possible to fully comply with ARARs until further response actions are selected and implemented.
>
> Fish and Game Code Section 5650, which prohibits "permit[ting] to pass into . . . the waters of this State . . . substance or material deleterious to fish, plant life, or bird life." Because the treatment plant would not address all sources at this site, this alternative would not eliminate all releases. It would, however, eliminate 99 percent of the material passing into the waters from the two portal sources.

The overall remedy, including the activities in the 1986 Record of Decision, this Operable Unit and subsequent operable units are expected to achieve compliance with these ARARs (at least in those portions of the Site immediately below Keswick Dam).

EPA has previously stated that the Boulder Creek Operable Unit will be followed by other studies and remedial actions to address matters such as releases from Old Mine/No. 8 and the sediments in the Spring Creek Arm of Keswick Reservoir. Those activities are not a part of this OU. The Boulder Creek Operable Unit, however, is not expected to achieve this ARAR in all years without the planned further remedial action. As such, the Boulder Creek Operable Unit is an interim remedy. In the event of an interim remedy, EPA may elect to invoke an interim remedial action waiver as provided in CERCLA §121(d)(4)(A), 42 U.S.C. §9621(d)(4)(A).

There is also some question regarding the technical practicability of meeting water quality objectives in certain segments of Boulder Creek. In particular, it may not be technically practicable to meet the water quality objectives in certain portions of Boulder Creek. In such a case, EPA may consider the use of a waiver under CERCLA §121(d)(4)(C), 42 U.S.C. §9621(d)(4)(C). The preamble to the NCP discusses the use of the technical impracticability waiver at 55 Fed. Reg. 8748 (March 8, 1990). The main criteria for invoking this ARAR waiver are engineering feasibility and reliability. EPA explained in the preamble that cost plays a "subordinate role" in determining whether a remedial action is "practicable from an engineering perspective." Id. Because this action is an interim remedial action, EPA is not today reaching any conclusions regarding the technical impractacability of achieving ARAR compliance in Boulder Creek, but is invoking the interim remedy waiver for all stream segments.

The selected remedy will not provide for compliance with the applicable chemical-specific ARARs of the Central Valley Regional Water Quality Control Basin Plan water-quality objectives, as discussed below. The selected remedy will allow for compliance with these water quality objectives most of the time and represents a significant improvement compared to the No-Action Alternative, P0. The selected remedy will not provide for meeting water quality objectives in Boulder Creek. Subsequent remedial measures will address other sources of contamination that prevent achievement of the water quality objectives in the Sacramento River. A subsequent study will also address whether or not a waiver for technological impracticability is appropriate for water quality objectives in the Boulder Creek watershed.

X.3 Cost-Effectiveness

EPA has concluded that the selected remedy is cost-effective in mitigating the risk posed by the discharge of heavy metal-laden AMD from the Richmond and Lawson portals and waste piles to surface waters. Section 300.430(f)(ii)(D) of the NCP requires EPA to evaluate cost-effectiveness by comparing all the alternatives against three additional balancing criteria: long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; and short-term effectiveness. The selected remedy meets these criteria and provides for effectiveness in proportion to its cost. The estimated cost for the HDS treatment component is $51.0 million. The estimated cost of the waste pile component is approximately $3.0 million. The total cost of the selected remedy is $54.0 million.

X.4 Utilization of Permanent Solutions and Alternative Technologies or Resource Recovery Technologies to the 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 cost-effective manner for the interim remedial action for the Boulder Creek OU at Iron Mountain Mine.

EPA recognizes that the mineralization at Iron Mountain Mine will continue to generate acid mine drainage unless additional remedial actions are developed, evaluated, and selected for implementation to reduce or eliminate the AMD-forming reactions. Treatment does not address the reactions themselves. Treatment effectively addresses the resultant discharges. EPA has developed and evaluated alternatives as part of the Boulder Creek OU that could reduce or eliminate the AMD-forming reactions. Resource recovery alternatives have been proposed and evaluated. EPA has concluded that further information is required to be developed and evaluated before one of these approaches could be selected for implementation. The needed further information would address technical feasibility, implementability, effectiveness, and cost-effectiveness concerns and risk factors with respect to these approaches. EPA encourages the further development of source control alternatives and resource recovery alternatives for future evaluation and potential selection in a subsequent action.

The selected remedy will provide for a significant reduction in the copper, cadmium, zinc, and acidity discharges from the site. The current water supply and fishery conditions are critical. There is a critical need to implement controls on these discharges as soon as possible, while studies are ongoing with respect to further source control or resource recovery approaches. Treatment is effective, a part of each approach developed to date, and is consistent with implementation of a subsequent action.

X.4.1 Preference for Treatment as a Principal Element.

Although EPA is not selecting a remedy which treats the source such that no further AMD is formed, EPA is using treatment to reduce the toxicity and mobility of the AMD which is being generated. By selecting lime/sulfide HDS instead of Simple Mix, the treatment will also reduce the expected volume of the sludge. HDS sludge will also be less toxic than the Simple Mix sludge.

Mine sealing or plugging alternatives present the potential to completely stop the AMD-forming reactions and the discharge if the surrounding rock mass can contain a mine pool at elevations sufficient to inundate all mineralization. The plugging alternatives might (with innovative approaches) address acidic metal-laden salts that dissolve in the flooding mine pool, and thus, are mobilized and create a discharge pathway through fractures or mining-related openings. A partially successful plugging alternative would reduce the AMD-forming reactions, but not eliminate them. A partially successful program presents risks of release of contaminants to the environment.

Other alternatives such as intercepting groundwater flow and capping areas which channel infiltrating water towards mineralization would likely reduce the rate of reaction of the AMD formation, but not eliminate them. These alternatives provide less risk of creating new discharge pathways and rely on conventional engineering approaches.

Resource recovery approaches merely treat the discharge recovering economic values. Conventional treatment is effective at eliminating the discharge, but does not treat the sources of the discharge.

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. EPA has concluded that further development and evaluation of the above approaches is necessary to address uncertainties with respect to technical feasibility, implementability, effectiveness, cost-effectiveness concerns, and risk factors.

XI. DOCUMENTATION OF SIGNIFICANT CHANGES

EPA is today approving the proposed plan with one change. That change involves the use of a more reliable and more effective treatment method than was used in the proposed plan. In all other respects, including the use of Brick Flat Pit as the sludge disposal location, this action is consistent with the proposal.

In the proposed plan dated May 20, 1992, EPA identified its preferred plan for cleanup of Boulder Creek contaminant sources as "collecting the acid mine drainage (AMD) discharges from the Richmond and Lawson tunnels and treating them at a lime neutralization plant. The treated water would be discharged into Slickrock or Boulder Creeks and the treatment plant sludge, containing the removed heavy metals, would be disposed of in the open pit mine on-site." As stated in the fuller discussion of Alternative P1, two treatment processes could be used, either P1A, the simple mix system, or P1B, the High Density Sludge option. EPA stated that its preferred alternative was P1A. Among other criteria, EPA indicated that it believed P1A was the lowest cost alternative.

Today's action selects treatment as proposed with one difference. Based upon a consideration of the public comments, EPA is today selecting use of a treatment system which relies principally upon the High Density Sludge method rather than the originally preferred Simple Mix System. Under the lime/sulfide HDS method selected, HDS would be the principal treatment method, but Simple Mix would be used as a back-up system for emergencies.

A major concern raised in public comment was the limited sludge disposal capacity using simple mix. In public comment, many persons noted that the disposal capacity of Brick Flat Pit was limited to only 60 to 150 years using the Simple Mix System, but as discussed above, the sludge capacity for HDS is much greater, conservatively estimated at 120 to 250 years. Even though EPA believes treatment is only an interim remedy, it is possible that sludge disposal capacity could become increasingly of concern in the next century, depending upon what other remedial actions are ultimately selected.

Use of lime/sulfide HDS rather than Simple Mix would also prolong the use of Brick Flat Pit for sludge disposal in the event one of the other alternatives, such as plugging, is later selected, since these alternatives would also require some treatment.

Use of lime/sulfide HDS instead of Simple Mix should also help address concerns regarding the toxicity of the sludge. Some persons submitting comments were concerned regarding the disposal of toxic metals, even if treated, back on the site and expressed concerns regarding the ability of the treated sludge to re-enter the environment. EPA's tests on treated sludge have shown that HDS is more effective in binding the metals in the sludge than is Simple Mix. These tests have shown that it is more probable that the treated sludge will not qualify as "hazardous" under federal characteristics after treatment with HDS, than is the case with simple mix.

An overwhelming number of comments called for the immediate implementation of an effective, reliable system. Use of HDS rather than Simple Mix is also responsive to these concerns. In response to these comments, EPA closely considered the relative effectiveness of Simple Mix and HDS, and has concluded that HDS may be a more reliable system.