Superfund Program
Proposed Plan
Captain Jack Mill Superfund Site

CDPHE and EPA Announce Proposed Plan

This Proposed Plan identifies the Preferred Alternative for remediation of the contaminated soils and surface water discharges associated with the Captain Jack Mill (CJM) Superfund Site along Left Hand Creek in Boulder County. In addition, this Plan summarizes other cleanup alternatives that were evaluated for use at this site. This document is issued by the Colorado Department of Public Health and Environment (CDPHE), the lead agency for site activities, and the U.S. Environmental Protection Agency (EPA), the support agency. CDPHE, in cooperation with EPA, will select a final remedy for the site after considering all information submitted during the 30-day public comment period. In addition, CDPHE, in consultation with the EPA, may modify the Preferred Alternative or select another response action presented in this Plan based on new information or public comments. Therefore, the public is encouraged to review and comment on all the alternatives presented in this Proposed Plan.

This Proposed Plan summarizes information that can be found in greater detail in the Remedial Investigation / Feasibility Study (RI/FS) report and other documents contained in the Administrative Record file. CDPHE and EPA encourage the public to review these documents to gain a more complete understanding of the site and the Superfund activities that have been conducted.

The Preferred Alternative for cleaning up the Captain Jack Site is a combination of Surface Contamination Sources Alternative 2B (On-Site Consolidation Cell for Principal Threat Waste and Capping) and Subsurface Contamination Sources Alternative 3B (Bulkhead and Mine Pool Mitigation at the Big Five Adit with Phased Successive Biochemical Reactor Treatment as required).

Dates to remember:

PUBLIC COMMENT PERIOD:

Monday June 16 – Tuesday July 15, 2008
CDPHE will accept written comments on the Proposed Plan during the public comment period. Submit comments to:

Angus Campbell, CDPHE
Hazardous Materials & Waste Management
4300 Cherry Creek Drive South
Denver, CO 80246-1530
angus.campbell@state.co.us

Space for written comments is provided at the end of the document. CDPHE will also extend the public comment period by 30 days, upon reasonable and timely request.

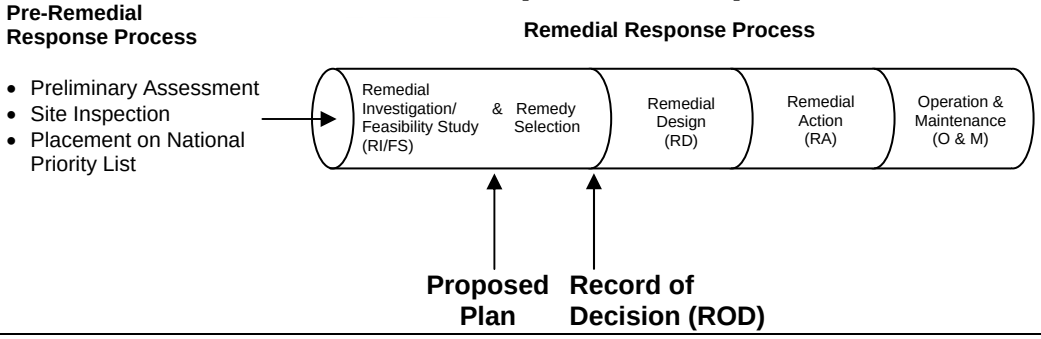
PUBLIC MEETING: Wed July 2, 2008
CDPHE will hold a public meeting to explain the Proposed Plan and all of the alternatives presented in the Feasibility Study. Oral and written comments will also be accepted at the meeting. The meeting will be held at the *Ward Municipal Dojo Room* at 6:00 p.m.

For more information, see the files at the following locations:
Ward Public Library
Post Office / Town Hall Building
Ward, CO 80481

University of Colorado Public Library
1720 Pleasant Street, Boulder, CO 80309

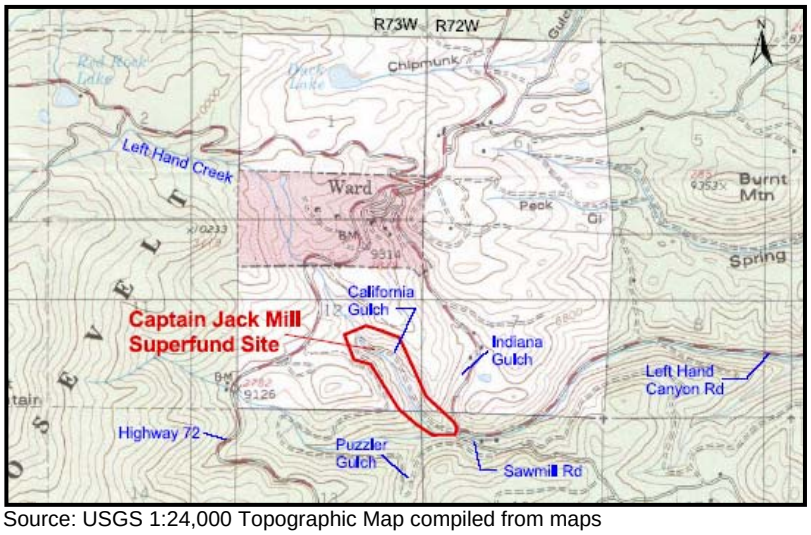
Administrative Record at:
CDPHE
4300 Cherry Creek Drive South
Denver, CO 80246-1530
303-692-2000
Hours: Mon-Fri, 8:30 a.m. to 5 p.m.

The Superfund Pipeline



Proposed Plan (continued)

Photograph of Big Five Mine draining adit and waste pile at Captain Jack Superfund Site



Source: USGS 1:24,000 Topographic Map compiled from maps dated 1967-1972; Revised from aerial photographs dated 1975-1976, and 1978; UTM Zone 13, NAD 27.

What are the "Contaminants of Concern"

CDPHE and the EPA have identified eight metals that pose a risk to human health and the environment at this site. Three of the metals; arsenic, lead and thallium, present significant human health risks, while antimony, arsenic, cadmium, copper, zinc, and manganese present risks primarily to fish and other aquatic life.

Antimony: Antimony in the soil ranges from "too low to measure" to 10,800 milligrams per kilogram (mg/kg). It has not been found in the surface water. Antimony has both high acute and chronic toxicity to aquatic life. Long term exposure has shown to cause fertility problems in laboratory animals.

Arsenic: Arsenic in the soil ranges from "too low to measure" to 10,676 mg/kg. It has not been found in the surface water. Arsenic can cause cancer in humans, and has been linked to lung, skin, bladder, liver, kidney and/or colon cancer. Other effects include skin and nerve damage.

Cadmium: Cadmium, a toxic metal, exists in the soil at the site in concentrations ranging from "too low to measure" to 241 mg/kg. Cadmium in the surface water ranges from "too low to measure" to 0.008 milligrams per liter (mg/L). Vegetables and other plants absorb cadmium easily, and can be extremely dangerous when eaten. Cadmium often diminishes plant growth. Aquatic organisms can vary greatly in their sensitivity to cadmium.

(continued on following page)

Site History

The CJM Superfund Site is located near Ward, Colorado, within the Left Hand Creek Watershed. In the 1980s, the EPA discovered fisheries and wetlands impacts in the watershed. These impacts were suspected to be associated with discharges of metal-contaminated water from the major abandoned mining and milling areas, including the CJM site. On September 29, 2003, the CJM site was listed on the National Priorities List (NPL).

Site Characteristics

A RI/FS was conducted between 2004 and 2008. The RI/FS identified the types, quantities and locations of contaminants and evaluated ways to address the contamination problems. The RI/FS identified three main mine and mill areas of contamination including The Big Five, Captain Jack and White Raven. Approximately 85,000 cubic yards of contaminated waste rock, tailings and soil were identified, which includes approximately 9,000 cubic yards of material that is considered Principal Threat Waste. In addition, up to 50 gallons per minute of metals-contaminated water is draining from the Big Five Adit, eventually flowing into Left Hand Creek.

The RI found that:

- The main contamination comes from toxic metals in soil, waste rock, tailings, surface water and mine impacted groundwater.
- Contaminants of concern include: antimony, arsenic, cadmium, copper, lead, manganese, thallium and zinc.

"Contaminants of Concern" (continued)

Copper: Copper in the soil ranges from 8 to 90,245 mg/kg. In the surface water, copper ranges from "too low to measure" to 2.5 mg/L. Copper in soil can harm microorganisms and earthworms. At higher doses copper is toxic to aquatic life.

Lead: Lead in the soil ranges from 27 to 177,000 mg/kg. In the surface water it ranges from "too low to measure" to 0.016 mg/L. A highly toxic element, lead causes a variety of health effects. Brief exposure to high levels of lead can cause brain and kidney damage and stomach or intestinal distress. Long-term exposure to low levels of lead can affect reproductive organs, the central nervous system, blood pressure and kidneys. Elevated lead levels stunt plant growth.

Manganese: Manganese in the soil ranges from 290 to 21,130 mg/kg. In the surface water it ranges from "too low to measure" to 6.69 mg/L. Long-term exposure to low levels of manganese can result in central nervous system damage while respiratory problems can occur from an acute high exposure. Most plants have a very high tolerance for manganese, but it is moderately toxic to aquatic organisms.

Thallium: Thallium in the soil ranges from "too low to measure" to 27.2 mg/kg. In the surface water it ranges from "too low to measure" to 0.009 mg/L. At high exposure levels, thallium causes nervous system disturbances. Long-term exposure to low levels of thallium can cause fatigue, headaches and depression because it accumulates in the human body. Thallium is very toxic to some rodents, and causes color changes and stunted growth in plants.

Zinc: Zinc in the soil ranges from 66 to 217,510 mg/kg. In the surface water, it ranges from "too low to measure" to 1.76 mg/L. Zinc is a trace element essential for human and animal health. At very high levels, zinc can cause arteriosclerosis in humans. Aquatic organisms can accumulate zinc and pass it to animals higher on the food chain. In freshwater, high zinc levels have acute effects and can be toxic to fish and other aquatic life.

- Sources of contamination include: the underground mine-workings and ore-materials that release acid mine drainage (AMD) from an open adit (entrance tunnel) at the Big Five mine; and exposed waste rock and tailings piles that leach and erode into the creek.

Scope and Role of the Action

The Remedial Action Objectives are to prevent current and future exposure to contaminated soil, water and groundwater through a combination of treatment and containment. The remedial response actions described in this Proposed Plan will permanently control and reduce the toxicity, mobility and volume of those source materials that pose a risk at the site. Site specific remedial action objectives are discussed on page 5.

Summary of Site Risks

Left Hand Creek is a public water supply, although the diversion is several miles downstream from the site. A primary reason for listing this site on the NPL was the potential for risks to the downstream public water supply, either from continuous discharge from the adit or future tunnel collapses that could cause large surges of AMD into Left Hand Creek.

As part of the RI/FS, CDPHE and EPA conducted a baseline risk assessment to determine the current and future effects of contaminants on human health and the environment. Residents currently reside onsite; therefore, the baseline risk assessment focused on health risks for children and adults in a residential setting resulting from direct contact with contaminated soil and/or contaminated water. CDPHE and EPA believe that the Preferred Alternative identified in this Proposed Plan is necessary to protect public health and the environment from actual or threatened releases of hazardous substances.

Human Health Risks

A human health risk assessment was performed to describe site-related risks to people who are exposed to contaminants of concern. Some non-cancer and cancer risks are elevated at the site. The risks are highest in the Captain Jack Mill area. All site areas have the potential for elevated non-cancer and cancer risks, if people come into contact with contaminated soil or water. These risks are much higher for residents than for other individuals. Contaminated surface soil is the material most likely to produce excess non-cancer or cancer risks. Eating garden vegetables produced non-cancer hazard quotients (*see box on page four for an explanation of hazard quotients)* as high

How Is Baseline Risk Calculated?

A Superfund human health risk assessment calculates the **"baseline risk,"** an estimate of the likelihood of health problems occurring if no cleanup action were taken at a site. To estimate the baseline risk at a Superfund site, CDHPE and EPA undertake a four-step process:

Step 1: Analyze Contamination
Step 2: Estimate Exposure
Step 3: Assess Potential Health Dangers
Step 4: Characterize Site Risk

In Step 1, CDPHE and EPA look at the concentrations of contaminants found at a site as well as past scientific studies on the effects these contaminants have had on people (or animals, when human studies are unavailable). Comparisons between site-specific concentrations and concentrations reported in past studies help regulators determine which contaminants are most likely to pose the greatest threat to human health.

In Step 2, CDPHE and EPA consider the different ways people might be exposed to the contaminants identified in Step 1, the concentrations people might encounter, and the potential frequency and length of exposure. Using this information, regulators calculate a **"reasonable maximum exposure"** scenario, which predicts the highest level of human exposure that could reasonably be expected to occur.

In Step 3, CDPHE and EPA combine the information from Step 2 with toxicity information for each chemical to assess potential health risks. Regulators consider two types of risk: cancer risk and non-cancer risk. The likelihood of any kind of cancer resulting from a Superfund site is expressed as an upper-bound probability; for example, a "one in 10,000 chance." In other words, for every 10,000 people that could be exposed to site contaminants, one extra cancer case may result. An extra cancer case means that one more person could get cancer than would be expected normally from all other causes. For non-cancer health effects, regulators calculate a **"hazard quotient" (HQ).** The key concept here is that a **"threshold level"** (usually measured as a hazard quotient of less than one) exists below which non-cancer health effects are no longer predicted.

In Step 4, CDPHE and EPA combine, evaluate and summarize the results of the three previous steps to determine whether site risks are great enough to cause health problems for people at or near the Superfund site. In this step, regulators add up the potential risks to the individual.

as two and excess cancer risks as high as one in 2,300. Using surface water as the sole drinking-water source produced higher risk estimates than skin contact or incidental use. Eating fish and drinking groundwater also produced higher excess cancer risks.

Ecological Risks

An ecological risk assessment indicated that the aquatic ecosystem is greatly impacted. Numerous metals in each exposure area produced hazard quotients (HQs) greater than one. The Captain Jack Mine (CJM) and Big Five areas present the highest ecological risk. Bottom-dwelling invertebrates were largely lacking during sampling events, and fish populations appear reduced in the Left Hand Creek through the site. The CJM area produced the highest HQs for plants and land-dwelling invertebrates exposed to surface soils. The Big Five area produced the highest HQs for aquatic life exposed to surface water.

Swallowing surface soil would produce HQs greater than one for all birds and mammals potentially exposed to surface soil. Numerous metals had HQs above one for birds and mammals. Lead produced the highest HQs for birds, and arsenic produced the highest HQs for mammals. The CJM area exhibited the highest HQs for birds and mammals.

Only burrowing animals are expected to be exposed to subsurface soil. Subsurface soils produced HQs greater than one for the montane vole, and the highest HQ was 11 for aluminum at the CJM area.

There were no HQs greater than one for birds and mammals drinking surface water, so using the stream as a drinking water source is not likely to pose a risk to them.

All exposure areas present a potential risk to living things. Soil, surface water and groundwater all produce HQs greater than one for at least one group of organisms. Surface water is potentially problematic for aquatic life. The CJM and Big Five areas present the highest ecological risk.

Remedial Action Objectives (RAOs)

The Remedial Action Objectives (RAOs) are:

- ***Soils, Tailings and Waste Rock:***

1) Reduce exposure to the Principal Threat Wastes — arsenic, lead and thallium — from incidental swallowing and/or breathing of surface tailings/waste rock and other mine wastes; and

2) Control and/or reduce water run-on and runoff from soils/tailings/waste rock piles.

- ***Surface Water:***

1) Reduce in-stream metals concentrations;

2) Ensure that in-stream metals concentrations do not degrade drinking water supplies diverted from Left Hand Creek; and

3) Reduce the toxicity to bottom-dwelling aquatic organisms living in or just above the sediment to levels that protect aquatic life.

- ***Groundwater:***

1) Control and/or reduce metals loading to groundwater from subsurface and surface sources to ensure that contaminated groundwater does not harm human health or result in releases that impair organisms living in Left Hand Creek.

The RAOs will be achieved by reducing the mobility of the contaminants in the soil and waste rock. Isolation/containment and capping the waste will prevent exposure to the materials.

Cleanup activities are triggered by a contaminant-specific and location-specific "Remedial Action Level." Table 1 presents these values. Priority will be given to the Principal Threat Wastes, which are considered the most dangerous contaminants of concern, either due to their concentration in the environment or other physical characteristics.

What is Principal Threat Waste?

Principal Threat Wastes are source materials that are highly mobile or highly toxic that cannot be reliably contained. Should exposure occur, they would present a significant risk to human health or environment. At the Captain Jack Mill site, lead, arsenic and thallium are the Principal Threat Wastes.

For the Captain Jack site Principal Threat Waste is defined as solid material which contains lead concentrations exceeding 1,460 mg/kg (based on the CDPHE Hazardous Materials and Waste Management Division Soil Cleanup Table Value Standard [TVS] for Industrial Land Use). The value of 1,460 mg/kg was derived through exposure modeling performed by CDPHE in an attempt to determine the most appropriate risk-based threshold for industrial land use, which is an appropriate land use for mining sites.

Management of this material exceeding the threshold level is described in the remedial alternatives. Because arsenic and thallium are typically co-located with lead, lead was selected as the definitive metal for this classification.

Table 1

Principal Threat Waste	Remedial Action Level (mg/kg)
Definition of Contaminated Material	
Arsenic	85
Thallium	5.2
Lead (by Exposure Area)	
Big Five to CJM	860
Big Five	830
CJM	380
White Raven	400
White Raven to Sawmill	750

Summary of Remedial Alternatives

Remedial alternatives for the site appear below. The alternatives are numbered to correspond with the numbers in the RI/FS Report. Alternatives have been separated into surface contamination sources alternatives and subsurface contamination sources alternatives. To meet Remedial Action Objectives (RAOs) for the site, two alternatives should be selected: one from the surface contamination sources group, and one from the subsurface contamination sources group.

The following remedial alternatives have been developed for the site.

- Alternative 1: No Action

Surface Contamination Sources Alternatives:

- Alternative 2A: Off-Site Disposal of Principal Threat Waste with Remainder Cap-in-Place
- Alternative 2B: On-Site Consolidation & Capped-Cell for Principal Threat Waste with Remainder Cap-in-Place
- Alternative 2C: On-Site Consolidation & Capped-Cells for Contaminated Soils

Subsurface Contamination Sources Alternatives (Big-Five Adit):

- Alternative 3A: Bulkhead with Monitoring
- Alternative 3B: Bulkhead and Internal Mine-Pool Mitigation with Phased Successive Biochemical Reactor Treatment Outside of Adit
- Alternative 3C: Neutralization and Biochemical Reactor Treatment of Big Five AMD Outside of Adit
- Alternative 3D: Outside-Adit Water Treatment System for Big Five AMD

Alternative 1: NO ACTION

Superfund regulations require the "no action" alternative to be evaluated to establish a baseline for comparison. Under this alternative, no action would be taken at the site to prevent exposure to contaminated soil and groundwater.

Estimated Capital Cost: $0
Estimated Remedial Action Cost: $0
Estimated Present-Worth Cost: $0

Surface Contamination Sources Alternatives:

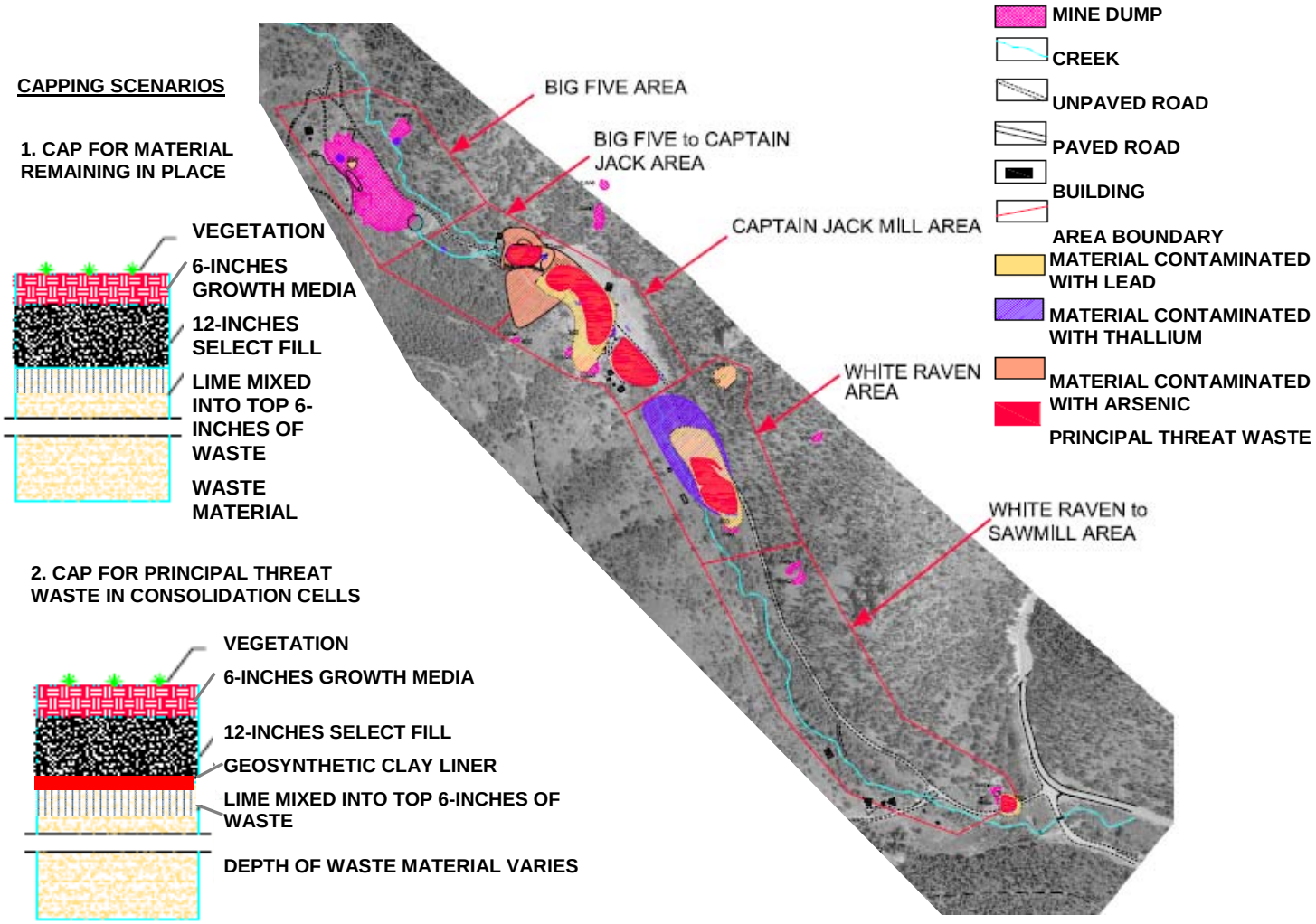
Alternative 2A: OFF-SITE DISPOSAL OF PRINCIPAL THREAT WASTE AND CAPPING
Estimated Design and Construction Cost: $2,368,986
Estimated Total O&M Present-Worth Cost: $27,700
Estimated Present-Worth Cost: $2,396,700

Removing Principal Threat Waste to an off-site facility requires the following basic steps:

- **Excavate** Principal Threat Waste;
- **Remove** excavated waste to an off-site landfill;
- **Cap** the remaining contaminated materials in place – materials that exceed the remedial action levels defined in Table 1 but which contain lead concentrations less than 1,460 mg/kg (*see Figure 1 and Table 1*);
- **Divert surface water** runoff during excavation and capping, and for purposes of permanent control; and
- **Implement access controls** such as fencing/signage and/or Institutional Controls to prevent or minimize activities that could jeopardize remedial components.

The Principal Threat Waste is located primarily at the Big Five to CJM area, CJM, White Raven, and White Raven to Sawmill areas. There are approximately 9,000 cubic yards (cy) of this waste *(see Figure 1)*.

Figure 1: Surface Contamination Sources Alternatives



Because a single-vehicle road is the only access to the site, road improvements will be required for this alternative. Excavation around existing structures can likely be accomplished.

Two commercial landfills were identified within 60 to 70 miles from the site. The first is the North Weld County Landfill in Ault, Colorado, and the second is the CSI Landfill in Bennett, Colorado. The CSI Landfill will most likely have the capacity for the waste removed from this site. Material that is determined to be hazardous, and which CSI Landfill is unable to accept, could be transported to Clean Harbors Deer Trail, LLC (known as the Highway 36 Landfill) for stabilization and burial.

Alternative 2B: ON-SITE CONSOLIDATION CELL FOR PRINCIPAL THREAT WASTE AND CAPPING

Estimated Design and Construction Cost: $1,067,637
Estimated Total O&M Present-Worth Cost: $276,580
Estimated Present-Worth Cost: $1,344,200

This alternative differs from Alternative 2A in that Principal Threat Waste is excavated and placed in an on-site consolidation cell instead of being removed to an off-site disposal facility. The on-site consolidation cell would potentially be located at

the CJM site along the scarred surface bordering the former tailings ponds on the northeast. The material currently in the former tailings ponds would not be excavated and therefore would become part of the cell. Approximately 5,050 cubic yards (cy) of waste material from all five areas of contamination at the site would be placed in the cell and compacted.

The cell cap likely would consist of six inches of topsoil on top of 12 inches of select fill, on top of a geosynthetic clay liner. Before the liner is placed, caustic material would be mixed into the top six inches of the waste material to neutralize waste and to minimize acidic leaching. The liner provides a barrier between the waste material and the upper cap layers and prevents clean water from seeping into the underlying waste material. Plants on top of the cover would require annual maintenance and may require reseeding several times within the first few years. A crushed-rock apron or cap layer also may be considered to keep rodents from burrowing into the cap. Project officials expect capping and erosion-protection materials to be available within a three- to four-acre borrow area near the site. The specific location for the cell would be fully evaluated during the design phase, including evaluation of the borrow area adjacent to the CJM and the alluvial valley above the Big Five tunnel.

Potential area for on-site consolidation cell at CJM area.

Related work would include design and oversight; mobilization; minor road improvements; site grading; drainage systems and erosion control; and demobilization.

Alternative 2C: ON-SITE CONSOLIDATION CELLS FOR CONTAMINATED SOILS

Estimated Design and Construction Cost: $1,066,920
Estimated Total O&M Present-Worth Cost: $182,602
Estimated Present-Worth Cost: $1,249,500

This alternative is similar to Alternative 2B in that material is placed in an on-site cell. The primary difference is that *all* waste is excavated and placed in several cells instead of solely the Principal Threat Waste. Under this alternative, the following areas would be excavated:

- 90 cy of waste from the Big Five area;
- 620 cy of waste from the Big Five to CJM area;
- 17,500 cy from the CJM area;
- 15,500 cy from the White Raven area; and
- 260 cy from the White Raven to Sawmill area.

(Please note that these quantities do not add up to the 85,000 cy of material discussed on page 2 as approximately 51,000 cy of material is already in place in the proposed consolidation cell areas and would not require excavation.)

All of these materials would be placed in on-site consolidation cells (most likely three cells) within the CJM and White Raven areas.

The cell cap likely would consist of six inches of topsoil, on top of 12 inches of select fill, on top of a clay liner. Before the liner is placed, caustic material would be mixed into the top six inches of the waste material to neutralize waste and to minimize acidic leaching. The liner provides a barrier between the waste material and the upper cap layers and prevents clean water from seeping into the underlying waste material. Plants on top of the cover would require annual maintenance and may require reseeding several times within the first few years. A crushed-rock apron or cap layer also may be considered to keep rodents from burrowing into the cap. Project officials expect capping and erosion-protection materials to be available within a three- to four-acre borrow area near the site. The specific location for the cells would be fully evaluated during the design phase. Location options include the borrow area adjacent to the CJM and the alluvial valley above the Big Five tunnel.

Related work would include design and oversight; mobilization; minor road improvements; site grading; drainage systems and erosion control; and demobilization.

What type of access restrictions will remain in place at the site?

Temporary fencing will be necessary throughout construction of any of the alternatives. In addition, temporary fencing will be maintained around newly capped areas for a period of time sufficient to allow new vegetation to take hold. The consolidation cell(s) would be fenced to maintain the integrity of the cap. Access to these particular areas would be permanently restricted.

Subsurface Contamination Sources Alternatives:

Alternative 3A: BIG FIVE ADIT BULKHEAD WITH MONITORING
Estimated Design and Construction Cost: $1,866,755
Estimated Total O&M Present-Worth Cost: $1,478,394
Estimated Present-Worth Cost: $3,345,100

This alternative addresses the Acid Mine Drainage (AMD) from the Big Five adit in an effort to meet the RAOs. Based on an examination of the Big Five adit, a concrete plug called a "bulkhead" could be installed approximately 470 to 675 feet from the portal. The bulkhead would consist of a concrete structure approximately 10 feet thick.

Water would back up behind the "plug," and underground mine workings would partially flood. The surrounding area would be closely monitored to detect water leaking out of the underground workings through seeps or previously unknown openings. The bulkhead would have a pressure gauge and flow-through valve to monitor water in the tunnel and maintain it at an optimum level.

The alternative is designed to decrease the amount of oxygen in the open mine workings by flooding, which will reduce the formation of toxic AMD and in addition will help contain AMD that is generated and entering Left Hand Creek.

Alternative 3B: BIG FIVE ADIT BULKHEAD AND MINE POOL MITIGATION WITH PHASED SUCCESSIVE BIOCHEMICAL REACTOR TREATMENT AS REQUIRED
Phase One:
Estimated Design and Construction Cost: $2,968,827
Estimated Total O&M Present-Worth Cost: $854,858
Estimated Present-Worth Cost: $3,823,700

Phase Two:
Estimated Design and Construction Cost: $2,166,549
Estimated Total O&M Present-Worth Cost: $4,408,065
Estimated Present-Worth Cost: $6,574,600

This alternative begins with the bulkhead described in Alternative 3A and, during the first phase, treats acidic water inside the mine through a process called "in-situ mine-pool neutralization."

By installing this bulkhead, water would back up behind the "plug" and underground mine workings would partially flood. The surrounding area would be closely monitored to detect and observe areas where water could "leak" out of the underground workings through seeps or other unknown openings. The bulkhead would have a pressure gauge and valve to monitor and manage the water in the tunnel at an optimum level that allows for the best management practices for the remedy.

As acidic water builds up behind the bulkhead, wells will inject and circulate sodium hydroxide or another caustic chemical into the mine pool. The chemical reaction would raise the pH of the underground water, making it more alkaline. As the alkalinity rises, some of the dissolved metals will change to a solid form and sink to the bottom of the tunnel.

During mine-pool neutralization, surface water will be monitored to assess the water quality of Left Hand Creek. If the mine-pool treatment appears to have stabilized enough to support bacterial growth after approximately two years of neutralization, but downstream RAOs are not being met for surface water, the second phase of this alternative will be evaluated. If downstream RAOs are being met for surface water, and monitoring indicates that AMD waters within the mine pool and groundwater

reservoir are being fully controlled, project officials will consider not implementing the second phase.

The second phase of this alternative involves installing a series of vessels called "biochemical reactors" on the flat area immediately outside of the adit atop the waste dump and/or at the base of the Big Five pile. The reactors use microorganisms to transform hazardous contaminants into nonhazardous substances. The process forms non-toxic metal sulfides, effectively reducing the mobility of copper, lead, zinc, and cadmium in AMD.

After the biochemical reactor treatment, water would flow through on-site wetlands for a "polishing treatment" before draining to Left Hand Creek.

The biochemical reactor designed would depend on "pre-treated" conditions of the mine-pool water, and would require detailed bench- and/or pilot-scale studies. These studies would determine the best vessel size, organic material and need for additional treatment.

Like other remedial components, biochemical reactors would require site-access restrictions. The

Example of biochemical reactor at the Leviathan mine in California.

process would produce small amounts of a hazardous, but easily dispersed hydrogen sulfide gas that may require management. CDPHE will monitor the release to ensure that it doesn't cause public health effects. In addition, the treatment system would require operation and maintenance to assess effectiveness, replenish organic materials and/or perform repairs. Road improvements and on-site monitoring controls would be necessary.

Alternative 3C: BIG FIVE ADIT BULKHEAD WITH ABOVE GROUND NEUTRALIZATION AND BIOCHEMICAL REACTOR TREATMENT OF DRAINAGE

Estimated Design and Construction Cost: $4,442,305
Estimated Total O&M Present-Worth Cost: $6,576,647
Estimated Present-Worth Cost: $11,019,000

This alternative is similar to Alternative 3B. It involves AMD-neutralization and biochemical reactors; however, the alternative differs significantly from 3B in that there is only one phase to this alternative. Instead of neutralizing acid water inside the mine, a neutralization/precipitation system would be built *outside* of the adit, along with the biochemical reactors. A bulkhead would be installed to control flow rates and restrict oxygen in the mine; however, neutralization of the acidic drainage would take place outside of the mine tunnel in neutralization and settling ponds.

As with the second phase of Alternative 3B, the biochemical reactors would require site access restrictions and operation and maintenance. Ongoing maintenance would most likely be more intensive under this alternative, because sludge management will be required for metal generated in the neutralization process and/or settling ponds. Sludge management would not be necessary with the in-situ mine pool neutralization of Alternatives 3A and 3B.

Alternative 3D: BIG FIVE ADIT BULKHEAD WITH PRECIPITATION WATER TREATMENT SYSTEM FOR DRAINAGE

Estimated Design and Construction Cost: $4,496,174
Estimated Total O&M Present-Worth Cost: $15,250,515
Estimated Present-Worth Cost: $19,746,700

This alternative involves a bulkhead similar to that proposed in Alternative 3A. However, the remainder of the alternative is vastly different than those previously presented because it involves a full-scale, active water treatment plant for the water exiting the bulkhead's flow-through valve.

Several active processes would treat the adit water:

- **Precipitation** is chemically similar to the process described in Alternatives 3B and 3C, but happens at the treatment plant. Raising the alkalinity of the AMD water creates a chemical change in the dissolved metal, causing it to solidify and settle to the bottom of the tank. The precipitation treatment would be expected to remove most of the metals of concern (cadmium, copper and zinc).
- **Filtration** would involve the use of mechanical filters and presses to remove the metals and sludges, which would have to be disposed of in an on-site consolidation cell or an off-site landfill.
- **Immobilized Ligand Treatment** may be required. A ligand is an atom or molecule that bonds to a metal. One such treatment would use iron salts to create a bond with arsenic, allowing it to be removed from the contaminated water.
- **Polymer Addition** would remove any remaining metals and further increase the alkalinity of the water before it is discharged into Left Hand Creek. A polymer is a natural or artificial chemical made up of smaller, identical molecules linked together. Polymers have high molecular weights, and are used for a variety of industrial processes.

A treatability study would need to be performed on the adit discharge water to select the specific polymer and base required. The treatability study would also be necessary to determine if an additional immobilized ligand treatment system is appropriate. Continuous operation and maintenance would be required for this system.

Evaluation of Alternatives

Nine criteria are used to evaluate the different remediation alternatives individually and against each other to select a remedy. This section describes the relative performance of each alternative against the nine criteria, noting how it compares to the other options under consideration. The nine evaluation criteria are discussed on the following page. The “Detailed Analysis of Alternatives” can be found in the FS.

EVALUATION CRITERIA FOR SUPERFUND REMEDIAL ALTERNATIVES
Protectiveness of Human Health and the Environment determines whether an alternative eliminates, reduces, or controls threats to public health and the environment through institutional controls, engineering controls, or treatment.
Compliance with Applicable or Relevant and Appropriate Requirements (ARARs) evaluates whether the alternative meets federal and state environmental statutes, regulations, and other requirements that relate to the site, or whether a waiver is justified.
Long-term Effectiveness and Permanence considers the ability of an alternative to maintain protection of human health and the environment over time.
Reduction of Toxicity, Mobility, or Volume of Contaminants through Treatment evaluates an alternative's use of treatment to reduce the harmful effects of principal contaminants, their ability to move in the environment, and the amount of contamination present.
Short-term Effectiveness considers the length of time needed to implement an alternative and the risks the alternative poses to workers, residents, and the environment during implementation.
Implementability considers the technical and administrative feasibility of implementing the alternative, including factors such as the relative availability of goods and services, including the reliability of Institutional Controls.
Cost includes estimated capital and annual operations and maintenance costs, as well as present worth cost. Present worth cost is the total cost of an alternative over time in terms of today's dollar value. Cost estimates are expected to be accurate within a range of +50 to -30 percent.
State/Support Agency Acceptance considers whether CDPHE agrees with EPA's analyses and recommendations, as described in the RI/FS and Proposed Plan.
Community Acceptance considers whether the local community agrees with CDPHE’s analyses and preferred alternative. Comments received on the Proposed Plan are an important indicator of community acceptance.

1. Overall Protection of Human Health and the Environment

No Action Alternative:
Alternative 1 does not provide adequate protection of human health and/or the environment.

Surface Contamination Sources Alternatives:
All three surface contamination sources alternatives (2A, 2B and 2C) would protect both human health and the environment. The consolidation of Principal Threat Waste in on-site consolidation cells or an off-site disposal facility would significantly reduce and/or eliminate human health risks from exposure to surface waste.

Subsurface Contamination Sources Alternatives:
All subsurface contamination sources alternatives (3A, 3B, 3C and 3D) significantly reduce the movement of contaminants from the Big Five adit to the waters of Left Hand Creek, and therefore would reduce, but not eliminate potential human health risks from surface and groundwater affected by the underground mine water.

Alternative 3A may ultimately be less protective of human health and the environment, because it does not include AMD treatment.

Alternative 3B, Phase I would partially reduce the risk to human health and the environment through in-situ neutralization of the mine pool. However, unknown hydraulic conditions of the mine pool reservoir add uncertainty to this phase of the alternative.

Alternative 3B, Phase II and Alternative 3C will protect human health and the environment.

Alternative 3D would likely be most protective of human health and the environment because a fully active treatment system would have the flexibility to adapt quickly to changing water-quality conditions and to add additional treatment components if needed.

2. Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)

No Action Alternative:
It is unknown whether Alternative 1 would ultimately comply with ARARs, given that no monitoring is provided. However, it is highly unlikely.

Surface Contamination Sources Alternatives:
Alternatives 2A, 2B and 2C would all comply with ARARs by providing moderate to high levels of containment of waste material on- and/or off-site.

Subsurface Contamination Source Alternatives:
Alternative 3A may be able to comply with ARARs; however, because seepage volume and potential locations are unknown and the quality of any water that may or may not seep from the plugged tunnel is unknown, it is impossible to state that this alternative will comply with all ARARs at the site.

Treatability studies would be required to determine whether Alternatives 3B, 3C and 3D would comply with chemical-specific ARARs; however, based on the water quality of the Big Five adit drainage and the efficiency of the biochemical reactor and precipitation processes, these alternatives would be considered capable of meeting chemical-specific ARARs if properly designed and operated. Alternative 3B, Phase I could potentially comply with ARARs, but will depend upon the response of the "natural containment system." If the mine workings form a tight underground reservoir with minimal seepage to the surrounding area, in-situ neutralization and natural attenuation could potentially help the alternative achieve chemical-specific ARARs. However, if Phase I is not effective in meeting ARARs, Alternative 3B, Phase II would need to be implemented, and would very likely achieve ARARs.

3. Long-Term Effectiveness and Permanence

No Action Alternative:
Alternative 1 would not implement any controls and significant concerns about residual effects would remain.

Surface Contamination Sources Alternatives:
All three alternatives are proposed long-term solutions with no concerns about residual effects. Principal Threat Waste would be contained in all alternatives and exposure to plants, animals and humans would be prevented.

Subsurface Contamination Sources Alternatives:
The actual bulkhead component of all alternatives would have long-term permanence and effectiveness because the concrete would

deteriorate very slowly, and corrosion-resistant stainless-steel or plastic piping would be used. Because of some uncertainty about how the Big Five adit connects with potential bedrock fractures and other mine workings in the region, groundwater discharges and/or releases from other locations may occur. Area monitoring would be required to accurately assess the effectiveness of the bulkhead, along with assessments of the elevation, location and geochemical conditions of the mine pool.

Alternatives 3B, 3C and 3D also are likely to be effective in the long term, as long as treatment systems are maintained. As discussed previously, water-quality monitoring would be required to assess the long-term effectiveness of the first phase of Alternative 3B to ascertain the need to implement the second phase. The timing of the decision to implement Phase II will depend on the response of the in-situ system and the downstream monitoring data. Project officials expect the decision to be made within the first year or two after installation of Phase I.

4. Reduction of Toxicity, Mobility or Volume

No Action Alternative:

Alternative 1 would not reduce toxicity, mobility or volume of contaminants, because no treatment is specified.

Surface Contamination Sources Alternatives:

Limited treatment (addition of lime as a neutralizing agent in the upper portion of the capped waste) is included in this alternative, which reduces the toxicity of the contaminants. Implementing any of the alternatives would partially eliminate or contain contaminated surface material, reducing their movement. In addition, Alternative 2A would reduce the volume of contaminated surface material at the site.

Subsurface Contamination Sources Alternatives:

Implementation of any of the four alternatives would reduce contaminant mobility and volume of AMD flowing into Left Hand Creek. Alternative 3A would primarily reduce the mobility of adit water and its associated contaminants; however, the extent of containment is uncertain.

Alternative 3B also would reduce contaminant mobility, and would reduce the toxicity and mass-loading of contaminants because it includes treatment. In addition, if containment/treatment is not achieved with mine-pool mitigation measures, contaminant toxicity, mobility and volume would be significantly reduced by additional treatment in the biochemical reactor.

Alternative 3C would be similar to Alternative 3B in reduction of contaminant toxicity, mobility and volume.

Alternative 3D also would significantly reduce contaminant toxicity, mobility and volume because it involves an active treatment system.

5. Short-Term Effectiveness

No Action Alternative:

Alternative 1 would not be effective in the short term.

Surface Contamination Sources Alternatives:

With the use of engineering controls, all three alternatives would provide short-term effectiveness. Risks to workers, residents and the environment would be minimal during construction.

Subsurface Contamination Sources Alternatives:

As with the surface contamination sources alternatives, all four alternatives would provide short-term effectiveness. If properly designed and constructed, risks to workers, residents and the environment would be minimal for any of the alternatives.

6. Implementability

No Action Alternative:

Alternative 1 would be easy to implement because it requires no action.

Surface Contamination Sources Alternatives:

All three alternatives would be implementable. However, Alternative 2A may pose technical difficulties associated with access and transportation of waste from the site, and Alternative 2C may pose additional technical difficulties associated with excavation of all contaminated material (rather than just Principal Threat Waste) and construction of multiple consolidation cells.

All three alternatives would be administratively feasible and would involve coordination with other offices and agencies. Because much of the land in

the Captain Jack site is on private property, permanent and enforceable arrangements with landowners will ensure access, easements and environmental covenants that are necessary for long-term effectiveness and permanence of the selected alternative. The required personnel, services and equipment would be readily available.

Subsurface Contamination Sources Alternatives:
Bulkhead installation (a component of all four alternatives) could be achieved, and has been implemented at numerous sites. This component of the alternatives would require well-qualified design engineering and construction personnel with extensive experience in evaluating the geotechnical conditions of underground adits.

Alternative 3B presents the challenge of locating injection and extraction wells into the mine pool and successfully treating AMD in place. Although this in-situ neutralization approach is relatively new, the treatment technology is reliable and easily understood. Phase II of this alternative – installing a biochemical reactor at a mine site – is not yet routine; however, it is becoming better developed. Several successful biochemical reactors have been installed at sites throughout the United States.

Alternative 3C also would be implementable according to the same parameters discussed in Alternative 3B. However, sludge management and disposal would create a challenge. Road improvements would be needed to make off-site sludge disposal practical. Additional acreage would likely be required for neutralization and/or settling ponds. Building those ponds most likely would require changes to the wetland areas.

Alternative 3D also would be implementable, and would greatly benefit from a treatability study prior to construction. Because the alternative is designed as an active water-treatment option, road improvements would be required to maintain year-round access. Sludge removal and maintenance would remain a challenge, similar to Alternative 3C.

7. Cost
The following present worth costs are estimated for the alternatives:

No Action Alternative:
Alternative 1: $0

Surface Contamination Sources Alternatives:
Alternative 2A: $2,396,700
Alternative 2B: $1,344,200
Alternative 2C: $1,249,500

Subsurface Contamination Sources Alternatives:
Alternative 3A: $3,345,100
Alternative 3B: $10,398,300 (both phases)
Alternative 3C: $11,019,000
Alternative 3D: $19,746,700

8. Support Agency Acceptance
The EPA and CDPHE have worked closely in the development of this document. EPA and CDPHE both support the preferred alternative.

9. Community Acceptance
Community acceptance of the preferred alternative will be evaluated after the public comment period ends and will be described in the Record of Decision (ROD) for the site.

Summary of the Preferred Alternative

The Preferred Alternative for cleaning up the Captain Jack Site is a combination of Surface Contamination Sources Alternative 2B (On-Site Consolidation Cell for Principal Threat Waste and Capping) and Subsurface Contamination Sources Alternative 3B (Bulkhead and Mine Pool Mitigation at the Big Five Adit with Phased Successive Biochemical Reactor Treatment as required).

The preferred surface contamination source alternative was selected over other alternatives because it:

- Is expected to achieve substantial and long-term risk reduction,
- Is implementable, given site conditions,
- Requires minimal maintenance of one major consolidation cell,
- Specifically addresses Principal Threat Waste, and
- Is cost-effective.

The preferred subsurface contamination source alternative was selected because it:

- Allows flexibility in phased implementation,

- Allows for in-situ neutralization of AMD,
- Avoids costly and labor-intensive sludge-management issues,
- Utilizes a semi-passive treatment system (biochemical reactor), and
- Is cost-effective.

Based on the information available at this time, CDPHE and EPA believe the Preferred Alternative would protect human health and the environment, would comply with ARARs, would be cost-effective, and would use permanent solutions and alternative treatment technologies to the maximum extent practicable. Because it would treat the source materials constituting principal threats, the remedy also would meet the statutory preference for the selection of a remedy that involves treatment as a principal element.

The Preferred Alternative can change in response to public comment or new information.

Community Participation

CDPHE and EPA provide information regarding the cleanup of the Captain Jack site to the public through public meetings, the Administrative Record at the Information Repository, and announcements published in the Boulder Daily Camera, Denver Post, and the Nederland Mountain-Ear. CDPHE and EPA encourage the public to gain a more comprehensive understanding of the site and the Superfund activities that have been conducted at the site.

The dates for the public comment period, the date, location, time of the public meeting, and the locations of the Administrative Record files are provided on the front page of this Proposed Plan.

For further information, or to request a 30-day public comment period extension, please contact:

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Glossary of Terms

Specialized terms used in this Proposed Plan are defined below:

Acid Mine Drainage (AMD) – water with a low pH draining from mines, usually caused by the oxidation of sulfides.

Adit – a nearly horizontal entrance into a mine.

Applicable or relevant and appropriate requirements (ARARs) – the Federal and State environmental laws that a selected remedy will meet. These requirements may vary among sites and alternatives.

Biochemical Reactors – treatment systems that utilize microorganisms to transform or alter, through metabolic or enzymatic action, hazardous contaminants into non-hazardous substances.

Consolidation Cell – an area in which waste material is placed and compacted for long-term disposal. Capping systems are designed and placed over the top of consolidation cells to prevent exposure to the underlying waste material.

Ex situ – the removal of a medium (for example, soil) from its original place, as through excavation, in order to perform the remedial action.

Groundwater – underground water that fills pores in soils or openings in rocks to the point of saturation. Groundwater is often used as a source of drinking water via municipal or domestic wells.

In situ – the treatment of a medium (for example, water) in its original place, in order to perform the remedial action.

Institutional Controls – mechanisms, such as legal controls, fences and warning signs that reduce the potential for human exposure to contamination left in place at a hazardous materials site.

Monitoring – ongoing collection of information about the environment that helps gauge the effectiveness of a clean-up action.

Natural Attenuation – the reduction in mass or concentration of a compound in groundwater over time or distance from the source because of naturally occurring physical, chemical and biological processes.

Neutralization – a chemical reaction between an acid and a base. In this plan, neutralization involves the changing of an acid solution to neutral by addition of an alkaline solution.

Polymer – a natural or artificial chemical made up of smaller, identical molecules linked together. Polymers have high molecular weights, and would be used in this plan for treating water contaminated with metals.

Preferred Alternative – the cleanup approach recommended by CDPHE and EPA, based upon how well it meets the nine criteria used to evaluate remediation alternatives.

Present Worth Analysis – a method of evaluation of expenditures that occur over different time periods. By discounting all costs to a common base year, the costs for different remedial action alternatives can be compared on the basis of a single figure for each alternative. When calculating present worth cost for Superfund sites, total operations and maintenance costs are to be included.

Record of Decision – a public document explaining which remediation alternative will be used at an NPL site.

Remedial Investigation / Feasibility Study (RI/FS) – investigative and analytical studies usually performed at the same time in an interactive process. The studies are intended to: gather the data necessary to determine the extent of the contamination; establish criteria for cleaning up the site; identify cleanup alternatives; and analyze the technology and costs of each alternative.

Revegetate – to replace topsoil, seed, and mulch on prepared soil to prevent wind and water erosion.

Treatability Studies – where a remedial alternative cannot predict the specific results of a treatment approach, a treatability study is performed to test various methods on a small scale (for example, in a laboratory) prior to construction on the site.

USE THIS SPACE TO WRITE YOUR COMMENTS

Your input on the Proposed Plan for the Captain Jack Site is important to CDPHE and EPA. Comments provided by the public are valuable in helping CDPHE and EPA select a final cleanup remedy for the site.

You may use the space below to write your comments, then fold and mail. Comments must be postmarked by July 22, 2008. If you have any questions about the comment period, please contact Angus Campbell at 303-692-3385 or through CDPHE's main number at 303-692-2000. You may submit comments to CDPHE at the following e-mail address: *angus.campbell@state.co.us*. Address mailed comments to: Mr. Angus Campbell, Project Manager, Colorado Department of Public Health and Environment, Hazardous Materials Waste Management Division, 4300 Cherry Creek Drive South, Denver, CO 80246-1530.

Name _____

Address _____

City_____ **State**_____ **Zip** _____