FEASIBILITY STUDY WORK PLAN
FOR STOCKPILED FINE SLAG
AT THE CALIFORNIA GULCH SUPERFUND SITE
LEADVILLE COLORADO

FINAL DRAFT

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Prepared for
Denver and Rio Grande Western Railroad

Prepared by
Morrison Knudsen Environmental Services

Submitted by
Denver and Rio Grande Western Railroad
Pursuant to the Consent Decree
# FEASIBILITY STUDY WORK PLAN FOR STOCKPILED FINE SLAG
AT THE CALIFORNIA GULCH SUPERFUND SITE, LEADVILLE COLORADO

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1.0 INTRODUCTION

This Feasibility Study Work Plan, submitted by D&RGW pursuant to D&RGW's Consent Decree (EPA, 1993a) entered by the Court on December 15, 1993, addresses the stockpiled slag fines at several slag piles (Arkansas Valley, La Plata, Harrison Street, Georgia Gulch, Upper Evans, Middle Evans and Lower Evans slag piles) within the California Gulch Superfund Site in Leadville, Colorado. A Remedial Investigation (RI) was performed for the lead slag piles by D&RGW in 1992 (MK 1992). Subsequent to the RI, a Site-wide Screening Feasibility Study (SFS), (EPA, 1993b), was undertaken as a joint effort between the PRPs and the EPA, and finalized in September of 1993. The purpose of the SFS was to:

1. Develop and evaluate alternatives for remedial action to prevent, mitigate or otherwise respond to or remedy the release or threatened release of hazardous substances from the site.

2. Consider the range of alternatives described in CERCLA, SARA and the NCP.

3. Evaluate remedial alternatives with special considerations given to technologies that permanently contain, immobilize, or recycle contaminants to the maximum extent possible.

The SFS evaluation considered effectiveness, implementability and relative cost of each alternative. As a result of the SFS, three alternatives for slag were retained. This work plan builds on the SFS and describes the methodologies and procedures to be used in the detailed analysis of alternatives for the stockpiled fines.

1.1 Objective of the Feasibility Study

The feasibility study process may be viewed as occurring in three distinct phases:

1. Development of Alternatives
2. Screening of Alternatives
3. Detailed Analysis of Alternatives
The SFS completed the first two phases. In the Feasibility Study, the Detailed Analysis of Alternatives will be conducted on the retained alternatives which are:

1. No Action
2. Institutional Controls
3. Resource Utilization

The development and screening of alternatives consist of six steps, which include:

1. Development of remedial action objectives.
2. Development of general response actions.
3. Identification of volumes or areas of media to which the general response actions may be applied.
4. Identification and screening of technologies applicable to each general response action.
5. Identification and evaluation of technology process options to select a representative process for each retained technology type.
6. Assemblage of the selected representative technologies into alternatives.

In the case of the SFS work, the screening of alternatives was conducted using the criteria of effectiveness, implementability and cost. The retained alternatives will be evaluated during the Detailed Analysis of Alternatives, which is the subject of the Feasibility Study outlined in this Work Plan. During the Detailed Analysis of Alternatives, nine evaluation criteria will be used:

- Overall protection of human health and the environment
- Compliance with ARARs
- Long term effectiveness and permanence
- Reduction of toxicity, mobility or volume
- Short-term effectiveness
- Implementability
- Cost
- State Acceptance
- Community Acceptance

MORRISON KNUDSEN CORPORATION
These analyses will allow comparison of the retained alternatives, and will lead to selection by the EPA of the preferred alternative. The preferred alternative for stockpiled slag fines in D&RGW's work area will be included in the proposed plan and record of decision.

1.2 Organization of the Project Team

Figure 1.1 of this plan depicts the project organization and personnel assignments for the Feasibility Study for stockpiled lead slag fines at the California Gulch Superfund site. The responsibilities of the Project Manager position are described in the following section. Because of the nature of the work in this FS, the project Manager is the only person on the project team which is described. Technical specialists may be asked by the project manager to provide specialized services for the FS on an as needed basis, but their role is not expected to be significant enough to warrant inclusion in the organization chart or explanation of duties.

Project Manager

Morrison Knudsen’s Project Manager will be the prime point of contact with EPA and D&RGW during the Feasibility Study and will have overall management responsibilities for technical and scheduling matters. Other responsibilities, as necessary, will include:

- Procurement and supervision of any subcontractor services.
- Assignment of duties to the project staff and orientation of the staff to the needs and requirements of the project.
- Coordination of the efforts of the in-house technical review committee.
- Review and approval of any project-specific procedures and internally prepared plans, drawings, specifications, cost estimates and reports.
- Dissemination of project-related information from EPA, D&RGW and others to the project staff.
- Liaison between the project technical staff and other internal disciplines, such as quality assurance and health and safety.
• Attendance at meetings and conferences between MK, D&RGW, CDH, EPA, citizens groups, the Technical Advisory Committee, and the Site Activities Coordinating Committee (SACC).

• Community Relations activities.

Any of these responsibilities may be delegated to members of the project staff.

1.3 Organization of the Work Plan
This Work Plan is organized into the following sections: Section 2.0, Site Background and Description; Section 3.0, Summary of Previous Slag Investigations; Section 4.0, Summary of Results of the Screening Feasibility Study; Section 5.0, Final Feasibility Study; Section 6.0, Schedule; and Section 7.0, References.
2.0 SITE BACKGROUND AND DESCRIPTION

The following description of the California Gulch Site includes a brief history of the Leadville mining district, a general description of the physiographic and hydrologic properties of the Site, and summary descriptions of the major slag piles.

2.1 General Site Description

The California Gulch CERCLA Site has seen over 130 years of mining and mineral processing activity. It encompasses the town of Leadville, Colorado and surrounding areas, which are approximately 100 miles southwest of Denver at an elevation of approximately 10,000 feet above mean sea level (MSL). Silver, gold, copper, lead, and zinc were mined by underground and placer methods from the major sulfide/carbonate ore deposit in the area. Approximately 17 smelter facilities are reported to have operated there. Only a few small to moderate-size mining operations now exist and no smelters currently operate in Leadville.

The main mining-related features in the Leadville area today include the following:

- Tailings impoundments
- Slag piles
- More than two thousand waste rock dumps
- Abandoned mining, milling, and smelting facilities
- A few active mining and reprocessing operations
- Mine water drainage tunnels

The Yak Tunnel, which drains into California Gulch, is the main point-source discharge of acidic metal-laden water in California Gulch. This tunnel drains underground mining areas with high concentrations of sulfide minerals. In 1983, the California Gulch Site was placed on the EPA's National Priorities List because of heavy metals loading to the Arkansas River.

2.1.1 Climatology

The climate of the Leadville area is typical of mountainous areas in central Colorado. The area has extreme temperature changes from summer to winter and in any season can have rapid changes of weather caused by storms travelling primarily from west to east through the region. The local topographic features strongly influence climatic variations. Average
annual precipitation is 12.67 inches (Res-ASARCO, 1991). July and August have the most precipitation, and December and January have the least. Summertime precipitation is usually associated with convective showers. Annual snowfall depths for mountains in the area range between 200 and 300 inches. During winter months, the depth of snow on the ground in Leadville is commonly six inches. Precipitation occurs sporadically, causing occasional flash floods. The precipitation and weather cycle give rise to an annual peak runoff, usually occurring during June. The temperature extremes range from 86° F to -30° F, with the average minimum daily temperature being 21.9°F. The average frost-free season is 79 days. Wind is predominately from the northwest (CDL, 1986b).

2.1.2 Geology
The geology of the Leadville Mining district is complex. Bedrock consists of the Precambrian crystalline rocks overlain by quartzites, shales, limestones, dolomites, and sandstones of the Paleozoic era. Numerous faults exist at the eastern edge of the site, ranging in width from several feet to hundreds of feet. This faulting was important to igneous intrusion and subsequent mineralization. Post mineralization faulting has been documented as well (EPA, 1989).

The primary minerals deposited by hydrothermal solutions which intruded quartzite and limestone sediments, were predominantly sulfides of iron, zinc, and lead, but also included copper, silver and gold. Late-Tertiary tectonic activity faulted the mineralized zones into blocks and exposed them to oxygenated ground waters. Sulfide minerals were oxidized, formed sulfuric acid, and released metals into solution. These solutions were transported to carbonate zones, where precipitation reactions occurred between the mineralized sulfuric acid solutions and the carbonate rock. This deposition zone of secondary, or remobilized, metal ores is termed the oxidized zone. These carbonate ores were the dominant ore zones in many of the area's mines (EPA, 1989).

The change in geology is significant downstream from the Pendery Fault, which is often used to demarcate upper from lower California Gulch and is located at the eastern edge of Leadville. Above the fault, Precambrian crystalline rocks are an upthrust relative to stratigraphic units of sediments or alluvium. Below the fault, three identifiable geologic units are noted: bedrock, lake bed sediments, and high terrace gravels. The thickness of the upper and middle stratigraphic units (gravels and the lake bed sediments) increases from east to west. The upper unit varies in thickness from approximately 50 feet near the
Pendery Fault to several hundred feet near the Arkansas River. Placer operations and mine waste disposal probably altered the surface and near-surface features of the high terrace gravels stratigraphic unit (EPA, 1989).

2.1.3 Ground Water
The complex geology in the area has a significant impact on ground water movement. Ground water occurs in both bedrock and alluvial systems, and recharge is principally from infiltration of snowmelt and rainfall. Ground water migrating through the bedrock system east and southeast of Leadville discharges directly to California Gulch surface waters, into mine workings and the Yak Tunnel, or into downgradient bedrock or alluvial ground water systems (EPA, 1989).

In lower California Gulch, there is an active interchange between the shallow ground water system and the surface water. Therefore, a pathway exists for metal contaminants originating from the Yak Tunnel or other sources that contribute to surface water contamination to affect ground water quality. Ground water quality is strongly influenced by depth, with the worst quality found at the shallower depths. Generally, the highest metal concentrations are within 25 to 50 feet of the surface (EPA, 1989).

2.1.4 Surface Water
The California Gulch Site area encompasses about 15 square miles of surface water drainage upstream from the confluence of California Gulch with the Arkansas River. The main stem of California Gulch flows east to west, just south of Leadville, and drains water from several small tributaries to the north and south. The Stray Horse Gulch/Starr Ditch watershed is the largest subbasin and drains lands extensively affected by mining operations. All tributaries to California Gulch, as well as the upper California Gulch, are ephemeral drainages. California Gulch receives flows from two continuous point-source discharges: the Yak Tunnel at 1 to 2 cubic feet per second (cfs) and the Leadville wastewater treatment plant at approximately 1 cfs (EPA, 1989).

Annual flows in both the Arkansas River and California Gulch are normally highest in the spring during snowmelt and lowest in the fall and winter. Local summer thunderstorms are, however, potentially capable of producing high-intensity, short-duration flows in the gulch. Flooding potential is high because of lack of vegetative cover. Maximum flood conditions in the area are expected in the May-June snowmelt period (EPA, 1989).
In general, "water quality in the upper Arkansas River is degraded below the discharge from the Leadville Drainage Tunnel, markedly degraded below California Gulch, and improved by the clean-water inflow from creeks further downstream" (EPA, 1989). The highest metal concentrations occur in the spring during snowmelt. During the 1984, 1985, and 1987 investigations by EPA, primary drinking water standards for cadmium and lead were commonly exceeded, as were the Ambient Water Quality Criteria (AWQC) for cadmium, copper, lead, and zinc (EPA, 1989).

2.1.5 Soils
The native soils of the Leadville area occur in the Troutville-Leadville association. They are primarily deep and well-drained, formed in stony and cobbly glacial outwash. Soil samples collected during a 1986 soil survey were found to be sandy loam and Pierian gravelly sandy loam. The samples became progressively more cobbly and gravelly with depth. Permeability and water capacity were estimated as moderate. pH values were moderately acidic to neutral in surface layers.

A significant portion of the Leadville/Stringtown area has elevated heavy metal concentrations. These concentrations decline from west to northwest, with soils closest to tailings, waste rock piles, and former smelter sites containing the highest concentrations of lead, arsenic, and cadmium (CDL, 1986a).

2.2 Definition of Lead Slag
Lead slag is a metalliferous by-product of smelting, resulting from the primary processing of lead ore by blast or reverberatory furnaces for the production of metal. Specifically, the lead slag in Leadville is an iron-rich slag that contains approximately 25% iron, substantial amounts of magnesium, calcium and silica, as well as traces of residual base metals. In geological terms the slag of the Leadville area is similar in appearance to extrusive igneous rock, black to grey in color, very dense, hard (>7 on Mohs scale) and vitreous, generally with a metallic luster.

The major metallic constituents of lead slag are iron, silicon and calcium, which sum to over 45% of the slag by weight. Of the contaminants of concern at the California Gulch site, lead and zinc occur at approximately 1% and 4% respectively, while arsenic and cadmium occur at values less than 1000 ppm and 20 ppm, respectively. Lead slag exhibits excess
neutralization capacity as measured by pyritic sulfur and neutralization potential analyses. The cation exchange capacity of slag is generally low. The measured pH of a pulverized slag slurry ranges between 7.6 and 10.1.

Leaching tests, conducted as part of the Slag Pile Remedial Investigation (MK, 1992), involved both EPA Method 1312, Synthetic Precipitation Leaching Procedure (SPLP) as well as column leaching studies. These studies showed minimal leaching of metals of concern. SPLP results for all elements were generally two orders of magnitude lower than the toxicity characteristic criteria, listed in 40 CFR 261.24. Additionally, several test design factors make the leaching results more aggressive than what is expected under normal site conditions.

2.3 Slag Pile Descriptions
Slag is one of the by-products of lead ore smelting that occurred in Leadville for nearly one hundred years. As defined in Section 2.2 of this work plan, slag is a dark vitreous material that is composed primarily of iron, magnesium, calcium, and silica, with residual heavy metals. Slag is hard and relatively dense and generally exists as layered or blocky and angular material generally found very near the former smelter sites. Figure 2.1 is a map of the site that shows the known historic lead smelter locations and lead slag piles sampled in late 1991 under the D&RGW slag pile RI (MK, 1992). The slag piles were selected for sampling based on previous identification by EPA, conformance with the definition for lead slag, and volumes greater than 1,000 cubic yards. The general characteristics and locations of the lead slag piles sampled are discussed in the following subsections. Detailed maps and data for the individual slag piles are presented in the Final Remedial Investigation Report for Lead Slag, Leadville, Colorado (RI) (MK, 1992). Stockpiled fines currently exist only at the Arkansas Valley pile, but the potential for creating additional fines piles exists at the other sites if the material is sorted for some beneficial use.

2.3.1 The Arkansas Valley Slag Pile
The Arkansas Valley (AV) Smelter was the longest operating smelter in the Leadville area. It was situated in lower California Gulch, west of the city limits. Slag piles were initially developed at the lowest level of the plant toward the base of the slope. Sometime during the 1940s, the molten slag was discharged with cold water, producing a fine-grained, water-quenched slag. Until this time, the molten slag was poured directly from crucibles onto the slag pile, where it was allowed to cool, forming a welded slag. Reliable estimates of slag generated by the AV smelter have not been made. Based upon aerial photography, the pile
volume in the late 1950s was approximately 1.2 million cubic yards. Today, approximately 423,000 cubic yards of slag remain on the site. The slag pile was purchased by D&RGW from ASARCO in 1961.

The AV pile is the largest and westernmost of the three slag piles owned by D&RGW in the Leadville area. This pile was generated from slag produced primarily by the Arkansas Valley smelter facility, which operated from 1882 to 1960 under various ownerships. This pile is bounded by Leadville Sewage Treatment Plant property and State Highway 24 to the south, old smelter works to the north, wooded property to the west, and other smelter-related wastes and Stringtown to the east. The California Gulch runs adjacent to the slag pile vicinity for approximately 1/5 the length of the pile, approximately 800 feet (MK, 1992).

The AV pile is actually composed of a number of sub-piles. These sub-piles can be broken down into two major types: processed (or sorted) and unprocessed (unsorted). Furthermore, the slag was cooled by two techniques: air-cooling and, in later years, water-quenching. The water-quenched slag is a granular material with particle sizes generally less than 1/4-inch. The air-cooled slag is a more blocky, welded material. The AV pile covers an area of approximately 200,000 square yards. The maximum depth of the pile is approximately 50 feet, but in some areas the depth is less than one foot.

In the past, the pile has been sorted for production of railroad ballast. Railroad ballast is a potential future use for the AV slag. Ballast-sized slag is defined as that greater than 3/8 inches and less than 2-1/2 inches in diameter. Material smaller or larger than this size is separated into oversize and fines piles. Therefore, the subpiles of the AV site include sorted fines, ballast-sized material, oversized material, and unsorted air-cooled and water-quenched material. The volume of existing sorted fines and water quenched fines have been estimated at 43,000 and 150,000 cubic yards, respectively (MK, 1992). The sorted fines pile occupies approximately 57,000 square feet while the water quenched pile covers about 354,000 square feet (MK, 1992). The existing fines piles and fines potentially generated from future ballast production will be the focus of the Feasibility Study.

2.3.2 The La Plata Slag Pile
The Berdell and Witherell Smelter first began operation in 1878. This smelter was located just west of the city limits of Leadville on Elm Street. This smelter was a bimetallic smelter, recovering two metals, lead and silver. The works were incorporated as the La Plata Mining and Smelting Company in 1879, which smelted ores from the La Plata mine
as well as other mines in the area until 1900. Molten slag was transported on rails to the slag pile, which was in front and south of the furnaces. The La Plata Smelter generated an estimated 300,000 tons of slag. Bimetallic smelter slag generation has been estimated at approximately 457,000 tons. Estimates based on survey information (MK, 1992) put the current volume of slag at the La Plata (LP) pile at 111,000 cubic yards. The majority of this pile is owned by D&RGW, although southern sections are owned by the Leadville Corporation. D&RGW purchased the pile 1970 from the Leadville Sanitation District for the purpose of potential ballast production. The pile has never been used for this purpose and no stockpiled fines exist at this pile.

The LP pile, owned by D&RGW, also referred to as the Super 8 or Leadville Sanitation District pile, is located approximately 3/4 mile northeast of the AV pile. It is northeast of Stringtown, east and south of various mining or smelter-related by-products and west of the Leadville Inn (formerly called the Super 8 Motel). The LP pile appears to be composed entirely of air-cooled slag. The LP slag pile has a very dense ropey, welded texture. Its structure is essentially monolithic, although the surface shows fracturing. This slag pile is irregular in shape and has steep sides approximately 20 to 30 feet high and covers an area of approximately 258,000 square feet (MK, 1992).

2.3.3 The Harrison Street Slag Pile
The easternmost slag pile owned by D&RGW is located in the town of Leadville at the corner of Harrison and Monroe Streets. The pile is bounded by residences to the north and the old smelter site to the east. The smelter in this area ceased operating around 1893. The Harrison Street (HR) pile, occasionally referred to as the NL Industries pile, consists primarily of air-cooled slag with a fairly dense, blocky texture overlaying welded slag. Pile thickness ranges from approximately five feet to over 40 feet. The areal extent of this pile is approximately 18,000 square yards. The coarse, angular, blocky material varies from approximately eight-inch blocks to a smaller fraction of dense, platey fragments, or chips, approximately one inch in size. Faces along the sides of the pile show the competent layers of welded slag.

The Harrison Reduction Works was constructed in 1877 as a branch of the St. Louis Smelting and Refining Company. It was situated on the northeast corner of Harrison Avenue and Elm Street, within the city limits of Leadville. Most of the ores smelted by this operation came through the A.R. Meyer Sampling Works, which was also owned by the St. Louis firm. In 1917, the Harrison Recovery Works was established to rework the slag pile.
At that time, it was estimated that the HR pile contained one million tons of slag. The HR pile was purchased by D&RGW from NL Industries in 1983 for potential ballast production. Only a small portion of this pile was processed for railroad ballast. Based on the survey information, the current volume is estimated at 106,000 cubic yards and no stockpiled fines currently exist at this pile. The HR pile occupies approximately 152,000 square feet (MK, 1992).

2.3.4 Other Slag Piles

Other slag piles resulting from lead smelting also exist within the California Gulch Site. The locations of four additional piles and historic smelter locations are indicated on Figure 2.1. One of these piles is in the California Gulch watershed and three are in Evans Gulch, the major drainage to the north of California Gulch. In the California Gulch watershed, one slag pile occurs at the base of Georgia Gulch, a tributary from the southeast that joins California Gulch between the AV and LP piles. The pile is relatively small and consists of loose, blocky and welded material. This pile is designated as the Georgia Gulch (GG) pile. This slag pile is not known to have been sampled prior to the 1992 Slag Pile RI (MK 1992) conducted by D&RGW. The GG pile occupies an area of 22,000 square feet and contains a volume of 4,500 cubic yards (MK, 1992). No stockpiled fines are known to exist at the Georgia Gulch pile.

The three piles in Evans Gulch occur east of Highway 24, just north of Leadville. The pile closest to the highway, designated Lower Evans (LE), appears to be the remnant of a previously existing, large air-cooled pile. The LE pile has been removed. The other piles are located one-half mile upstream. These slag piles are adjacent to each other and consist of a blocky, air-cooled slag pile [Middle Evans (ME)] and a larger, welded, air-cooled pile [Upper Evans (UE)]. The following estimated surface areas and volumes were generated for each of these two Evans Gulch piles during the RI (MK, 1992): Middle Evans area 19,300 square feet, volume 3,000 cubic yards and upper Evans area 80,000 square feet, volume 18,000 cubic yards (MK, 1992). No stockpiled fines are known to exist at the Evans Gulch piles.
3.0 SUMMARY OF SLAG INVESTIGATIONS

Several of the previous investigations at California Gulch have addressed slag at the three D&RGW-owned piles. This section summarizes the relevant data and discussions presented in the investigation reports.

3.1 State of Colorado RI 1986
Slag was not considered to be a significant source of contamination and, therefore, was not studied during the State RI (CDL, 1986b). Page 3-18 of the State RI report states that:

Much of the metal in slag has been oxidized in the smelting process and is in a relatively stable oxide mineral form. In addition, smelting results in the encapsulation of much of the metal in refractory sites and in the formation of silicate minerals. Therefore, although numerous slag piles occur throughout the study area, they are not expected to be a major source of hazardous metal contamination.

3.2 EPA Phase II RI 1989
In 1986, the EPA’s contractor, CH2M Hill, sampled surface water, ground water, and numerous mine waste piles (EPA, 1989). The objective of the mine waste sampling was to better characterize the piles in California Gulch. Three of these piles were slag. This was the first slag sampling program undertaken by the EPA at the site.

Composite samples were collected from locations on each of the three slag piles based upon a grid system or upon a visual approximation of the center and equidistant perimeter points. The depth interval at which samples were to be collected was specified in CH2M Hill’s work plan as zero to six inches below the surface of the material.

Samples were analyzed in the field for the metals of concern using a portable X-ray fluorescence (XRF) analyzer, and analyzed in a Contract Laboratory Program (CLP) lab for metals composition, extraction procedure (EP) toxicity leaching characteristics, ASTM-modified acid shake extractable metals, and ASTM water shake extractable metals. Total metals analysis yielded results similar to those for other mining wastes in the area. The report (EPA, 1989) stated that while mine waste piles typically contain the highest concentrations of arsenic, cadmium, copper, manganese, and lead, slag typically contains the
highest levels of iron and zinc. Slag was also shown to contain metals such as manganese, lead, copper, and arsenic.

The report noted that because the slags were generally a solid mass with a low surface area to volume ratio, they would have more limited solubility than other mine wastes. Leaching tests showed that the only metal exceeding the RCRA criteria using the EP toxicity test was lead, and that this occurred only for the Harrison Street and the La Plata slag samples. Leaching data for all other constituents of concern were below the EP toxicity criteria.

This data is considered useable only for limited purposes because the design and implementation of the above study did not result in collection of representative data. Samples collected were of varying sizes, from varying depths, and selected for varying particle sizes. The resulting composites were not only inconsistent, but were unrepresentative with respect to size. Particle size was altered by field collection techniques, often using metal sampling tools. Cross-contamination of samples with other mine waste material or surface waters was also observed and documented in the field. Many aspects of the XRF procedure were inappropriate for use on the slag piles or were improperly performed, making those readings unreliable. Finally, the EP toxicity tests were run only on the <200 mesh fraction of the sample, a size fraction that is unrepresentative of the piles. This test and the acid shake extraction test are also overly conservative and not representative of site conditions (MK, 1992).

3.3 James P. Walsh and Associates, Inc. Soils Investigation 1988
The stated objectives of this study were to define potential action levels for soil, determine background metals content of soils, delineate the extent of soil contamination, and determine sources of soil contamination. This study was initiated by another PRP and was not coordinated with or brought to the attention of D&RGW until 1991. Three samples of slag were collected as part of this study: one from the Harrison Street pile, one from the La Plata pile, and one from an area west of Leadville.

The samples were prepared and analyzed by an ASARCO laboratory. A small and unrepresentative less than 2 mm fraction was extracted with a nitric acid/perchloric acid solution and analyzed for total lead, cadmium, arsenic, and zinc.
The initial report of these investigations was a draft report (Walsh, 1988), in which the findings were not adequately supported by discussion of methodology and quality control information. Also, no sample splits were provided to interested parties.

3.4 Jacobs Engineering Slag Sampling 1989

In May 1989, Jacobs Engineering performed the second sampling of slag for the EPA (EPA, 1990d). The purpose of the study was to determine the concentrations of metals in the three D&RGW slag piles and to evaluate the potential for migration of these metals to soil, water, or air. Potential hazards to the environment and public health from the slag in Leadville, as well as slag intended for use off site, were to be evaluated. Most of the data from this study was of good quality and considered useable for the intended purposes. Exceptions include five samples that were analyzed for EP toxicity that, for reasons discussed below, were unrepresentative and of questionable quality, acid-base accounting data that was conservative and not substantiated by split sample results, and some particle size data that was inadequate to evaluate the percent of respirable-sized slag.

In order to obtain a preliminary evaluation of the variability within the slag piles, four locations were sampled at each of the following piles: the Harrison Street pile, La Plata pile, AV oversized and unprocessed subpiles, AV sorted fines subpile, AV ballast-sized subpile, and AV water-quenched fines subpiles. Samples were collected from the center of individual piles or pile quadrants using shovels, a backhoe, or a ripper blade and a backhoe. Surface samples (zero to six inches) were collected at all locations. Subsurface samples (at approximately three feet) were also collected for each pile except the AV sorted fines and ballast-sized, which were assumed to be homogeneous after sorting. Sample size was determined according to ASTM D-75 (ASTM, 1987) weight recommendations, which are based on particle size of the material to be sampled.

Samples were analyzed for 23 target analyte list (TAL) metals according to CLP procedures. Total sulfur and neutralization potential were determined by EPA Methods 3.2.4 and 3.2.3, respectively. Particle size distribution was determined by both the sieve and the hydrometer tests, adjusting the hydrometer readings for the specific gravity of slag. Leachability was evaluated with the same three tests used previously by the EPA: EP toxicity, ASTM-modified acid shake extraction, and ASTM water shake extraction. Leaching tests were performed only on the ballast-sized and the sorted fines samples. Sample preparation deviated from standard procedures in an effort to make the testing more representative: slag was not ground or pulverized prior to leaching test extractions.
The most significant results for the particle size analysis are the percentages of fine material (passing the 200 mesh sieve) in each pile. For the Harrison Street pile, La Plata pile, and AV ballast-sized, oversized, and unprocessed subpiles, fines were present at approximately 0.5 weight percent. The AV sorted fines and the water-quenched fines subpiles contained 5 and 1.5 weight percent material passing the 200-mesh sieve, respectively.

The results of the three leaching tests show that none of the RCRA metals leached from slag in concentrations exceeding the RCRA criteria of 100 times the drinking water standards. Five additional EP toxicity tests were performed by the EPA that were not called for in the sampling plan. The tests were run on material passing the 10-mesh sieve from samples with the highest total metals concentrations from each pile or subpile that had not been previously tested for leachability. Lead was the only metal that exceeded the RCRA criteria and this occurred in three of the five samples. It should be noted that the percent passing a 10-mesh sieve ranges from <0.5 to 6.0 weight percent for these three samples. Therefore, the fraction tested constitutes only a very small portion of the slag and is not representative of the piles. No quality control data was presented with these results, nor was the opportunity to run split samples presented, so the validity of these results cannot be determined. These five sample results are considered unrepresentative and of questionable quality (MK, 1992). In addition, the EP toxicity test conducted is also very aggressive and unrepresentative of conditions in the California Gulch. This test was designed to simulate situations in which a waste is co-disposed in a municipal landfill and saturated with organic acid.

Statistical evaluation of the data shows that the slag piles differ in composition, with the exception of some of the AV subpiles. Chemical and particle size variability within piles were not significant, nor were the differences between surface and subsurface chemistry (EPA, 1990).

3.5 Summary of D&RGW Slag Pile Remedial Investigation Activities
D&RGW conducted a Remedial Investigation into the Slag Piles during 1991 and 1992. The intent of the RI was to characterize major lead slag piles in sufficient detail such that their chemical and physical properties could be evaluated for potential impacts on human health and the environment. Research for the Slag Pile RI was performed to determine the former smelter locations and the history and present ownership of the slag piles. The field investigation phase consisted of reconnaissance of the historic smelter sites of Leadville for the identification of existing lead slag piles, and surveying and sampling of selected lead slag...
piles. The laboratory investigation phase included the determination of the physical, chemical compositional, and leaching characteristics of the samples. An overview of each phase is presented in the following sections. More detailed descriptions of activities can be found in the Final Lead Slag RI (MK, 1992).

3.5.1 Historical and Ownership Research
The histories of the slag piles and their parent smelters were researched and summarized in order to estimate the location, years of operation of the smelters, and the approximate amount of slag generated. Current and historic aerial photography was also reviewed to scan the study area for previously unlocated slag piles. Ownership research of the slag piles selected for sampling was performed to facilitate permission for access.

3.5.2 Field Work
A field reconnaissance of the known historic smelter locations was performed to locate all slag piles at the California Gulch Site. The vicinity of each pile was described for other smelter wastes or debris and any apparent impact of the slag on the environment. Slag pile structural/geotechnical stability conditions were also noted.

The piles selected for sampling were surveyed by a professional survey team under the supervision of a registered land surveyor. Elevation data of the slag pile perimeter, tops, toes and grade breaks were recorded so that pile heights, side slope angles of repose, and pile volumes could be calculated.

A total of seven lead slag piles were sampled. These included the Arkansas Valley; La Plata; Harrison Street; Georgia Gulch; and Upper, Middle and Lower Evans Gulch piles (Figure 2.1). Sample locations were identified by overlaying a numbered grid cell system on the slag pile base maps. Random numbers were generated to select the locations to be sampled (MK, 1991b). For the D&RGW-owned piles (Arkansas Valley, La Plata, and Harrison Street), four discrete bulk samples were collected. For the remainder of the piles, an attempt was made to collect four samples from each pile for compositing; however, at the Upper Evans and Middle Evans, only three and one sample, respectively, could be collected due to lack of access to the pile with the backhoe. The slag was sampled by excavating from zero to three feet. A weight considered to be representative, based on grain size, with a maximum of four hundred pounds was collected. Further details of the sampling procedure may be found in the Sampling and Analysis Plan (MK, 1991a). This material was homogenized on a sheet of high density polyethylene (HDPE), coned,
quarted, and sampled. In addition to bulk sampling, "old slag" and subslag sampling was conducted at the D&RGW-owned piles. The definition of "old slag" may be found in the Work Plan (MK, 1991a). Two samples per pile were collected from areas designated as containing "old slag"; four samples of soil from beneath the Arkansas Valley pile were collected; and three samples of soil were collected from beneath both the La Plata and the Harrison Street piles. A total of 56 locations were sampled.

Samples were processed for analysis in the following manner. For chemical compositional testing, a sample fraction of approximately sixty pounds was crushed to minus 1/4" and mixed. Ten pounds of the mixed material was then pulverized to less than 250 microns (μm), mixed, and placed in ten sample bottles. This <250 μm material was submitted for chemical compositional and metal speciation analyses. The intent of the preparation step was to supply all analytical programs with materials that were equally representative of the chemical composition of the slag collected at the piles. Particle size and leaching tests were performed without sample size reduction.

3.5.3 Laboratory Analyses

Particle size analyses were performed on samples that contained appreciable quantities of fine particles by visual inspection using sieve, hydrometer and microtrac techniques.

The total composition of the samples was determined by EPA CLP methods described in Statement of Work (SOW) 4/90 (EPA, 1990c) and a Bureau of Mines sample digestion method (MK, 1991b). The analytes included the 23 TAL metals with the addition of silicon and exclusion of mercury. Other analytes included the anions: sulfate, nitrate, nitrite and chloride as well as the following forms of sulfur: total, pyritic, and non-extractable. Cation exchange capacity and neutralization potential were also quantified.

Two types of leach testing were performed on the samples. All samples were submitted for analysis using the Synthetic Precipitation Leaching Procedure (SPLP) EPA Method 1312, (57 FR 21450, Hazardous Waste Identification Rule, May 20, 1992), without particle size reduction. SPLP is a 24-hour shaker test using a simulated rain water lixiviant with nitric and sulfuric mineral acids in concentrations resulting in a pH of 5. The eluate was analyzed for metals and, in some cases, anions. Six samples were selected for column leach testing. This test introduced the same lixiviant to three-foot columns containing slag or subslag material. The quantities of lixiviant used simulated one-inch rainfall events over a one hour period. Application was followed by one hour of drainage and aeration. This procedure
was repeated for 100 cycles. The eluate was collected and analyzed for metals and, in some cases, anions. Both leaching tests were designed to estimate metals leachability of the piles under natural, in situ, weathering conditions.

3.5.4 Slag Pile Conceptual Model

The purpose of the RI was to characterize the major lead slag piles in sufficient detail such that their physical and chemical properties could be evaluated for potential impacts on human health and the environment. The RI data was used to assess the viability of five potential release mechanisms identified in the site conceptual model. These five release mechanisms included wind, leaching, mixing by human activities, runoff of particulates, and direct contact. Direct contact was discounted in the baseline human health risk assessment conducted by EPA, leaving four remaining mechanisms to be evaluated.

The air pathway analysis results showed that wind erosion is not a release mechanism in Leadville. Hourly average wind speed data multiplied by the appropriate factor to determine the maximum sustained wind gust does not meet or exceed the velocity necessary to lift particles off the stationary pile. The conclusion reached was that wind erosion is not a viable release mechanism for the lead slag piles, including the AV water-quenched and sorted fines piles.

Leaching of constituents of concern from lead slag was tested by two different leaching procedures (SPLP and column leach) yielding the quantity of metals leached from a given mass or volume of a slag pile. At the conclusion of the RI leaching was retained as a potential release mechanism.

Transport by human activities has occurred, as slag was historically used for road maintenance within the site. Slag has not been used within the site for these purposes for several years and is not contemplated to be used in these ways in the future. The characteristics of slag on the railroad tracks (ballast) are represented by the results for the AV ballast-sized subpile samples. The ballast-sized sample results show a low potential for leaching (well below toxicity characteristic criteria). Based on field observations and chemical analysis of the soils beneath the slag piles, it can be concluded that subslag soils have not been significantly impacted by the placement of slag. The concentration of elements of concern in subslag material is very low. This potential release mechanism was eliminated by the RI.
No evidence of transport of slag fines by surface runoff was observed at any of the piles examined. Slag does not appear to be transported from piles onto adjacent soils in rivulets or channels. Pile integrity, especially for fines piles where this is most critical, appears intact. Pile integrity was evaluated based on structural stability, deflation potential and effects of freeze/thaw cycling during the RI (MK, 1992). This potential release mechanism was eliminated by the RI.

3.6 Conclusions from all of the Slag Investigations

As a result of the various remedial investigations, and most particularly the Final Slag Pile Remedial Investigation (MK, 1992), it has been concluded that ballast sized slag material (3/8"-2 1/2") and larger blocky slag material pose no threat to human health and the environment. EPA has concluded that ballast operations may resume, pending approval of a plan describing operational methodology (EPA, 1993a). The results of the RI's were less conclusive regarding the fine fraction of slag resulting from ballast sorting operations and fine slag generated from water quenched slag production. The potential pathways as described in the site conceptual model were discussed in the RI and each of the five were eliminated except for the retention of leaching which was retained as a possible pathway of concern for fine slag.
4.0 SUMMARY OF RESULTS OF THE SCREENING FEASIBILITY STUDY

A Screening Feasibility Study (SFS) (EPA, 1993) was conducted to develop and evaluate possible response alternatives for addressing control of and/or remediation of the various sources at the California Gulch Site. The SFS initiated the overall CERCLA Feasibility Study process and developed and screened remedial action alternatives applicable to slag. One important conclusion of the RI/SFS process for slag was that fine slag was the only material of concern and larger slag (ballast sized and blocky slag) was determined by EPA to be available for D&RGW's use. The SFS provided the framework for proceeding with the Final Feasibility Study for stockpiled slag fines. The SFS screened the list of alternatives to three alternatives which will be evaluated in detail in the Final Feasibility Study. The retained alternatives are:

- No Action
- Institutional Controls
- Resource Utilization

The major activities conducted in the SFS were as follows:

1. Identification of Remedial Action Objectives
2. Identification and Screening of Technology Types
3. Development and Analysis of Remedial Alternatives
4. Presentation of Applicable or Relevant and Appropriate Requirements (ARARs)

4.1 Identification of Remedial Action Objectives

Unlike other media addressed by the FS, the Remedial Investigation (RI) for the Slag Piles has been finalized. A comparison of the RI results to the conceptual model showed that only one potential release pathway was retained as viable for the slag fines. The one retained potential release pathway was examined and one remedial action objective (RAO) was formulated to address this potential pathway. The remedial action objective for the stockpiled fines at slag piles is to prevent leaching of metals of concern in concentrations that would have an adverse impact on soils, surface or ground water in the vicinity of the slag piles.
4.2 Identification and Screening of Technologies Types
A summary of the identification and screening of technology types for slag is presented in the following sections.

4.2.1 Potentially Applicable Technologies and Process Options for Slag Piles
Table 4-1 lists all of the technologies and process options that were considered technically implementable at the California Gulch site. In the SFS, general response actions relative to the all stated remedial action objectives for all source areas were developed. The developed general response actions are broad classes of actions which may be implemented alone, or in combination, to satisfy the remedial action objectives. The criteria of technical implementability was applied to the universal list of remedial technologies and process options. The list, after deletion of those remedial technologies and process options that were considered not to be technically implementable at the California Gulch Site, is presented in Table 4-1 of this work plan. This list was then compared to the remedial action objective for slag and the criteria of effectiveness, implementability and cost were used to further screen this list. The surviving remedial technologies and process options were then compiled into remedial alternatives designed to address the remedial action objective for slag. The remedial alternatives are presented in Table 4-2.

4.2.2 Screening Criteria
The retained technologies and process options were evaluated using the criteria of effectiveness, implementability and relative cost in accordance with EPA Guidance for conducting Remedial Investigations and Feasibility Studies under CERCLA (EPA, 1987).

Effectiveness relates to the potential effectiveness of the technology or process option in handling the estimated areas or volumes of the slag piles and meeting the remedial action objective that has been defined. Overall reduction in toxicity, contaminant mobility or source volume that is achieved by implementation of the process option was also considered in the effectiveness criteria. Potential impacts to human health and the environment during the construction and implementation phase as well as the reliability of the process with respect to the California Gulch site conditions were also considered. Both short-term (during implementation) activities and long term periods were considered.

Implementability relates to technical maturity and feasibility (i.e., ability to construct and reliably operate the system and meet regulations) and administrative feasibility (i.e., ability
to get permits, to procure treatment, storage and disposal services, and to procure needed land, equipment and expertise). For purposes of the screening, the degree of implementability was characterized as "high," "medium," or "low." A process option with "high" implementability is relatively easy to construct or put into practice at this site, and is reliable and easy to permit due to its technical maturity. A "medium" characterization applies to a process option that is commercially available but not widely used for the specific application. This characteristic would also apply to those technologies or options that have some difficulty in permitting and potential constructability or operability problems. A process with "low" implementability may not be commercially available, such as innovative or emerging technologies. This characteristic would also apply to those technologies or options that would be unworkable at the California Gulch site or difficult to permit and have significant constructability or operability problems for the particular source.

Cost screening at this stage involved preparation and comparison of relative estimates to screen equally effective but significantly higher cost options. For purposes of the screening FS, costs of technologies or process options were characterized as "high," medium," or "low" relative to one another.

4.2.3 Screening of Potentially Applicable Remedial Technology Process Options for Slag Piles

Table 4-1 lists the technologies and process options that were considered technically implementable and applicable for slag piles. Each process option was characterized based on effectiveness, implementability and relative cost with relative indicators of these criteria.

The process options evaluated and the basis for retention are described in detail in the Screening Feasibility Study. Those remedial technology process options that were retained for assemblage into remedial action alternatives are listed in Table 4-1 and a complete description may be found in the SFS.

4.3 Development and Analysis of Remedial Action Alternatives

The remedial technologies and process options that have been screened and the remaining technologies and process options were assembled to formulate remedial action alternatives for the slag piles.

The retained technologies were assembled to formulate Remedial Action Alternatives. General descriptions for the Remedial Action Alternatives for the slag piles are described
below. Each of the alternatives was screened to create the short list of alternatives, and meets the RAO of preventing metals of concern from leaching from the slag piles in concentrations that would have adverse impacts on the environment. Screening of the alternatives included preliminary determinations of effectiveness in achieving the RAO, technical and administrative implementability, and cost. It should be noted that at this time, costs are relative and have been categorized only as low, medium and high.

The screening of alternatives is provided in Table 4-2. Alternatives retained after this process are so noted in Table 4-2 and described in the following section. This section details the short list of retained alternatives for the slag piles based upon the identified Remedial Action Objective and the screening processes.

The retained alternatives are presented below.

Alternative 1 - No Action
No action, slag piles left in place.

Alternative 2 - Institutional Controls
Institutional controls involve restricting access or activities that could increase the potential for leaching from slag. Controls include fencing, land-use restrictions, and deed restrictions. Additionally, community awareness programs could be implemented which would be useful in alerting the community to any hazards associated with this potential source material. Controls could be implemented separately or in combination. Coordination with state and local agencies would be required. Periodic monitoring may be required to ensure that any restrictions remain in force.

Alternative 3 - Resource Utilization
The utilization of slag as a resource could involve a number of activities and/or processes. This alternative includes using slag as railroad ballast, with undersized material used as an additive material in construction. Any oversized material left after screening out the ballast-sized material would be crushed to augment the ballast material. Examples of uses for the undersized material would be as an aggregate for concrete or asphalt manufacturing, an additive to building materials such as cinder blocks, and an additive to grout, shotcrete or slurry formulations.

4.4 ARARs Analysis
Under the Superfund Amendments and Reauthorization Act of 1986 (SARA), determination of Applicable or Relevant and Appropriate Requirements (ARARs) is required, and potential remedial alternatives should be considered at the initiation of a Remedial Investigation/Feasibility Study (RI/FS).

As part of the RI/FS, remedial measures are evaluated to assess the degree to which they attain or exceed applicable or relevant and appropriate Federal, State and local public health and environmental standards. These cleanup standards are found in environmental laws other than CERCLA and are imposed upon the site cleanup. CERCLA does not include cleanup standards and Section 121 mandates the imposition of the requirements developed pursuant to other environmental laws. Different ARARs that may apply to a site and its remedial activities are identified at multiple points in the remedy selection process.

The SFS presented an appendix concerning ARARs for the entire site. The Final FS will begin with this list of ARARs and focus the evaluation on those ARARs that are of importance to slag fines.
5.0 FINAL FEASIBILITY STUDY

As stated in the Statement of work for D&RGW's Consent Decree, the three retained alternatives from the screening feasibility study (SFS) will be evaluated in detail in the Final Feasibility Study for stockpiled fines at the slag piles. In the SFS it was determined that the three retained alternatives satisfy the remedial action objective of preventing leaching of metals of concern in concentrations that cause adverse impacts to soils, ground water and surface water in the vicinity of the slag piles.

The detailed analysis of alternatives considers the nine evaluation criteria of:

- Overall protection of human health and the environment
- Compliance with ARARs
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility or volume
- Short-term effectiveness
- Implementability
- Cost
- State acceptance
- Community acceptance

The results of the detailed analysis provide the basis for identifying a preferred alternative and preparing the proposed plan. Upon completion of the detailed analysis, the FS report will be prepared and, along with the proposed plan, submitted for public review and comment. Final selection of a remedial action will occur following the comment period and will form the foundation for the Record of Decision. The Final FS will ultimately support remedy selection and development of a Record of Decision by the EPA. The results of the ongoing risk assessment activities may ultimately affect the remedy selection, but, according to EPA's schedule, may not be available for incorporation in the final FS.

Recently, a technical memorandum has been released by Allen Medine of Water Science (Medine, 1994) which attempts to model the contaminant transport to the California Gulch. The stream segments relative to the stockpiled fines piles include CG04 to CG05 and CG05 to CG06. The report (Medine, 1994) demarcates all slag as being of "lessor significance" with regard to contribution of leaching. Further, based upon the leaching studies conducted in the RI, MK 1992, the loading of lead calculated from the leaching tests (1.3 kg/year)
compared with the loading which was observed in the year 1991-1992 (Table 2, Medine, 1994) 18,651 kg/year at stream segment CG05. CG05 is the stream gauging station which is downstream of potential impacts of the fine slag. Additionally, the value of 1.3 kg/year is based on leaching tests specifically designed to overestimate the leaching potential of the slag. It should also be noted that not detectable concentrations of lead could be extracted from the slag until approximately one-half way through the testing period. Relying on those conclusions, the analysis consider the mass of lead available for release from the fines pile (per unit time) divided by the flow in the California Gulch (per unit time) for each of the three alternatives. This analysis may include such factors as sorption and surface water discharge to ground water.

5.1 Detailed Analysis of Alternatives
For the final FS the detailed analysis of alternatives consists of the following components:

- An assessment and a summary profile of each alternative against the evaluation criteria.

- A comparative analysis among the alternatives to assess the relative performance of each alternative with respect to each evaluation criterion.

5.2 Alternatives Evaluation Criteria
Each of the retained alternatives will be evaluated against the nine evaluation criteria detailed below. Additionally, the individual alternatives will be compared with each other to aid in the selection by EPA of the preferred alternative to be presented in the proposed plan and ROD.

5.2.1 Overall Protection of Human Health and the Environment
This evaluation criterion provides a final check to assess whether each alternative provides adequate protection of human health and the environment. The overall assessment of protection draws on the assessments conducted under other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARS.

Evaluation of the overall protectiveness of an alternative during the RI/FS should focus on whether a specific alternative achieves adequate protection and should describe how site risks posed through each pathway being addressed by the FS are eliminated, reduced or
controlled through treatment, engineering or institutional controls. This evaluation also allows for consideration of whether an alternative poses any unacceptable short-term or cross-media impacts.

5.2.2 Compliance with ARARs

As a first step, an introduction will identify the concept of ARARs; define applicable versus relevant and appropriate requirements; present the NCP evaluation criteria for relevance and appropriateness; present the basis for waivers; and describe the structure (i.e., chemical specific, location specific, action specific) in which the ARARs will be evaluated.

The second step in the ARARs analysis is the preparation of a table or appendix which reiterates the universe of ARARs considered during the SFS. Those requirements that are determined to be potentially ARARs at the site are identified as such and retained for further evaluation. Those requirements that are not potential ARARs are identified and a simple explanation of the basis for rejection is provided. Preparation of the table or appendix efficiently formalizes the initial selection and may remove numerous requirements from further evaluation.

Once the potential ARARs are identified, the chemical-specific ARARs are evaluated fully on a media-specific basis. If an exemption or variance to a chemical specific regulation is indicated or if a basis for waiver exists it will be developed and presented.

The location and action specific ARARs retained following the initial screening are then identified in a bullet format, or alternatively, are defined briefly in a narrative format. At this juncture, the reader will be directed to the analysis of alternatives. There, the action or location ARARs that attach to each identified alternative will be fully evaluated. The logic behind this approach is straightforward. If ARARs are "attached" to technologies during the screening, a number of location and action specific ARARs analyses would be documented for technologies that will not proceed to remedy selection. Reserving and presenting the location and action specific analyses as part of the analysis of alternatives is efficient, and allows the analysis to focus upon alternatives which are better defined.

The detailed analysis should summarize which requirements are applicable or relevant and appropriate to an each alternative identified in the SFS and describe how the alternative will attain these requirements during and following the selected remedial action. The FS report will rely upon the NCP and relevant preamble language.
5.2.3 Long-Term Effectiveness and Permanence
Each of the three alternatives will be assessed for the long-term effectiveness and permanence that are afforded by each, along with the degree of certainty that the alternative will prove successful. Factors that are considered include the following:

1. Magnitude of residual risk remaining from untreated waste or treatment residuals remaining at the conclusion of the remedial activities. The characteristics of the residuals should be considered to the degree that they remain hazardous, taking into account their volume, toxicity, mobility and propensity to bioaccumulate.

2. Adequacy and reliability of controls such as containment systems and institutional controls that are necessary to manage treatment residuals and untreated waste. This factor addresses in particular the uncertainties associated with the assessment of the potential need to replace the technical components of the alternative and the potential exposure pathways and risks posed should the remedial action need replacement.

5.2.4 Reduction of Toxicity, Mobility or Volume
The degree to which alternatives employ recycling or treatment that reduces toxicity, mobility or volume shall be assessed, including how treatment is used to address the principal threats posed by the site. Factors that will be considered include the following, as appropriate:

1. The treatment or recycling processes that the alternative employs and materials they will treat.

2. The amount of hazardous substances, pollutants, or contaminants that will be destroyed, treated or recycled.

3. The degree of expected reduction in toxicity, mobility, or volume of the waste due to treatment or recycling and the specification of which reductions are occurring.

4. The degree to which the treatment is irreversible.
5. The type and quantity of residuals that will remain following treatment, considering the persistence, toxicity, mobility and propensity to bioaccumulate of the hazardous substances.

6. The degree to which treatment reduces the inherent hazards posed by any principal threats at the site.

5.2.5 Short-Term Effectiveness
The short-term effectiveness impacts of the alternatives will be assessed considering the following:

1. Short-term risks that might be posed to the community during implementation of an alternative.

2. Potential impacts on workers during remedial action and the effectiveness and reliability of protective measures.

3. Potential environmental impacts of the remedial action and the effectiveness and reliability of mitigative measures during implementation.

4. Time until protection is achieved.

5.2.6 Implementability
The ease or difficulty of implementing the alternatives will be assessed by considering the following types of factors as appropriate:

1. Technical Feasibility, including technical difficulties and unknowns associated with the construction and operation of a technology, the reliability of the technology, the ease of undertaking additional remedial action, and the ability to monitor the effectiveness of the remedy.

2. Administrative Feasibility, including activities needed to coordinate with other offices and agencies and the ability and time required to obtain any necessary approvals from other agencies.
3. Availability of services and materials, including the availability of adequate storage capacity and services, the availability of necessary equipment and specialists, and provisions for the availability of services and materials, and the availability of prospective technologies.

5.2.7 Cost
The types of costs that shall be assessed include the following:

1. Capital costs, including both direct and indirect costs.
2. Annual operation and maintenance costs.
3. Net present value of capital and O&M costs.

5.2.8 State Acceptance
The State comments and concerns will be addressed, as appropriate, during the development of the FS. Assessment of CDH concerns will be formally presented and discussed in the proposed plan issued for public comment. All State concerns will be addressed with special emphasis on: 1) The State's position on concerns related to the preferred alternative and other alternatives; and, 2) the State's comments on ARARs or the proposed use of waivers.

5.2.9 Community Acceptance
Community concerns will be taken into account throughout the FS process through the communications that occur as the community relations plan is implemented to allow for a preliminary assessment of community acceptance. Formal public comments received during the public comment period for the proposed plan and the FS report will also be addressed.

5.3 Presentation of Individual Alternatives
The analysis of the individual alternatives with respect to the specified criteria will be presented in the Final FS. This information will be used to compare the alternatives and support analysis for the remedy selection process. The narrative discussion should, for each alternative, provide 1) a description of the alternative and 2) a discussion of the individual criteria assessment.

5.4 Comparative Analysis of Alternatives
After the alternatives have been described and individually assessed against the criteria, a comparative analysis should be conducted to evaluate the relative performance of each alternative in relation to each specific evaluation criterion. This is in contrast to the preceding analysis in which each alternative was analyzed independently without a consideration of the other alternatives. The purpose of this comparative analysis is to identify the advantages and disadvantages of each alternative relative to one another so that the key tradeoffs can be identified.

5.5 Presentation of Comparative Analysis
The comparative analysis may include a narrative discussion describing the strengths and weaknesses of the alternatives relative to one another with respect to each criterion, and how reasonable variations of key uncertainties could change the expectations of their relative performance. The presentation of differences among the three alternatives may be measured either qualitatively or quantitatively, and will identify substantive differences.

5.6 Cultural Resources Survey and Evaluation
D&RGW will include in the Final Feasibility Study a cultural resources survey which will be patterned after the cultural resource documents provided by ASARCO which were conducted for the site as a whole. D&RGW's cultural resources survey will be specific to the areas in which the work will be performed, including the AV slag pile, the Harrison street slag pile, the La Plata Slag pile, the railyard and railroad easement through town.
6.0 SCHEDULE

The original schedule for the FS was presented as part of the overall RI/FS schedule in the slag pile RI work plan (MK, 1991a). That schedule has been revised based on changes in the overall site schedule and schedules imposed by the Statement of Work. The following summarizes the revised EPA deliverable dates relative to the FS:

- Final FS Work Plan, three weeks after receipt of EPA comments on Draft FS Work Plan.
- Final FS Report, four weeks after receipt of EPA comments on Draft FS Report.

The schedule for the Final FS Work Plan and the FS Report is dependent on timely receipt of pertinent data and reports from others.
7.0 REFERENCES


EPA, 1993a, Consent Decree between EPA and the D&RGW, Entered in Court on December 15, 1993

EPA, 1993b, *Final Screening Feasibility Study for Remediation Alternatives at the California Gulch Site*, Leadville Colorado, September 1993


<table>
<thead>
<tr>
<th>GENERAL RESPONSE ACTION</th>
<th>REMEDIATION TECHNOLOGY</th>
<th>PROCESS OPTION</th>
<th>EFFECTIVENESS</th>
<th>IMPLEMENTABILITY</th>
<th>RELATIVE COST</th>
<th>RETAIN</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO ACTION</td>
<td>None</td>
<td>None</td>
<td>This action would do nothing to reduce the toxicity, mobility or volume of contaminants</td>
<td>High</td>
<td>None</td>
<td>Yes, for cost comparison</td>
</tr>
<tr>
<td>INSTITUTIONAL CONTROLS</td>
<td>Land Use</td>
<td>Zoning, Deed restrictions</td>
<td>Effective in limiting the potential for direct human and some animal contact with contaminated materials. Will not provide protection of the environment from any existing contamination.</td>
<td>High</td>
<td>Low</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Access Restrictions</td>
<td>Fencing and Posted Warnings</td>
<td>Effective in limiting direct contact with contaminated materials</td>
<td>High</td>
<td>Low Capital</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Community Awareness</td>
<td></td>
<td></td>
<td>High</td>
<td>Low O&amp;M</td>
<td>Yes</td>
</tr>
<tr>
<td>CONTAINMENT</td>
<td>Surface Water Controls</td>
<td>Diversion Ditches</td>
<td>Would not reduce toxicity or the volume of contaminants, surface water run on to piles is minimal.</td>
<td>High</td>
<td>Low Capital</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Channelization</td>
<td>Diversion of surface water flow through source is not major pathway of concern</td>
<td>High</td>
<td>Medium Capital</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Source Surface Controls</td>
<td>Revegetation</td>
<td>Effective at reducing infiltration, erosion and visual impacts</td>
<td>High</td>
<td>Low Capital</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Simple Cover</td>
<td>Effective in minimizing the vertical transport of infiltrating water. Does not reduce the toxicity or volume of contaminants.</td>
<td>High</td>
<td>Low Capital</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Containment (Cont.)</td>
<td>Multi-Layer Cover</td>
<td>Most effective complex type of cap in minimizing vertical transport of infiltrating water. Does reduce toxicity or volume of contaminants.</td>
<td>Medium</td>
<td>High Capital</td>
<td>Yes</td>
<td></td>
</tr>
</tbody>
</table>

Sheet 1 of 3
Table 4-1 Evaluation of Process Options for Slag Files

<table>
<thead>
<tr>
<th>GENERAL RESPONSE ACTION</th>
<th>REMEDIAL TECHNOLOGY</th>
<th>PROCESS OPTION</th>
<th>EFFECTIVENESS</th>
<th>IMPLEMENTABILITY</th>
<th>RELATIVE COST*</th>
<th>RETAIN</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Surface Barriers</td>
<td>Retaining</td>
<td>Effective in preventing sliding and erosion of slopes when used in conjunction with capping. Does not reduce contaminant toxicity or volume.</td>
<td>High</td>
<td>High Capital Low O&amp;M</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Sediment Dams/Traps</td>
<td>Effective in reducing migration of runoff to surface waterways. Does not reduce toxicity or volume of contaminants; trapped solids must be treated.</td>
<td>High</td>
<td>Medium Capital Medium O&amp;M</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Removal, Transport, Disposal</td>
<td>Mechanical Excavation/Dredging</td>
<td>Effective means of removing material</td>
<td>High</td>
<td>Medium</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Transport</td>
<td>Truck/Rail Hauling</td>
<td>Effective for moving material</td>
<td>High</td>
<td>Medium</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Disposal</td>
<td>On-site Repository</td>
<td>Effective in reducing exposure pathways depending on the engineering controls at the repository</td>
<td>Medium, Would require permitting or landfill</td>
<td>Medium Capital Medium O&amp;M</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>On-Site Consolidation</td>
<td>Effective in reducing exposure pathways and number of slag piles.</td>
<td>High</td>
<td>Medium Capital Low O&amp;M</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Treatment</td>
<td>Physical/Chemical Separation</td>
<td>Effective in sizing the slag particles. May not reduce toxicity to below acceptable levels.</td>
<td>High</td>
<td>Medium Capital Medium O&amp;M</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Neutralization</td>
<td>Addition of lime would not be effective at neutralizing slag because of high intrinsic neutralization capacity, increases volume of material.</td>
<td>Low</td>
<td>High Capital Medium O&amp;M</td>
<td>No</td>
</tr>
</tbody>
</table>

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Sheet 2 of 3
<table>
<thead>
<tr>
<th>GENERAL RESPONSE ACTION</th>
<th>REMEDIAL TECHNOLOGY</th>
<th>PROCESS OPTION</th>
<th>EFFECTIVENESS</th>
<th>IMPLEMENTABILITY</th>
<th>RELATIVE COST</th>
<th>RETAIN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resource Utilization</td>
<td>Resource Utilization</td>
<td>Ballast</td>
<td>Effective in source removal</td>
<td>High</td>
<td>Medium</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Production, use as additives in construction materials, stand alone construction materials</td>
<td></td>
<td></td>
<td>Capital</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Low O&amp;M</td>
<td></td>
</tr>
<tr>
<td>REMEDIAL ALTERNATIVES &amp; PRIMARY COMPONENTS</td>
<td>DESCRIPTION OF PROCESS</td>
<td>EFFECTIVENESS</td>
<td>IMPLEMENTABILITY</td>
<td>COST</td>
<td>FINAL DISPOSITION</td>
<td></td>
</tr>
<tr>
<td>------------------------------------------</td>
<td>------------------------</td>
<td>---------------</td>
<td>-----------------</td>
<td>------</td>
<td>------------------</td>
<td></td>
</tr>
<tr>
<td>1) No action</td>
<td>No action</td>
<td>Unknown</td>
<td>Implementable</td>
<td>None</td>
<td>Retained</td>
<td></td>
</tr>
<tr>
<td>2) Institutional Controls</td>
<td>Combination of one or more of the following: Fencing, Deed Restrictions, and Use Restrictions, Monitoring, Management Practices</td>
<td>Unknown</td>
<td>Conventional procedures</td>
<td>Low to moderate, depending on materials and O&amp;M costs</td>
<td>Retained</td>
<td></td>
</tr>
<tr>
<td>3) Source Surface Controls/Institutional Controls</td>
<td>Cover piles with soil/clay mixture, revegetate</td>
<td>Marginal reduction in infiltration</td>
<td>Medium, Pile non-uniformity, would lead to large quantities of soil/clay cover material, steep slopes would be difficult to cover.</td>
<td>Medium cost</td>
<td>Not Retained</td>
<td></td>
</tr>
<tr>
<td>4) Surface Water/Barrier/Institutional Controls</td>
<td>Diversion Ditches</td>
<td>Surface water run-on only important at certain piles, effectiveness unknown</td>
<td>Medium, Conventional technology, diversion ditches may be difficult due to surface/ground water interactions</td>
<td>Low implementation and O&amp;M cost</td>
<td>Not Retained</td>
<td></td>
</tr>
<tr>
<td>5) Removal/Transport/Disposal/Institutional Controls</td>
<td>Removal of piles for consolidation on-site or on-site repository</td>
<td>Depending upon characteristics of repository and engineering controls leaching may not be minimized</td>
<td>Medium, permitting land use, transportation are all problems associated with implementability</td>
<td>High Cost</td>
<td>Not Retained</td>
<td></td>
</tr>
<tr>
<td>6) Resource Utilization - Railroad Ballast - Additive material for construction</td>
<td>Sort/ crush slag, obtain greater than 3/8&quot; but less than 2 1/2&quot; for railroad ballast</td>
<td>Source Removal off-site or usage within the site</td>
<td>High, conventional technology for ballast operations, unknown usage for fine material</td>
<td>Low Cost</td>
<td>Retained</td>
<td></td>
</tr>
</tbody>
</table>
California Gulch Lead
Slag Pile Feasibility
Study

Organization Chart

D&RGW
Project Coordinator
Kathy Snead

HRO
Outside Counsel
Charlotte Neitzel

MK
Project Manager
Doug Uhland
CALIFORNIA GULCH CERCLA SITE
SLAG PILE REMEDIATION
INVESTIGATION
DENVER, COLORADO

Figure 2.1
SITE MAP
WITH LEAD SLAG
PILE LOCATIONS

DENVER & RIO GRANDE WESTERN RAILROAD
DENVER, COLORADO

MORRISON-KNADSEN CORPORATION

NOTE: TOPOGRAPHIC CONTOURS AND SURFACE FEATURES
DRAWN TO SCALE.  INFRARED PHOTOGRAPH AND PROPOSED BY ROY F. WILKER, INC.

CALIFORNIA GULCH CERCLA SITE
SLAG PILE REMEDIATION
INVESTIGATION
DENVER, COLORADO

LEGEND
- HISTORIC SHELTER LOCATION
- HISTORIC SHELTER LOCATION - TENTATIVE
- SITE BOUNDARY
- SLAG PILE
- SAMPLE LOCATION
Responsiveness Summary
California Gulch Feasibility Study Work Plan
Responsiveness Summary
California Gulch Feasibility Study Work Plan

GENERAL COMMENTS:

1) The document contains detail regarding previous work performed at the site, however it is brief on project team, schedule and proposed work. The project team and schedule need more detail and the proposed work needs to be more specific as to how the plan will be applied to California Gulch.

Response: The Final Draft FS Work Plan has been revised to address this comment.

2) Section 5.2 could be shortened considerably by listing the nine criteria in a table with a brief description of what each criterion includes.

Response: Section 5.2 is important to the FS work plan because of the criteria listed and the evaluation of the alternatives versus the criteria.

3) Many acronyms are not defined upon their first appearance in the text. These include PRPs, D&RGW, CERCLA, NCP, ARARs, CLP, RCRA.

Response: A list of acronyms will be presented in the work plan.

4) The document contains numerous discrepancies between cited references and those listed in Section 7.0. Most noticeable is the absence of any specific citation of the Screening Feasibility Study (SFS).

Response: Specific citations from the Screening Feasibility Study will be included, where appropriate. Other instances, if any, where discrepancies between cited references and the reference list will be addressed.

5) It is unclear whether Section 4.0 is entirely a summary of the SFS, or incorporates some aspects of subsequent alternatives screening. The summary Tables 4-1 and 4-2 are also inconsistent in their discussion of various process options.

Response: Section 4.0 summarizes the results of the SFS and does not incorporate any additional alternative screening. The Tables were directly taken from the SFS, which is an EPA document, released in 1993.

6) The SFS addresses all slag sizes while the draft FS Work Plan for Stockpiled Fine Slag addresses fine-sized fraction material. According to the RI, leaching from fine slag was retained as a pathway of exposure and should be addressed in the FS. Source surface controls are described in Table 4-1 as being effective at reducing infiltration and vertical transport.
Response: Those alternatives remaining from the SFS are to be examined in the FS. This approach is documented in the Consent Decree between EPA and D&RGW of December 15, 1993. Other alternatives which were screened out in the SFS will not be reconsidered in the FS.

8) Section 5.0 provide no information as to how the detailed analysis of alternatives will proceed. The section presents a plan for guiding work for the final FS, but it is not clear how this plan will be applied to the California Gulch slag piles for which Denver and Rio Grande Western (D&RGW). The FS should include some quantitative or semiquantitative estimates of the reduction of leachate generation resulting from the process options considered.

Response: The FS will include a quantitative or semiquantitative assessment of leachate generated from the stockpiled fines as the base case (no action alternative). The comparison of other remedial alternatives against the no action alternative will be documented in the FS. The FS work plan should not, and does not, provide this assessment, rather the approach to the assessment is defined. More detail as to the approach has been added to the FS Work Plan in Section 5.0. Generally, the approach is to calculate the mass loading of metals of concern from stockpiled fine slag piles at the AV Slag Pile and using appropriate geochemical transport models, estimate the mass loading to the California Gulch. Estimates of mass of metals leachable from Column Leach and other studies conducted during the RI do not consider any retardation mechanisms which actively inhibit the transport of metals to the California Gulch. Additionally, the ground water/surface water interactions need to be further examined because it appears as if the Gulch is a losing stream in the vicinity of the AV.

SPECIFIC COMMENTS

Page ii. The Table and Figure references should agree with the Table and Figure Titles. Specifically, the Tables are titled 4-1 and 4-1 (rather than 4.1 and 4.2), and the Figures are titled 1-1 and 1-1 (rather than 1.1 and 1.2). The second figure should in fact be Figure 2.1.

Response: Figure number 1-1 will be changed to be Figure 2.1.

Page 1, Paragraph 1, line 6. "MK 1992" should be enclosed in parentheses.

Response: The revised FS Work Plan will reflect this change.

Page 1, Para. 1, Lines 6-7. Provide a reference for the Screening Feasibility Study.

Response: The SFS will be referenced in Section 7.0.

Page 2, Para. 4, line 3. The capitalization of "proposed plan" and "Record of Decision" is not consistent throughout the document.
Response: The revised FS Work Plan will reflect this change.

Page 3, Para. 2, bullet three. The technical review committee should be shown on Figure 1.1

Response: The figure is intended to present the D&RGW organization and not necessarily all of the interactions with government and local groups interested in the California Gulch site.

Page 3, Section 1.2. There are eight positions/individuals shown on the organization chart (Figure 1.1.), yet only one is described in the text. Either simplify the organization chart, or at least briefly describe responsibilities and duties of the other positions. Under "other responsibilities, as necessary," please add: "State, and site activities Coordinating Committee (SACC)" to the last bullet and add an additional bullet addressing community relations activities.

Response: The other committees will be added to the text.

Pages 4-7, Sec. 2.1. Each of the subheadings should be numbered, e.g., 2.1.1 Climatology

Response: The section numbers will be added.

Page 4, Para. 1, line 2. The word "physiologic" should probably be replaced by "physiographic"; "physiologic refers to the functioning of a living creature.

Response: Physiographic will replace physiologic.

Page 4, Sec. 2.1, Para. 1, line 5. It is unlikely that placer methods were used to mine major sulfide/carbonate ore deposits. Clarify this statement.

Response: Placer mining was a major activity in the early history of Leadville mining.

Page 4, Sec. 2.1 Para. 3, line 3. Substitute "concentrations" for "proportions".

Response: The substitution will be made in the Draft Final FS Work Plan.

Page 5, Para. 1, line 8. The reference to "CDL. 1986" should be either 1986a or 1986b.


Page 5, Para. 4, Line 1. The Pendery Fault should be shown on a figure.

Response: The Pendery Fault has been added to the Figure. One should be cautious that the Pendery Fault's location is approximate.

Page 5, Para. 4 Lines 3 and 4. The word "Fault" should be lower case unless it is part of
a formal name or the "the Fault" should be referenced.

Response: Comment Noted

Page 5, Para. 4, line 6. Substitute "upper California Gulch..." for "upper Gulch itself"  

Response: The suggestion has been incorporated in the Draft Final FS Work Plan.

Page 7, Para. 1, line 3. If the quotation is from EPA, 1989, the quotes should precede the parenthetical expression. If the parenthetical is part of the quotation, then a reference for the quotation should be provided.

Response: The quotation marks have been relocated. The quote is from EPA, 1989.

Page 7, Para. 1, sentence 2. What is the explanation for highest metal concentration during the time period when surface water flow is highest? Is the metal present as dissolved or suspended constituents.

Response: Typically metal concentrations, both dissolved and suspended, are highest in the spring (May/June). These high concentrations are probably due to influx of runoff induced particulates from various source areas.

Page 7, Para. 1, line 6. The word "Aquatic" should probably be changed to "Ambient."

Response: Aquatic will be changed to Ambient in the Draft FS Work Plan.

Page 7, Sec. 2.2, Para 1, line 1. Slag is more likely a metalliferous by-product rather than mineralized. If mineralized, what are the minerals?

Response: Metalliferous is a better term and will be included in the Draft Final FS Work Plan.

Page 7, Sect 2.2, Para. 2, Line 1. Silicon is not a metal.

Response: Metallic elements in general are distinguished from the non-metallic elements by their lustre, malleability, conductivity and usual ability to form positive ions. While silicon is not particularly malleable, the other definitions are true for silicon. Because it is in the same row on the periodic table as germanium, tin and lead, silicon is often referred to as a metal.

Page 8, Para. 2, line 1. Provide a reference citation for the Slag Pile Remedial Investigation.


Page 8, Sec. 2.3, Para. 1, lines 1-5. This discussion is essentially redundant to Sec. 2.2.
Consider combining these two sections.

Response: Comment Noted.

Page 8, Sec. 23, Para. 1 line 1. Delete the word "activity".

Response: The text of the Draft Final FS Work Plan has been revised.

Page 8, Sec 23, Para. 1, line 5. The reference should be to Figure 2.1, not 2-1, or the caption of Figure 1.1 should be revised.

Response: The text of the Draft Final FS Work Plan has been revised.

Page 8, Sec. 23, Para. 1, line 7. Provide a reference citation for the D&RGW slag pile RI. Substitute "slag" for "pile," or insert "slag" before "pile".

Response: The text of the Draft Final FS Work Plan has been revised.

Page 9, Para. 2, last sentence. Describe how long the pile is, or how many feet is 1/5 of the pile length.

Response: The text of the Draft Final FS Work Plan has been revised.

Page 9, Para. 3. Describe the relative proportion of air quenched to water quenched slag in the pile. Describe the areal extent of the pile.

Response: The text of the Draft Final FS Work Plan has been revised. Air quenched (sorted fines) currently consist of about 1/3 the volume of the water quenched fines. The areal extent of the AV pile is described in the Slag RI report, MK 1992.

Page 9, Section 2.3.2, line 6. It is not clear if "Bimetallic smelter slag.." is referring to slag from the Bimetallic Smelter, or smelter slag from bimetallic concentrates. If the former, be consistent on capitalization. If the former, how does it relate to the Berdell and Witherall Smelter, or the La Plata Slag Pile.

Response: The La Plata slag pile is the result of smelting operations for two metals, lead and silver (bimetallic). Berdell and Witherall was the original name of the smelter prior to the name changing to the La Plata Smelter. At one time the La Plata smelter was named the Bimetallic smelter. La Plata is the current name and the last name for the smelter operations.

Page 9, Sec. 2.3.2, last line. Provide a reference citation for the source of survey information.

Response: All survey information was either derived from 1) physical surveys at the site during the RI or 2) from aerial photographs. All information relative to surveying is
presented in the RI report.

Page 10, Para. 1, line 1. Substitute ".... La Plata (LP)...." for "...La Plata...".

Response: The text of the Draft Final FS Work Plan has been revised.

Page 10, Para. 2, line 1. Substitute "The LP Pile..." for "The La Plata (LP) Piles...". This work plan needs more consistent definition and use of acronyms.

Response: The text of the Draft Final FS Work Plan has been revised.

Page 10, Para. 2. Describe the areal extent of the pile.

Response: The text of the Draft Final FS Work Plan has been revised.

Page 10, Sec 2.3.3, Para. 1 and 2. Is the Harrison Street (HR) pile the same as the Harrison Slag pile? If so, be consistent with nomenclature. Is HR the proper acronym?

Response: The Harrison Street (HR) pile is the same as the Harrison Slag pile. HR is the proper acronym. The text of the Draft Final FS Work Plan has been revised.

Page 10, Sec. 2.3.3, Para. 2, Describe the areal extent of this pile.

Response: The Draft FS Work Plan has been modified to detail this requested information.

Page 11, Para. 1, line 2. The reference should be to Figure 2.1, not 2-1, or the caption of Figure 1.1 should be revised.

Response: The text of the Draft Final FS Work Plan has been revised.

Page 11, Para. 1. Has this pile been surveyed? If so, describe the estimated tonnage and areal extent.

Response: The text of the Draft Final FS Work Plan has been revised.

Page 11, Para. 2, line 4. Describe to what the slag piles are adjacent. It the intent to say they are adjacent to each other?

Response: The piles are adjacent to each other.

Page 11, Para. 2. Have these slag piles been surveyed? If so, describe the estimated tonnage and areal extent of the piles.

Response: All of this information was presented in the Slag Pile RI, MK 1992. The Draft Final FS Work Plan will be revised to describe the information requested.
Page 12, Para. 1, first sentence. Delete "... in the California Gulch."

Response: The text of the Draft Final FS Work Plan has been revised.

Page 12, Sec. 3.2, Para. 2, line 3. Insert "at" following "interval."

Response: The text of the Draft Final FS Work Plan has been revised.

Page 12, Sec. 3.2, Para. 3, line 6-7. Define the concentration levels represented by "highest concentrations", and "highest levels."

Response: The term highest is relative to all media at the California Gulch Superfund Site.

Page 14, Para. 2, line 1. A reference should be provided for the study by Jacobs Engineering; it is probably EPA 1990b.

Response: The text of the Draft Final FS Work Plan has been revised.

Page 14, Para. 2. Please clarify whether four samples were collected at each slag pile, or four samples were collected total.

Response: Generally, four samples were collected from each pile. The text of the Draft Final FS Work Plan has been revised.

Page 15, Para. 1, last sentence. Substitute "...contained 5 and 15 weight percent fine material, respectively." for "...showed 5 and 15 percent, respectively."

Response: The text of the Draft Final FS Work Plan has been revised.

Page 16, Para. 1, line 1. The word compositional needs an adverb to describe what kind of composition is being referred to. If chemical, then state it.

Response: The text of the Draft Final FS Work Plan has been revised.

Page 16, Sec. 3.5.2, Para 2. Does the term "registered land surveyor" refer to "licensed surveyor".

Response: Registered Land Surveyor is the correct term.

Page 16, Sec. 3.5.2, Para. 3, line 4. Describe what percent of the grid was selected randomly for sampling, and how many samples were collected per slag pile.

Response: The intent of the FS is to provide a background and indicate the direction and scope of work in the FS. The reviewer is referred to the Slag RI reports or the Sampling
and Analysis plan for more detail.

Page 16, Sec. 3.5.2, Para. 3, line 10. Expand the discussion of the process used to determine a representative weight. What procedures were used to ensure that the sampling process did not bias the sample?

Response: The intent of the FS is to provide a background and indicate the direction and scope of work in the FS. The reviewer is referred to the Slag RI reports or the Sampling and Analysis plan for more detail.

Page 16, Sec. 3.5.2, Para. 3, line 13. Define "old Slag."

Response: Old slag is a term of art coined by the EPA. D&RGW does not understand what the term old slag refers. Additionally, statistical evaluations of chemical compositions of all slag samples do not indicate that there would be a basis for the use of such a term.

Page 17, Para. 2 lines 1 and 4. The word "compositional" needs a modifier to describe what type of composition is being referred to.
Response: The text of the Draft Final FS Work Plan has been revised.

Page 17, Sec. 3.5.3, para. 2, 1st sentence. This is the first place that CLP has been defined as an acronym, although the acronym has already been used several times.

Response: The text of the Draft Final FS Work Plan has been revised.

Page 17, Sec. 3.5.3, para. 2, lines 2-3. A reference should be provided for the Bureau Mines sample digestion method.

Response: The text of the Draft Final FS Work Plan has been revised.

Page 17, Sec. 3.5.3, Para. 2, line 3. The acronym TAL has previously been defined, it does not need to be defined again.

Response: The text of the Draft Final FS Work Plan has been revised.

Page 17, Sec. 3.5.3, Para. 3. What are the results of the leaching tests? How do the results contribute or impact this work plan?

Response: The results of the leaching tests were provided in detail in the Lead Slag RI report. The results impact the Feasibility study in that the amount of metals potentially leached from the fine slag provides the baseline from which to judge the effect of any contemplated remedial actions.
State the constituents of concern. What quantities of metals were leached per unit mass or volume.

Response: The primary constituent of concern is lead. The quantities of metals leached were presented in the Lead Slag RI report. The quantities of metals liberated during the leaching tests are considered overestimates of leaching potential because of the way the tests were conducted. The mass of metals leached are to be compared to the mass introduced to California Gulch from all sources taking into account the various retardation mechanisms in the transport to surface water calculations in the FS. Comparison of the base case with the alternatives will provide the basis for evaluation of alternatives.

Include a table showing the results being discussed.

Response:

Define "pile integrity." How was pile integrity determined.

Response: Pile integrity was evaluated with respect to structural stability, deflation potential, and effects of freeze/thaw cycling. The structural stability was evaluated based on results of field reconnaissance and the slag pile contour maps from surveying and aerial photography. Evidence of fissure zones, slag block slumping or block rotation were noted in the field. Angles of repose of the piles were calculated from topographic surveys. Further details are presented in Section 4.4 Slag Pile Stability in the Lead Slag RI report.

Cite the references for the Final Slag Pile RI and the EPA conclusions.

Response: The text of the Draft Final FS Work Plan has been revised. The EPA Conclusions were presented in the Consent Decree and accompanying Statement of Work.

Provide a reference for the Screening Feasibility Study.

Response: The Screening Feasibility Study is an EPA document, dated September 1993. The reference will be added to the Draft Final FS Work Plan.

The prescreening FS has not been discussed before. Cite a reference.

Response: The Screening Feasibility Study is an EPA document, dated September 1993. The reference will be added to the Draft Final FS Work Plan.

This "list" has only a single bullet, so it should just be written as a conclusion to the introductory statement on the previous page as a single continuous sentence.
Response: The text of the Draft Final FS Work Plan has been revised.

Page 21, Sec. 4.2.1, Para. 1. This discussion is confusing. The text refers to Table 4-1 as providing a list of "...all of the technologies and process options that were considered technically implementable ...," and then goes on to say that all but the bulleted items were "... evaluated during the screening FS." The implication is that the bulleted items are included within the universe of "... technologies and process options..." that are "technically implementable," but that they were not evaluated during the screening FS. Several questions arise:

1) Why are the bulleted items not included on Table 4-1?

2) Why were the bulleted items not evaluated during the screening FS?

3) Why are the bulleted items not discussed further in the present FS Work Plan?

Response: The Draft Final FS Work Plan will be modified to more fully explain the Screening FS. The SFS began with a "universal list of technologies and process options." Those technologies and process options that were considered to be not "technically implementable" were screened out prior to evaluation of the remaining technologies for effectiveness, implementability and cost for any particular potential source area. The bulleted items were those items screened out from the universal list (developed for the site as a whole based on general response actions).

Page 21, Section 4.2.2, Para. 1. Cite a reference for the EPA Guidance.

Response: The text of the Draft Final FS Work Plan has been revised.

Page 22, Sec. 4.2.3, Para. 1, line 2. The word "Slag" should be lower case.

Response: The text of the Draft Final FS Work Plan has been revised.

Page 22, Sec. 4.2.3, Para. 2, lines 2-4. Does Table 4-1 represent the starting point for the analysis of the SFS?

Response: In the SFS, a list of General Response actions was formulated for all potential source areas evaluated. From these General Response Actions a list of potentially applicable remedial technologies and process options was developed (Table 2-2 of the SFS). These potentially applicable remedial technologies and process options were screened based on whether they were technically feasible to be conducted at the California Gulch Site. From this screening, Table 4-1 was developed and is essentially the same for each potential source area. Then Table 4-1 was screened based on the unique characteristics, information and remedial action objective. From Table 4-1, Table 4-2 was developed.
Is Table 4-1 a reproduction from the SFS, or was it prepared new for this work plan?

Response: Table 4-1 and Table 4-2 were taken directly from the SFS for this work plan.

Page 23, Para. 2, lines 2-3. Not all of the Remedial Action Alternatives for the slag piles are described in the subsequent text. Rather, only the short list of screened alternatives is described.

Response: The retained alternatives are described. For a more complete description the SFS should be consulted.

Page 23, Para. 2, lines 3-4. The word "were" should be "was" and "are" should be "is".

Response: The text of the Draft Final FS Work Plan has been revised.

Page 23, Para. 3, line 1. Delete the comma after alternatives.

Response: The text of the Draft Final FS Work Plan has been revised.

Page 23, Para. 3. Does Table 4-2 represent the ending point for the analysis of the SFS?

Response: Table 4-2 is the ending point of the SFS and the beginning point of the Feasibility Study to be conducted as described by this work plan.

Page 24, Para. 1. Presumably, this discussion refers to possible uses of all slag materials as reflected in the SFS. By definition, the slag fines that are the subject of the present work plan are not coarse enough to serve as ballast.

Response: Fine slag cannot be used as ballast. However, examples of resource utilization options are presented for fine slag in the referenced paragraph.

Page 24, Sec. 4.4, para. 2, line 2. Replace "applicable and relevant" with "applicable or relevant and appropriate".

Response: The text of the Draft Final FS Work Plan has been revised.

Page 24, Sec. 4.4, last para. Include a table showing those ARARs of importance to slag fines.

Response: Screening of ARARs to those of most importance to slag fines is an exercise to be conducted as part of the Feasibility Study.

Page 25, Para. 2, lines 6-8. Do the ongoing risk assessment activities address the entire
California Gulch site, or just the slag?

Response: The Risk Assessment activities are for the entire site.

Page 26, Para. 1, line 3. The word "determine" should be replaced by "aid"; EPA will select the preferred alternative, with the aid of the evaluations discussed in the FS.

Response: The text of the Draft Final FS Work Plan has been revised.

Page 26, Sec. 5.2.1 Para. 1, line 1. The word "criteria" should be "criterion."

Response: The text of the Draft Final FS Work Plan has been revised.

Page 26, Sec. 5.2.2, Para. 2, line 3. Replace "potentially" with "potential."

Response: The text of the Draft Final FS Work Plan has been revised.

Page 26, Sec. 5.2.2, Compliance with ARARs. The ARARs appendix in the SFS cannot be viewed as the "universe of ARARs." The ARARs presented in the SFS do not include State ARARs which will be identified in SFS addendum or in the detailed FS.

Response: The list of ARARs produced for the FS Work Plan is the same list as was presented in the SFS Addendum. This list will be examined in the FS to identify any ARARs that have been overlooked. Any further information updating the list of ARARs currently contemplated would be appreciated.

Page 27, Compliance with ARARs. Please explain why the location and action specific ARARs are being evaluated differently than the chemical specific ARARs.

Response: The location and action specific ARARs will be evaluated in the same manner as the chemical specific ARARs. The language in the Work Plan was intended to point out the sequence in which the ARARs will be evaluated. Chemical specific ARARs are evaluated first because they are required to establish preliminary remediation goals. The universe of potential location and action specific ARARs are screened early in the FS but are not formally evaluated until the detailed analysis of alternatives. Attempting to fully evaluate the location and action specific ARARs earlier in the FS would be wasteful as many of the technology options will not survive the screening process.

Page 29, Sec. 5.2.8, State Acceptance. Pursuant to the NCP, this section needs to be re-written as follows:

"State comments and concerns will be addressed, as appropriate, during the development of the FS.

"Assessment of CDH Concerns will be formally presented and discussed in the
Proposed Plan issued for public comment. All State concerns will be addressed with special emphasis on: 1) The State's position on concerns related to the preferred alternative and other alternatives; and, 2) The State's comments on ARARs or the proposed use of waivers.

Response: The Final Draft FS Work plan has been revised to incorporate the above comment.

Page 30, Sec 5.2.9. Community Acceptance. Pursuant to the NCP, the language in this section should be re-written as:

"Community comments will be taken into account throughout the FS process through the communication that occur as the community relations plan is implemented to allow for a preliminary assessment of community acceptance. Formal public comments received during the public comment period for the Proposed Plan and the RI/FS report will also be addressed."

Response: The Final Draft FS Work plan has been revised to incorporate the above comment.

Page 30, Sec. 5.6, lines 2-3. A site-wide cultural resources survey has not been conducted as of yet. Current policy is that each PRP will take responsibility for conducting surveys in their respective areas of the site.

Response: D&RGW intends to conduct a cultural resources survey in their work area. The text was intended to point out that several base document which lay the foundation for this work have been already prepared by ASARCO.


Response: The Final Draft FS Work plan has been revised to incorporate the above comment.

Table 4-1 and 4-2. There are numerous inconsistencies in these tables with respect to process options retained per Table 4-1, and those cited in Table 4-2:

1) Zoning is included in Table 4-1 but not noted in Table 4-2.
2) Posted Warnings are included in Table 4-1 but not noted in Table 4-2.
3) Community Awareness is included in Table 4-1 but not noted in Table 4-2.
4) Diversion Ditches are screened out on Table 4-1 but included on Table 4-2. No defensible reason is given for not retaining the alternative in Table 4-2.
5) Sediment Dams/Traps are included on Table 4-1 but not noted in Table 4-2
6) Onsite Repository is screened out on Table 4-1 but included on Table 4-2.
7) Physical Separation is included in Table 4-1 but not noted in Table 4-2.
Response: The items carried from Table 4-1 to 4-2 include Remedial Alternatives made up of one or more Remedial Technologies which address a General Response Action category. Table 4-1 screened out process options. One or more process options within a Remedial Technology were screened out in Table 4-1, but in most cases an entire Remedial Technology category was not deleted. Relevant remedial technologies were grouped together to form a remedial alternative (which is what is provided on Table 4-2). Table 4-2 screened Remedial Alternatives and categorized them as retained or not retained for evaluation in the Feasibility Study. As mandated by the Consent Decree of December 15, 1993 between D&RGW and the EPA, the only remedial alternatives to be evaluated in the Feasibility Study for Stockpiled Fine Slag are those retained by the SFS. It should be noted that the SFS is an EPA document which was the subject of many review and comment cycles and is now a final document, as of September 1993. Because these tables were taken directly from the SFS, and provide the starting point of the FS, comments on whether the screening process is appropriate is probably not a useful exercise.