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EPA Superfund Record of Decision:

California Gulch OU 4
Leadville, CO
3/31/1998

FINAL
RECORD OF DECISION

UPPER CALIFORNIA GULCH
OPERABLE UNIT 4
CALIFORNIA GULCH SUPERFUND SITE
LEADVILLE, COLORADO

March 1998

U.S. Environmental Protection Agency
999 18th Street, Suite 500
Denver, Colorado 80202

RECORD OF DECISION

UPPER CALIFORNIA GULCH OPERABLE UNIT 4
CALIFORNIA GULCH SUPERFUND SITE
LEADVILLE, COLORADO

The U.S. Environmental Protection Agency (EPA), with the concurrence of the Colorado Department of Public Health and Environment (CDPHE), presents this Record of Decision (ROD) for the Upper California Gulch Operable Unit 4 (OU4) of the California Gulch Superfund Site in Leadville, Colorado. The ROD is based on the Administrative Record for OU4, including the Remedial Investigation/Feasibility Study (RI/FS), the Proposed Plan, the public comments received, including those from the potentially responsible parties (PRPs), and EPA responses. The ROD presents a brief summary of the RI/FS, actual and potential risks to human health and the environment, and the Selected Remedy. EPA followed the Comprehensive Environmental Response, Compensation, and Liability Act, as amended, the National Contingency Plan (NCP), and appropriate guidance in preparation of the ROD. The three purposes of the ROD are to:

1. Certify that the remedy selection process was carried out in accordance with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act, 42 U.S.C. 9601 *et seq.*, as amended by the Superfund Amendments and Reauthorization Act (collectively, CERCLA), and, to the extent practicable, the National Contingency Plan (NCP);

2. Outline the engineering components and remediation requirements of the Selected Remedy; and

3. Provide the public with a consolidated source of information about the history, characteristics, and risk posed by the conditions of OU4, as well as a summary of the cleanup alternatives considered, their evaluation, the rationale behind the Selected Remedy, and the agencies' consideration of, and responses to, the comments received.

The ROD is organized into three distinct sections:

1. The **Declaration** section functions as an abstract for the key information contained in the ROD and is the section of the ROD signed by the EPA Regional Administrator and the CDPHE Director.

2. The **Decision Summary** section provides an overview of the OU4 characteristics, the alternatives evaluated, and the analysis of those options. The Decision Summary also identifies the Selected Remedy and explains how the remedy fulfills statutory requirements; and

3. The **Responsiveness Summary** section addresses public comments received on the Proposed Plan, the RI/FS, and other information in the Administrative Record.

DECLARATION

DECLARATION

SITE NAME AND LOCATION

Upper California Gulch Operable Unit 4
California Gulch Superfund Site
Leadville, Colorado

STATEMENT OF BASIS AND PURPOSE

This decision document presents the Selected Remedies for waste rock and fluvial tailing material for OU4 within the California Gulch Superfund Site in Leadville, Colorado. EPA, with the concurrence of CDPHE, selected the remedies in accordance with CERCLA and the NCP.

This decision is based on the Administrative Record for OU4 within the California Gulch Superfund Site. The Administrative Record (on microfilm) and copies of key documents are available for review at the Lake County Public Library, located at 1115 Harrison Avenue in Leadville, Colorado, and at the Colorado Mountain College Library, in Leadville, Colorado. The complete Administrative Record may also be reviewed at the EPA Superfund Record Center, located at 999 18th Street, 5th Floor, North Terrace, in Denver, Colorado.

The State of Colorado concurs with the Selected Remedies, as indicated by concurrence letter.

ASSESSMENT OF THE SITE

Actual or threatened releases of hazardous substances at and from OU4, if not addressed by implementing the response action selected in this ROD, may present an imminent and substantial endangerment to public health, welfare, or the environment.

DESCRIPTION OF THE SELECTED REMEDY

The Selected Remedies for the waste rock and fluvial tailing material is the third response action to be taken at OU4 of the California Gulch Superfund Site. Two Engineering Evaluation/Cost Analyses (EE/CAs) (TerraMatrix/SMI, 1995a and 1996a) were performed to identify removal actions for the waste rock contained within the Garibaldi and the Upper Whites Gulch mine areas. An Action Memorandum was issued by the EPA on August 4, 1995, which selected the removal actions for the Garibaldi Mine area (EPA, 1995a). On July 19, 1996, the EPA issued an Action Memorandum which selected the removal actions for the Agwalt Mine site (EPA, 1996a). Implementation of the Removal Action for Garibaldi Mine site was initiated during the fall of 1995, and included a portal collection system for the collapsed Garibaldi Mine portal, approximately 1,960 linear feet of concrete-lined channel, and two groundwater interception trenches constructed to intercept and divert surface and groundwater flow around the Garibaldi waste rock pile. Similarly, the Removal Action conducted for the Agwalt Mine site in the fall of 1996 included a portal collection system for the collapsed Agwalt Mine portal and approximately

1,000 linear feet of concrete-lined channels to intercept and divert surface water runon and portal flow away from the Agwalt waste rock pile. The two removal actions (Garibaldi and Agwalt) are consistent with the Selected Remedies for the waste rock and fluvial tailing material which are described below.

The Final Focused Feasibility Study for Upper California Gulch Operable Unit 4 (TerraMatrix/SMI, 1998) evaluated and screened remedial alternatives retained in the Site-Wide Screening Feasibility Study (EPA, 1993) for the waste rock and fluvial tailing material within OU4. The Focused Feasibility Study (FFS) used a comparative analysis to evaluate alternatives for the waste rock (Garibaldi Sub-basin, Printer Girl, Nugget Gulch, AY-Minnie, Iron Hill and California Gulch) and Fluvial Tailing Site 4 and identified the advantages and disadvantages of each.

For the Garibaldi Sub-basin Waste Rock, EPA has selected Alternative 2: Diversion of Surface Water and Selected Removal as the preferred alternative. Diversion ditches would be constructed to reduce surface water runon to the UCG-109A (McDermith) waste rock pile and reduce leaching and erosional releases associated with surface flow. The stream channel will be reconstructed around UCG-109A.

For the Printer Girl Waste Rock, EPA has selected Alternative 4: Waste Rock Removal as the preferred alternative. The lowermost portion of the waste rock would be excavated and consolidated onto waste rock pile UCG-71 (Colorado No. 2). The remaining disturbed areas will be regraded to increase stability and promote non-erosive runoff. Two diversion ditches would be constructed to control surface water runon to the regraded disturbed areas.

For the waste rock within Nugget Gulch, EPA has selected Alternative 4: Diversion Ditches, Consolidation, and Cover as the preferred alternative. Waste rock piles UCG-74 (Rubie), UCG-76 (Adirondack), UCG-77 (Colorado No. 2 east), and UCG-85 (North Mike) would be excavated and consolidated onto waste rock pile UCG-71 (Colorado No. 2). UCG-71 would be regraded and a simple cover placed over the consolidated material. The surface material will be revegetated or have rock placed upon it. Disturbed areas which were cleared of waste rock would be terraced, soils amended and revegetated. Diversion ditches would be constructed to control surface water runon.

For the AY-Minnie Waste Rock, EPA has selected Alternative 4: Diversion Ditches and Road Relocation as the preferred alternative. Diversion ditches would be constructed to reduce surface water runon to the AY-Minnie waste rock pile and reduce leaching and erosional releases associated with surface flow. Lake County Road 2 will be realigned to provide area for construction of a sediment pond and further add protection from stability failures of the timber cribbing without destroying the mining heritage and cultural resources of this mining area.

For the waste rock west of Iron Hill, EPA has selected Alternative 3: Regrade and Cover as the preferred alternative. Waste rock pile UCG-12 (Mab) Castle View will be regraded. A simple cover will be placed on UCG-12 along with revegetation of the surrounding disturbed areas. The surface material will be revegetated or have rock placed upon it. Implementation of this alternative will minimize infiltration at UCG-12, reduce leaching, increase stability of the regraded waste rock and promote non-erosive runoff from the regraded waste rock pile surfaces.

For the waste rock within California Gulch, EPA has selected Alternative 2: Stream Channel Reconstruction as the preferred alternative. The upper California Gulch stream channel would be reconstructed and stabilized. Implementation of this alternative would stabilize the stream channel for the 500-year flood event and reduce contact of waste rock with surface flows in upper California Gulch, minimizing leaching and erosional releases associated with surface flow.

For the fluvial tailing within Fluvial Tailing Site 4, EPA has selected Alternative 5: Channel Reconstruction, Revegetation, Sediment Dams, Wetlands and Selected Surface Material Removal as the preferred alternative. The upper California Gulch stream channel would be reconstructed and channel spoil material and selected fluvial tailings areas would be regraded and removed (if necessary). Eight sediment dams and approximately 1.5 acres of wetlands would be constructed along the channel. Implementation of this alternative would stabilize the site to convey the 500-year flood event, reduce contact of surface water with fluvial tailings, promote non-erosive flow, and minimize leaching.

The Selected Remedies are protective of human health and the environment through the following:

1. The covers will eliminate airborne transport of waste rock particles and limit the potential for contact of precipitation and surface water with waste material;

2. Ponding of water on the tailings surface will be minimized through selected regarding and revegetation.

3. Infiltration through the waste rock piles will be greatly reduced due to the runon controls and engineered covers;

4. Erosion and transport of tailings and waste rock will be eliminated or reduced by diversion ditches and reconstructed channels;

5. Stability of the side slopes will be increased by regrading to flatten existing slopes prior to constructing the covers.

STATUTORY DETERMINATIONS

The Selected Remedies are protective of human health and the environment, comply with federal and state requirements that are legally applicable or relevant and appropriate to the remedial action, and are cost effective. Given the type of waste present at this site, these remedies use permanent solutions (e.g., diversion ditches) to the maximum extent practicable and satisfy the preference for remedies that reduce toxicity, mobility, or volume as a principal element. Because these remedies may result in hazardous substances remaining on site above health-based levels, a review will be conducted within five years after commencement of remedial action to ensure that these remedies continue to provide adequate protection of human health and the environment. These remedies are acceptable to both the State of Colorado and the community of Leadville.

Max H. Dodson
Assistant Regional Administrator
Ecosystems Protection and Remediation
U.S. Environmental Protection Agency, Region VIII

3/31/98
Date

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LIST OF ACRONYMS AND ABBREVIATIONS

ABA	Acid-Base Accounting
AMSL	Above Mean Sea Level
AOC	Administrative Order on Consent
ARD	Acid Rock Drainage
AWQC	Ambient Water Quality Criteria
BARA	Baseline Aquatic Ecological Risk Assessment
BMP	Best Management Plan
CD	Consent Decree
CDPHE	Colorado Department of Public Health and Environment
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFS	Cubic Feet per Second
COCs	Contaminants of Concern
CPT	Cone Penetrometer Test
CTE	Central Tendency Exposure
CZL	Colorado Zinc-Lead
EE/CA	Engineering Evaluation/Cost Analysis
EPA	Environmental Protection Agency
ERA	Ecological Risk Assessment
ESI	Engineering Science, Inc.
FFS	Focused Feasibility Study
HI	Hazard Index
HQ	Hazard Quotient
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
NRHP	National Register of Historic Places
OU4	Operable Unit 4
PRPs	Potentially Responsible Parties
RA	Risk Assessment
RAO	Remedial Action Objective
RI/FS	Remedial Investigation/Feasibility Study
RME	Reasonable Maximum Exposure
ROD	Record of Decision
RUSLE	Revised Universal Soils Loss Equation
SFS	Screening Feasibility Study
SHPO	State Historic Preservation Office
SPLP	Synthetic Precipitation Leaching Procedure
SPT	Standard Penetration Test
TBV	Toxicity Benchmark Values
TDS	Total Dissolved Solids
TSS	Total Suspended Sediment
UAO	Unilateral Administrative Order
UCL	Upper Confidence Limit

LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

WAMP	Work Area Management Plan
WCC	Woodward-Clyde Consultants
WWL	Water, Waste, and Land, Inc.

1.0 SITE NAME, LOCATION, AND DESCRIPTION

Upper California Gulch Operable Unit 4 (OU4)
California Gulch Superfund Site
Leadville, Colorado

The California Gulch Superfund Site is located in Lake County, Colorado, in the upper Arkansas River basin, approximately 100 miles southwest of Denver (see Figure 1). The Site encompasses approximately 16.5 square miles and includes the towns of Leadville and Stringtown, a portion of the Leadville Historic Mining District, and the portion of the Arkansas River from its confluence with California Gulch downstream to the Lake Fork Creek confluence. Upper California Gulch is a V-shaped valley with an intermittent stream that flows in a westerly direction. California Gulch extends about 7.8 miles from its headwaters, at an elevation of about 11,300 feet above mean sea level (AMSL), to the confluence with the Arkansas River, at an elevation of about 9,500 feet AMSL. Several sub-basins drain into upper California Gulch, including Whites Gulch and Nugget Gulch. The California Gulch Superfund Site has been organized into 12 operable units. Figure 2 shows the Site boundaries and the location of OU4 within the California Gulch Superfund Site.

OU4 covers an area of approximately 2.4 square miles and contains waste rock piles and fluvial tailing and is divided into six sub-basins, as shown in Figure 3. Resurrection Mining Company (Resurrection) identified 131 waste rock piles within OU4 (SMI/TerraMatrix, 1994a). Screening reduced the total number of waste rock piles to 22 piles based on location, geochemistry, remote sensing data, water quality, and physical characteristics. The total volume of waste rock included in 22 piles identified in the screening process is approximately 431,000 cubic yards impacting a total area of approximately 28.3 acres. Supplemental evaluation indicated that two piles were not significant. Consequently, 20 piles were evaluated.

The deposition of fluvial tailings along upper California Gulch is neither uniform nor continuous and the site appears to be divided into several distinct pockets. Fluvial Tailing Site 4 extends for a distance of approximately 1.5 miles along upper California Gulch, from slightly upstream of the Yak Tunnel portal to the upstream end of the Printer Boy Mine area. In general, the site covers a total area of approximately 10 acres with the fluvial tailings material extending 20 to 100 feet across the valley floor. The estimated volume of fluvial tailings is 102,000 cubic yards.

The sources of metal contamination within OU4 identified in the Work Area Management Plan (WAMP), which is an appendix to the Consent Decree (CD), include the following mine waste rock piles and fluvial tailings material:

- Waste rock near the Garibaldi mine which may contribute to surface water and sediment contamination;

- Waste rock in Upper Whites Gulch which may contribute to surface water and sediment contamination;

- Waste rock and fluvial tailings near the AY-Minnie and Printer Boy mining area which may contribute to surface water and sediment contamination;

- Waste rock piles at North Moyer/North Mike which may contribute to surface water and sediment contamination; and

- Mine waste rock piles located near the Minnie pump shaft extending into California Gulch which may contribute to stream sediment contamination.

Lake County is relatively small (380 square miles) and is predominately rural, with a 1990 population of 6,007 (U.S. Department of Commerce, 1990). About half of this population resides within the City of Leadville. The population of Lake County has fluctuated with the mining industry. The population increased to about 9,000 between 1960 and 1981 and then declined throughout the 1980's. About two-thirds of the land in Lake County is federally owned and is either part of San Isabel National Forest or managed by the Bureau of Land Management. OU4 is primarily privately owned with land surrounding and within California Gulch predominately dedicated to mining, commercial, and residential uses (TerraMatrix/SMI, 1998).

County Road 2 parallels the Upper California Gulch drainage channel for approximately 1.5 miles from the catchment outlet to the road switchback that climbs to the topographic divide separating California and Iowa Gulches. Several dirt roads extend from County Road 2 to historic mine sites within OU4. These access roads are generally utilized by residents and tourists during the summer and fall months.

The climate of Lake County is semi-arid continental, characterized by long, cold winters and short, cool summers. The average annual maximum temperature in the Leadville area is 50.5 degrees Fahrenheit and the average annual minimum temperature is 21.9 degrees Fahrenheit, with an annual mean temperature of 36.2 degrees Fahrenheit. The annual climatological normal precipitation for Leadville is 18.48 inches. Prevailing winds in the Leadville are largely from the west-northwest and to a lesser extent to the northeast, with wind speeds typically ranging from 0 to 20 miles per hour (mph). Populated areas of Leadville are predominantly upwind of OU4 (TerraMatrix/SMI, 1998).

2.0 HISTORY AND ENFORCEMENT ACTIVITIES

The California Gulch Superfund Site is located in the highly mineralized Colorado Mineral Belt of the Rocky Mountains. Mining, mineral processing, and smelting activities have produced gold, silver, lead, and zinc for more than 130 years in the Leadville area. Mining and its related industries continue to be a source of income for both Leadville and Lake County. The Leadville Historic Mining District includes an extensive network of underground mine workings in a mineralized area of approximately 8 square miles located around Breece Hill. Mining in the District began in 1860, when placer gold was discovered in California Gulch. As the placer deposits were exhausted, underground workings became the principle method for removing gold, silver, lead, and zinc ore. As these mines were developed, waste rock was excavated along with the ore and placed near the mine entrances. Ore was crushed and separated into metallic concentrates at mills, with mill tailings generally slurried into tailings impoundments.

The California Gulch Site was placed on the National Priorities List (NPL) in 1983, under the authority of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980. The Site was placed on the NPL because of concerns about the impact of mine drainage on surface waters in the California Gulch and the impact of heavy metals loading in the Arkansas River. Several subsequent investigations have been conducted within the California Gulch Superfund Site that have addressed Upper California Gulch (OU4).

Resurrection entered into a Consent Decree (CD) (USDC, 1994) with the United States, the State of Colorado (State), and other potentially responsible parties (PRPs) at the California Gulch Site on May 4, 1994. In the CD, Resurrection agreed to perform certain remediation work in three operable units (OU4, OU8, and OU10). The Work Area Management Plan (WAMP), included as Appendix D to the CD (USDC, 1994), defines the scope of work to be performed by Resurrection.

Engineering Science, Inc. (ESI) prepared the *Yak Tunnel/California Gulch Remedial Investigation* (ESI, 1986) for the State. This RI evaluated the human health and environmental impacts due to historic mining activities. Waste rock piles were selected for sampling based upon their potential to impact surface water systems. Waste rock and fluvial tailing material samples (from 0 to 6 inches) were collected at 14 sites in OU4. Waste rock and/or tailing samples were collected in the Iron Hill drainage, at the Garibaldi, Agwalt, Printer Girl, and AY-Minnie mine sites, and along Fluvial Tailing Site 4.

In 1986 and 1987, EPA conducted additional RI investigations within California Gulch and prepared the *Draft Phase II Remedial Investigation Technical Memorandum 1986-1987* (Phase II RI)(EPA, 1989a). The Phase II RI evaluated mine-related wastes and surface water and groundwater quality to further characterize contaminant sources at the California Gulch Site. EPA sampled two locations in OU4 during the Phase II RI. These locations were associated with the Printer Girl and the AY-Minnie mine sites.

Water, Waste, and Land, Inc. (WWL) conducted a hydrologic investigation of the California Gulch drainage for Resurrection in 1989 and prepared the *California Gulch Hydrologic Investigation, Leadville, Colorado* (WWL, 1990). The study included surface water, groundwater, and sediment sampling; laboratory analysis of samples; and an inventory of mine and mineral waste. The primary objectives of the investigation were to characterize the surface and groundwater quality and flow patterns, and to identify sources of contaminant loading in California Gulch. Approximately 11 surface water samples were collected along Upper California Gulch and its tributary drainages (Nugget Gulch and Whites Gulch). Groundwater was sampled in the spring and fall of 1989 at monitoring wells previously installed by the EPA in the fall of 1984.

Woodward-Clyde Consultants (WCC) conducted a site-wide surface water RI for Asarco, Inc. in 1991 and 1992. The *Final-Surface Water Remedial Investigation Report* (Surface Water RI)(Golder, 1996a) describes the results of the investigation. The study involved surface water and sediment sampling in the Arkansas River and its tributaries, including California Gulch. The Upper California Gulch basin was sampled at one site (CG-1), located immediately upstream of the Yak Tunnel portal.

WCC conducted a Hydrogeologic RI at the California Gulch Site for Asarco, Inc. from the fall of 1991 through the winter of 1992. The *Final-Hydrogeologic Remedial Investigation Report* (Hydrogeologic RI)(Golder, 1996b) describes the results of the investigation. The study included well and piezometer installation and monitoring, and groundwater sampling and analysis. Objectives of the study were to investigate groundwater quality and flow directions, evaluate potential impacts to water users and surface water receptors, and to characterize background groundwater quality. Four monitoring well sites (one alluvial and three bedrock monitoring wells), two mine portals, and three springs were sampled in Upper California Gulch.

WCC conducted a remedial investigation of the five major tailing impoundments and seven fluvial tailing deposits at the California Gulch Site for Asarco, Inc. in the fall of 1991. The *Final-Tailings Disposal Area Remedial Investigation Report* (Tailings RI) was issued in 1994 (WCC, 1994a). The primary objectives of the investigation were to characterize the physical nature of the tailing materials and to evaluate the tailing's potential impacts on surface and groundwater. The Tailings RI included an evaluation of Fluvial Tailing Site 4 within Upper California Gulch. Five boreholes were drilled and sampled, and 10 surface samples were collected along the reach of Upper California Gulch extending from the Printer Boy mining area to the Yak Tunnel portal. The 10 surface samples were composited into a single sample for laboratory analysis. Surface water samples were also collected in conjunction with the Tailings RI.

SMI and TerraMatrix conducted a field reconnaissance survey of waste rock piles in the Upper California Gulch basin on behalf of Resurrection during August 1993. The *Draft Final-Field Reconnaissance Survey of Mine Waste Piles Located Within the Upper California Gulch Drainage* was issued in 1994 (SMI/TerraMatrix, 1994a). The investigation identified 131 individual waste rock piles within the Upper California Gulch basin. The survey included a field reconnaissance of the waste rock piles to document the physical, geographical, mineralogical, vegetative, and potential contaminant release characteristics of each waste rock pile. As part of the reconnaissance survey, an identification system was created to label each waste rock pile with a unique identification number (e.g. UCG-#). Each pile was sequentially numbered from 1 to 131, beginning at the western edge of the operable unit.

Each waste rock pile was ranked for two criteria: 1) potential physical instability which may expose or spread materials, and 2) minerals contained on the surface of the pile. Ranking of the piles consisted of assigning a rank from 0 to 2 to each pile for each criteria based on the pile characteristics with 0 indicating a lower potential risk and 2 indicating the highest potential risk (TerraMatrix/SMI, 1998).

In addition to the site investigations, selected areas within OU4 were surveyed for cultural resources in 1990, 1994, and 1995. The 1990 cultural resource investigation included a survey of the Garibaldi mine site in OU4 (Martorano, 1990). FEC conducted cultural resources surveys at the North Moyer mine site on August 3 and 4, 1994 and June 20, 1995; at the Agwalt mine site on July 11 an 12, 1994 and October 25, 1994; and at the North Mike mine site on July 22, 1990 and July 19, 1994 (FEC, 1996). In September and October of 1995, P-III conducted a cultural resource inventory of waste rock pile UCG-92A at the Printer Girl mine site located in Whites Gulch and several potential access road corridors in OU4 (P-III, 1996a). In September and October of 1995, P-III also conducted cultural resource inventories of several additional waste rock piles and fluvial tailing areas within OU4 where remedial activities are anticipated (P-III, 1996b).

TerraMatrix and SMI, on behalf of Resurrection, conducted additional field investigation activities within the Upper California Gulch basin during the fall of 1994. Field activities included surface sampling of mine waste piles for geochemical analysis, a spring and seep survey, installation of shallow groundwater monitoring wells, and the further characterization of fluvial tailing material. Seventeen mine waste rock piles were sampled for geochemical analysis. The primary objectives of the sampling program was to evaluate the potential risk of the waste rock piles to generate acid rock drainage (ARD) and leach metals, and to provide supplemental information for use in EE/CAs and the FFS.

Three shallow groundwater monitoring wells were installed as part of the groundwater investigation. Two of the wells were installed at the Garibaldi mine site and the third was installed at the Agwalt mine site. The wells were installed to assess groundwater conditions at these mine sites, and to evaluate whether groundwater contributes to seepage observed at the base of the waste rock piles (TerraMatrix/SMI, 1998).

A groundwater, surface water, and stream bed sediment field sampling program was performed by SMI and TerraMatrix on behalf of Resurrection in October 1993; May, June and October 1994; January, May, June, July, August, and September 1995; and May, June, July, and September 1996. The purpose of the program was to obtain additional groundwater, surface water, and stream bed sediment data for California Gulch, its tributaries, and the Arkansas River.

Sampling in Upper California Gulch included four groundwater monitoring wells and 28 surface water sampling sites.

TerraMatrix, on behalf of Resurrection, conducted additional field investigation activities within the Upper California gulch basin during the spring and fall of 1995. Field activities included measuring surface water field parameters, surface sampling of waste rock piles, stream bed sediment sampling, and a geotechnical investigation of selected waste rock piles. At the request of CDPHE, additional waste rock samples were also collected by TerraMatrix at waste rock piles UCG-109A and -116 (Garibaldi Sub-basin) during July, 1997. The objectives of the field activities were to further define conditions within OU4 and supplement existing RI information with additional physical, chemical, and geotechnical data to facilitate the completion of OU4 EE/CAs and the FFS.

The Garibaldi Mine Site (located in the upper most reaches of Upper California Gulch) and the Agwalt Mine Site (located in upper Whites Gulch) were addressed through non-time critical removal actions in the fall of 1995 and 1996, respectively. Engineering Evaluations/Cost Analyses (EE/CAs) were prepared to identify and evaluate removal action alternatives for these source areas (TerraMatrix/SMI, 1995a and 1996b). Action Memoranda were issued by the EPA on August 4, 1995 for the Garibaldi mine site (EPA, 1995a) and on July 19, 1996 for the Agwalt mine site within Whites Gulch (EPA, 1996a), presenting the selected removal action alternatives. Final Removal Action Design Reports (TerraMatrix/SMI, 1995b; TerraMatrix/SMI, 1996b) were submitted to the EPA on August 28, 1995 for the Garibaldi mine site and on September 13, 1996 for the Agwalt mine site. Removal Action Work Plans (TerraMatrix/SMI, 1995c; TerraMatrix/SMI, 1996c) providing implementation plans were submitted on September 8, 1995 and September 13, 1996, respectively, for the Garibaldi and Agwalt mine sites. A Removal Action Completion report for the Garibaldi mine site and Agwalt (Resurrection, 1996) describing the construction process, design changes, costs, and results was issued by Resurrection in January 1996.

The selected removal actions for these locations in Upper California Gulch represent interim responses contributing to the efficient performance of the remedial actions for OU4. As such, these removal actions are included in the analysis of remedial alternatives presented in the FFS report for OU4 (TerraMatrix/SMI, 1998).

In January of 1998, Resurrection submitted the *Final Focused Feasibility Study for Upper California Gulch Operable Unit 4* (TerraMatrix/SMI, 1998), according to the terms of the Consent Decree. The FFS provided a detailed analysis for the following waste rock piles and fluvial tailing material:

- Waste rock near the Garibaldi Mine;
- Waste rock in Upper Whites Gulch;
- Waste rock and fluvial tailing near the AY-Minnie and Printer Boy mining areas;
- Waste rock piles at North Moyer/North Mike; and
- Mine waste rock piles located near the Minnie pump shaft.

A Proposed Plan describing the EPA's preferred alternatives was issued on January 15, 1998. The preferred cleanup alternatives for the waste rock and fluvial tailing material located within OU4 consist of:

Garibaldi Sub-basin Waste Rock:	Alternative 2 - Diversion of Surface Water and Selected Removal
Printer Girl Waste Rock:	Alternative 4 - Waste Rock Removal
Nugget Gulch Waste Rock:	Alternative 4 - Diversion Ditches, Consolidation and Cover
AY-Minnie Waste Rock:	Alternative 4 - Diversion Ditches and Road Relocation
Iron Hill Waste Rock:	Alternative 3 - Regrade and Cover
California Gulch Waste Rock:	Alternative 2 - Stream Channel Reconstruction
Fluvial Tailing Site 4:	Alternative 5 - Channel Reconstruction, Revegetation, Sediment Dams, Wetlands and Selected Material Removal

3.0 HIGHLIGHTS OF COMMUNITY PARTICIPATION

Public participation is required by CERCLA Sections 113 and 117. These sections require that before adoption of any plan for remedial action to be undertaken by EPA, the State, or an individual (PRP), the lead agency shall:

1. Publish a notice and brief analysis of the Proposed Plan and make such plan available to the public; and

2. Provide a reasonable opportunity for submission of written and oral comments and an opportunity for a public meeting at or near the site regarding the Proposed Plan and any proposed findings relating to cleanup standards. The lead agency shall keep a transcript of the meeting and make such transcript available to the public. The notice and analysis published under item #1 above shall include sufficient information to provide a reasonable explanation of the Proposed Plan and alternative proposals considered.

Additionally, notice of the final remedial action plan set forth in the ROD must be published and the plan must be made available to the public before commencing any remedial action. Such a final plan must be accompanied by a discussion of any significant changes to the preferred remedy presented in the Proposed Plan along with the reasons for the changes. A response (Responsiveness Summary) to each of the significant comments, criticisms, and new data submitted in written or oral presentations during the public comment period must be included with the ROD.

EPA has conducted the required community participation activities through the presentation of the RI/FS and the Proposed Plan, a 30-day public comment period, a formal public hearing, and the presentation of the Selected Remedy in this ROD. No written comments were received during the public comment period. Verbal comments received at the public meeting are addressed in the Responsiveness Summary.

The Proposed Plan for Upper California Gulch OU4 was released for public comment on January 15, 1998. The RI/FS and the Proposed Plan were made available to the public in the Administrative Record located at the EPA Superfund Records Center in Denver and the Lake County Public Library and Colorado Mountain College Library in Leadville. A formal public comment period was designated from January 15 through February 13, 1998.

On January 29, 1998 the EPA hosted a public meeting to present the Proposed Plan for Upper California Gulch OU4 of the California Gulch Superfund Site. The meeting was held at 7:00 p.m. in the Mining Hall of Fame in Leadville, Colorado. Representatives from the Resurrection Mining Company presented the Proposed Plan. The alternatives were discussed for the waste rock (Garibaldi Sub-basin, Printer Girl, Nugget Gulch, AY-Minnie, Iron Hill and California Gulch) and the Fluvial Tailing Site 4. A portion of the hearing was dedicated to accepting formal oral comments from the public. Community acceptance of the Selected Remedies is discussed in Section 8.0, Summary of Comparative Analysis of Alternatives of this Decision Summary.

4.0 SCOPE AND ROLE OF OPERABLE UNIT

The California Gulch Superfund Site covers a wide area (Figure 2). EPA has established the following OUs for the cleanup of geographically-based areas within the Site. The OUs are designated as:

OU1	Yak Tunnel/Water Treatment Plan
OU2	Malta Gulch Fluvial Tailings/Leadville Corporation Mill/Malta Gulch Tailings Impoundment
OU3	D&RGW Slag Piles/Railroad Easement/Railroad Yard and Stockpiled Fine Slag
OU4	Upper California Gulch
OU5	ASARCO Smelter/Slag/Mill Sites
OU6	Starr Ditch/Penrose Dump/Stray Horse Gulch/Evans Gulch
OU7	Apache Tailings Impoundment
OU8	Lower California Gulch
OU9	Residential Populated Areas
OU10	Oregon Gulch
OU11	Arkansas River Valley Floodplain
OU12	Site Water Quality

The purpose of the Upper California Gulch OU4 RI/FS was to gather sufficient information to support an informed risk management decision on which remedies are the most appropriate for the sources within OU4 (waste rock piles and fluvial tailing material). The RI/FS was performed in accordance with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 Code of Federal Regulations (CFR) Part 300, and CERCLA Section 104, 42 U.S.C. § 9604.

The objectives of the RI/FS were to:

- Characterize the physical nature of the waste rock piles, fluvial tailings material and stream sediments, and to evaluate the potential impacts of the waste rock piles, tailings material and stream sediments to the surface water and groundwater.
- Define the potential pathways along which metals can migrate, as well as the physical processes and, to the extent necessary, the chemical processes that control these pathways;
- Determine risk assessment information including potential receptors, exposure patterns, and food chain relationships;
- Develop, screen, and evaluate remedial alternatives and predict the consequences of each remedy;
- Analyze each of the FS alternatives against the NCP (40 C.F.R. 300.430) criteria and WAMP criteria; and

- Compare the relative performance among each alternative with respect to the evaluation criteria.

Based on the findings of previous investigations, the contamination at the Upper California Gulch has been adequately delineated to evaluate alternatives in the RI/FS.

This ROD was prepared according to EPA guidance (EPA, 1989). The remedy outlined in this ROD is intended to be the final remedial action for OU4. Preliminary qualitative remedial action objectives (RAOs) for waste rock were developed in the SFS (EPA, 1993). The following qualitative RAOs were presented in the Screening Feasibility Study (SFS) (EPA, 1993):

- Control wind and water erosion of waste rock materials from the source locations;
- Control leaching and migration of metals from waste rock into surface water; and,
- Control leaching and migration of metals from waste rock into groundwater.

To achieve the goals of this FFS, the effectiveness of the remedial action alternatives for waste rock were evaluated with respect to these RAOs (TerraMatrix/SMI, 1998).

The qualitative RAOs presented in the SFS for fluvial tailing include the following (EPA, 1993):

- Control erosion of contaminated materials into local water courses;
- Control leaching and migration of metals from contaminated materials into surface water; and,
- Control leaching and migration of metals from contaminated materials into groundwater.

The effectiveness of the remedial action alternatives for fluvial tailing were evaluated with respect to these objectives. In addition to these RAOs, the remedial alternatives were also evaluated with respect to the compatibility of the alternative with anticipated remedial actions in other operable units of the California Gulch Site. This California Gulch Site-wide compatibility was defined as controlling erosion and metal loading to surface water and groundwater that may adversely affect other operable units, and minimizing any potential adverse effects to other operable units caused by implementing the remedial alternative in OU4 (TerraMatrix/SMI, 1998).

5.0 SUMMARY OF SITE CHARACTERISTICS

5.1 PHYSICAL CHARACTERISTICS

The upper California Gulch watershed drains approximately 2.4 square miles (1,540 acres). Major tributaries to the California Gulch within OU4 include: the reach of upper California Gulch in the vicinity of the Garibaldi mine site (upper California Gulch upstream of Lake County Road 2), Whites Gulch, Nugget Gulch, and gulch between Iron Hill and Carbonate Hill (Iron Hill). Surface water flow in upper California Gulch and its tributaries is generally intermittent, typically occurring only as the result of snow-melt runoff and high intensity summer precipitation events.

In order to facilitate the discussion of the nature and extent of contamination within OU4, the Operable Unit has been subdivided into the following six areas:

- Garibaldi Sub-basin;
- Whites Gulch Sub-basin;
- Nugget Gulch Sub-basin;
- AY-Minnie;
- Iron Hill; and
- Fluvial Tailing Site 4 and South Area.

Five mining areas in OU4 were originally identified (in the WAMP [USDC, 1994] and other studies [ESI, 1986; EPA, 1989a; WWL, 1990]) as containing waste rock piles that potentially contribute to human health and environmental risks including:

- Garibaldi (UCG-121);
- Upper Whites Gulch (UCG-92A);
- North Moyer (UCG-79) and North Mike (UCG-85);
- AY-Minnie (UCG-81); and
- Minnie pump shaft (UCG-75).

Additional waste rock piles identified during supplemental investigations as sources of contamination include:

- Waste rock piles UCG-109A and -116 in the Garibaldi Sub-basin;
- Waste rock pile UCG-104 in the upper Whites Gulch drainage;
- Waste rock piles UCG-71, -74, -76, -77 and -80 in upper Nugget Gulch;
- Waste rock piles UCG-12 in the upper Iron Hill drainage; and
- Waste rock piles UCG-33A, -65, -82A, -93, -95, and -98 along Fluvial Tailing Site 4.

The sub-basins and waste rock piles identified as sources of contamination are shown in Figure 3. The surface areas and volumes for each of the waste rock piles are presented in Table 1.

5.2 NATURE AND EXTENT OF CONTAMINATION

Media evaluated include waste rock, surface water, groundwater and stream sediments within and downgradient of OU4. The following sections summarize the nature and extent of contamination for each of these media found within each of the six sub-basins.

5.2.1 GARIBALDI SUB-BASIN

The Garibaldi Sub-basin is the upstream most tributary basin to upper California Gulch (Figure 3). The basin is defined as the area hydraulically drained from where Lake County Road 2 crosses upper California Gulch to the topographic divide on Ball Mountain. Figure 4, Garibaldi Mine Site and Upper California Gulch Vicinity, displays the sub-basin boundary and shows the locations of surface water, groundwater and sediment monitoring stations. Surface water monitoring site CG-1G is located at the catchment outlet.

Surface water flow has been measured at CG-1G fourteen times between June 1989 and September 1996. Flow at CG-1G generally ceases in late-summer/early-fall and measured flows ranged from 0.006 cubic feet per second (cfs) to 6.85 cfs.

5.2.1.1 Garibaldi Waste Rock Pile

The Garibaldi waste rock pile (Figure 4) is the primary source of contamination within the Garibaldi Sub-basin. The Garibaldi waste rock pile (UCG-121) occupies two upper California Gulch headwater channels. Waste rock is primarily coarse to fine-grained weathered porphyry (WWL, 1990) with no vegetation present on the pile. Erosion and gullying were observed on the waste rock pile surface (WWL, 1990). The waste rock pile reconnaissance survey identified staining of the waste rock and noted that surface material contained greater than one percent sulfides (SMI/TerraMatrix, 1994a). An evaluation of total metals concentrations measured in the waste rock surface sample indicate elevated (as compared to background) concentrations of arsenic, cadmium, and lead. A summary of the laboratory results of the metals analyses and acid-base accounting (ABA) tests for the Garibaldi waste rock sample is presented in Table 2, Garibaldi Sub-basin Waste Rock Geochemical Data. Analyses of EPA Method 1312 leachate from the Garibaldi waste rock composite sample were also performed. The analyte concentrations are presented in Table 2, and include: arsenic, 0.0015 mg/l; cadmium, 0.034 mg/l; lead, 4.59 mg/l; zinc, 6.24 mg/l; and sulfate, 345 mg/l. The pH of the leachate was 2.9 standard units (s.u.).

5.2.1.2 Waste Rock Pile (UCG-109A and -116)

In response to CDPHE's concerns that waste rock pile UCG-109A (McDermith) and -116 (Figure 4) may be potential sources of contamination, composite samples of each waste rock pile were collected in July, 1997. The waste rock from these piles is coarse to fine-grained porphyry and weathered, with minor amounts of sulfides. A summary of the laboratory analyses for total metals, ABA and EPA Method 1312 for these samples is summarized in Table 2.

5.2.1.3 Surface Water

An evaluation of surface water quality data downstream of the Garibaldi mine site indicates that the Garibaldi waste rock pile is the major contributor to surface water total suspended solids (TSS), sulfate, and metals loading in the Garibaldi Sub-basin. Surface water runon, portal discharge runon, and groundwater inflows upgradient of the Garibaldi waste rock pile generally account for less than 2 percent of contaminants of concern (COC) loadings detected at sampling station CG-1G. Prior to 1996, surface water COC loadings attributed to lateral flow from the waste rock pile (surface water monitoring site GM-1) generally accounted for almost 100 percent, or greater, of the COC loadings detected at CG-1G (TerraMatrix/SMI, 1998).

During the fall of 1995, Resurrection completed a removal action (TerraMatrix/SMI, 1995a) at the Garibaldi mine site. The major component of the removal action was the construction of diversion ditches and collection systems which reduced surface water and groundwater contact with the Garibaldi waste rock pile.

Ten water quality samples were collected from the toe of the waste rock pile (GM-1) between June 1989 and June 1996. The pre-removal action spring flow average loadings at GM-1 accounted for: 96 percent of the sulfate loading; 1,700 percent of the dissolved arsenic loading; 205 percent of the total arsenic loading; 113 percent of the dissolved cadmium; 128 percent of the total cadmium loading; 92 percent of the dissolved copper loading; 89 percent of the total copper loading; 11 percent of the dissolved lead loading; 3 percent of the total lead loading; 98 percent of the dissolved zinc loading; and 96 percent of the total zinc loading of the associated loadings detected at sampling station CG-1G. CG-1G is located downstream of the sub-basin boundary, just below the McDermith pile (UCG-109A).

Following the Garibaldi removal action, the 1996 spring flow average loading data at GM-1 indicate a reduction in COC loadings. The post-removal action spring flow average loadings at GM-1 generally accounted for less than two percent of the associated loadings at CG-1G. Dissolved and total arsenic loadings are the exception, however, the percentage of the dissolved arsenic loading from GM-1 was reduced from 1,700 percent to 11 percent and the percentage of the total arsenic loading was reduced from 205 percent to 5 percent.

Comparison of the 1995 and 1996 data shows the decrease in loadings downstream of the Garibaldi mine site as the result of the Garibaldi removal action. Upstream of the Garibaldi mine site, the loading data indicates that surface water flow generally does not contribute to sub-basin loadings. A comparison of the 1995 peak flow loadings versus the 1996 peak flow loadings downstream of the Garibaldi mine site shows that loadings of sulfate and dissolved copper and zinc decreased from 1995 to 1996. Surface water monitoring at the toe of the waste rock pile at monitoring site GM-1 indicates that the Garibaldi removal action resulted in a significant decrease in sulfate and dissolved copper and zinc loadings attributed to lateral flow from the Garibaldi waste rock pile. In addition, the sulfate and dissolved copper and zinc loadings at CG-1G were reduced in half between the 1995 and 1996 peak flow events (TerraMatrix/SMI, 1998).

5.2.1.4 Groundwater

Two alluvial monitoring wells (GMW-1 and GMW-2) are located upgradient of the Garibaldi mine site, the locations of these wells are shown in Figure 4. Groundwater samples collected from these wells indicated unimpacted conditions. Groundwater samples from GMW-1 and GMW-2 had near neutral pH values (approximately 6 s.u. to 7.1 s.u.) and generally metals concentrations, except for dissolved zinc, were at or below the analytical method detection limits. Dissolved zinc concentrations at GMW-1 ranged from 0.13 mg/l to 0.41 mg/l, while the dissolved zinc concentrations detected at GMW-2 ranged from 0.03 mg/l to 0.13 mg/l. These monitoring wells are screened between 5 feet and 11 feet below ground surface.

5.2.1.5 Stream Sediment

The average spring flow TSS loading at CG-1G prior to the Garibaldi removal action was 1,689 lbs/day and the post-removal action spring flow average TSS loading at CG-1G was 364 lbs/day. The peak flow TSS loading at CG-1G in 1995 was 9,238 lbs/day and the 1996 peak flow TSS loading was 1,278 lbs/day. The water quality data from the Garibaldi Sub-basin, as monitored at CG-1G, indicate that the Garibaldi removal action resulted in a significant reduction in the contribution of the Garibaldi Sub-basin TSS concentrations and loads.

5.2.2 WHITES GULCH SUB-BASIN

Downstream of the Garibaldi Sub-basin, to the north of upper California Gulch, is the Whites Gulch Sub-basin (Figure 3). Whites Gulch drains a portion of the south and south-west facing slopes of Breece Hill. The catchment is defined as the area hydraulically drained from where Lake County Road 2 crosses Whites Gulch to the topographic divide of Breece Hill which separates upper California Gulch from upper Evans Gulch. The Garibaldi Sub-basin lies to the east of the White Gulch Sub-basin, while Nugget Gulch drains the topography immediately to the west. Figure 5, Whites Gulch and Vicinity, displays the sub-basin boundary and shows the locations of surface water, groundwater and sediment monitoring stations. Surface water monitoring site WG-1 is located at the catchment outlet (TerraMatrix/SMI, 1998). Measured flows at WG-1 ranged from 0.005 cfs to 2.4 cfs. Field observations noted that during several OU4 low-flow sampling events there was no flow in Whites Gulch at WG-1.

5.2.2.1 Waste Rock Piles

The Agwalt (UCG-104) and Printer Girl (UCG-92A) waste rock piles (Figure 5) are the primary sources of contamination within the Whites Gulch Sub-basin. The Agwalt waste rock pile is primarily coarse to fine-grained, highly weathered porphyry with no vegetation present on the pile. The surface is highly oxidized, with greater than one percent sulfide minerals present (SMI/TerraMatrix, 1994a).

The Printer Girl waste rock is primarily coarse to fine-grained weathered porphyry, with pyrite and galena mineralization present (WWL, 1990). Erosion and gullying were observed on the waste rock pile surface (WWL, 1990; SMI/TerraMatrix, 1994a).

Resurrection collected one composite sample from the Agwalt and two composite samples from the Printer Girl waste rock pile during October 1994. A summary of the laboratory results of the metal analyses, ABA tests, and leachate analyses using EPA Method 1312 for these samples are presented in Table 4.

5.2.2.2 <u>Surface Water</u>

Eight surface water monitoring stations are located within the Whites Gulch Sub-basin. Figure 5 shows the location of the surface water sampling sites. The 1995 and 1996 peak flow loadings and 1995/1996 spring flow average loading values for the COCs are summarized in Table 3, Surface Water COC Loadings. The COC loadings from each headwater catchment were expressed as a percentage of the corresponding loadings at WG-1.

Surface runoff from headwater areas in the Whites Gulch Sub-basin include:

- east Agwalt headwater catchment, monitored at surface water sampling location AG-2E; and,
- north Agwalt headwater catchment, monitored at surface water sampling location AG-2N.

In general the data indicate that water flowing from the east headwall catchment (AG-2E) was a major contributor of COC loadings to Whites Gulch during 1995 and 1996, particularly for cadmium and copper. Flow from the north headwall catchment (AG-2N) is not a major contributor of metals loading to Whites Gulch (TerraMatrix/SMI, 1998).

Two abandoned mine portals have been identified discharging portal flow to Whites Gulch. One portal is located at the Agwalt mine site and the second portal is at the Printer Girl mine site. Based on limited portal discharge data, it appears that the Agwalt portal discharge (AP-1) is a contributor to COC loadings in Whites Gulch, especially for sulfate, dissolved cadmium and dissolved zinc. Flow from the collapsed portal at the Printer Girl mine site is not considered a major contributor of metal loads to Whites Gulch, however, during base flow the seepage from Printer Girl mine site becomes a contributor to the COC loadings detected at WG-1 (TerraMatrix/SMI, 1998).

Seepage from the Agwalt waste rock pile appears to be a major contributor to COC loadings in White Gulch. Lateral flow through the Agwalt waste rock piles has been observed from late spring through late fall. The lateral flow through the waste rock pile emerges at the toe of the waste rock pile as two seeps. Monitoring station AG-1A is the surface water sample site at the upgradient of the two seeps, while AG-1B is the surface water site at the downgradient seep. The lateral flow is the result of surface runon, portal discharge, groundwater inflows, and direct precipitation infiltrating through the waste rock pile.

The base flow loadings from AG-1A accounted for less than 10 percent of the corresponding loads at WG-1, except sulfate (22 percent) and dissolved and total zinc (13 and 12 percent, respectively). During base flow, the percentage of the loadings at WG-1 associated with the loading at AG-1B generally increased. The base flow average sulfate load at AG-1B accounted for 73 percent of the associated loading at WG-1. Dissolved cadmium, copper, and zinc base flow loadings at AG-1B represented 32 percent, 24 percent, and 43 percent, respectively, of the corresponding loadings at WG-1. In general the flow from the toe of the Agwalt waste rock pile was a major contributor of sulfate and metals loading to Whites Gulch. There was no comparison of pre- and post removal data (e.g. percent loading reduction) for the Agwalt mine site, that evaluation is being conducted as part of the removal action.

Surface water monitoring station WG-3 is located on Whites Gulch upstream of the Printer Girl mine site. The water quality data at WG-3 was compared against the water quality data at WG-1 to evaluate the contaminant contribution from the Printer Girl waste rock pile. The loading data indicate that during the spring flow season, the Printer Girl waste rock piles is a major contributor of cadmium and lead loads detected at WG-1 (TerraMatrix/SMI, 1998).

5.2.2.3 Groundwater

In August 1994, Resurrection excavated four test pits at the Agwalt mine site during a groundwater investigation. The test pits were excavated to either the point of refusal or the equipment limit. Water was observed in only the test pit immediately adjacent to the collapsed portal. A groundwater monitoring well, identified as AMW-1, was installed, and groundwater samples have been collected at AMW-1 five times between October 1994 and June 1996. The average concentrations of TSS, sulfate, and metals of concern are generally below the average concentrations at WG-1 (TerraMatrix/SMI, 1998).

5.2.2.4 Stream Sediment

Water quality data from Whites Gulch generally indicate that Whites Gulch is not a major contributor to the TSS loads in upper California Gulch. The spring flow average TSS load at WG-1 accounted for less than one percent of the spring flow average TSS load at CG-1. However, the 1995 peak flow load at WG-1 was 9,408 lbs/day and the associated TSS load at WG-1 accounted for 19 percent of the detected 1995 peak flow TSS load at CG-1 (TerraMatrix/SMI, 1998).

5.2.3 NUGGET GULCH SUB-BASIN

The Nugget Gulch Sub-basin is tributary to upper California Gulch immediately downstream of the Whites Gulch Sub-basin (Figure 3). The catchment drains the east and south-east facing aspects of Iron Hill and a portion of the south facing hillslope that separates upper California Gulch from Stray Horse Gulch. The Nugget Gulch drainage is defined as the area hydraulically drained from where Lake County Road 2 crosses Nugget Gulch to the topographic divide which separates Nugget Gulch from Stray Horse Gulch and along Iron Hill. Figure 6 shows the sub-basin boundary and the locations of surface water, groundwater and sediment monitoring stations.

Monitoring station NG-1 is the sub-basin outlet surface water monitoring site on Nugget Gulch. Surface flow has only been observed during the snow-melt runoff season and has been measured ten times during the spring snow-melt season between 1989 and 1996. Measured flows at NG-1 ranged from 0.002 cfs to 1.1 cfs, and flow at NG-1 generally ceases in early- to mid-summer (TerraMatrix/SMI, 1998).

5.2.3.1 Waste Rock Piles

The primary sources of contamination found within the Nugget Gulch Sub-basin are shown in Figure 6 and include the following waste rock piles; UCG-71 (Colorado No. 2), UCG-74 (Rubie) UCG-76, UCG-77, UCG-79 (North Moyer), UCG-80 (Moyer) and UCG-85 (North Mike).

The waste rock at UCG-71 (Colorado No. 2) is primarily coarse-grained weathered porphyry, with no vegetation present on the pile. The surface is highly oxidized, with greater than one percent sulfide minerals present (SMI/TerraMatrix, 1994a). Analyses of paste pH and paste conductivity measured in the waste rock surface sample collected from UCG-71 indicated that the material was slightly acidic (pH of 5.8 s.u.) with a conductivity measurement of 3,450 micro mhos per centimeter (μmhos/cm). Observations in the 1995 noted seepage from the collapsed portal at the toe of the waste rock pile.

The waste rock at UCG-74 (Rubie) is primarily coarse-grained weathered porphyry, with less than 10 percent of the pile covered with vegetation. The surface is moderately oxidized, with greater than one percent sulfide minerals present (SMI/TerraMatrix, 1994a). Paste pH and paste conductivity measurements of the waste rock surface sample collected from UCG-74 indicated the surface material was near neutral (pH of 6.8 s.u.) with a conductivity measurement of 2,580 μmhos/cm.

The waste rock at UCG-76 and UCG-77 is primarily coarse- to fine-grained weathered porphyry, with no vegetation present on either pile. The surfaces of both piles are moderately oxidized, with greater than one percent sulfide minerals present (SMI/TerraMatrix, 1994a). Paste pH measurements of waste rock piles UCG-76 and -77 surface samples indicated the surface materials at both UCG-76 and -77 have the potential to generate ARD and leach metals, with pH values of 3.8 s.u. and 2.1 s.u., respectively. Paste conductivity measurements were recorded at 13,300 μmhos/cm and 14,600 μmhos/cm, respectively.

The waste rock at the North Moyer (UCG-79) and Moyer (UCG-80) mine sites is primarily coarse- to fine-grained weathered porphyry with visible pyrite mineralization present (WWL, 1990). Erosion and gullying were observed on each waste rock pile surface (WWL, 1990; SMI/TerraMatrix 1994a). Both waste rock piles extend into Nugget Gulch. The surfaces are moderately oxidized, with greater than one percent sulfide minerals present (SMI/TerraMatrix, 1994a).

Resurrection collected a waste rock composite surface sample from both the North Moyer and Moyer waste rock piles in October 1994. An evaluation of total metals concentrations indicated elevated concentrations of arsenic, cadmium, lead, and zinc as shown in Table 5. Analyses of leachate extracted from the waste rock composite sample using EPA Method 1312 were also performed. The analyte concentrations for the North Moyer and Moyer waste rock pile leachates are presented in Table 5.

The North Mike Waste Rock is primarily coarse-grained, highly weathered porphyry with no vegetation present on the pile. The surface is highly oxidized, with greater than one percent sulfide minerals present (SMI/TerraMatrix, 1994a). Moderate gullying exists on the waste rock pile and in the denuded area downgradient of the waste rock pile. A collapsed shaft appears to be located along the eastern edge of the waste rock pile. Seasonal field observations noted seepage discharging from the toe of the waste rock pile at the downgradient edge of the denuded area along the Nugget Gulch access road (TerraMatrix/SMI, 1998).

An evaluation of total metals concentrations measured in a North Mike waste rock surface sample indicated elevated concentrations of arsenic, cadmium, and lead as presented in Table 5. Analyses of leachate extracted from the waste rock sample using EPA Method 1312 were also performed and are presented in Table 5.

5.2.3.2 Surface Water

Eight surface water monitoring stations are located with the Nugget Gulch Sub-basin. Figure 6 shows the location of the Nugget Gulch surface water sampling sites. The spring flow average 1995 and 1996 peak flow loading values for the COCs are summarized in Table 3. The COC loadings from each headwater catchment were expressed as a percentage of the spring flow average and 1995 and 1996 peak flow loadings at NG-1.

Surface runoff from headwater catchments in the Nugget Gulch Sub-basin include:

- headwater catchment, east and upgradient of the North Mike waste rock pile, monitored at surface water sampling location NM-2; and

- headwater catchment, east and upgradient of the North Moyer waste rock pile, monitored at surface water sampling location NG-3.

Water quality at each of the surface water monitoring stations was compared against water quality at NG-1, the sub-basin outlet.

In general, surface water downgradient of the North Mike waste rock pile was a major contributor of metals loading to Nugget Gulch, particularly for sulfate and dissolved and total cadmium, copper, and zinc. The 1995/1996 spring flow average sulfate load at NM-1 represented 22 percent of the corresponding 1995/1996 spring flow sulfate load at NG-1. The 1995/1996 spring flow average dissolved and total cadmium loadings at NM-1 accounted for 29 and 297 percent, respectively, of the associated cadmium loadings at NG-1. dissolved and total spring flow average copper loads represented approximately 22 percent of the corresponding copper loads at NG-1. Spring flow average loadings for dissolved and total zinc accounted for approximately 24 percent of the corresponding zinc loadings at NG-1.

The 1996 data also indicated surface water downgradient of waste rock piles UCG-71, -74, -76, and -77 was a contributor of metals loading to Nugget Gulch. Field water quality parameters, including pH and specific conductivity were only measured at surface water monitoring site NG-5A, located immediately downgradient of UCG-76. The field pH of 2.69 s.u. and conductivity measurement of 2,200 μmhos/cm indicate that the surface runoff downgradient of waste rock pile UCG-76 may have contained elevated levels of metals and sulfate. A surface water sample for laboratory analysis was collected downgradient of waste rock pile UCG-74 at monitoring site NG-5. The 1996 peak flow measured at NG-5 accounted for less than one percent of 1996 peak flow measured at NG-1. Consequently, the peak flow COC loadings from NG-5 generally accounted for less than five percent of the associated loadings at NG-1 (TerraMatrix/SMI, 1998).

The water quality data at NG-4A and NG-4B indicate that surface runoff, and potentially lateral flow, from the North Moyer and Moyer waste rock contributes to COC loadings in Nugget Gulch. Surface water monitoring stations NG-4A and NG-4B are located downgradient of the North Moyer and Moyer waste rock piles. A single surface water sample was collected in June 1995 at both monitoring sites NG-4A and NG-5B.

Loading calculations were performed on the 1995 water quality data collected at NG-4A and NG-4B. The loading values were then compared against the loading at NG-1 for that date. Measured flows at NG-4A and NG-4B both accounted for approximately 8 percent of the flow measured at NG-1 on that date. Sulfate loadings at NG-4A and NG-4B represented 88 and 62 percent, respectively, of the sulfate loading detected at NG-1. Metal loadings at NG-4A accounted for: dissolved arsenic, 192 percent; total arsenic, 14 percent; dissolved and total cadmium, 153 percent; dissolved copper, 13 percent; dissolved lead, 12 percent; total lead, 5 percent; dissolved zinc, 178 percent; and total zinc, 174 percent of the associated loadings at NG-1. Metal loading at NG-4B represented approximately: dissolved arsenic, 1,697 percent; total arsenic, 127 percent; dissolved cadmium, 80 percent; total cadmium, 96 percent; dissolved copper, 26 percent; dissolved lead, 45 percent; total lead, 32 percent; dissolved zinc, 67 percent;

and total zinc, 68 percent of the corresponding loadings detected at NG-1 (TerraMatrix/SMI, 1998).

The water quality data at NG-2 indicates that the waste rock piles at the North Moyer/Moyer, and the North Mike, and in the vicinity of UCG-71 represent a major contributor to the metal loading in Nugget Gulch. The spring flow average COC loadings at NG-2 generally accounted for 50 to 60 percent of the corresponding COC loadings at NG-1. In 1995, the peak flow loading at NG-2 generally represented over 100 percent of the associated peak flow loadings at NG-1. The 1995 dissolved cadmium peak flow load represented 97 percent, the 1995 dissolved copper peak flow load represented 121 percent, the 1995 dissolved lead peak flow load accounted for 73 percent, and the 1995 dissolved and total zinc peak flow loads represented approximately 78 percent of the corresponding loads detected at NG-1 (TerraMatrix/SMI, 1998).

5.2.3.3 Groundwater

One Yak Tunnel bedrock monitoring well (BBW-1) is located in the northeastern corner of the Nugget Gulch Sub-basin (Figure 6). Quarterly bedrock groundwater sampling results indicate that this well is uncontaminated (Golder, 1996b). Although there are no alluvial monitoring wells located in the Nugget Gulch Sub-basin, COC loadings from the seep downgradient of the North Mike waste rock pile (NM-1) indicate that the shallow groundwater contributes to surface water contamination in the Nugget Gulch Sub-basin.

5.2.3.4 Stream Sediment

Generally, Nugget Gulch is also not a major contributor to the TSS loads in upper California Gulch. The average spring flow TSS load at NG-1 represents approximately four percent of the average spring flow TSS load at CG-1. However, Nugget Gulch peak flow TSS load measured at NG-1 during 1995 and 1996 were 5,115 lbs/day and 3,095 lbs/day, respectively, which indicates that Nugget Gulch does contribute TSS to upper California Gulch surface waters (TerraMatrix/SMI, 1998).

5.2.4 AY-MINNIE SUB-BASIN

The AY-Minnie waste rock pile, identified as waste rock pile UCG-81 during the waste rock reconnaissance survey (SMI/TerraMatrix, 1994a), is located on the lower hillside of the south facing slope of Iron Hill, immediately adjacent to Fluvial Site 4 (Figure 3). The AY-Minnie mine site is generally not hydrologically connected with Nugget Gulch. However, Nugget Gulch does flow through the eastern most portion of the AY-Minnie mine site. Figure 6 shows the AY-Minnie Sub-basin boundary and the drainage area upgradient of the mine site. There are no surface water, groundwater or sediment monitoring locations specifically associated with the AY-Minnie Sub-basin.

5.2.4.1 Waste Rock Pile

The AY-Minnie waste rock is primarily coarse-grained, highly weathered porphyry with no vegetation present on the pile. The surface is high oxidized, with greater than one percent sulfide minerals present (SMI/TerraMatrix, 1994a). Erosion and moderate gullying were observed on the waste rock pile (WWL, 1990).

Resurrection collected a waste rock surface composite sample in October 1994. total metals concentrations measured in the waste rock surface sample indicated elevated concentrations of arsenic, cadmium, and zinc as presented in Table 5. Analyses of leachate extracted from the waste rock composite sample using EPA Method 1312 were also performed, and are shown in Table 5.

5.2.5 IRON HILL SUB-BASIN

Immediately downstream of the Yak Tunnel portal, the Iron Hill Sub-basin, draining the west slope of Iron Hill and the east slope of Carbonate Hill, discharges to California Gulch. Figure 7 shows the sub-basin boundary and the location of surface water monitoring stations. There are no groundwater or sediment monitoring locations specifically associated with the Iron Hill Sub-basin.

Surface water monitoring station IHW-1 is located at the catchment outlet immediately upstream of the confluence with California Gulch. Flow at IHW-1 was monitored on six occasions in the springs of 1995 and 1996. Measured flow at IHW-1 ranged from 0.2 cfs to 4 cfs. Based on the 1995 and 1996 data, flow at IHW-1 begins in early- to mid-May and ceases by late June (TerraMatrix/SMI, 1998). In addition, the Iron Hill sub-basin has been identified as a possible significant contaminant source to California Gulch during snowmelt and thunderstorms.

5.2.5.1 Waste Rock Piles

The primary source of contamination found with the Iron Hill Basin as shown in Figure 7, is the UCG-12 (Mab/Castle View) waste rock pile.

The UCG-12 waste rock pile is located in the upper reach of the Iron Hill drainage, on the northeast slope of Carbonate Hill just below the topographic divide that separates the Iron Hill drainage from Stray Horse Gulch, and it is approximately 2,500 feet upstream of Lake County Road No. 2. The waste rock at UCG-12 is primarily coarse-grained weathered porphyry, with limited vegetation present on the pile. The surface is highly oxidized, with greater than one percent sulfide minerals present (SMI/TerraMatrix, 1994a).

Resurrection collected a waste rock surface composite sample in October 1994. An evaluation of total metals concentrations measured in the waste rock surface sample indicated elevated concentrations. Total concentrations of arsenic, cadmium, lead, and zinc, ABA test results, and leachate analyses using EPA Method 1312, are presented in Table 6.

Three surface water monitoring stations are located in the Iron Hill Sub-basin. Figure 7 shows the location of the Iron Hill surface water sampling stations. The spring flow average and 1995 and 1996 peak flow loading values for the COCs are summarized in Table 3. The COC loadings from the headwater catchment (IHW-3) is expressed as a percentage of the spring flow average and 1995 and 1996 peak flow loadings at IHW-1.

Tributary inflows to the Iron Hill Sub-basin have been observed during 1995 and 1996 from OU6 along a historic road grade in the vicinity of waste rock pile UCG-86. The waste rock pile is located immediately north of the topographic divide which separates the Iron Hill catchment from Stray Horse Gulch located in OU6. Resurrection collected a single surface water sample in 1996, identified as IHW-3, downgradient of UCG-86 where the flow entered the Iron Hill drainage. Loading values calculated at IHW-3 indicates that surface runoff from OU6 contributed to COC loadings in the Iron Hill drainage during 1996. The TSS loading at IHW-3 accounted for 234 percent of the TSS loading detected at IHW-1. Metal loadings at IHW-3 generally accounted for 30 to 45 percent of the associated constituent loading at IHW-1. The dissolved and total copper loadings at IHW-3 represented 86 and 84 percent, respectively, of the associated copper loadings at IHW-1 (TerraMatrix/SMI, 1998).

A single surface water sample has been collected downgradient of the two identified waste rock contaminant sources in the Iron Hill catchment. Surface water monitoring site IHW-2 is located downstream of the flow paths which convey surface runoff from waste rock pile UCG-12. The loadings for the May 1996 IHW-2 sample were expressed as a percentage of the associated loadings on that day at IHW-1.

With the exception of arsenic which was reported as below the analytical detection limit and total lead, COC concentrations at IHW-2 for the May 1996 sample were generally slightly elevated when compared to the corresponding sample at IHW-1. The flow measurement at IHW-2 accounted for 26 percent of the flow measured at IHW-1. However, the data does not differentiate if the contaminant concentrations and corresponding loadings at IHW-2 can be attributed to surface runoff from OU6 or to surface runoff from either waste rock pile UCG-12 or UCG-54 (TerraMatrix/SMI, 1998).

5.2.6 FLUVIAL TAILING SITE 4 AND SOUTH AREA SUB-BASIN

The Fluvial Tailing Site 4 and South Area Sub-basin drains the hillslope which separates OU4 from Iowa Gulch and includes the reach of upper California Gulch stretching from the Yak Tunnel portal to monitoring station CG-1G. While the topography to the north of Fluvial Tailing Site 4 is generally defined by a series of tributary drainages, the portion of OU4 to the south of Fluvial Tailing Site 4 is generally not defined by tributary drainages. Eureka Gulch, which separates Printer Boy Hill and Rock Hill is the only well defined South Area tributary drainage. In addition to the identified tributary drainages, flow has been observed discharging to upper California Gulch from three springs located along the main reach of upper California Gulch (TerraMatrix/SMI, 1998). Figure 8 shows the sub-basin boundary and the locations of surface water, groundwater and sediment monitoring stations.

The downstream outlet of the OU4 watershed is defined as the Yak Tunnel portal (USDC, 1994). Surface water monitoring site CG-1 is located on upper California Gulch immediately upstream of the Yak Tunnel portal. Flow at CG-1 varies from year to year, but generally flow begins in early May, peaks around the beginning of June, and ceases in late summer.

5.2.6.1 Waste Rock Piles/Fluvial Tailing

The primary sources of contamination found within the Fluvial Tailing Site 4 and South Area are shown in Figure 8 and include Fluvial Tailing Site 4 and the following waste rock piles; UCG-33A, UCG-65, UCG-75 (Minnie Pump Shaft), UCG-82A, UCG-93, UCG-95 and UCG-98 (Lower Printer Boy).

Fluvial Tailing Site 4 extends for a distance of approximately 1.5 miles along upper California Gulch, from slightly upstream of the Yak Tunnel portal to the upstream end of the Printer Boy mine area. The total volume of fluvial tailings and fluvial tailings intermixed with alluvial sediments within Fluvial Tailing Site 4 is estimated to be 102,000 cy.

Fluvial tailings and mixed tailings/alluvium thickness at Fluvial Tailing Site 4 range from less than 1 foot to 16 feet with alluvial sands, gravels, and cobbles and organic soils underlying the fluvial tailings. Grain sizes of the fluvial tailings material typically range from fine- to coarse-grained sands. Vegetation on the fluvial tailings is limited with approximately 75 percent of the fluvial site unvegetated. The remaining 25 percent is vegetated with grasses and lodgepole pine; wetlands exist along the upper California Gulch channel within Fluvial Tailing Site 4 (TerraMatrix/SMI, 1998).

Several investigations collected fluvial tailing samples which were submitted for geochemical analysis. Geochemical samples were also collected from the five boreholes drilled in October 1991 as part of the Tailings RI (WCC, 1994a). In addition, one surface composite sample was obtained from 10 locations along the site during the RI investigation (WCC, 1994a). Resurrection collected surface soil samples at four locations within Fluvial Tailing Site 4, downstream of the AY-Minnie, in 1994 in conjunction with the OU4 terrestrial ecological risk assessment (Stoller, 1996). The locations where fluvial tailings samples were collected for geochemical analysis are shown on Figure 9. Metals concentrations measured in fluvial tailing samples collected during the Tailing RI indicate elevated concentrations. Arsenic, cadmium, copper, lead, and zinc total metals concentrations were elevated in the surficial tailings sample. Arsenic, cadmium, lead, and zinc concentrations were generally elevated in subsurface tailing samples. Foundation soils beneath the tailings material contained elevated concentrations of cadmium, lead, and zinc (WCC, 1994a). A summary of the Tailings RI (WCC, 1994a) metals analysis laboratory results are presented in Table 7.

The UCG-33A waste rock is primarily coarse-grained, highly weathered porphyry with limited vegetation present on the pile. The surface is moderately oxidized, with no visible sulfide minerals present (SMI/TerraMatrix, 1994a). The waste rock pile reconnaissance survey indicated considerable staining of the UCG-33A waste rock pile.

The UCG-65 waste rock is primarily coarse-grained, weathered porphyry with limited vegetation present on the pile. The surface is moderately oxidized, with less than one percent sulfide minerals present (SMI/TerraMatrix, 1994a). Resurrection collected a waste rock surface composite sample in October 1994. An evaluation of total metals concentrations indicate elevated concentrations of arsenic, cadmium, lead, and zinc as presented in Table 8. Analyses of leachate extracted from the waste rock composite sample using EPA Method 1312 were also performed, and are presented in Table 8.

The waste rock pile UCG-75 (Minnie Pump Shaft) is primarily coarse to fine-grained, highly weathered porphyry with limited vegetation present on the pile. The surface is highly oxidized, with greater than one percent sulfide minerals present (SMI/TerraMatrix, 1994a). Resurrection collected a waste rock surface composite sample in October 1994. An evaluation of total metals concentrations indicated elevated concentrations of arsenic, cadmium, lead, and zinc as presented in Table 8. Analyses of leachate extracted from the waste rock composite sample using EPA Method 1312 were also performed and are presented in Table 8.

The UCG-82A waste rock is primarily coarse-grained, highly weathered porphyry with limited vegetation present on the pile. The surface is high oxidized, with greater than one percent sulfide minerals present (SMI/TerraMatrix, 1994a). Staining of the waste rock and adjacent, downgradient areas was observed during several OU4 field investigations.

The UCG-93 waste rock is primarily coarse to fine-grained, high weathered porphyry with no vegetation present on the pile. The surface is highly oxidized, with less than one percent sulfide minerals present (SMI/TerraMatrix, 1994a). Staining of downgradient adjacent areas was observed during OU4 field investigations.

The UCG-95 waste rock is primarily coarse to fine-grained, weathered porphyry with limited vegetation on the pile. The surface is moderately oxidized, with less than one percent sulfide minerals present (SMI/TerraMatrix, 1994a). Staining of the waste rock and adjacent areas was not observed during OU4 field investigations.

The UCG-98 waste rock is primarily coarse to fine-grained, highly weathered porphyry with limited vegetation present on the pile. The surface is highly oxidized, with less than on percent sulfide minerals present. Staining of the waste rock and adjacent areas was minimal during OU4 field investigations. The toe of the waste rock pile intercepts the upper California Gulch channel.

An evaluation of total metals values measured in the waste rock surface samples collected during October 1994 indicate concentrations are not elevated with the exception of cadmium and lead. Total metal concentrations, EPA Method 1312 leachate analyses, and ABA test results are presented in Table 8.

5.2.6.2 Surface Water

Several surface water monitoring sites were established along Fluvial Tailing Site 4 to allow for the evaluation of changes in water quality and flow through the main reach of upper California Gulch. The monitoring stations are generally located upstream and downstream of major tributary catchment inflows and Fluvial Tailing Site 4 source areas. Figure 8 shows the locations of the monitoring sites located along the main reach of upper California Gulch. Tributary inflow surface water monitoring sites are also shown on Figure 8.

Three surface water monitoring locations (CG-1C, CG-1D and CG-1E) were established along the main reach of upper California Gulch between CG-1G, the monitoring site which serves as the outlet from the Garibaldi Sub-basin, and CG-1, the OU4 watershed outlet where OU4 discharges to OU8. These three monitoring sites and CG-1G provide control points along Fluvial Tailing Site 4 upstream and downstream of contaminant source areas and tributary inflows. The spring flow average and the 1995 and 1996 peak flow loading values for the COCs are summarized in Table 3, Surface Water COC Loadings. The COC loadings from each monitoring site were expressed as a percentage of the spring flow average and 1995 and 1996 peak flow loadings at CG-1.

The three surface water monitoring stations are located along Fluvial Tailing Site 4 and include:

- Surface water sampling location CG-1C, located downstream of the Printer Boy mining area and upstream of Whites Gulch;
- Surface water sampling location CG-1D, located downstream of Whites Gulch and upstream of Nugget Gulch and the AY-Minnie mine site; and,
- Surface water sampling location CG-1E, located downstream of the AY-Minnie mine site and approximately 1,700 feet upstream of CG-1.

Water quality samples have been collected at CG-1C seven times between October 1991 and September 1996. The spring flow measured at CG-1C accounts for approximately 69 percent of the spring flow measured at CG-1. The CG-1C spring TSS flow average loading accounts for 18 percent of the spring flow average TSS loading detected at CG-1. The spring flow average sulfate load at CG-1C represents 41 percent of the sulfate load at CG-1. Spring flow average loadings of cadmium, copper, and zinc at CG-1C represent between 19 percent to 35 percent of the corresponding metals spring flow average loadings detected at CG-1 (TerraMatrix/SMI, 1998).

Water quality samples have been collected at CG-1D five times between June 1989 and June 1996. The spring flow measured at CG-1D accounts for approximately 88 percent of the spring flow measured at CG-1. The CG-1D spring flow average TSS loading accounts for 24 percent of the spring flow TSS loading detected at CG-1. The sulfate load at CG-1D represents 64 percent of the sulfate load at CG-1. Spring flow average loadings of cadmium at CG-1D represents 31 percent and 28 percent of the corresponding dissolved and total cadmium loadings detected at CG-1. The spring flow average dissolved and total copper loadings at CG-1D accounted for 69 percent and 54 percent of the associated copper loadings at CG-1. Lead loadings at CG-1D, while less than ten percent of the lead loadings at CG-1 were three to four times greater at CG-1D than the corresponding lead loadings at CG-1C. The spring flow average zinc loadings at CG-1D represented 37 percent and 33 percent of the corresponding spring flow dissolved and total zinc loading detected at CG-1 (TerraMatrix/SMI, 1998).

Water quality samples have been collected five times at CG-1E between June 1989 and July 1996. The spring flow measured at CG-1E accounts for approximately 112 percent of the spring flow measured at CG-1. Also, the 1995 and 1996 peak flows measured at CG-1E represented 106 and 117 percent of the corresponding peak flows measured at CG-1. The flow data indicate that upper California Gulch between CG-1E and CG-1 may be a losing system. The CG-1E spring flow average TSS loading accounts for 37 percent of the spring flow average TSS loading detected at CG-1. The spring flow average sulfate load at CG-1E represents approximately 90 percent of the spring flow average sulfate load at CG-1. Spring flow loadings of cadmium at CG-1E represents 61 percent and 53 percent of the corresponding spring flow average dissolved and total cadmium loadings detected at CG-1. The average spring flow dissolved and total copper loadings at CG-1E accounted for 93 percent and 75 percent of the associated copper loadings at CG-1. Lead loadings at CG-1E represented 31 and 11 percent of the corresponding dissolved and total lead loadings at CG-1. The spring flow average zinc loadings at CG-1D represented 66 percent and 63 percent of the corresponding springs flow average dissolved and total zinc loading detected at CG-1 (TerraMatrix/SMI, 1998).

Inflows to the main reach of upper California Gulch include:

- Garibaldi Sub-basin, monitored at surface water sampling location CG-1G;
- Eureka Gulch, a South Area tributary gulch, monitored at EUG-1;
- Whites Gulch Sub-basin, monitored at surface water sampling station WG-1;
- Nugget Gulch Sub-basin, monitored at surface water sampling station NG-1; and,
- Iron Hill Sub-basin, monitored at surface water sampling site IHW-1.

Inflow water quality at the tributary catchment outlets were compared to water quality at CG-1. The COC loadings from each tributary catchment outlets was compared to the water quality at CG-1.

A comparison of pre-removal action and post-removal action water quality data indicate that the Garibaldi removal action resulted in an improvement in water quality leaving the Garibaldi Sub-basin. Whites Gulch is a major contributor to upper California Gulch surface water sulfate and copper loadings. Concentration and loading data for Nugget Gulch indicate that Nugget Gulch is a major contributor to upper California Gulch surface water contamination, especially for sulfate and metals. Average metals concentrations at NG-1 are generally two to four times greater than the concentrations measured at CG-1. While the percentage of flow at CG-1 attributed to Nugget Gulch is less than 10 percent, the average COC loadings from Nugget Gulch generally account for 17 percent to 82 percent of the loading detected at CG-1. Surface water from the Iron Hill drainage also contributes to California Gulch surface water contamination. Landscapes upgradient of historic mine activities do not appe to contribute to OU4 COC loadings (TerraMatrix/SMI, 1998).

5.2.6.3 Groundwater

Groundwater inflows to the main reach of upper California Gulch have been observed from three springs, SPR-15, -17, and -18. Field observations indicate that the springs flow from late spring through late fall. Figure 8 shows the locations of the three springs. Water quality at the three springs was compared against the water quality at CG-1.

In general, the COC concentrations detected from the three springs are less than the COC concentrations detected at CG-1. In addition, the average flow from the springs accounts for less than one percent of the average flow measured at CG-1. Groundwater inflow was not a major contributor of metals loading to the main reach of upper California Gulch (TerraMatrix/SMI, 1998).

5.2.6.4 Stream Sediment

Stream sediment geochemistry samples for laboratory analyses were collected at selected water monitoring sites in OU4 in 1989, these samples were analyzed for total metals concentrations.

The following observations were made following analysis of laboratory results from the 1989 sediment sampling episode:

- Total metals concentrations in stream sediments from tributary catchments, as measured at surface water sampling site CG-1G, WG-1, and NG-1, were generally less than total metals concentrations measured at CG-1;

- Total metals concentrations from the Garibaldi Sub-basin, as measured at CG-1G, were generally high than corresponding total metals concentrations measured at WG-1 or NG-1;

- The highest total arsenic concentrations in OU4 stream sediments were measured immediately downstream of the Garibaldi mine site; and,

- Total metals concentrations in the stream sediment samples increased in a downstream direction along the main reach of upper California Gulch.

5.3 HISTORIC AND CULTURAL RESOURCES

Historic sites considered eligible for listing on the National Register of Historic Places or contributing to the Leadville Historic District are indicated in Table 9. The sites listed in Table 9 were identified after consultation with the Colorado State Historical Preservation Officer (SHPO). The table also indicates which sites may be adversely affected by the remedial action. Avoidance and minimization of adverse effects to historic properties was considered during the remedy selection process. A Cultural Resources Plan will be developed during the remedial design.

Cultural resource inventories were performed for areas within OU4 where remedial action may occur. The inventories were conducted by P-III Associates, Inc. on behalf of Resurrection Mining Company in order to assist the company in fulfilling its responsibilities under Section 106 and Section 110(f) of the National Historic Preservation Act (NHPA). The specific mechanisms for fulfilling these responsibilities are identified in the "First Amended Programmatic Agreement among the U.S. EPA, the Advisory Council on Historic Preservation, and SHPO regarding the California Gulch Superfund Site, Leadville, Colorado". This amended Programmatic Agreement was executed in 1994.

The inventory reports contain information about sites identified as having historical significance. Site surveys were performed in these areas in accordance with the Identification and Evaluation Plan (Martorano et al.1994). Individual sites were identified that were considered either eligible for the National Register of Historic Places or contributing to the Leadville Historic District. The Lake County Historic Preservation Board, SHPO, and other interested parties were offered the opportunity to comment on all inventory reports. All comments were considered in analyzing the inventory reports and are reflected in Table 9. The table represents the final determination of historical significance for each site. However, changes to these designations may be made at a later date if additional information is discovered.

As cleanup alternatives in the Focused Feasibility Study were developed, consideration was given to avoid or minimize adverse effects to landscape features that may present historical significance. The alternatives provided for varying levels of adverse affects to the historical properties. By complying with the NHPA, potential adverse affects to historical properties were evaluated when determining which alternative would be the preferred remedy. In addition to evaluating the potential for adverse effects, criteria such as cost and the ability of the alternative to offer protection to human health and the environment were also evaluated against each alternative. Some alternatives were rejected from further consideration if the alternative did not provide for acceptable protection of human health and the environment. All the criteria used in the remedy selection process are identified in Section 8 of this ROD.

The preferred remedy was then identified in the Proposed Plan. The public was offered a 30-day period to comment on the Proposed Plan. SHPO was also offered an additional comment period. Recommendations from the public and SHPO were taken into account when making the final remedy selection as described in this ROD.

The Cultural Resources Plan will describe efforts to avoid, minimize, and mitigate for adverse effects to historic sites. If adverse effects to historical properties are unavoidable, any needed mitigation efforts will depend upon the historical significance and importance of the site affected.

Mitigation is not needed in many situations because alternatives were selected that would avoid adverse effects to historic properties. For example, instead of regrading the site, surface water diversions will be constructed around the A-Y Minnie area to minimize surface water contact with mine waste, avoiding adverse effects. However, some historic properties will be adversely affected. Efforts to mitigate adverse effects due to cleanup activities will be required. A Cultural Resources Plan will be developed during the remedial design phase of the project. SHPO will be offered the opportunity to comment on the draft plan as well as the design. A final plan will be developed in consultation with SHPO.

6.0 SUMMARY OF SITE RISKS

Baseline human health and ecological risk assessments (RAs) characterize potential site risks present at a site if no action were taken. The presence of human health or ecological risks provides the basis for remedial action; the RA indicates the media and exposure pathways to be addressed. RA information describing exposure pathways, contaminants, and potential risks at OU4 is summarized below.

6.1 HUMAN HEALTH RISKS

Human health RAs pertinent to OU4 consist of the following:

Weston. 1995a. *Baseline Human Health Risk Assessment for the California Gulch Superfund Site. Part C. Evaluation of Recreational Scenarios.*

Woodward-Clyde Consultants (WCC). 1994a. *Final - Tailings Disposal Area Remedial Investigation Report, California Gulch Site, Leadville, Colorado.*

Woodward-Clyde Consultants (WCC). 1994b. *Final - Mine Waste Pile Remedial Investigation Report, California Gulch Site, Leadville, Colorado.*

A brief summary of these RAs is presented below, including contaminant identification information, exposure assessment information, and risk characterization results. Although information presented in all three reports (Weston 1995a; WCC 1994a; and WCC 1994b) was reviewed and is summarized below, decisions presented in this ROD are based only on information presented in Weston (1995a) prepared by EPA. Conclusions presented in WCC (1994a and 1994b) did not constitute the basis for risk management decisions.

6.1.1 CONTAMINANT IDENTIFICATION

In response to concerns raised by Leadville officials and business leaders, EPA committed to performing an "expedited" risk assessment to quickly determine whether environmental contamination was of concern at commercial, industrial, or recreational areas. The results of the expedited risk assessment are presented in Weston (1995a). Weston (1995a) evaluates risks resulting from recreational exposure to contaminated surface soils (i.e., to depths of 6 inches below ground surface). Exposures to other media (e.g., waste piles and surface tailings) are considered to be minimal (Weston 1995a). This assumption is corroborated by results of WCC (1994a) and WCC (1994b) which evaluate risks to recreational users from exposure to surface tailings (0-2 inches) and waste piles (0-2 inches), respectively.

Arsenic and lead were used as indicator contaminants for risk (Weston 1995a). Selection of these chemicals was based on the results of preliminary RAs (WCC 1994b, Weston 1991) which indicated that arsenic and lead are responsible for the majority of human health risks at the Site. The Weston (1991) report evaluates risks to residents and workers, hence, it is not discussed herein other than in terms of contaminant selection in the later Weston (1995a) report. The WCC (1994a) report provides cumulative risk estimates from exposure to all contaminants.

Contaminants evaluated in the tailings RA (WCC 1994a) consisted of antimony, arsenic, beryllium, cadmium, chromium (VI), copper, lead, manganese, and zinc. The waste rock RA (WCC 1994b) evaluated health risks resulting from exposure to arsenic, cadmium, copper, lead, manganese, silver, and zinc.

Chemical concentrations in waste rock and tailings are discussed in Section 5.2, Nature and Extent of Contamination. Surface soil concentrations of lead and arsenic are discussed in the Weston (1995a) RA; the RA noted that average lead concentrations in and around Leadville are generally below 7,000 mg/kg (Weston 1995a). Average arsenic concentrations generally do not exceed 50 mg/kg in the main section of Leadville and do not exceed 1,400 mg/kg anywhere at the Site (Weston 1995a).

6.1.2 EXPOSURE ASSESSMENT

Residential, commercial, and industrial uses do not occur in OU4, nor are these uses anticipated to occur in the future at OU4. Therefore, commercial workers, industrial workers, and residents are not exposed to contaminated media in OU4. Recreation is the most likely land use scenario for OU4. Therefore, recreational visitors were selected as the receptors of concern for OU4 (WCC 1994a, WCC 1994b, Weston 1995a).

Each RA selected exposure pathways through which receptors were most likely to contact contaminated media. Both the tailings RA (WCC 1994a) and the waste rock RA (WCC 1994b) evaluated health risks to visitors and recreational users through ingestion and inhalation of contaminated media. The Weston (1995a) RA determined that, although several pathways were complete, ingestion of soil was the only significant exposure pathway. Therefore, Weston (1995a) only evaluated risks associated with ingestion of soil during recreational activities.

In both the tailings and waste rock RAs, WCC (1994a, 1994b) used the 95th percent upper confidence limit of the arithmetic mean (95% UCL) as the contaminant exposure point concentration to calculate the reasonable maximum exposure (RME). RME is defined as an exposure well above the average but within the range of those possible (EPA 1992). WCC (1994a, 1994b) used the average contaminant concentration as the exposure point concentration to calculate central tendency exposure (CTE) to contaminants of concern. CTE uses exposure assumptions that predict an average or best estimate exposure to an individual and provide the risk manager with a range of risk estimates for the site. EPA (1992) indicates that only the 95% UCL should be used as the exposure point concentration, unless that value is greater than the maximum concentration. In those instances, the maximum concentration should be used should be used as the exposure point concentration.

Risk-based action levels for lead and arsenic were developed rather than calculating risks for all areas of recreational land use in the Weston (1995a) RA.

6.1.3 RISK CHARACTERIZATION

Results of the tailings RA (WCC 1994a) indicated that risks to recreational visitors and other visitors from exposure to contaminants in surface tailings did not exceed EPA levels of concern for carcinogenic and systemic risks. Likewise, results of the waste rock RA (WCC 1994b) indicated that risks to recreational visitors and other visitors resulting from exposure to waste rock did not exceed EPA levels of concern for carcinogenic and systemic risks.

Weston (1995a) developed risk-based action levels for lead and arsenic rather than calculating risks for all areas of recreational land use. The action levels represent risk-based concentrations protective of human health and may be used to identify soils of potential concern to recreational visitors.

For lead, action levels ranged from as low as 5,000 mg/kg to 85,000 mg/kg, depending upon which input parameters were used (Weston 1995a). A lead concentration of 16,000 mg/kg was selected for comparison to soil concentrations of lead (Weston 1995a). For arsenic, action levels ranged from 1,400 to 3,200 mg/kg based on carcinogenic and systemic effects, respectively (Weston 1995a). An arsenic concentration of 1,400 mg/kg was selected for comparison to soil arsenic concentrations, based on the potential for carcinogenic health effects (Weston 1995a). Average concentrations of arsenic and lead in exposure areas where recreational use is considered likely were less than these action levels, indicating that health risk is unlikely to result from recreational exposure to lead or arsenic in surface soils (Weston 1995a).

6.2 ECOLOGICAL RISKS

Baseline RAs characterizing ecological risks at OU4 consist of:

Weston. 1995b. *Final Baseline Aquatic Ecological Risk Assessment, California Gulch NPL Site* (BARA).

Weston. 1997. *Ecological Risk Assessment for the Terrestrial Ecosystem, California Gulch NPL Site, Leadville, Colorado* (ERA).

Stoller. 1996. *Screening Level Ecological Risk Assessment for Operable Unit No. 4, California Gulch Superfund Site, Leadville, Colorado* (SLERA).

Impacts of mine waste contamination on the aquatic ecosystem at the California Gulch NPL Site are characterized in the BARA (Weston 1995b). The ERA (Weston 1997) identifies potential risks to the terrestrial ecosystem from mine wastes within the California Gulch NPL Site. The SLERA was performed to provide additional, OU4-specific, data to augment the ERA. The SLERA is equivalent to the preliminary risk calculation step recommended for ecological RAs.

Results of these ecological RAs are summarized below. Conclusions presented in the SLERA (Stoller 1996) did not constitute the basis for any risk management decisions; decisions presented in this ROD are based on information presented in the ERA (Weston 1997) and the BARA (Weston 1995b).

6.2.1 CONTAMINANT IDENTIFICATION

The BARA (Weston 1995b) identifies the impact of mine waste contamination on the aquatic ecosystem at the California Gulch Superfund Site. The media of concern evaluated in the BARA (Weston 1995b) were surface water and sediments. Contaminants evaluated in the BARA (Weston 1995b) consist of aluminum, antimony, arsenic, barium, cadmium, copper, iron, lead, manganese, nickel, selenium, and zinc.

Media evaluated in the ERA (Weston 1997) include soil, slag, waste rock, and tailings in uplands areas, and fluvial tailings and sediment in riparian areas. Only data from the top two inches of these media were evaluated in the ERA. Adverse impacts on the terrestrial ecosystem from exposure to contaminants in surface water were also evaluated. Contaminants evaluated in the ERA (Weston 1997) consist of arsenic, antimony, barium, beryllium, cadmium, chromium, copper, lead, nickel, manganese, mercury, silver, thallium, and zinc.

The SLERA evaluated terrestrial risks associated with exposure to contaminants in OU4 soils and surface water. Contaminants evaluated consist of pH, arsenic, cadmium, copper, lead, magnesium, mercury, selenium, silver, and zinc (Stoller 1996).

Contaminant concentrations in waste rock, tailings, surface water, and sediments are described in Section 5.2, Nature and Extent of Contamination.

6.2.2 EXPOSURE ASSESSMENT

The BARA (Weston 1995b) evaluated ecological receptors typical of those present or historically present at the Site, consisting of aquatic plants, benthic macroinvertebrates, and fish (primarily trout species). The potential exposure pathways for aquatic receptors were ingestion of surface water, sediments, and dietary items, and direct contact with surface water, sediments, and modeled concentrations of dissolved contaminants in sediment pore water. Only the direct contact pathways were evaluated quantitatively.

Receptors evaluated in the ERA (Weston 1997) were representative of those found at OU4: upland and riparian vegetation communities, birds, and herbivorous and predatory mammals. Contaminant intakes were estimated for these receptors based on assumptions regarding exposure, such as food ingestion rates and body weight. Exposure pathways evaluated in the ERA were as follows: direct exposure to contaminated media, ingestion of ponded water or surface runoff contaminated by primary source media, incidental ingestion of contaminated media, and indirect exposure through the food chain.

The SLERA evaluated terrestrial ecosystem exposure pathways. Exposure routes evaluated in the ERA were evaluated in the SLERA.

The BARA used the 95% UCL as the exposure point concentration for chronic exposure. If the 95% UCL was greater than the maximum contaminant concentration, the maximum was used as the chronic exposure point concentration. The maximum contaminant concentration was used to represent acute exposure (Weston 1995b).

The ERA used the 95% UCL as the exposure point concentration to evaluate risks by OU. If the maximum contaminant concentration was less than the 95% UCL, the maximum was used as the exposure point concentration. Risks were also characterized by sampling station in the ERA; maximum contaminant concentrations were used to calculate risks at individual sampling stations due to limited data quantities per station.

6.2.3 RISK CHARACTERIZATION

The BARA used EPA AWQC as well as standards developed by the State of Colorado to evaluate the toxicity of contaminants in surface water to aquatic receptors. Sediment toxicity values were derived from the toxicological literature. The BARA compared sediment and surface water toxicity criteria to contaminant exposure point concentrations to determine risk to aquatic receptors. The resulting value is termed a hazard quotient (HQ). An HQ less than one indicates there is little potential for adverse effects to occur. An HQ greater than one indicates a potential for risk but does not necessarily mean that adverse effects will occur. The sum of the HQs is the hazard index (HI). As stated previously, only direct exposure pathways were evaluated, therefore, contaminant intake was not calculated for aquatic receptors.

HQs and HIs specific to OU4 were not presented in the BARA; therefore, this summary does not provide quantitative risks associated with surface water in OU4. Results of the BARA (Weston 1995b) indicate that mine waste poses potential risk to all aquatic species. The BARA states that Girabaldi Mine, North Mike, and fluvial tailing, as well as other sources such as high metal waste rock piles, contribute to the metals entering California Gulch and, ultimately, the Arkansas River.

The ERA (Weston 1997) reviewed toxicological literature to derive acceptable contaminant intake values for birds and mammals. Resulting benchmark values, termed Toxicity Benchmark Values (TBV), were compared to calculated contaminant intakes for upland and riparian receptors.

To estimate terrestrial risks, the ERA calculated HQs for all contaminants for each receptor by dividing estimated intake by the TBV. Results of the ERA indicated that the abundance of small mammals and breeding bird species were generally similar between OU4 and reference areas. Risk to the mountain bluebird, a songbird, exceeded EPA acceptable levels for exposure to contaminants in solid surficial material (i.e., tailings, soil). Predatory birds and some mammals were also at risk at some locations. Cadmium, lead, and zinc frequently contributed to the elevated risk levels. HIs specific to terrestrial receptors in OU4 are presented below. Results of the ERA indicate that surface water ingestion may present a risk to all ecological receptors in OU4. Action levels were not developed for terrestrial receptors.

Hazard Indices for Receptors Exposed to All Solid Surficial Media in OU4							
Blue Grouse	Mountain Bluebird	American Kestrel	Red-tailed Hawk	Bald Eagle	Least Chipmunk	Mule Deer	Red Fox
12	296	8	4	5	20	1	6
Source: Weston 1997							

The SLERA used a screening level approach to evaluate whether localized disturbances or metal sources, such as waste rock, have impacted vegetation community quality and wildlife habitat. Risks were assessed using a HQ approach. The SLERA concluded that vegetation communities and wildlife habitat in non-waste areas of OU4 show signs of physical impacts from human activity but do not appear to be adversely impacted by chemical toxicity. Vegetation growth tests indicated that metal concentrations in soil may inhibit vegetation growth in test species but that low pH was the most important factor affecting vegetation. Preliminary risk estimates in the SLERA indicated negligible risk to mammalian and avian predators.

Response actions are necessary at OU4 to control the release of contaminants and acidic water into the environment. These releases currently present a risk to aquatic and terrestrial ecological receptors.

7.0 DESCRIPTION OF ALTERNATIVES

A wide range of remedial action alternatives for waste rock, fluvial tailings and non-residential soils were considered in the Screening Feasibility Study (SFS) (EPA, 1993). Some of the alternatives were eliminated during preliminary screening because they would not effectively address contamination, could not be implemented, or would have had excessive cost. Remedial action alternatives for OU4 that were retained after screening alternatives from the SFS were evaluated in the FFS. These alternatives are designed to meet the RAOs of: 1) controlling wind and water erosion of waste rock materials, and 2) controlling leaching and migration of metals from waste rock into surface water and groundwater. In general, the alternatives meet these RAOs through the use of surface water controls, engineered covers, slope stabilization, and selected removal of waste rock. All of the alternatives were evaluated using the nine criteria required by the NCP and six additional performance criteria required by the WAMP as a part of the CD. This evaluation is described in the next section.

This section provides a description of the remedial action alternatives for the waste rock source areas in OU4 and the Fluvial Tailing Site 4. In addition, the following paragraphs also summarize the alternatives for the two removal actions (Garibaldi mine site and Agwalt) as presented in the EE/CAs (TerraMatrix/SMI, 1995a and 1996b). These removal actions have been completed.

7.1 GARIBALDI MINE SITE (UCG-121)

The Garibaldi mine site (UCG-121) is located near the headwaters of California Gulch in a small tributary drainage (Garibaldi Sub-basin). The following four alternatives described below were analyzed for the Garibaldi mine site waste rock pile. The removal action has been completed.

Garibaldi Mine Site Alternative 1 - No Action
Estimated capital and operating cost: $0[1]
Implementation time: Immediate

No remediation would take place under this alternative. This is the "no action" alternative required under CERCLA and is used as a baseline against which the other alternatives are evaluated. Baseline conditions at the Garibaldi mine site indicate that the waste rock pile is susceptible to leaching of metals, acid drainage and erosion of surface material.

Garibaldi Mine Site Alternative 2 (Selected Alternative) - Diversion of Surface Water, Portal Flow and Groundwater Interception
Estimated capital and operating cost: $208,039
Implementation time: 1 year

[1]Incidental administrative costs are incurred under the No Action Alternative

This alternative consists of construction of surface water diversions, shallow alluvial groundwater interception trenches, and a portal flow collection system. Specifics of this alternative are described below:

- Approximately 1,960 feet of diversion ditches;
- Two groundwater interception trenches;
- Portal flow collection system;
- Energy dissipating channel outlet apron; and,
- Approximately 500 feet of access road improvement by regrading.

Garibaldi Mine Site Alternative 3 - Flow Diversion Regrading and Simple Cover
Estimated capital and operating cost: $324,232
Implementation time: 1 year

This alternative would consist of surface water diversion ditches, shallow alluvial groundwater interception, a portal flow collection system, regrading of the waste rock, and construction of a simple cover. Details of this alternative are described below:

- Approximately 1,960 feet of diversion ditches;
- Energy dissipating channel outlet aprons;
- Two groundwater interceptor trenches;
- Portal flow collection system;
- Regrading of the pile to maximum 3H:1V side slopes (approximately 3,100 cy);
- Construction of a 12-inch simple soil cover and revegetation; and,
- Approximately 500 feet of access road improvement by regrading.

This alternative is similar to Alternative 2, but includes regrading the pile and construction of a simple cover in addition to diversion ditches, shallow groundwater interception and a portal collection system.

Garibaldi Mine Site Alternative 4 - Removal, Transport and Consolidation
Estimated capital and operating cost: $531,190
Implementation time: 1 year

This alternative consists of removal of waste rock and consolidation at a preselected location. Specific elements of this alternative include:

- Removal of waste rock (approximately 27,900 cy);
- Amendment and revegetation of the site following removal;
- Construction of approximately 1,600 feet of haul road; and,
- Improvement of approximately 500 feet of access road as in Alternatives 2 and 3.

7.2 GARIBALDI SUB-BASIN WASTE ROCK (UCG-109A)

Waste rock pile UCG-109A (McDermith) is located along the lower reach of upper California Gulch in the Garibaldi Sub-basin. The following three alternatives have been analyzed for waste rock pile UCG-109A:

Garibaldi Sub-basin Waste Rock Alternative 1 - No Action
Estimated capital and operating cost: $0
Implementation time: Immediate

No remediation would take place under this alternative. This is the "no action" alternative required under CERCLA and is used as a baseline against which the other alternatives are evaluated. Baseline conditions at the waste rock pile UCG-109A indicate that it is susceptible to leaching of metals, acid drainage and erosion of surface material.

Garibaldi Sub-basin Waste Rock Alternative 2 (Selected Alternative) - Diversion of Surface Water and Stream Channel Reconstruction
Estimated capital and operating cost: $130,510
Implementation time: 1 year

This alternative would include construction of runon diversion ditches and reconstruction of the adjacent stream channel to decrease erosion from the waste rock pile. Specific elements of this alternative include:

- Approximately 850 feet of diversion ditches;
- Improvement of approximately 475 feet of roadway side ditch;
- Installation of one culvert;
- Energy dissipating channel outlet apron; and
- Reconstruction and stabilization of approximately 225 feet of stream channel to prevent erosion from the waste rock pile.

Garibaldi Sub-basin Waste Rock Alternative 3 - Diversion of Surface Water and Selected Removal
Estimated capital and operating cost: $138,413
Implementation time: 1 year

This alternative would include construction of runon diversion ditches and selected waste rock removal. Specific elements of this alternative include:

- Approximately 850 feet of diversion ditches;
- Improvement of approximately 475 feet of roadway side ditch;
- Installation of one culvert;
- Energy dissipating channel outlet apron;

- Selected removal of approximately 1,000 cubic yards of waste rock material and consolidation within OU4; and,
- Stabilization of removal area.

7.3 AGWALT (UCG-104)

The Agwalt waste rock pile and portal are located in the Whites Gulch Sub-basin, a tributary to Upper California Gulch. The following four alternatives described below were analyzed for Agwalt waste rock piles. The removal action has been completed.

Agwalt Alternative 1 - No Action
Estimated capital and operating cost: $0[1]
Implementation time: Immediate

No remediation would take place under this alternative. This is the "no action" alternative required under CERCLA and is used as a baseline against which the other alternatives are evaluated.

Agwalt Alternative 2 (Selected Alternative) - Diversion Ditches and Portal Diversion
Estimated capital and operating cost: $162,506
Implementation time: 1 year

This alternative would include construction of runon diversion ditches and a portal collection system to divert portal flow. Specific elements of this alternative include:

- Construction of approximately 1,000 feet of diversion ditches to prevent surface runon to the pile;
- Portal discharge collection system;
- Energy dissipating channel outlet aprons; and,
- Improvements to approximately 1,000 feet of access road (i.e., regrading, widening and blading with heavy equipment).

Agwalt Alternative 3 - Diversions, Regrading and Simple Cover

Estimated capital and operating cost: $259,524
Implementation time: 1 year

This alternative would include construction of runon diversion ditches and a portent collection system to divert portal flow, as presented for Alternative 2, but would also include regrading of the pile and placement of a simple cover. Specific elements of this alternative include:

[1]Incidental administrative costs are incurred under the No Action Alternative

- Construction of diversion ditches, a portal collection system, and an outlet apron as in Alternative 2;
- Pile regraded to 3H:1V to increase stability and promote non-erosive runoff;
- Construction of a simple cover and establish vegetation to decrease infiltration from direct precipitation; and,
- Improvements to approximately 1,000 feet of access road (ie., regrading, widening and blading with heavy equipment).

Agwalt Alternative 4 - Waste Rock Removal

Estimated capital and operating cost: $228,590
Implementation time: 1 year

This alternative would consist of complete waste rock removal with revegetation of the disturbed area. Specific details of this alternative are described below:

- Waste rock would be removed to UCG-71 in Nugget Gulch for remediation under Alternative 4, Nugget Gulch;
- Stream channel would be reconstructed (approximately 450 feet);
- Disturbed areas would be revegetated (~1 acre); and,
- Approximately 1,000 feet of access road would require improvements such as regrading and blading.

7.4 PRINTER GIRL (UCG-92A)

The Printer Girl waste rock pile is the second source area retained in Whites Gulch Sub-basin. As previously described, Whites Gulch is a tributary to upper California Gulch. The following four alternatives have been analyzed for the Printer Girl waste rock pile.

Printer Girl Alternative 1 - No Action
Estimated capital and operating cost: $0[1]
Implementation time: Immediate

No remediation would take place under this alternative. This is the "no action" alternative required under CERCLA and is used as a baseline against which the other alternatives are evaluated.

Printer Girl Alternative 2 - Stream Channel Reconstruction
Estimated capital and operating cost: $54,937
Implementation time: 1 year

[1]Incidental administrative costs are incurred under the No Action Alternative

This alternative consists of stream channel reconstruction for the main stem of Whites Gulch upstream and adjacent to the Printer Girl waste rock pile. Specific elements of this alternative include:

- Re-construction of approximately 420 feet of stream channel;
- Lining of the re-constructed channel with rip-rap; and,
- Minor grading of approximately 700 feet of access road.

Printer Girl Alternative 3 - Stream Channel Reconstruction and Regrading
Estimated capital and operating cost: $55,453
Implementation time: 1 year

Stream channel reconstruction and regrading are the main features of this alternative at the Printer Girl mine site. Specific elements of this alternative include:

- Regrading of all waste rock adjacent to the stream channel;
- Re-construction of approximately 420 feet of stream channel;
- Approximately 700 feet of access road would require minor improvement.

Printer Girl Alternative 4 (Selected Alternative) - Waste Rock Removal
Estimated capital and operating cost: $99,288
Implementation time: 1 year

For this alternative the waste rock located along the channel of Whites Gulch would be removed, the disturbed area above the access road would be regraded and channels would be constructed to minimize impacts of runon and runoff. Specific elements of this alternative include:

- Waste rock from pile UCG-92A would be removed to the UCG-71 for remediation under Alternative 4, Nugget Gulch;
- Remaining material would be regraded to increase stability and promote non-erosive runoff;
- Approximately 300 feet of lined diversion ditch would be constructed;
- Approximately 250 feet of unlined diversion ditch would be constructed and armored with riprap as necessary;
- Disturbed areas would be revegetated (~1.1 acres); and,
- Approximately 700 feet of access road would require minor blading.

7.5 NUGGET GULCH (UCG-71, -74, -76, -77, -79, -80, -85)

The Nugget Gulch source area is characterized by the waste rock piles retained from the screening process within the Nugget Gulch Sub-basin. These waste rock piles include; UCG-71 (Colorado No. 2), UCG-74 (Rubie), UCG-76, UCG-77, UCG-79 (North Moyer), UCG-80 (Moyer) and UCG-85 (North Mike). The following alternatives have been analyzed for the Nugget Gulch Sub-basin waste rock piles:

Nugget Gulch Alternative 1 - No Action
Estimated capital and operating cost: $0[1]
Implementation time: Immediate

No remediation would take place under this alternative. This is the "no action" alternative required under CERCLA and is used as a baseline against which the other alternatives are evaluated.

Nugget Gulch Alternative 2 - Diversion Ditches
Estimated capital and operating cost: $299,026
Implementation time: 1 year

This alternative would include construction of surface water diversion ditches and a groundwater interception trench. Details of this alternative are described below:

- Approximately 5,700 linear feet of diversion ditches would be constructed;
- Groundwater interception trench would be installed upgradient of North Mike waste rock;
- Three culverts would be installed, and
- Selective revegetation would be performed as required.

Nugget Gulch Alternative 3 - Diversion Ditches and Waste Rock Regrading
Estimated capital and operating cost: $369,702
Implementation time: 1 year

This alternative would include diversion ditches and regrading waste rock piles (UCG-71, -74, -76, -77 and -85) to enhance stability. Specific details of this alternative are described below:

- Diversion ditches, groundwater interception trench and culverts would be constructed, the same as Alternative 2;
- Waste rock piles UCG-71, -74, -76, -77, and -85 (approximately 14,200 cy) would be regraded; and,
- Terraces would be added and disturbed areas revegetated.

This alternative is similar to Alternative 2, but includes regrading of selected piles in addition to the diversion ditches.

Nugget Gulch Alternative 4 (Selected Alternative) - Diversion Ditches, Consolidation and Cover
Estimated capital and operating cost: $800,012
Implementation time: 1 year

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[1]Incidental administrative costs are incurred under the No Action Alternative

This alternative incorporates diversion ditches, consolidation of waste rock at UCG-71, placement of a simple cover to reduce infiltration, and revegetation of disturbed areas. Details of this alternative are described below:

- Diversion ditches and culverts as described for Alternative 3;
- Haul waste rock piles UCG-74, -76, -77, and -85 to UCG-71 for consolidation (19,250 cy);
- Regrading and placement of a simple cover over the consolidated material at UCG-71 (the surface will be revegetated or covered with rock);
- Amendment and revegetation of disturbed areas; and,
- Addition of terraces to waste rock removal/disturbed areas.

7.6 AY-MINNIE (UCG-81)

The AY-Minnie waste rock (UCG-81) is located north of County Road 2, along both sides of lower Nugget Gulch. The following four alternatives have been analyzed for the AY-Minnie waste rock pile:

AY-Minnie Alternative 1 - No Action
Estimated capital and operating cost: $0[1]
Implementation time: Immediately

No remediation would take place under this alternative. This is the "no action" alternative required under CERCLA and is used as a baseline against which the other alternatives are evaluated.

AY-Minnie Alternative 2 - Diversion Ditches
Estimated capital and operating cost: $169,081
Implementation time: 1 year

This alternative would consist of constructing diversion ditches. Details of this alternative are described below:

- Construction of 2,000 feet of unlined channel; and,
- Installation of one culvert.

AY-Minnie Alternative 3 - Diversion Ditches and Regrade
Estimated capital and operating cost: $184,131
Implementation time: 1 year

This alternative includes diversion ditches, removal of cribbing, and limited regrading of waste rock. Specific elements of this alternative include:

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[1]Incidental administrative costs are incurred under the No Action Alternative

- Diversion ditches and culvert as in Alternative 2;
- Removing cribbing along County Road 2; and
- Regrading waste rock.

AY-Minnie Alternative 4 (Selected Alternative) - Diversion Ditches and Road Relocation
Estimated capital and operating cost: $240,820
Implementation time: 2 years

This alternative consists of realigning County Road 2, constructing diversion ditches, and adding a sediment pond to capture sediment from the AY-Minnie during runoff events. Specific elements of this alternative include:

- Diversion ditches and culvert as in Alternative 2;
- Construction of a sediment retention pond; and,
- Realignment of County Road 2.

7.7 IRON HILL (UCG-12)

The Iron Hill drainage is located southeast of, and is the closest OU4 sub-basin to, the populated areas of Leadville. Waste rock pile UCG-12 (Mab) has been identified as a potential source of contamination within the Iron Hill Sub-basin. The following alternatives have been evaluated for the Iron Hill Sub-basin waste rock pile:

Iron Hill Alternative 1 - No Action
Estimated capital and operating cost: $0[1]
Implementation time: Immediate

No remediation would take place under this alternative. This is the "no action" alternative required under CERCLA and is used as a baseline against which the other alternatives are evaluated.

Iron Hill Alternative 2 - Diversion Ditches
Estimated capital and operating cost: $117,189
Implementation time: 1 year

This alternative would consist of constructing diversion ditches around the waste rock pile to reduce runon of surface water. Specific elements of this alternative include:

- Construction of 500 feet of lined diversion channel at UCG-12,
- Amendment application and revegetation of disturbed area below UCG-12 (~3.0 ac).

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[1]Incidental administrative costs are incurred under the No Action Alternative

Iron Hill Alternative 3 (Selected Alternative) - Regrading and Simple Cover
Estimated capital and operating cost: $159,776
Implementation time: 1 year

This alternative consists of regrading the waste rock pile (UCG-12) and the placement of a simple cover over the pile to eliminate ponding of surface water on the waste rock and reduce infiltration of surface water through the waste rock pile. Specific elements of this alternative include:

- Minor grading to improve surface runoff (approximately 1,000 cy at UCG-12);
- Placement of a simple cover on UCG-12 (~1,700 cy of material); and,
- Revegetation of surrounding areas (~ 3.0 ac) and revegetation of the cover surface or placement of rock on the cover surface.

Iron Hill Alternative 4 - Waste Rock Consolidation
Estimated capital and operating cost: $227,759
Implementation time: 1 year

This alternative consists of consolidating the waste rock pile (UCG-12) with waste rock pile UCG-71. The area disturbed by waste rock removal will be revegetated. Specific elements of this alternative include:

- Removal and haulage of approximately 5,500 cy of waste rock from UCG-12 to UCG-71; and,
- Amendment and revegetation of disturbed area at UCG-12.

7.8 CALIFORNIA GULCH WASTE ROCK (UCG-33A, -65, -75, -82A, -93, -95 AND -98)

The remaining waste rock piles in Upper California Gulch requiring remediation are located in the South Area Sub-basin. These waste rock piles include; UCG-33A, UCG-65, UCG-75 (Minnie Pump Shaft), UCG-82A, UCG-93, UCG-95 and UCG-98 (Lower Printer Boy). The following alternatives have been analyzed for the South Area Sub-basin (California Gulch) waste rock piles:

California Gulch Waste Rock Alternative 1 - No Action

Estimated capital and operating cost: $0[1]
Implementation time: Immediate

[1]Incidental administrative costs are incurred under the No Action Alternative

No remediation would take place under this alternative. This is the "no action" alternative required under CERCLA and is used as a baseline against which the other alternatives are evaluated.

California Gulch Waste Rock Alternative 2 (Selected Alternative) - Stream Channel Reconstruction

Estimate capital and operating cost: $548,341
Implementation time: 1 year

This alternative would prevent contact of waste rock with Upper California Gulch surface water flows. The reconstructed stream channel would be sized to provide stability for the 500-year flood event. Specific elements of this alternative include:

- Reconstruction and stabilization of approximately 2,150 feet of stream channel to prevent erosion from the waste rock piles.

California Gulch Waste Rock Alternative 3 - Selected Regrading

Estimated capital and operating cost: $67,085
Implementation time: 1 year

This alternative consists of regrading selected waste rock piles to enhance slope stability and reduce surface erosion. Specific element of this alternative include:

- Grading to improve surface runoff and erosional stability (~7,500 cy of material).

California Gulch Waste Rock Alternative 4 - Selected Waste Rock Removal

Estimated capital and operating cost: $425,731
Implementation time: 1 year

This alternative consists of the removal of selected waste rock piles and consolidation at a selected location. The area disturbed by waste rock removal will be revegetated. Specific elements of this alternative include:

- Removal and haulage of selected waste rock (~15,000 cy); and,
- Amendment and revegetation of disturbed area (3.7 acres).

7.9 FLUVIAL TAILING (SITE 4)

The Fluvial Tailing Site 4 and the South Area Sub-basin drains the hillslope which separates OU4 from Iowa Gulch. The following four alternatives have been analyzed for the Fluvial Tailing Site 4.

Fluvial Tailing Site 4 Alternative 1 - No Action

Estimated capital and operating cost: $0[1]
Implementation time: Immediate

No remediation would take place under this alternative. This is the "no action" alternative required under CERCLA and is used as a baseline against which the other alternatives are evaluated.

Fluvial Tailing Site 4 Alternative 2 - Channel Reconstruction with Revegetation

Estimated capital and operating cost: $2,393,933
Implementation time: 1 year

This alternative includes reconstruction of the stream channel and adjacent floodplain to provide stability under a 500-year flood event and revegetation of disturbed areas to increase erosional stability. Specific elements of this alternative include the following:

- Channelization of approximately 8,600 feet of upper California Gulch;
- Regrading and blending of channelization spoil material into adjacent areas;
- Regrading side slopes along the channel;
- Minor surface regrading to enhance positive runoff; and,
- Amending and revegetating approximately 16 acres (selective revegetation).

Fluvial Tailing Site 4 Alternative 3 - Channel Reconstruction with Sediment Dams and Wetlands

Estimated capital and operating cost: $2,226,929
Implementation time: 1 year

This alternative consists of reconstruction of the stream channel and adjacent floodplain to provide stability under a 500-year flood event. Sediment check dams and wetlands will be constructed to control sediment discharge. Specific elements of this alternative include:

- Channelization of approximately 8,600 feet of upper California Gulch;
- Regrading and blending of channelization spoil material into adjacent areas;

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[1]Incidental administrative costs are incurred under the No Action Alternative

- Regrading side slopes along channel to 2H:1V (13,500 cy);
- Minor surface regrading to enhance positive runoff;
- Construction of approximately eight sediment control dams; and,
- Construction of approximately 1.5 acres of wetlands.

Fluvial Tailing Site 4 Alternative 4 - Channel Reconstruction, Revegetation, Sediment Dams and Wetlands

Estimate capital and operating cost: $2,544,293
Implementation time: 1 year

This alternative is similar to Alternative 3 plus revegetation of disturbed areas is added to further reduce sediment generation and discharge. Specific elements of this alternative include:

- Channelization of approximately 8,600 feet of upper California Gulch;
- Regrading and blending of channelization spoil material into adjacent areas;
- Regrading of side slopes along channel to 2H:1V (13,500 cy);
- Minor surface regrading to enhance positive runoff;
- Amending and revegetating approximately 16 acres (selective revegetation);
- Construction of approximately eight sediment dams; and,
- Construction of approximately 1.5 acres of wetlands.

Fluvial Tailing Site 4 Alternative 5 (Selected Alternative) - Channel Reconstruction, Revegetation, Sediment Dams, Wetlands and Selected Surface Material Removal

Estimate capital and operating cost: $2,653,493
Implementation time: 1 year

This alternative combines selected surface material removal with Fluvial Tailing Site 4 Alternative 4. Specific element of this alternative include:

- Channelization of approximately 8,600 feet of upper California Gulch;
- Regrading and blending of channelization spoil material into adjacent areas;
- Minor surface regrading to enhance positive runoff;
- Amending and revegetating approximately 16 acres (selective revegetation);
- Construction of approximately eight sediment dams;
- Selected removal of one foot of surface material (depth to be determined during implementation) from the floodplain of upper California Gulch from immediately upstream of the confluence with Nugget Gulch to immediately upstream of the Minnie Pump Shaft (waste rock pile UCG-75) and replacement with one foot of imported borrow material (removal of one foot of material over the entire area has been assumed for costing purposes);
- Material removed from Fluvial Site 4 will be consolidated within OU4;

- Construction of one sediment retaining structure along the toe of waste rock pile UCG-82A; and,
- Construction of approximately 2.5 acres of wetlands.

7.10 NON-RESIDENTIAL SOILS

Due to the lack of ecological risk posed by non-residential soils in OU4, the only alternative retained is the No Action alternative.

Non-Residential Soils Alternative 1 - No Action

Estimated capital and operating cost: $0[1]
Implementation time: Immediate

[1]Incidental administrative costs are incurred under the No Action Alternative

8.0 SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

Section 300.430(e)(9) of the NCP requires that the EPA evaluates and compares the remedial cleanup alternatives based on the nine criteria listed below. The first two criteria, (1) overall protection of human health and the environment and (2) compliance with applicable or relevant and appropriate requirements (ARARs) in Appendix A, are threshold criteria that must be met for the Selected Remedy. The Selected Remedy must then represent the best balance of the remaining primary balancing and modifying criteria. In addition the cleanup alternatives were evaluated using six performance criteria specified in the WAMP (USDC, 1994) to assist in evaluating the effectiveness of each alternative.

8.1 NCP EVALUATION AND COMPARISON CRITERIA

8.1.1 THRESHOLD CRITERIA

1. Overall protection of human health and the environment addresses whether or not a remedy provides adequate protection and describes how potential risks posed through each pathway are eliminated, reduced, or controlled through treatment, engineering controls, or Institutional Controls.

2. Compliance with ARARs addresses whether or not a remedy will comply with identified federal and state environmental and siting laws and regulations.

8.1.2 PRIMARY BALANCING CRITERIA

3. Long-term effectiveness and permanence refers to the ability of a remedy to maintain reliable protection of human health and the environment over time.

4. Reduction of toxicity, mobility and volume through treatment refers to the degree that the remedy reduces toxicity, mobility, and volume of the contamination.

5. Short-term effectiveness addresses the period of time needed to complete the remedy and any adverse impact on human health and the environment that may be posed during the construction and implementation period until cleanup goals are achieved.

6. Implementability refers to the technical and administrative feasibilities of a remedy, including the availability of materials and services needed to carry out a particular option.

7. Cost evaluates the estimates capital costs, operation and maintenance (O&M) costs, and present worth costs of each alternative.

8.1.3 MODIFYING CRITERIA

8. State acceptance indicates whether the State (CDPHE), based on its review of the information, concurs with, opposes, or has no comment on the preferred alternative.

9. Community acceptance is based on whether community concerns are addressed by the Selected Remedy and whether or not the community has a preference for a remedy.

8.2 WAMP PERFORMANCE CRITERIA

Additional site-specific criteria beyond the required NCP criteria have been developed for evaluating remedial alternatives for OU4. These criteria are described in the WAMP attached as Appendix D to the Consent Decree for the California Gulch Site. The six WAMP (USDC, 1994) criteria described below have assisted in the evaluation of the effectiveness of each proposed alternative:

1. Surface Erosion Stability: Remedial alternatives for source material will ensure surface erosion stability through the development of surface configurations and implementation of erosion protection measures. The remedial design will meet the following criteria:

    a. Erosional releases of waste material are predicted by use of all or some of the following procedures: the Revised Universal Soils Loss Equation (RUSLE), wind erosion soil loss equation (Woodruff and Siddoway, 1965), and the procedures set forth in the U.S. Nuclear Regulatory Commission's *Staff Technical Position, Design of Erosion Protection Covers for Stabilization of Uranium Mill Tailings Sites* (NRC, 1990) for site-specific storm flow conditions set forth in 1.b below.

    b. Remediated surfaces located within the 500-year floodplain will be stable under 500-year, 24-hour, and 2-hour storm events. Remediated surfaces located outside the 500-year floodplain will be stable under 100-year, 24-hour, and 2-hour storm events. On source embankments or where the slope of the reconstructed source is steeper than 5:1 (Horizontal:Vertical), surface flow will be concentrated by a factor of 3 for purposes of evaluating erosion stability.

2. Slope Stability: Source remediation alternatives will ensure geotechnical stability through the development of embankments or slope contours. The remedial design will meet the following criteria:

    a. Impounding embankments will be designed with a Factor of Safety (Safety Factor) of 1.5 for static conditions and 1.0 for pseudo-static conditions.

    b. Recontoured slopes will be designed with a Safety Factor of 1.5 for static conditions and 1.0 for pseudo-static conditions.

c. Analysis of geotechnical stability will be performed using an acceptable computer model. Material and geometry input parameters will be obtained from available data.

3. Flow Capacity and Stability: Remedial alternatives utilizing retaining structures, diversion ditches, or reconstructed stream channels will ensure sufficient capacity and erosional stability of those structures. The remedial design will meet the following criteria:

a. Capacity: Diversion ditches will be sized to convey the 100-year, 24-hour, and 2-hour storm events. Reconstructed stream channels will be sized to convey flow equal to or greater than the flow capacity immediately upstream of the reconstruction.

b. Stability: Erosional release of waste material from ditches, stream channels, or retaining structures will be determined by either or both of the following models: U.S. Army Corps of Engineers Hydrologic Engineering Center HEC-1 (COE, 1991) and HEC-2 (COE, 1990) models.

1) Diversion Ditches and Reconstructed Stream Channels: Remedial surfaces located within the California Gulch 500-year floodplain will be designed to be stable under flows resulting from 500-year, 24-hour, and 2-hour storm events. Remedial construction outside the 500-year floodplain will be designed to withstand flows resulting from the 100-year, 24-hour, and 2-hour storm events. Reconstructed stream channels will be configured to the extent practicable to replicate naturally occurring channel patterns.

2) Retaining Structures: Structures such as gabions, earth dikes, or riprap will be designed to be stable under the conditions stated above under item 3.b.1 for the diversion ditch or stream channel with which the structure is associated. If riprap is to be placed in stream channels or ditches, the riprap will be sized utilizing one of the following methods:

- U.S. Army Corps of Engineers (COE, 1991);
- Safety Factor Method (Stevens and Simons, 1971);
- Stephenson Method (Stephenson, 1979);
- Abt/CSU Method (Abt, et. al., 1988).

Selection of one of these methods will be based on the site-specific flow and slope conditions encountered.

4. Surface and Groundwater Loading Reduction: Remedial alternatives will ensure reduction of mass loading of COCs (including TSS and sulfate), as defined in the Draft

Final Terrestrial Risk Assessment (see WAMP [USDC, 1994]), and change in pH, resulting from runon, runoff, and infiltration from source areas. The FFS will incorporate the following:

a. For each source of contamination evaluated in the FFS, the present mass loading of COCs (including TSS and sulfate) will be calculated for both surface and groundwater using scientifically accepted methods. Present pH measurements will be used.

b. For each source of contamination evaluated in the FFS, the net loading reduction of COCs (including TSS and sulfate) and change in pH resulting from implementation of each remedial alternative shall be calculated for surface and groundwater using scientifically accepted methods.

5. Terrestrial Ecosystem Exposure: Evaluation of remedial action alternatives with respect to reduction of risk to the terrestrial ecosystems within each OU should be based on area-wide estimates of risk to receptor populations. Exposure estimates for assessing this risk should consider factors that affect the frequency and duration of contact with contaminated media, such as: (1) the concentrations and areal extent of contamination, and (2) the effect of home range on the amount of time a given species will spend in contact with contaminated media. For each source of contamination evaluated in the FFS, the reduction of the potential exposure predicted to result from the implementation of each remedial action alternative will be compared to the present potential exposure predicted by the terrestrial ecosystem risk assessment, as follows:

a. For each source of contamination evaluated in the FFS, the present risk due to exposure as defined in the terrestrial ecosystem risk assessment will be estimated for soil, each source of contamination, and ponded surface water associated with each source of contamination.

b. For each source of contamination evaluated in the FFS, reduction of exposure and ecological risk resulting from the implementation of each remedial alternative will be estimated for soil and the media types above. The potential exposure predicted to result from implementation of each remedial alternative will be compared to the present potential baseline exposure predicted by the terrestrial ecosystem risk assessment.

6. Non-residential Soils: Non-residential soils will be addressed in the FFS. These non-residential soils are in areas zone agricultural/forest, highway/business, and industrial/mining. The non-residential areas within the OU will be evaluated in the FFS consistent with current and likely future land use.

8.3 EVALUATING THE ALTERNATIVES WITH THE NCP CRITERIA

A comparative analysis of the Garibaldi and Agwalt mine site removal action alternatives were performed in the EE/CAs (TerraMatrix/SMI, 1995a and 1996a) and subsequently summarized in their respective Action Memorandum (EPA, 1995a and 1996a). The EE/CAs found that the selected alternatives for the Garibaldi Mine site (Alternative 2 - Diversion of Surface Water, Portal Flow and Groundwater Interception) and the Agwalt Mine site (Alternative 2 - Diversion Ditches and Portal Diversion) would both achieve RAOs and comply with ARARs.

The following is a brief summary of the evaluation and comparison of the alternatives for the waste rock (Garibaldi Sub-basin, Printer Girl, Nugget Gulch, AY-Minnie, Iron Hill and California Gulch) and the Fluvial Tailing Site 4 located within OU4. Additional details evaluating the alternatives are presented in the FFS. This section evaluates each alternative with the nine NCP criteria. Tables 10 through 16 provide a comparison of the remedial alternatives and the nine NCP criteria for the waste rock and fluvial tailing. Information for this section was obtained from the FFS for Upper California Gulch (OU4) (TerraMatrix/SMI, 1998).

8.3.1 OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

The criterion is based on the level of protection of human health and the environment afforded by each alternative.

Garibaldi Sub-basin Waste Rock (UCG-109a)

Because Alternative 1 (No Action) is not protective of human health and the environment, it is not considered further in this analysis as an option for this site. Alternatives 2 and 3 would reduce the erosion of waste rock soils through the construction of diversion ditches. Alternative 3 potentially adds further protection to human health at the selected source removal locations.

Printer Girl Waste Rock

Because Alternative 1 (No Action) is not protective of human health and the environment, it is not considered further in this analysis as an option for this site. Alternatives 2 and 3 would reduce erosion and releases to surface water and groundwater through channel reconstruction and regrading. However, neither alternative would reduce the potential for leaching contaminants to surface and groundwater due to meteoric water that falls directly on the waste rock. By removing the source Alternative 4 would provide the best protection of human health and the environment and meet the RAO's defined for waste rock.

Nugget Gulch Waste Rock

Because Alternative 1 (No Action) is not protective of human health and the environment, it is not considered further in this analysis as an option for this site. Alternatives 2 and 3 would reduce the erosion of waste rock soils through regrading and the construction of diversion ditches by diverting runon away from the waste rock. Erosion and leaching due to the precipitation that falls directly onto the waste rock would not be addressed. Alternative 4 would provide protection to human health and the environment by meeting RAO's for waste rock. Alternative 4 would offer the greatest reduction in erosion, transport and airborne emissions of waste rock through the placement of a simple cover.

AY-Minnie Waste Rock

Because Alternative 1 (No Action) is not protective of human health and the environment, it is not considered further in this analysis as an option for this site. Alternatives 2, 3 and 4 would reduce the erosion of waste rock soils through the construction of diversion ditches and regrading by diverting runon away from the waste rock. Erosion and leaching due to the precipitation that falls directly onto the waste rock would not be addressed. Alternative 4 adds further protection by realigning County Road 2 to allow timber cribbing to fail naturally, while not providing an adverse effect to the historic site.

Iron Hill Waste Rock

Because Alternative 1 (No Action) is not protective of human health and the environment, it is not considered further in this analysis as an option for this site. Alternative 2 would reduce the erosion of waste rock soils through the construction of diversion ditches by diverting runon away from the waste rock. Erosion and leaching due to the infiltration of precipitation that falls directly onto the waste piles would not be addressed. Alternatives 3 and 4 would provide the best protection of human health and the environment by meeting the RAO's for waste rock through the placement of a simple cover.

California Gulch Waste Rock

Because Alternative 1 (No Action) is not protective of human health and the environment it is not considered further in this analysis as an option for this site. Alternatives 2 and 3 would reduce erosion and infiltration to surface and groundwater through channel reconstruction and selected regrading. However neither alternative would reduce the leaching of contaminants due to the precipitation that falls directly on the waste rock. Alternative 4 would provide protection of human health and the environment at the selected source removal locations by meeting the RAO's defined for waste rock.

Fluvial Tailing Site 4

Because Alternative 1 (No Action is not protective of human health and the environment, it is not considered further in this analysis as an option for this site. Alternatives 2, 3, 4 and 5 would reduce erosion and releases to surface water and groundwater associated with stream flow through channel reconstruction. Alternatives 3, 4 and 5 would further reduce the transport of soil and meet the RAOs defined for fluvial tailing by the construction of sedimentation dams and wetlands.

8.3.2 COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)

This criterion is based on compliance with the ARARs presented in Appendix A.

Garibaldi Sub-basin Waste Rock

Alternatives 2 and 3 would comply with all ARARs.

Printer Girl Waste Rock

Alternatives 2 through 4 would comply with all ARARs.

Nugget Gulch Waste Rock

Alternatives 2 through 4 would comply with all ARARs.

AY-Minnie Waste Rock

Alternatives 2 through 4 would comply with all ARARs.

Iron Hill Waste Rock

Alternatives 2 through 4 would comply with all ARARs.

California Gulch Waste rock

Alternatives 2 through 4 would comply with all ARARs.

Fluvial Tailing Site 4

Alternatives 2 through 5 would comply with all ARARs.

8.3.3 LONG-TERM EFFECTIVENESS AND PERMANENCE

Garibaldi Sub-basin Waste Rock

For Alternatives 2 and 3 the construction of diversion ditches would reduce leaching and erosion with stream flow. Effectiveness and permanence would be achieved through the use of design and construction methods that have proved to be effective at other sites. Alternative 3 would potentially provide the highest level of permanence and long term effectiveness through selected waste rock removal.

Printer Girl Waste Rock

For Alternatives 2 and 3 the effectiveness and permanence of channel reconstruction would be achieved through use of design and construction methods that have proved effective at other sites. However, through removal of the source (Alternative 4), both long-term-effectiveness and permanence would be assured.

Nugget Gulch Waste Rock

For Alternatives 2 and 3 the construction of diversion ditches and waste rock regrading would reduce leaching and erosion with stream flow. Effectiveness and permanence would be achieved through the use of design and construction methods that have proved to be effective at other sites. Alternative 4 would provide the highest level of permanence and long term effectiveness through construction of a cover.

AY-Minnie Waste Rock

For Alternatives 2, 3 and 4 the construction of diversion ditches would reduce erosion and leaching with stream flow. Effectiveness and permanence would be achieved through use of proven design and construction methods by designing the alternative to meet WAMP criteria for flow capacity and stability. Alternative 4 would provide the highest level of permanence and long term effectiveness through the realignment of County Road 2, allowing the timber cribbing to fail naturally, while not adversely affecting the historic site.

Iron Hill Waste Rock

For Alternative 2 the construction of diversion ditches would reduce erosion, leaching and transport of contaminants associated with stream flow. Alternatives 3 and 4 would provide the highest level of permanence and long term effectiveness through the construction of a cover.

California Gulch Waste Rock

For Alternative 2 the effectiveness and permanence of channel reconstruction would be achieved through use of design and construction methods that have proved effective at other sites. Selected regrading of waste piles (Alternative 3) would enhance slope stability and reduce erosion. Through removal of the source (Alternative 4) both long term effectiveness and permanence would be assured.

Fluvial Tailing Site 4

Channelization of upper California Gulch (Alternatives 2, 3, 4 and 5) would reduce erosion, infiltration, leaching and transport of contaminants. Effectiveness and permanence would be achieved for the stream channel through the use of design and construction methods that have proven to be effective at other sites. Alternatives 3 and 4 provide additional long term stabilization through construction and maintenance of sediment dams and by regrading tailing surfaces to promote positive drainage. Alternative 5 would provide a slightly higher level of permanence and long term effectiveness through revegetation and selected surface material removal.

8.3.4 REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT

This criterion is based on the treatment process used; the amount of contamination destroyed or treated; the reduction of toxicity, mobility, and volume; the irreversible nature of the treatment; the type and quantity of residuals remaining; and the statutory preference for treatment.

Garibaldi Sub-basin Waste Rock

The mobility of contaminants would be decreased by a reduction of runon to the piles through diversion ditches (Alternatives 2 and 3). A reduction in toxicity, mobility, and volume at this site would be achieved by implementation of Alternative 3 (selected removal of waste rock), however treatment is not applicable for this alternative.

Printer Girl Waste Rock

For Alternatives 2 and 3 the mobility of waste rock soils (contaminants) would be reduced by the prevention of erosion from the pile through the construction of diversion ditches. Toxicity and volume of waste rock would be unaffected by these alternatives. Treatment is not applicable for these alternatives. A reduction in toxicity, mobility, and volume at this site would be achieved through implementation of Alternative 4 (Waste Rock Removal), however treatment is not applicable for this alternative.

Nugget Gulch Waste Rock

The mobility of contaminants would be decreased by a reduction of runon to the piles through diversion ditches and regrading (Alternatives 2 and 3). Toxicity and volume of waste rock would be unaffected by these alternatives, and treatment is not included. An additional reduction in toxicity and mobility at this site would be achieved through waste pile consolidation and the construction of a simple cover (Alternative 4), however treatment is not applicable for this alternative.

AY-Minnie Waste Rock

For Alternatives 2, 3 and 4 the mobility of waste rock soils would be reduced by prevention of erosion from the pile through the construction of diversion ditches and regrading. Toxicity and volume of waste rock would be unaffected by these alternatives and treatment is not included.

Iron Hill Waste Rock

The construction of diversion ditches (Alternative 2) would reduce the mobility of waste rock soils by prevention of runon to the piles. Toxicity and volume of waste rock would be unaffected by this alternative, and treatment is not included. An additional reduction in mobility at this site would be achieved through the construction of a simple cover (Alternatives 3 and 4). Through waste pile consolidation Alternative 4 would further reduce leaching and loading from the site, however treatment is not applicable for either of these alternatives.

California Gulch Waste Rock

For Alternatives 2 and 3 the mobility of waste rock soils would be reduced by the prevention of erosion from the piles through channel reconstruction and selected grading. Toxicity and volume would be unaffected by these alternatives. These alternatives would not comply with the statutory preference for treatment. A reduction in toxicity, mobility, and volume at this site would be achieved through selected waste rock removal (Alternative 4) however, treatment is not applicable for this alternative.

Fluvial Tailing Site 4

For alternatives 2, 3 and 4 the mobility of soil would greatly be reduced by channelization, but the toxicity and volume of material would not be affected by these alternatives. Through the construction of sediment retention dams (Alternatives 3, 4 and 5) and revegetation (Alternatives 4 and 5) mobility of soil would be further reduced. A reduction in toxicity, mobility, and volume at this site would be achieved by selected surface material removal (Alternative 5), however, treatment is not applicable for any of these alternatives.

8.3.5 SHORT-TERM EFFECTIVENESS

This criterion is based on the degree of community and worker protection offered, the potential environmental impacts of the remediation, and the time until the remedial action is completed.

Garibaldi Sub-basin Waste Rock

Potential risks to the community include dust emissions and increased road traffic. Risks would be minimized through the implementation of dust abatement measures and engineering controls during construction.

Printer Girl Waste Rock

Risk to the community during the implementation of Alternatives 2, 3 and 4 may result from construction related dust emissions and increased road traffic. Short-term risks could be effectively managed using conventional construction techniques for dust abatement (site watering) and traffic control.

Nugget Gulch Waste Rock

Additional risk to the community during implementation of Alternatives 2 through 4 may result from dust emissions and increased road traffic. Short-term risk factors could be effectively managed with standard engineering controls during construction. Dust abatement (site watering) is a commonly practiced construction method.

AY-Minnie Waste Rock

Risk to the community during implementation of Alternatives 2 through 4 may result from construction related dust emissions and increased road traffic. Realignment of County Road 2 (Alternative 4) would slightly increase dust emissions and heavy equipment traffic. Engineering controls for dust abatement (construction site watering and dust control practices) would effectively reduce these short-term risks.

Iron Hill Waste Rock

For Alternatives 2, 3 and 4 engineering controls would be used to reduce the short-term risk to the community due to dust emissions and exposure of workers to contaminants. Dust generation would be mitigated using standard construction dust control practices (site watering).

California Gulch Waste Rock

Risk to the community during the implementation of Alternatives 2 through 4 may result from construction related dust emissions and increased road traffic. Risk to workers during implementation of these alternatives may result from dust inhalation, contact with contaminated materials and other industrial hazards. Contact with tailings by trained remediation workers would be minimal, because appropriate safety measures would be utilized. Short-term risks due to dust emissions could be effectively managed using engineering controls for dust abatement.

Potential impacts to the environment as a result of implementation of Alternatives 3 and 4 include construction related discharge of sediment to downstream surface water resources. This impact would be minimized, however, through the use of sediment control measures.

Fluvial Tailing Site 4

Additional risk to the community during implementation of Alternatives 2 through 5 may result from dust emissions and increased road traffic. The topography surrounding the remediation area and the prevailing wind directions in the area (predominantly from the northwest) are conducive to natural abatement of short-term risk to the community from these alternatives. Furthermore, short-term risk factors could be effectively managed with standard engineering controls during construction. Dust abatement is a commonly practiced construction method. Additional traffic would be light and limited to private roads in the immediate vicinity of Fluvial Tailing Site 4.

8.3.6 IMPLEMENTABILITY

This criterion is based on the ability to perform construction and implement administrative actions.

<u>Garibaldi Sub-basin Waste Rock</u>

The construction technologies used in Alternatives 2 and 3 are commonly used and widely accepted. Materials and personnel would be readily available for this type of work. Unusual administrative issues are not anticipated.

<u>Printer Girl Waste Rock</u>

The construction technologies used in Alternatives 2 through 4 are commonly used and widely accepted. Materials and personnel would be readily available for this type of work. Unusual administrative issues are not anticipated.

<u>Nugget Gulch Waste Rock</u>

The construction technologies used in Alternatives 2 through 4 are commonly used and widely accepted. Materials and personnel would be readily available for this type of work. Unusual administrative issues are not anticipated.

<u>AY-Minnie Waste Rock</u>

The construction technologies used in Alternatives 2 through 4 are commonly used and widely accepted. Materials and personnel would be readily available for this type of work. Unusual administrative issues are not anticipated.

<u>Iron Hill Waste Rock</u>

The construction technologies used in Alternatives 2 through 4 are commonly used and widely accepted. Materials and personnel would be readily available for this type of work. Unusual administrative issues are not anticipated.

<u>California Gulch Waste Rock</u>

The construction technologies used in Alternatives 2 through 4 are commonly used and widely accepted. Materials and personnel would be readily available for this type of work. Unusual administrative issues are not anticipated.

Fluvial Tailing Site 4

The construction technologies used in Alternatives 2 through 5 are commonly used and widely accepted. Materials and personnel would be readily available for this type of work. Unusual administrative issues are not anticipated.

8.3.7 COST

This criterion evaluates the estimated capital, O&M and present worth costs of each alternative.

Garibaldi Sub-basin Waste Rock

Present worth costs range from $130,510 (Alternative 2) to $138, 413 (Alternative 3). The present worth of post-removal site control costs for a 30-year period were calculated using a 7 percent discount rate.

Alternative 2: Surface Water Diversion, Stream Channel Reconstruction

The estimated cost for this alternative would be $130,510. Estimated cost details are summarized in Table 17.

Alternative 3: Surface Water Diversion, Selected Removal

The estimated cost for this alternative would be $138,413. Estimated cost details are summarized in Table 18.

Printer Girl Waste Rock

Present worth costs range from $54,900 (Alternative 2) to $99,300 (Alternative 4). The present worth of post-removal site control costs for a 30-year period were calculated using a 7 percent discount rate.

Alternative 2: Stream Channel Reconstruction

The estimated cost for this alternative would be $54,900. Estimated cost details are summarized in Table 19.

Alternative 3: Stream Channel Reconstruction and Regrading

The estimated cost for this alternative would be $55,400. Estimated cost details are summarized in Table 20.

Alternative 4: Waste Rock Removal

The estimated cost for this alternative would be $99,300. Estimated cost details are summarized in Table 21.

Nugget Gulch Waste Rock

Present worth costs range from $299,026 (Alternative 2) to $800,012 (Alternative 4). The present worth of post-removal site control costs for a 30-year period were calculated using a 7 percent discount rate.

Alternative 2: Diversion Ditches

The estimated cost for this alternative would be $299,026. Estimated cost details are summarized in Table 22.

Alternative 3: Diversion Ditches and Waste Rock Regrading

The estimated cost for this alternative would be $369,702. Estimated cost details are summarized in Table 23.

Alternative 4: Diversion Ditches, Consolidation, and Cover

The estimated cost for this alternative would be $800,012. Estimated Cost details are summarized in Table 24.

AY-Minnie Waste Rock

Present worth costs range from $169,081 (Alternative 2) to $240,820 (Alternative 4). The present worth of post-removal site control costs for a 30-year period were calculated using a 7 percent discount rate.

Alternative 2: Diversion Ditches

The estimated cost for this alternative would be $169,081. Estimated cost details are summarized in Table 25.

Alternative 3: Diversion Ditches and Regrading

The estimated cost for this alternative would be $184,131. Estimated cost details are summarized in Table 26.

Alternative 4: Diversion Ditches and Road Reconstruction

The estimated cost for this alternative would be $240,820. Estimated cost details are summarized in Table 27.

Iron Hill Waste Rock

Present worth costs range from $117,189 (Alternative 2) to $227,759 (Alternative 4). The present worth of post-removal site control costs for a 30-year period were calculated using a 7 percent discount rate.

Alternative 2: Diversion Ditches

The estimated cost for this alternative would be $117,189. Estimated cost details are summarized in Table 28.

Alternative 3: Regrading and Cover

The estimated cost for this alternative would be $159,776. Estimated cost details are summarized in Table 29.

Alternative 4: Waste Rock Consolidation

The estimated cost for this alternative would be $227,759. Estimated cost details are summarized in Table 30.

California Gulch Waste Rock

Present worth costs range from $67,083 (Alternative 3) to $548,341 (Alternative 2). The present worth of post-removal site control costs for a 30-year period were calculated using a 7 percent discount rate.

Alternative 2: Channel Reconstruction

The estimated cost for this alternative would be $548,341. Estimated cost details are summarized in Table 31.

Alternative 3: Selected Regrading

The estimated cost for this alternative would be $67,085. Estimated cost details are summarized in Table 32.

Alternative 4: Selected Waste Rock Removal

The estimated cost for this alternative would be $425,731. Estimated cost details are summarized in Table 33.

Fluvial Tailing Site 4

Present worth costs range from $2,226,929 (Alternative 3) to $2,653,493 (Alternative 5). The present worth of post-removal site control costs for a 30-year period were calculated using a 7 percent discount rate.

Alternative 2: Channel Reconstruction and Revegetation

The estimated cost for this alternative would be $2,393,933. Estimated cost details are summarized in Table 34.

Alternative 3: Channel Reconstruction, Sediment Dams and Wetlands

The estimated cost for this alternative would be $2,226,929. Estimated cost details are summarized in Table 35.

Alternative 4: Channel Reconstruction, Revegetation, Sediment Dams and Wetlands

The estimated cost for this alternative would be $2,544,293. Estimated cost details are summarized in Table 36.

Alternative 5: Channel Reconstruction, Revegetation, Sediment Dams, Wetlands and Selected Surface Material Removal

The cost estimate for this alternative would be $2,653,493. Estimated cost details are summarized in Table 37.

8.3.8 STATE ACCEPTANCE

The State has been consulted throughout this process and concurs with the Selected Remedies.

8.3.9 COMMUNITY ACCEPTANCE

Public comment on the RI/FS and Proposed Plan was solicited during a formal public comment period extending from January 15 through February 13, 1998. The community is assumed to be generally supportive of the selected remedial alternatives. There were no written comments received during the public comment period. Questions received during the public meeting pertained to clarification of specific issues associated with the selected remedial alternatives. There were no objections to the selected remedial alternatives and questions posed during the public meeting appeared to be satisfactorily addressed during the meeting. The Responsiveness Summary addresses all comments received during the public comment period.

8.4 EVALUATING THE ALTERNATIVES WITH THE WAMP CRITERIA

A comparative analysis of the Garibaldi and Agwalt mine sites removal action alternatives using the WAMP criteria was performed in the FFS. The Action Memorandums (EPA, 1995a and 1996a) implemented the Removal Action for the Garibaldi and Agwalt mine sites. The selected alternatives for the Garibaldi and Agwalt complied with the WAMP criteria.

What follows is a brief summary of the evaluation and comparison of the alternatives for the waste rock (Garibaldi Sub-basin, Printer Girl, Nugget Gulch, AY-Minnie, Iron Hill and California Gulch) and the Fluvial Tailing Site 4 located within OU4. Additional details evaluating the alternatives are presented in the FFS. Tables 38 through 44 provide a comparison of the ability of the remedial alternatives to achieve WAMP criteria. Information for this section was obtained from the FFS for Upper California Gulch (OU4) (TerraMatrix/SMI, 1998).

8.4.1 SURFACE EROSION STABILITY

This criterion evaluates surface erosion stability through the development of surface configurations and implementation of erosion protection.

Garibaldi Sub-basin Waste Rock

Because the "no action" alternative (Alternative 1) does not provide erosional stability it is not evaluated further in this analysis as an option for this site. For Alternatives 2 and 3 (diversion channels) will divert surface runon away from the waste rock, reducing surface erosion. Waste rock removal from the floodplain (Alternative 3) would most likely provide the highest level of erosional protection.

Printer Girl Waste Rock

Because the "no action" alternative (Alternative 1) does not provide erosional stability, it is not evaluated further in this analysis as an option for this site. For Alternative 2 the potential for surface erosion would be reduced through stream channel reconstruction due to a decrease in run onto the waste rock pile. Alternative 3 would provide a greater reduction in long-term surface erosion because the side slopes of the waste rock pile would be regraded increasing erosional stability. Alternative 4 waste rock removal would provide the highest level of erosional stability.

Nugget Gulch Waste Rock

Because the "no action" alternative (Alternative 1) does not provide erosional stability it is not evaluated further in this analysis as an option for this site. For Alternative 2 the potential for surface erosion would be reduced through the construction of diversion ditches due to a decrease in runon to the waste rock pile. The regraded pile (Alternative 3) would be designed to be stable during the 100-year storm. The consolidated and covered pile (Alternative 4) would provide the highest level of erosional stability.

AY-Minnie Waste Pile

Because the "no action" alternative (Alternative 1) does not provide erosional stability it is not evaluated further in this analysis as an option for this site. For Alternatives 2 and 4 (diversion ditches) will divert surface runon away from the waste rock, reducing surface erosion. For Alternative 3 the regraded pile would be designed to be stable during the 100-year storm.

Iron Hill Waste Rock

Because the "no action" alternative (Alternative 1) does not provide erosional stability it is not evaluated further in this analysis as an option for this site. For Alternative 2 diversion channels would reduce the potential for surface erosion due to a decrease in runon to the waste rock pile. The regraded pile (Alternative 3) would be designed to be stable during the 100-year storm. Alternative 4 (waste rock consolidation/simple cover) would provide the highest level of erosional stability.

California Gulch Waste Rock

Because the "no action" alternative (Alternative 1) does not provide erosional stability it is not evaluated further in this analysis as an option for this site. For Alternative 2 diversion channels will divert surface water runon away from the waste rock, reducing surface erosion. Selected regrading of the waste rock pile (Alternative 3) would be designed to be stable during the 500-year storm. Alternative 4, selected waste rock removal, would reduce surface erosion.

Fluvial Tailing Site 4

Because the "no action" alternative (Alternative 1) does not provide erosional stability it is not evaluated further in this analysis as an option for this site. For Alternatives 2 through 5 the surface soils would be remediated to remain stable during the 100-year storm event. The reconstruction of the stream channel of upper California Gulch would be designed to remain stable during the 500-year flood.

8.4.2 SLOPE STABILITY

This criterion evaluates geotechnical stability through the development of embankments or slope contours to meet factors of safety criteria defined by the WAMP.

Garibaldi Sub-basin Waste Rock

In order to meet WAMP criteria for slope stability (Alternatives 2 and 3) a retaining wall would be required to stabilize the oversteepened slope at the toe of the slope (Pile 109A).

Printer Girl Waste Rock

The slope stability of the waste rock pile would not be changed by implementation of Alternative 2. For Alternative 3 the slope stability of the regraded waste rock pile would be enhanced due to the flattening of the side slopes. Alternative 4 would eliminate slope stability issues by removal of the waste rock source.

Nugget Gulch Waste Rock

The slope stability of the waste rock pile would not be changed by implementation of Alternative 2. Slope stability of regraded waste rock piles (Alternative 3) would be increased by flattening the side slopes. Consolidation and cover (Alternative 4) at pile UCG-71 would provide the highest level of slope stability. Alternative 4 would provide embankment slopes regraded to 3:1 or flatter to meet WAMP criteria.

AY-Minnie Waste Rock

For Alternative 2 slope stability of the waste rock pile would not be changed. Slope stability would be improved by regrading the waste piles (Alternative 3) and flattening the side slopes. Although Alternative 4 would not improve the slope stability of the waste rock pile, realignment of County Road 2 would reduce the risk associated with the eventual failure of the timber cribbing.

Iron Hill Waste Rock

The slope stability of the waste rock pile would not be changed by implementation of Alternative 2. Slope stability of regraded waste rock (Alternative 3) and consolidated waste rock (Alternative 4) would be enhanced due to flattening of side slopes.

California Gulch Waste Rock

The slope stability of the waste rock pile would not be improved by implementation of Alternative 2. For Alternative 3 the stability of regraded waste piles would be improved by the reduction of side slopes. Alternative 4 would remove any slope stability issues at the waste rock piles removed. Existing stability problems, if any, would remain at those piles not removed.

Fluvial Tailing Site 4

Due to the fairly flat topography of the fluvial tailing within OU4, Alternatives 2 through 5 pose little risk of large scale stability problems. Any channelization work would be designed and completed such that the stability of the fluvial tailing would not be adversely affected.

8.4.3 FLOW CAPACITY AND STABILITY

This criterion evaluates the capacity and erosional stability of retained structures, diversion ditches, or reconstructed stream channels.

Garibaldi Sub-basin Waste Rock

For Alternatives 2 and 3 the diversion channels and culverts will be designed and constructed to adequately convey and be stable under the 100-year runoff event.

Printer Girl Waste Rock

For Alternatives 2 and 3 the diversion ditches would be sized to adequately convey and be stable for the 100-year flood event according to WAMP criteria. For Alternative 4 the removal area would be stabilized for the 100 year flood.

Nugget Gulch Waste Rock

For Alternatives 2 through 4 the diversion channels would be designed to adequately convey and be stable for the 100-year flood event according to WAMP criteria.

Iron Hill Waste Rock

For Alternative 2 the diversion ditches would be adequately sized to provide stability for the 100-year flood event according to WAMP criteria. The pile cover (Alternatives 3 and 4) would also be designed to remain stable during the 100-year storm as per WAMP criteria.

California Gulch Waste Rock

For Alternatives 2 and 3 stream channel reconstruction and stabilization measures will be designed to remain stable during the 500-year flood event. For Alternative 4 the removal area would be stabilized for the 500-year flood.

Fluvial Tailing Site 4

For Alternatives 2 through 5 the stream channelization and stabilization of adjacent flood plain of upper California Gulch would be designed to remain stable during and convey the 500-year flood.

8.4.4 SURFACE WATER AND GROUNDWATER LOADING REDUCTION

This criterion evaluates the extent to which an alternative would ensure the reduction of mass loading of COCs resulting from runon, runoff, and infiltration from source areas.

Garibaldi Sub-basin Waste Rock

By implementing Alternatives 2 and 3 the range of COC loading reduction to surface water would be from 78 to 83 percent for metals and sulfate and a minimal reduction of TSS.

Printer Girl Waste Rock

For Alternatives 2 through 4 the reduction in loading of COCs to groundwater was not calculated due to water balance calculations indicating that for existing conditions this site is a groundwater discharging area. By implementing Alternatives 2 and 3 the range of COC loading reduction to surface water would be from 81.5 percent to 83.3 percent for metals and sulfate and a reduction of 0.0 percent (Alternative 2) and 14.2 percent (Alternative 3) for TSS. Alternative 4 would provide the highest reduction for COC loading to surface water; 100.0 percent for metals and sulfate and a reduction of 79.3 percent for TSS.

Nugget Gulch Waste Rock

The estimated reduction in the loading of COCs to groundwater ranges from 51.4 to 68.4 percent resulting from implementation of Alternative 2. The estimated range of COC loading reduction to surface water for Alternative 2 would be from 7.9 to 78.9 percent for metals and sulfate and a reduction of 0.0 percent for TSS. By implementing Alternative 3 the reduction in loading of COCs to groundwater is estimated to range from 52.4 to 69.0 percent. For Alternative 3 the range of COC loading reduction to surface water would be from 8.0 percent to 79.4 percent for metals and sulfate and a reduction of 10.0 percent for TSS. The reduction in loading of COCs to groundwater is estimated to range from 28.5 percent to 52.1 percent resulting from implementation of Alternative 4. The range of COC loading reduction to surface water for this alternative would be from 8.8 percent to 79.9 percent for metals and sulfate and a reduction of 82.0 percent for TSS.

AY-Minnie Waste Rock

For Alternatives 2 through 4 the reduction in loading of COCs to groundwater is estimated to range from 5.7 percent to 40.0 percent resulting from implementation of these alternatives. The range of COC loading reduction to surface water for Alternatives 2 through 4 would be from 60.6 percent to 61.8 percent for metals and sulfate and a reduction of 0.0 percent for TSS. However, implementation of Alternative 4 would result in an estimated 70.0 percent loading reduction to surface water for TSS.

Iron Hill Waste Rock

Alternatives 2 and 3 would provide a similar reduction in loading of COCs to groundwater. The estimated reduction in groundwater loading ranges from 12.4 percent (Alternative 3) to 13.1 percent (Alternative 2). Alternative 4 would provide the greatest reduction in loading COCs to groundwater (21.2 to 99.1 percent). Alternatives 2 and 3 would provide a similar reduction in loading COCs to surface water. The estimated reduction in surface water loading would be 20.8 percent for metals and sulfate (Alternative 2) and -13.6 percent for metals and sulfate by implementing Alternative 3. For Alternative 2 there would be an estimated 0.0 percent reduction in surface water loading for TSS and an 85.4 percent reduction for Alternative 3. Implementation of Alternative 4 would result in an estimated increase of metals and sulfate COC loadings to surface water that would range from 79.5 to 99.4 percent, however, a reduction of 92.0 percent for TSS.

California Gulch Waste Rock

For Alternative 2 the reduction in loading COCs to groundwater is estimated to range from 12.5 to 18.5 percent. The range of COC loading reduction to surface water for Alternative 2 would be 57.1 to 60.0 percent for metals and sulfate and a 0.0 percent reduction for TSS. By implementing Alternative 3 the reduction in loading of COCs to groundwater is estimated to range from 13.0 percent to 17.0 percent. The estimated range of COC loading reduction to surface water would be from 42.9 to 46.7 percent for metals and sulfate and a 2.5 percent reduction for TSS from implementation of this alternative. Implementation of Alternative 4 would result in the estimated reduction in loading of COCs to groundwater from 15.0 to 20.0 percent. The range of COC loading reduction to surface water for Alternative 4 would be from 52.4 percent to 58.9 percent for metals and sulfate and a reduction of 42.3 percent for TSS.

Fluvial Tailing Site 4

For alternatives 2 through 5 the reduction in loading of COCs to groundwater is estimated to range from 61.0 to 80.9 percent resulting from implementation of these alternatives. The range of COC loading reduction to surface water for Alternatives 2 through 5 would be from 57.4 percent to 57.8 percent for metals and sulfate. However, the estimated loading reduction to surface water for TSS would range from 68.2 percent (Alternative 3) to 97.8 (Alternatives 4 and 5).

8.4.5 TERRESTRIAL ECOSYSTEM EXPOSURE

This criterion evaluates the ability of each alternative to reduce risk to the terrestrial ecosystem within OU4.

Garibaldi Sub-basin Waste Rock

Implementation of Alternatives 2 and 3 would reduce risk to the terrestrial ecosystem by reducing the risk for ingestion of contaminated surface water.

Printer Girl Waste Rock

Implementation of Alternatives 2 and 3 would reduce risk to the terrestrial ecosystem by reducing the risk for ingestion of contaminated surface water. However, implementation of Alternative 4 (waste rock removal) would eliminate risk due to direct exposure to waste rock at the Printer Girl site.

Nugget Gulch Waste Rock

By reducing the risk for ingestion of contaminated surface water, implementation of Alternatives 2 and 3 would reduce risk to the terrestrial ecosystem. However, through construction of a cover (Alternative 4) risk due to direct exposure of the waste rock at the Nugget Gulch site would be eliminated.

AY-Minnie Waste Rock

Implementation of Alternatives 2 through 4 would reduce risk to the terrestrial ecosystem, through decreasing the risk of ingestion of contaminated surface water.

Iron Hill Waste Rock

Implementation of Alternative 2 would reduce the risk of ingestion of contaminated surface water. However, through the construction of a cover, Alternatives 3 and 4 would reduce risk due to direct exposure of waste rock.

California Gulch Waste Rock

Implementation of Alternatives 2 and 3 would reduce risk to the terrestrial ecosystem by reducing the risk for ingestion of contaminated surface water. Alternative 4 (waste rock removal) would eliminate any risk due to direct exposure to waste rock.

Fluvial Tailing Site 4

For Alternatives 2 through 5, erosion control, regrading and revegetation would significantly reduce exposure pathways due to erosion and ponded water and reduce exposure due to leaching of metals, therefore the potential risk to the terrestrial ecosystem would be reduced. These alternatives would have a limited effect on direct exposure pathways due to contact with the soil.

8.4.6 NON-RESIDENTIAL SOILS

This criterion is not applicable. The sources of contamination at OU4 are waste rock piles and fluvial tailing material, not non-residential soils. Non-residential soils are not a source of contamination within OU4.

9.0 SELECTED REMEDY

An Action Memorandum (EPA, 1995a) was issued on August 4, 1995 by the EPA that selected the following as the Removal Action for the Garibaldi Mine area:

Alternative 2: Diversion Channels, Portal Collection and Groundwater Interception. This alternative consists of constructing a portal collection system for the collapsed Garibaldi Mine portal, approximately 1,960 linear feet of concrete-line channel, and two groundwater interception trenches constructed to intercept and divert surface and groundwater flow around the Garibaldi waste rock pile.

The proposal for the Removal Action for the Garibaldi Mine was released for public comment in 1995 and implementation of the Removal Action was initiated during the Fall of 1995.

An Action Memorandum (EPA, 1996a) was issued on July 19, 1996 by the EPA that selected the following as the removal action for the Agwalt Mine site:

Alternative 2: Diversion Ditches and Portal Diversion. This alternative consists of constructing approximately 1,000 linear feet of concrete-lined channels to prevent surface water runon to the piles and a portal discharge collection system for the collapsed Agwalt Mine portal.

The proposal for the Removal Action for the Agwalt Mine was released for public comment in 1996 and implementation was initiated in the fall of 1996.

Based upon consideration of CERCLA requirements, the detailed analysis of alternatives, and public comments, EPA has determined that the following alternatives are the appropriate remedies for the waste rock (Garibaldi Sub-basin, Printer Girl, Nugget Gulch, AY-Minnie, Iron Hill and California Gulch) and the Fluvial Tailing Site 4 located within OU4:

Garibaldi Sub-basin Waste Rock:	Alternative 2 - Diversion of Surface Water and Stream Channel Reconstruction
Printer Girl Waste Rock:	Alternative 4 - Waste Rock Removal
Nugget Gulch Waste Rock:	Alternative 4 - Diversion Ditches, Consolidation and Cover.
AY-Minnie Waste Rock:	Alternative 4 - Diversion Ditches and Road Relocation
Iron Hill Waste Rock:	Alternative 3 - Regrade and Cover
California Gulch Waste Rock:	Alternative 2 - Stream Channel Reconstruction
Fluvial Tailing Site 4:	Alternative 5 - Channel Reconstruction, Revegetation, Sediment Dams, Wetlands and Selected Surface Material Removal.

These Selected Remedies will reduce risk to human health and the environment and meet RAOs described earlier through the following:

- Provides the highest level of permanence and long-term effectiveness with the greatest reduction of infiltration into the waste rock.

- Meets or exceeds all of the stability requirements predicated in the WAMP and reduces the present risk to the terrestrial ecosystem.

- Eliminates airborne transport of waste rock particles and minimizes both the erosion of tailings materials and deposition into local water courses and the leaching and migration of metals into groundwater and surface water.

- Controls the risks defined by the risk assessment including ingestion of surface tailings by terrestrial wildlife, contact of plants and soil fauna with surface tailings, and ingestion of surface water by wildlife.

These Selected Remedies best meet the entire range of selection criteria and achieve, in EPA's determination, the appropriate balance considering site-specific conditions and criteria identified in CERCLA, the NCP and the WAMP, as provided in Section 10.0, Statutory Determinations.

9.1 REMEDIES FOR THE WASTE ROCK AND FLUVIAL TAILING WITHIN OU4

The following sections will provide a detailed description of the Selected Remedies for the waste rock and Fluvial Tailing Site 4 within Operable Unit 4.

9.1.1 REMEDY FOR THE GARIBALDI SUB-BASIN WASTE ROCK

The selected remedy would consist of constructing approximately 850 feet diversion channels to reduce surface water runon to the UCG-109A waste rock pile. The improvement of approximately 475 feet of roadway side ditch and the installation of one culvert would reduce leaching and erosional releases associated with surface flow. Approximately 225 feet of stream channel will be reconstructed around UCG-109A (Figure 10) to prevent erosion.

9.1.2 REMEDY FOR THE PRINTER GIRL WASTE ROCK

The Selected Remedy would consist of excavating and consolidating the lowermost portion of the Printer Girl waste rock (UCG-92A) onto waste rock pile UCG-71 (Colorado No. 2). The remaining waste rock material will be regraded and the remaining disturbed area (~1.1 acres) revegetated to increase stability and promote non-erosive runoff. Two diversion ditches would be constructed and armored with riprap to control surface water runon to the regraded disturbed areas (Figure 11).

9.1.3 REMEDY FOR THE NUGGET GULCH WASTE ROCK

The Selected Remedy would consist of excavating and consolidating waste rock piles UCG-74 (Rubie), UCG-76 (Adirondack), UCG-77 (Colorado No. 2 east), and UCG-85 (North Mike) onto waste rock pile UCG-71 (Colorado No. 2). UCG-71 would be regraded and a simple cover (18 inches of soil, the borrow source will be determined during design) placed over the consolidated material. The cover surface on UCG-71 will be revegetated or covered with rock material. Disturbed areas which were cleared of waste rock would be terraced, soils amended and revegetated. Diversion ditches would be constructed to control surface water runon (Figure 12).

9.1.4 REMEDY FOR THE AY-MINNIE WASTE ROCK

The Selected Remedy would consist of constructing diversion ditches to reduce surface water runon to the AY-Minnie waste rock pile and reduce leaching and erosional releases associated with surface flow. Lake County Road 2 will be realigned to provide area for construction of a sediment pond and further add protection from stability failures of the timber cribbing without destroying the mining heritage and cultural resources of this mining area (Figure 13).

9.1.5 REMEDY FOR THE IRON HILL WASTE ROCK

The Selected Remedy would consist of regrading waste rock piles UCG-12 (Mab/Castle View). A simple cover (18 inches of soil, the borrow source will be determined during design) will be placed on UCG-12 along with revegetation of the surrounding disturbed areas (Figure 14) and revegetation or placement of rock on the cover surface. Implementation of this alternative will minimize infiltration at UCG-12, reduce leaching, increase stability of the regraded waste rock and promote non-erosive runoff from the regraded waste rock pile surfaces.

9.1.6 REMEDY FOR THE CALIFORNIA GULCH WASTE ROCK

The Selected Remedy would consist of reconstructing and stabilizing approximately 2,150 feet of the Upper California Gulch stream channel (Figure 15). Implementation of this alternative would stabilize the stream channel for the 500-year flood event and reduce contact of waste rock with surface flows in upper California Gulch, minimizing leaching and erosional releases associated with surface flow. Specific details of channel reconstruction will be determined during design. This alternative has also been incorporated into the selected remedy for Fluvial Site 4.

9.1.7 REMEDY FOR FLUVIAL TAILING SITE 4

The Selected Remedy would consist of reconstructing the Upper California Gulch stream channel and regrading the channel spoil material and selected fluvial tailing areas. Eight sediment dams and approximately 2.5 acres of wetlands would be constructed along the channel (Figure 16). Implementation of this alternative would stabilize the stream channel and adjacent floodplain to convey the 500-year flood event and reduce contact of surface flows with fluvial tailing in Fluvial Tailing Site 4, promote non-erosive flow, and minimize leaching and erosional releases from the site. Specific details of channel reconstruction will be determined during design.

9.2 CONTINGENCY MEASURES AND LONG TERM MONITORING

Specific water quality goals for surface streams and heavy metals contamination have not been established at this time. EPA has agreed to establish specific surface and groundwater requirements at a later date when EPA, and CDPHE have determined the allowable water quality standards pursuant to OU12 (Site Wide Water Quality).

Pre-remedial data will be compared to water quality and sediment data collected after the Selected Remedy has been implemented. An evaluation of the degree of surface water-quality improvement will be made by EPA and CDPHE at that time. If the improvement in Upper California Gulch surface water quality is not considered sufficient to meet OU12 water quality standards, additional response actions may be required.

The Selected Remedies will be designed to minimize active maintenance requirements. Post-closure maintenance of the covers and diversion channels will be used to ensure that the integrity and permanence of the covers and diversion channels are maintained. Provisions for surveillance and repair/cleanout will be established for sediment ponds and other features requiring routine maintenance.

Because the Upper California Gulch waste rock and fluvial tailing will remain on site, the Selected Remedies will require a five-year review under Section 121(c) of CERCLA and Section 300.430(f)(4)(ii) of the NCP. The five-year review includes a review of the groundwater and surface water monitoring data, inspection of the integrity of the covers, diversion channels and reconstructed channels, and an evaluation as to how well the Selected Remedies are achieving the RAOs and ARARs that they were designed to meet.

10.0 STATUTORY DETERMINATIONS

Under CERCLA Section 121, EPA must select a remedy that is protective of human health and the environment; that complies with ARARs; is cost effective; and utilizes permanent solutions, and alternative treatment technologies, or resource recovery technologies to the maximum extent practicable. In addition, CERCLA includes a preference for remedies that include treatment which permanently and significantly reduces the volume, toxicity, or mobility of hazardous wastes as a principal element. The Selected Remedies do not satisfy the statutory preference for treatment as a principal element of the remedy. In narrowing the focus of the FFS, treatment of the Upper California Gulch waste rock and fluvial tailing material was determined to be impracticable. The following sections discuss how the Selected Remedies meets statutory requirements. A similar determination was made in selecting the Removal Actions for the Garibaldi Mine area and the Agwalt Mine site as presented in their respective Action Memorandums (EPA, 1995a and EPA, 1996a).

10.1 PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

The following section summarizes the estimated effectiveness of the Selected Remedies for the waste rock and Fluvial Site 4 located within OU4 for the protection of human health and the environment.

Garibaldi Sub-basin Waste Rock: Alternative 2 - Diversion of Surface Water and Stream Channel Reconstruction

The Selected Remedy protects human health and the environment through reducing direct contact with contaminants at the site. The Selected Remedy uses diversion channels and channel reconstruction to control contaminant movement and effectively reduce exposure to contaminants. The range of COC loading reduction to surface water would be from 78 to 83 percent for metals and sulfate and a minimal reduction of TSS. Potential risk to the terrestrial ecosystem due to ingestion or exposure to waste rock would be reduced through stream channel reconstruction by the Selected Remedy (TerraMatrix/SMI, 1998).

Printer Girl Waste Rock: Alternative 4 - Waste Rock Removal

The Selected Remedy protects human health and the environment through the prevention of direct contact of contaminants at the site. The Selected Remedy uses source removal to effectively reduce direct contact with contaminants at the site. The reduction in total loading of COCs to groundwater was not calculated due to water balance conditions indicating that this site is a groundwater discharging area. Loading of COCs to surface water runoff from the waste rock was estimated to be reduced 100.0 percent for metals and sulfate and a reduction of 79.3 percent for TSS. Potential risk to the terrestrial ecosystem due to ingestion or exposure to waste rock would be eliminated by the Selected Remedy since the waste rock would be removed (TerraMatrix/SMI, 1998).

Nugget Gulch Waste Rock: Alternative 4 - Diversion Ditches, Consolidation and Cover

The Selected Remedy protects human health and the environment through the prevention of direct contact with contaminants at the site. The Selected Remedy uses diversion ditches and an engineered cover to effectively control contaminant movement and reduce direct contact, ingestion, and inhalation of all contaminants. The reduction in loading of COCs to groundwater is estimated to range from 28.5 to 52.1 percent resulting from implementation of the Selected Remedy. The range of COC loading reduction to surface water runoff from the waste rock would be from 8.8 to 79.9 percent for metals and sulfate and a reduction of 82.0 percent for TSS. Potential risk to the terrestrial ecosystem due to ingestion or exposure to waste rock would be eliminated by the Selected Remedy since the waste rock would be covered (TerraMatrix/SMI, 1998).

AY-Minnie Waste Rock: Alternative 4 - Diversion Ditches and Road Relocation

The Selected Remedy protects human health and the environment through reducing direct contact with contaminants at the site. The Selected Remedy uses diversion ditches to control contaminant movement from the source area and effectively reduce exposure to contaminants. The reduction in loading of COCs to groundwater is estimated to range from 5.7 to 40.0 percent resulting from implementation of the Selected Remedy. Loading of COCs to surface water runoff from the waste rock was estimated to range from 60.6 to 61.8 percent for metals and sulfate and a reduction of 70.0 percent for TSS. Potential risk to the terrestrial ecosystem due to ingestion or exposure to waste rock would be reduced through constructing diversion ditches by the Selected Remedy (TerraMatrix/SMI, 1998).

Iron Hill Waste Rock: Alternative 3 - Regrade and Cover

The Selected Remedy protects human health and the environment through the prevention of direct contact with contaminants at the site. The Selected Remedy uses regrading and an engineered cover to effectively reduce direct contact, ingestion and inhalation of contaminants. The reduction in total loading of COCs to groundwater is estimated to be 12.4 percent resulting from implementation of the Selected Remedy. The range of COC loading reduction to surface water is estimated to be 13.6 percent for metals and sulfate and a reduction of 85.4 percent for TSS. Potential risk to the terrestrial ecosystem due to ingestion or exposure to waste rock would be eliminated by the Selected Remedy since the waste rock would be covered (TerraMatrix/SMI, 1998).

California Gulch Waste Rock: Alternative 2 - Stream Channel Reconstruction

The Selected Remedy protects human health and the environment through reducing direct contact with contaminants at the site. The Selected Remedy uses channel reconstruction to control contaminant movement and effectively reduce exposure to contaminants. The reduction in loading of COCs to groundwater is estimated to range from 12.5 to 18.5 percent resulting from implementation of the Selected Remedy. The range of COC loading reduction to surface water would be from 57.1 to 60.0 percent for metals and sulfate and a reduction of 0.0 percent for TSS. Potential risk to the terrestrial ecosystem due to ingestion or exposure to waste rock would be reduced through stream channel reconstruction by the Selected Remedy (TerraMatrix/SMI, 1998).

Fluvial Tailing Site 4: Alternative 5 - Channel Reconstruction, Revegetation, Sediment Dams, Wetlands and Selected Surface Material Removal

The Selected Remedy protects human health and the environment through reducing direct contact with contaminants at the site. The Selected Remedy uses channel reconstruction revegetation and sediment dams to control contaminant migration and reduce exposure to contaminants. The reduction in loading of COCs to groundwater is estimated to range from 61.0 to 80.9 percent resulting from implementation of this alternative. The range of COC loading reduction to surface water would be from 57.4 to 57.8 percent for metals and sulfate and a reduction of 97.8 percent for TSS. Potential risk to the terrestrial ecosystem due to ingestion or exposure would be reduced by decreasing exposure pathways due to erosion and ponded water by the Selected Remedy (TerraMatrix/SMI, 1998).

10.2 COMPLIANCE WITH ARARs

The selected Remedy for OU-4 will comply with all ARARs identified in Appendix A to this ROD. No waiver of ARARs is expected to be necessary. Remediation of Site-wide groundwater and surface water has been deferred to OU-12, Site-wide Ground Water and Surface Water Quality (USCD, 1994). Remedial work conducted pursuant to OU-12 will be addressed under a separate ROD. If a ROD addressing Site-wide surface and ground waters selects additional source remediation, the responsible settling defendant in whose work area such source remediation is required shall be responsible for such additional source remediation (USCD, 1994).

10.3 COST EFFECTIVENESS

EPA has determined that all of the Selected Remedies for waste rock and Fluvial Tailing Site 4 within OU4 are cost effective in mitigating the principal risks posed by contaminated tailings. Section 300.430(f)(ii)(D) of the NCP requires evaluation of cost effectiveness. Overall effectiveness is determined by the following three balancing criteria: long-term effectiveness and permanence; reduction of toxicity, mobility, and volume through treatment; and short-term effectiveness. Overall effectiveness is then compared to cost to ensure that the remedy is cost effective. The Selected Remedies meet the criteria and provide for overall effectiveness in proportion to their cost. Specific cost estimates for all of the Selected Remedies include:

Garibaldi Sub-basin Waste Rock Alternative 2:	$	130,510
Printer Girl Waste Rock Alternative 4:	$	99,288
Nugget Gulch Waste Rock Alternative 4:	$	800,012
AY-Minnie Waste Rock Alternative 4:	$	240,820
Iron Hill Waste Rock Alternative 3:	$	159,776
California Gulch Waste Rock Alternative 2:	$	548,341
Fluvial Tailing Site 4 Alternative 5:	$	2,653,493

The estimated combined cost for all of the Selected Remedies for waste rock and fluvial tailing material within OU4 is $4.08 million. The cost estimated includes periodic inspection.

To the extent that the estimated cost of the Selected Remedies exceed the cost for other alternatives, the difference in cost is reasonable when related to the greater overall effectiveness achieved by the Selected Remedies.

10.4 UTILIZATION OF PERMANENT SOLUTIONS AND ALTERNATIVE TREATMENT TECHNOLOGIES (OR RESOURCE RECOVERY TECHNOLOGIES) TO THE MAXIMUM EXTENT POSSIBLE

EPA has determined that the Selected Remedies represent the maximum extent to which permanent solutions can be utilized in a cost effective manner for the waste rock and fluvial tailing material within OU4.

Of those alternatives that are protective of human health and the environment and comply with ARARs, EPA has determined that the Selected Remedies for the waste rock and fluvial tailing material within OU4 provide the best balance of trade-offs in terms of long-term effectiveness and permanence, treatment, implementability, cost, and state and community acceptance.

While the Selected Remedies for OU4 does not utilize the most permanent solution treatment or complete removal, the use of engineered covers, diversion ditches, channel reconstruction, revegetation and sediment dams provide a long-term effective and permanent barrier to contaminated waste materials, thus reducing risk to an equivalent extent. Because the waste rock and fluvial tailing materials will remain on site with no treatment, the Selected Remedies will require a five-year review under Section 121(c) of CERCLA and Section 300.430(f)(4)(ii) of the NCP.

10.5 PREFERENCE FOR TREATMENT AS A PRINCIPAL ELEMENT

Various treatment options for the waste rock and fluvial tailing material were considered early in the FS process; however, due to the nature and size of the waste rock and fluvial tailing, these options were determined to be either technically impracticable and/or not cost-effective.

11.0 DOCUMENTATION OF SIGNIFICANT CHANGES

The Selected Remedies for the waste rock and Fluvial Tailing Site 4 is the third response action to be taken at OU4 of the California Gulch Superfund Site. The first action implemented the Action Memorandum (EPA, 1995a) for the waste rock contained within the Garibaldi mine site and was initiated during the fall of 1995. The second action implemented the Action Memorandum (EPA, 1996a) for the waste rock contained within the Agwalt mine site and was completed in the Fall of 1996. These removal actions are consistent with the Selected Remedies for the waste rock and Fluvial Tailing Site 4 within OU4.

The Proposed Plan for Upper California Gulch, OU4 was released for public comment on January 15, 1998. The Proposed Plan identified the following alternatives as the preferred alternatives for the waste rock and fluvial tailing material within OU4:

- Garibaldi Sub-basin Waste Rock: Alternative 2 - Diversion of Surface Water and Stream Channel Reconstruction
- Printer Girl Waste Rock: Alternative 4 - Waste Rock Removal
- Nugget Gulch Waste Rock: Alternative 4 - Diversion Ditches, Consolidation and Cover
- AY-Minnie Waste Rock: Alternative 4 - Diversion Ditches and Road Relocation
- Iron Hill Waste Rock: Alternative 3 - Regrade and Cover
- California Gulch Waste Rock: Alternative 2 - Stream Channel Reconstruction
- Fluvial Tailing Site 4: Alternative 5 - Channel Reconstruction, Revegetation, Sediment Dams, Wetlands and Selected Surface Material Removal

Comments received during the public comment period are addressed in the Responsiveness Summary. The EPA determined that no significant changes to the remedy, as it was originally identified in the Proposed Plan, are necessary.

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Weston. 1997. *Ecological Risk Assessment for the Terrestrial Ecosystem, California Gulch NPL Site, Leadville, Colorado* (ERA).

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Woodward-Clyde Consultants (WCC). 1994b. *Final - Mine Waste Pile Remedial Investigation Report, California Gulch Site, Leadville, Colorado.*

FIGURES

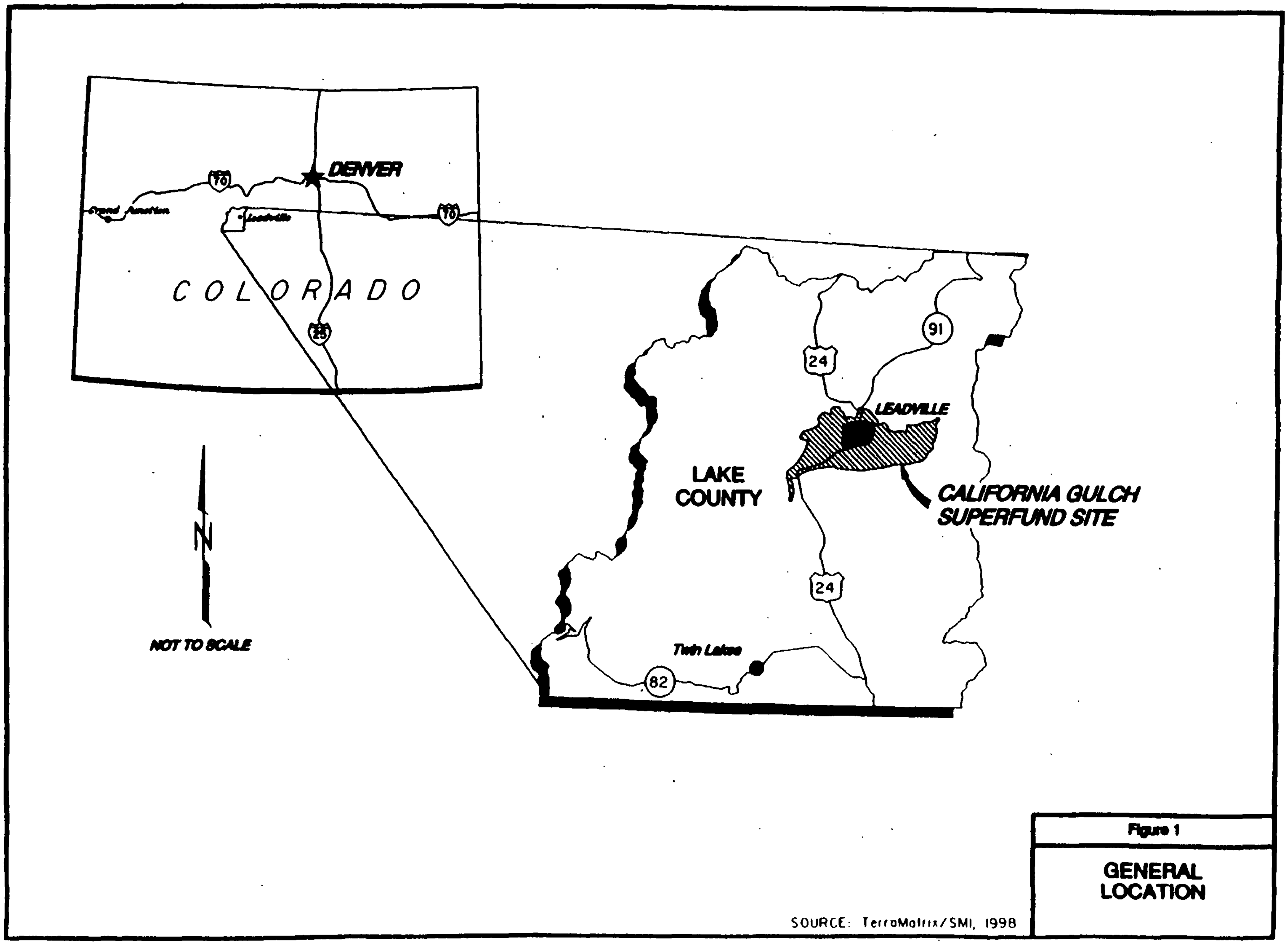
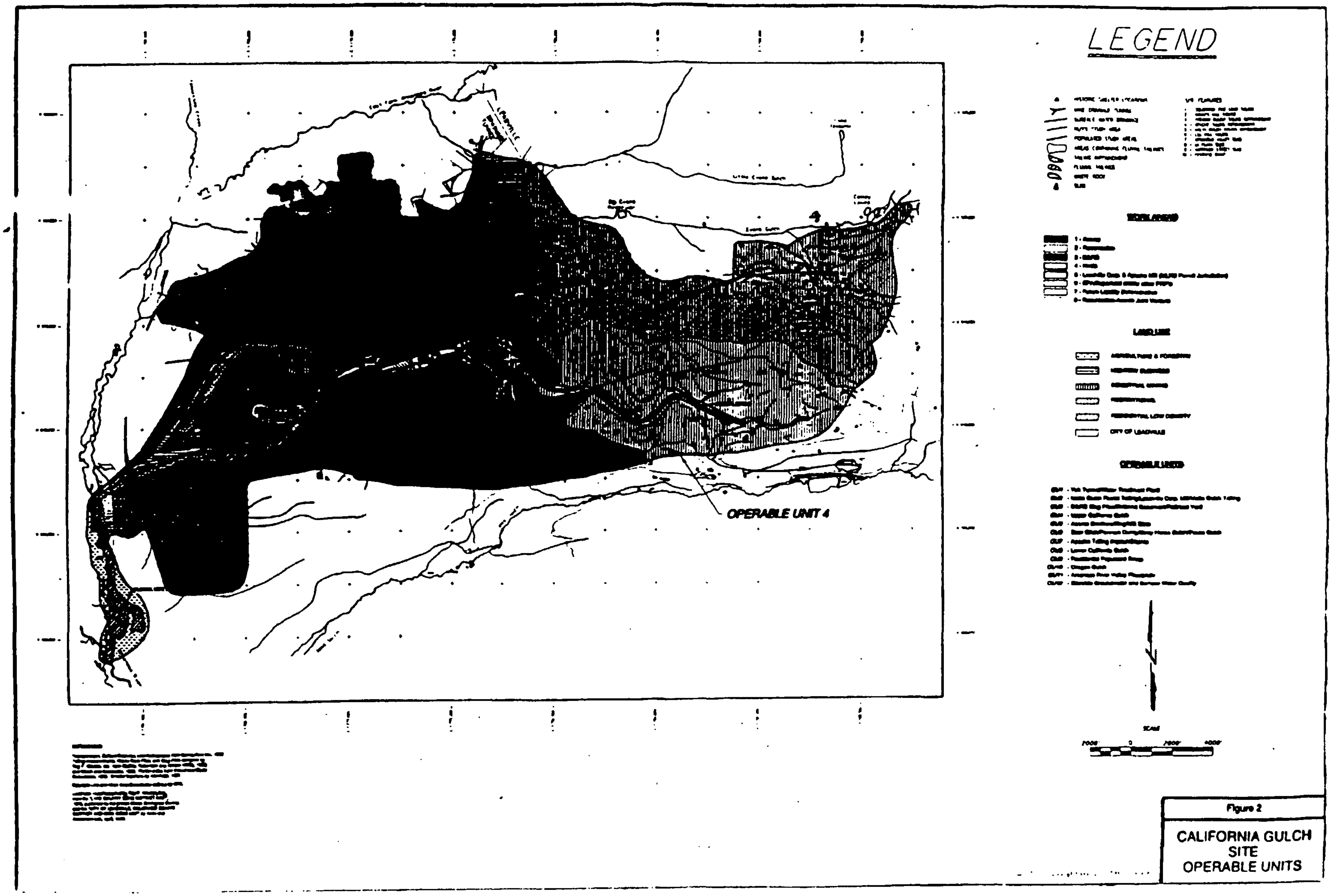


Figure 1

GENERAL LOCATION


LEGEND
OPERABLE UNIT 4
Figure 2
CALIFORNIA GULCH
SITE
OPERABLE UNITS

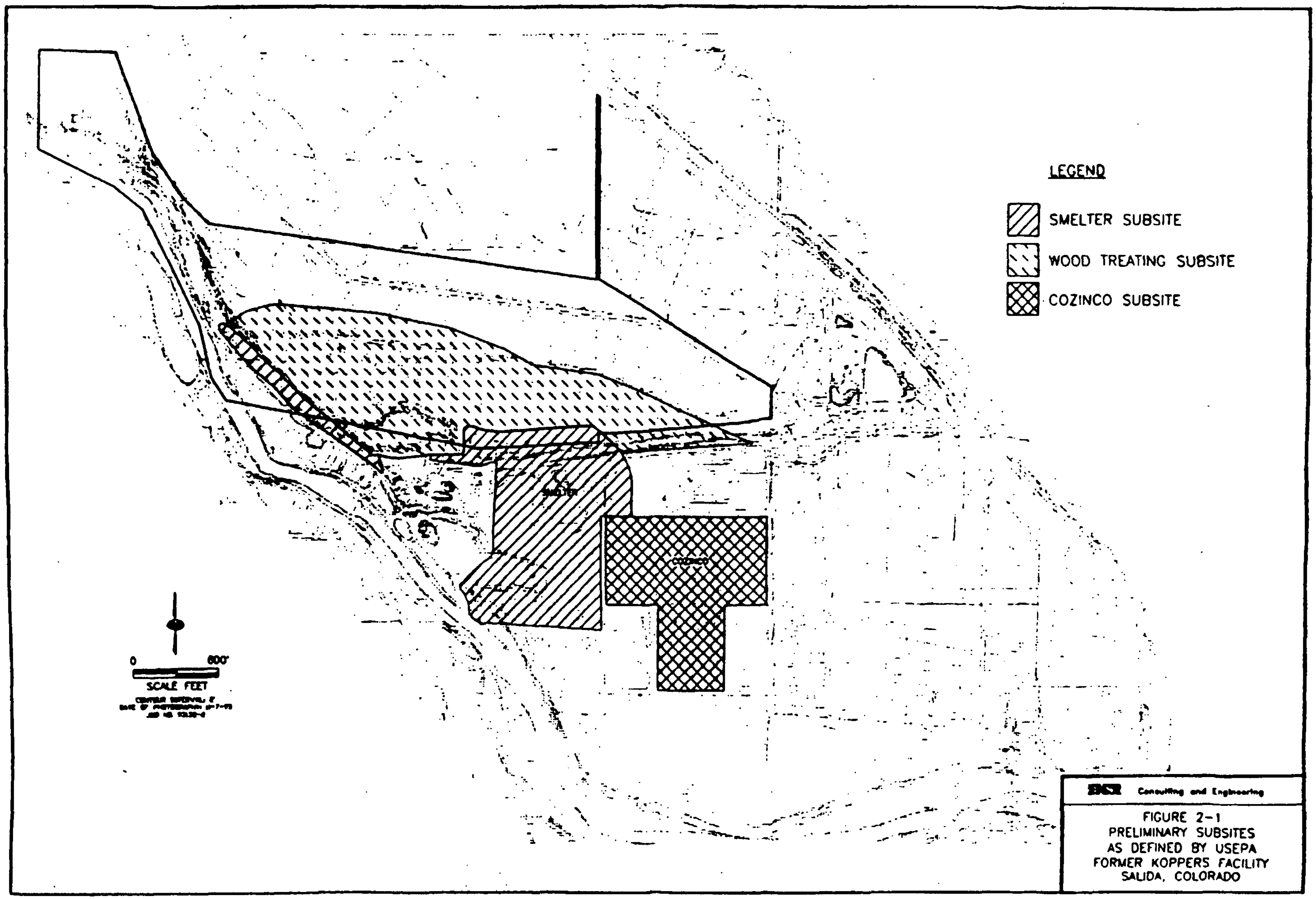


FIGURE 2-1
PRELIMINARY SUBSITES
AS DEFINED BY USEPA
FORMER KOPPERS FACILITY
SALIDA, COLORADO

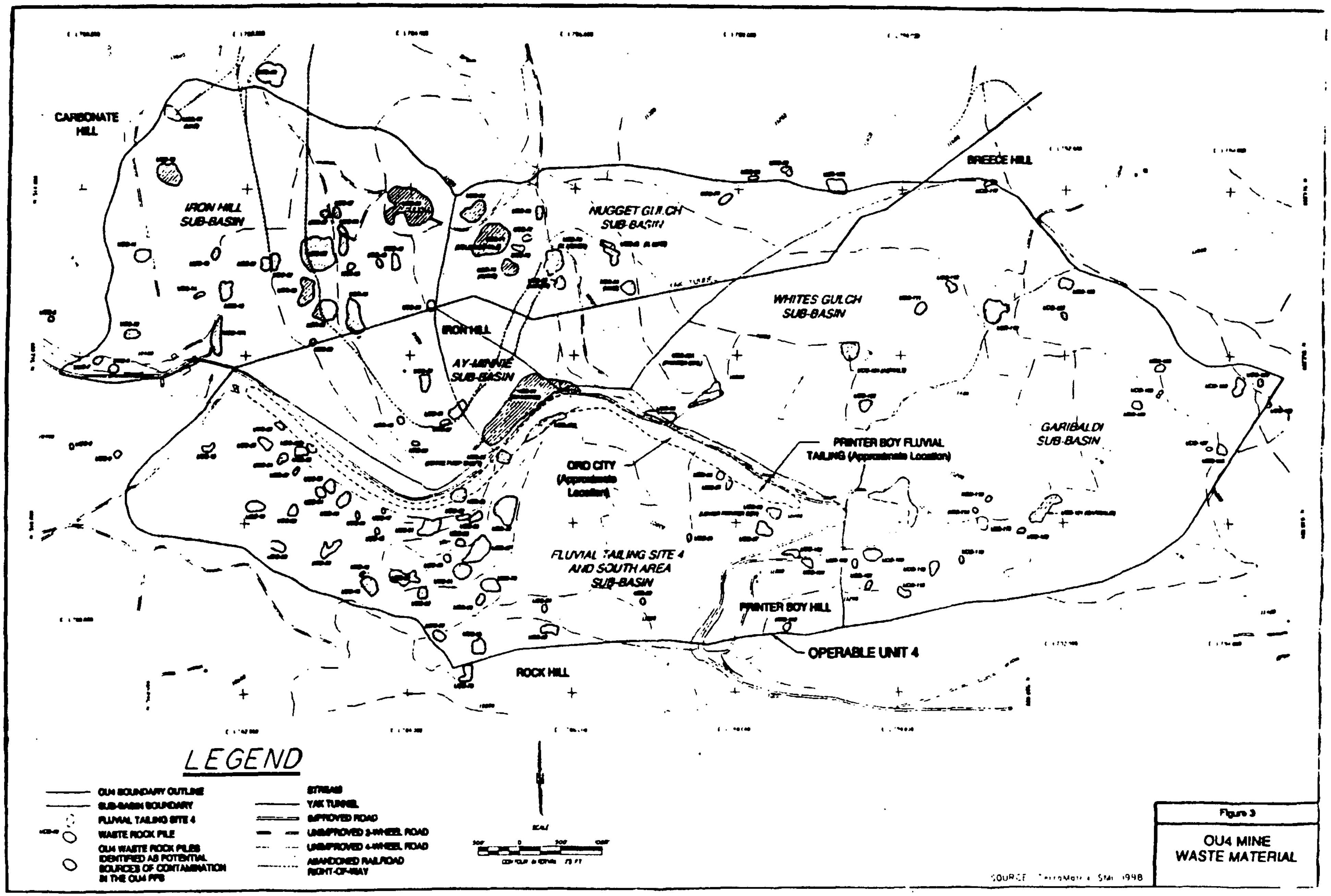
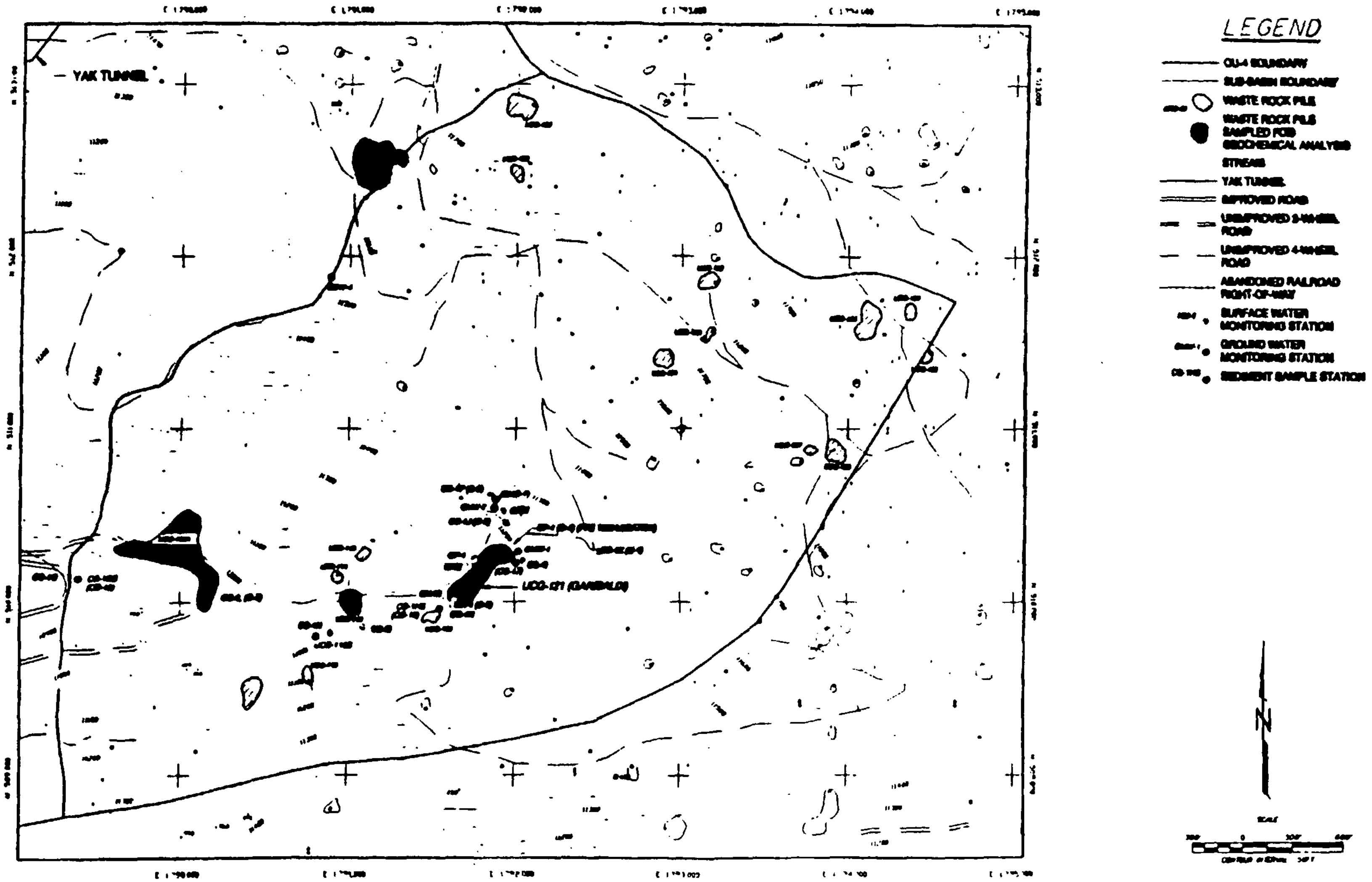


Figure 3

OU4 MINE WASTE MATERIAL



NOTES:

1.) SURFACE WATER MONITORING DESIGNATIONS IN PARENTHESES WERE SAMPLED DURING THE [illegible] PEAK FLOW RECONNAISSANCE.

2.) SEDIMENT SAMPLING STATION DESIGNATIONS IN PARENTHESES WERE SAMPLED IN [illegible].

3.) IN JUNE [illegible], GROUND WATER STATION GMW-1 WAS REPLACED WITH GITE. GROUND WATER STATION GMW-2 REPLACED BY GITR.

4.) THE LOCATION OF SURFACE WATER MONITORING STATION GP-1 WAS MOVED FOLLOWING COMPLETION OF REMOVAL ACTION IN FALL [illegible].

SOURCE: TerraMatrix/SMI 1998

Figure 4

GARIBALDI SUB-BASIN

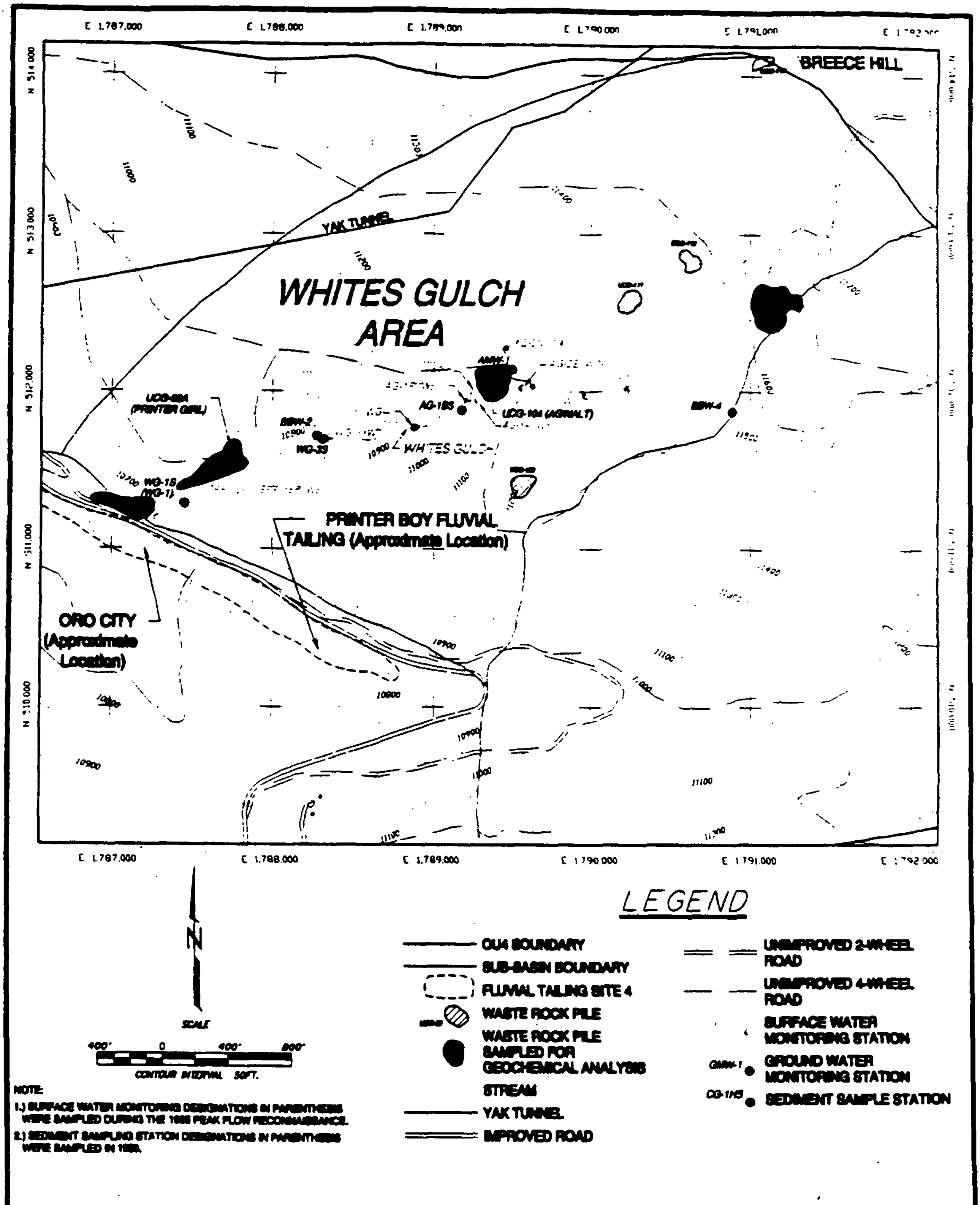
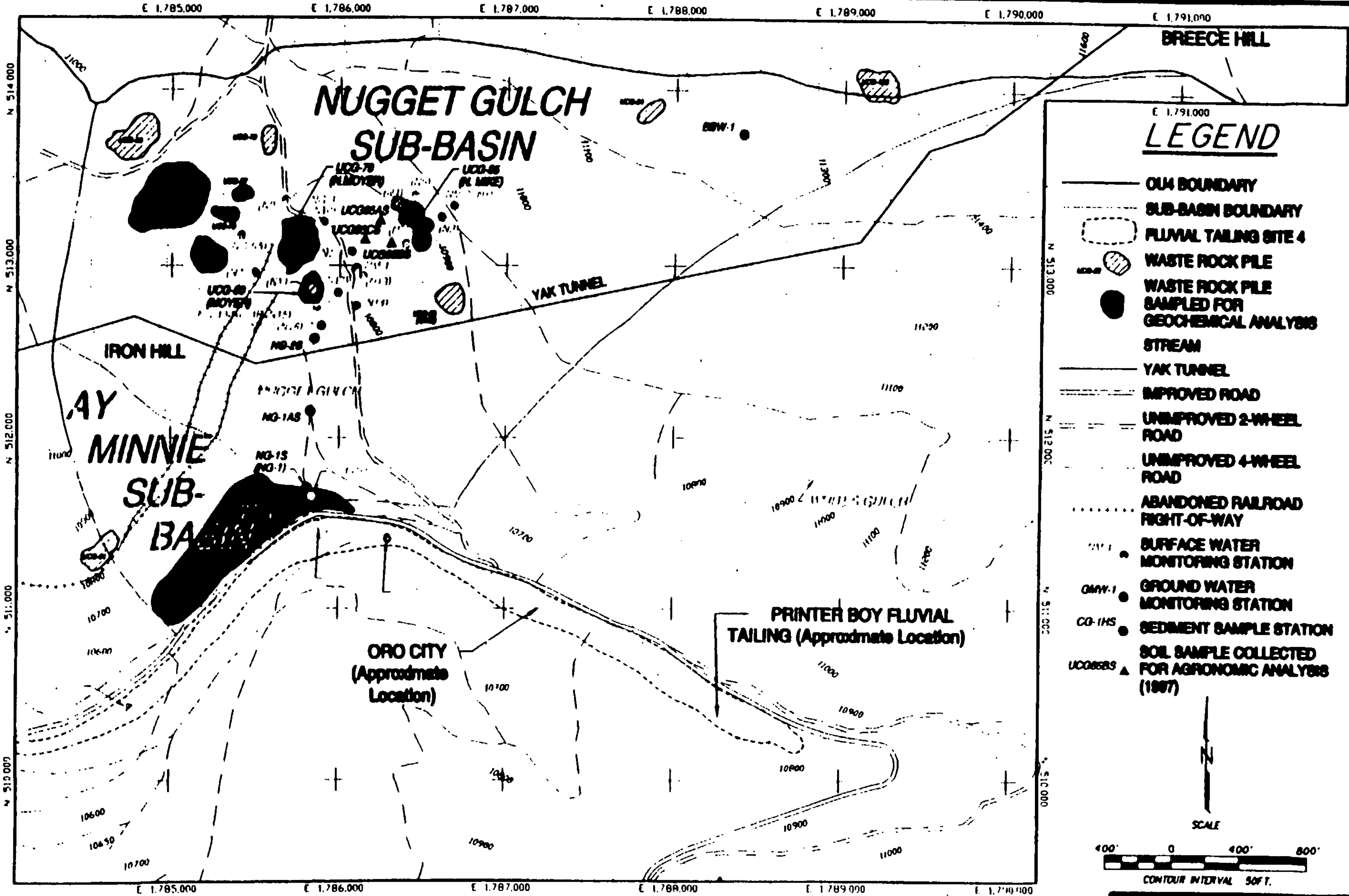


Figure 5

WHITES GULCH AND VICINITY

SOURCE: TerraMatrix/SMI, 1998

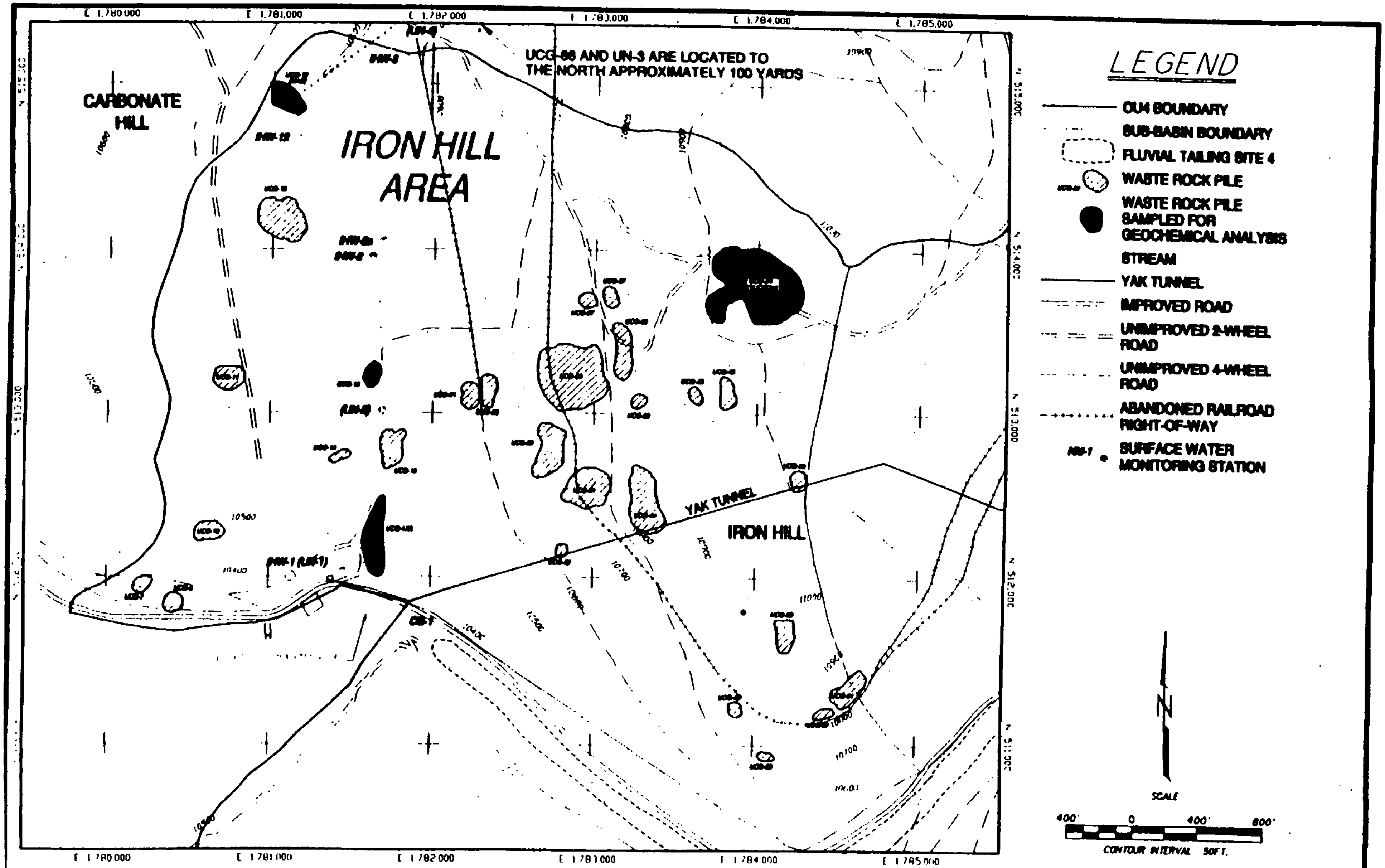


NOTE:
1.) SURFACE WATER MONITORING DESIGNATIONS IN PARENTHESIS WERE SAMPLED DURING THE 1986 PEAK FLOW RECONNAISSANCE.
2.) SEDIMENT SAMPLING STATION DESIGNATIONS IN PARENTHESIS WERE SAMPLED IN 1989
3.) THE LOCATION OF NG-6A IS APPROXIMATE

SOURCE: TerraMatrix/SMI, 1998

Figure 6

NUGGET GULCH AND VICINITY



NOTE:

1) SURFACE WATER MONITORING DESIGNATIONS IN PARENTHESIS WERE SAMPLED DURING THE 1995 PEAK FLOW RECONNAISSANCE

2) WASTE ROCK PILE UCG-66 AND SURFACE WATER RECONNAISSANCE SITE UN-3 ARE OUTSIDE OF THE OU-4 BOUNDARY

SOURCE TerraMatrix/SMI, 1998

Figure 7

IRON HILL AND VICINITY

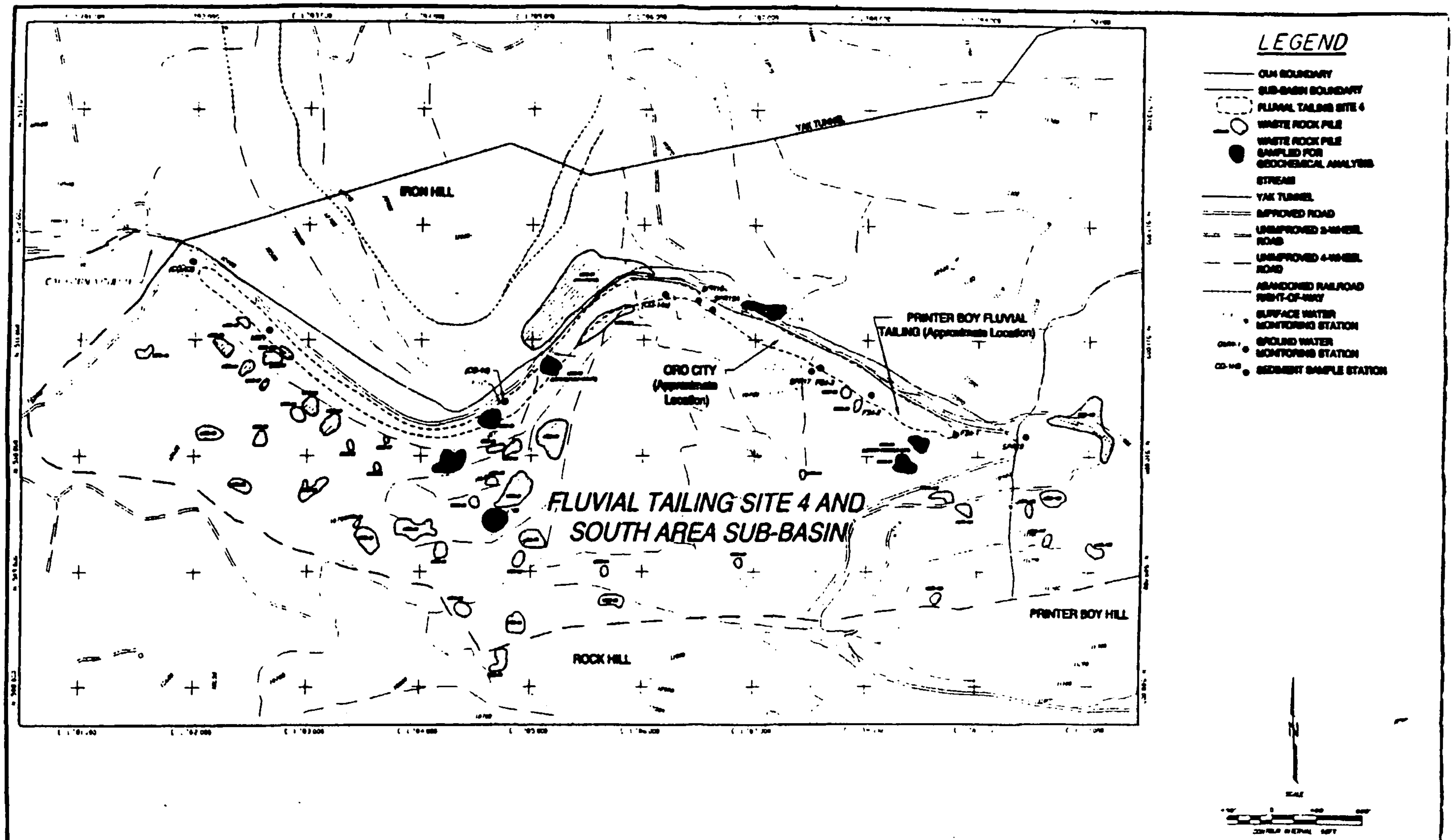
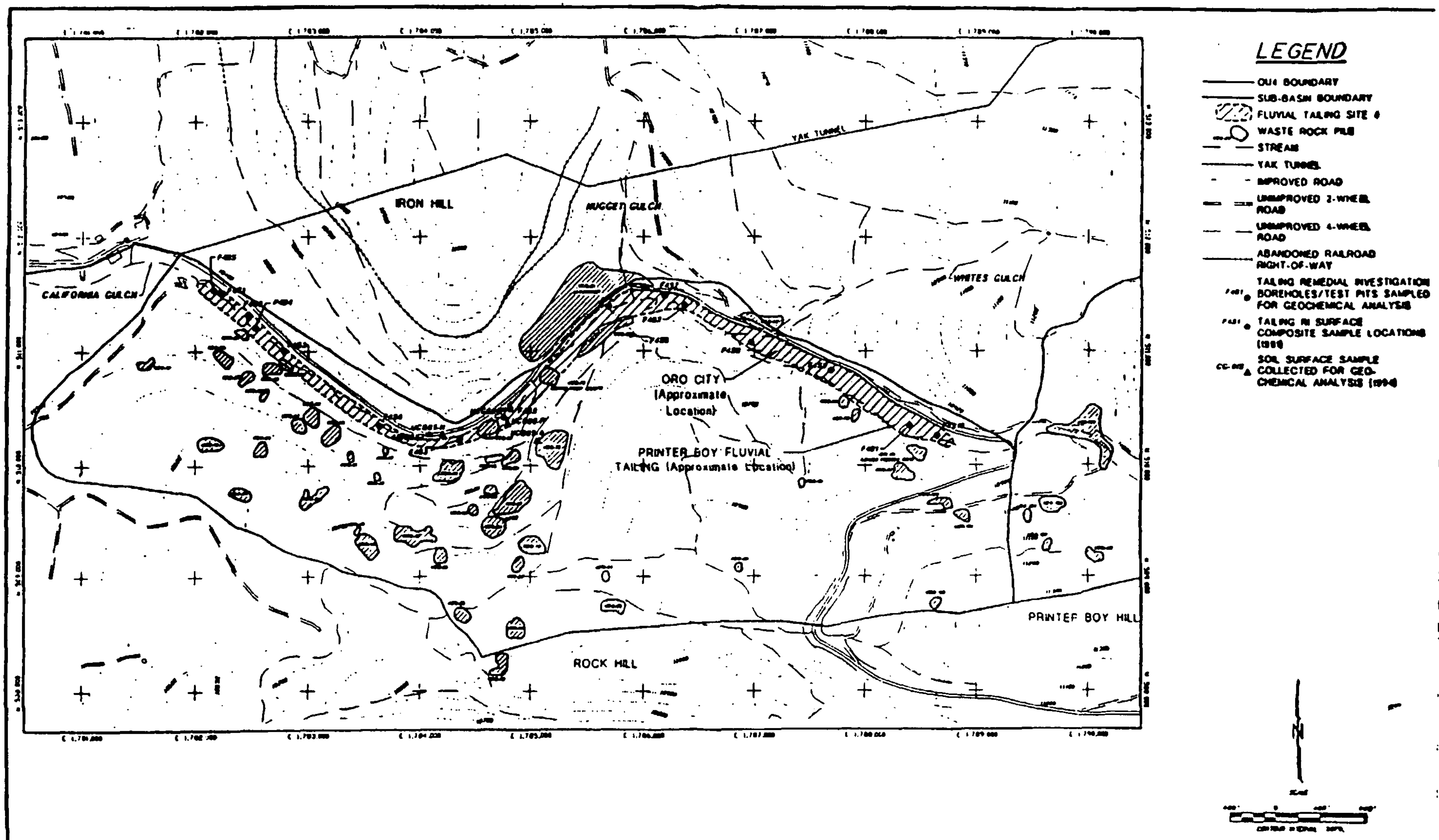


Figure 8

FLUVIAL TAILING SITE 4 AND SOUTH AREA



SOURCE TerraMatrix/SMI 1998

Figure 8

FLUVIAL TAILING SITE 4 GEOCHEMICAL SAMPLE LOCATIONS

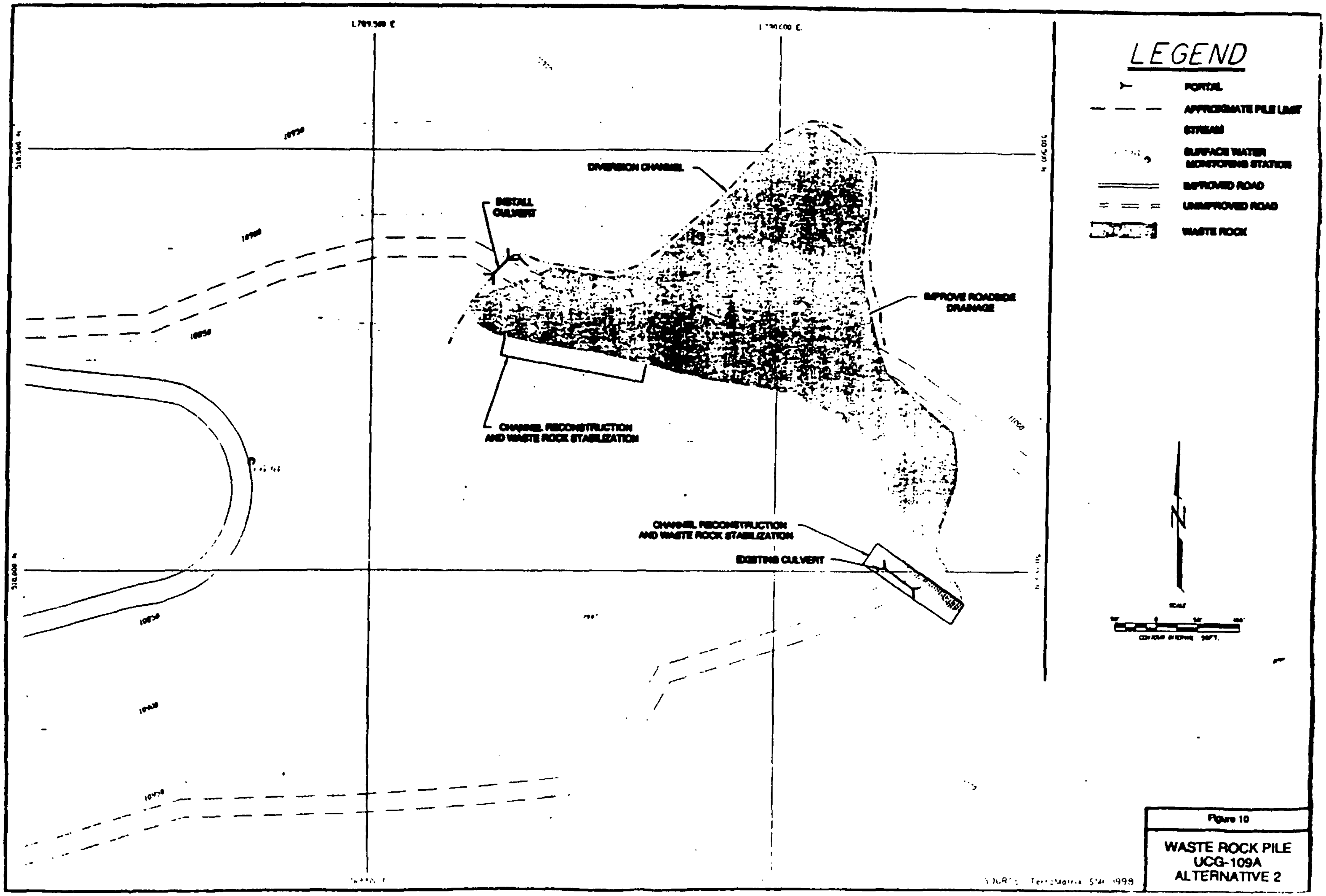


Figure 10

WASTE ROCK PILE
UCG-109A
ALTERNATIVE 2

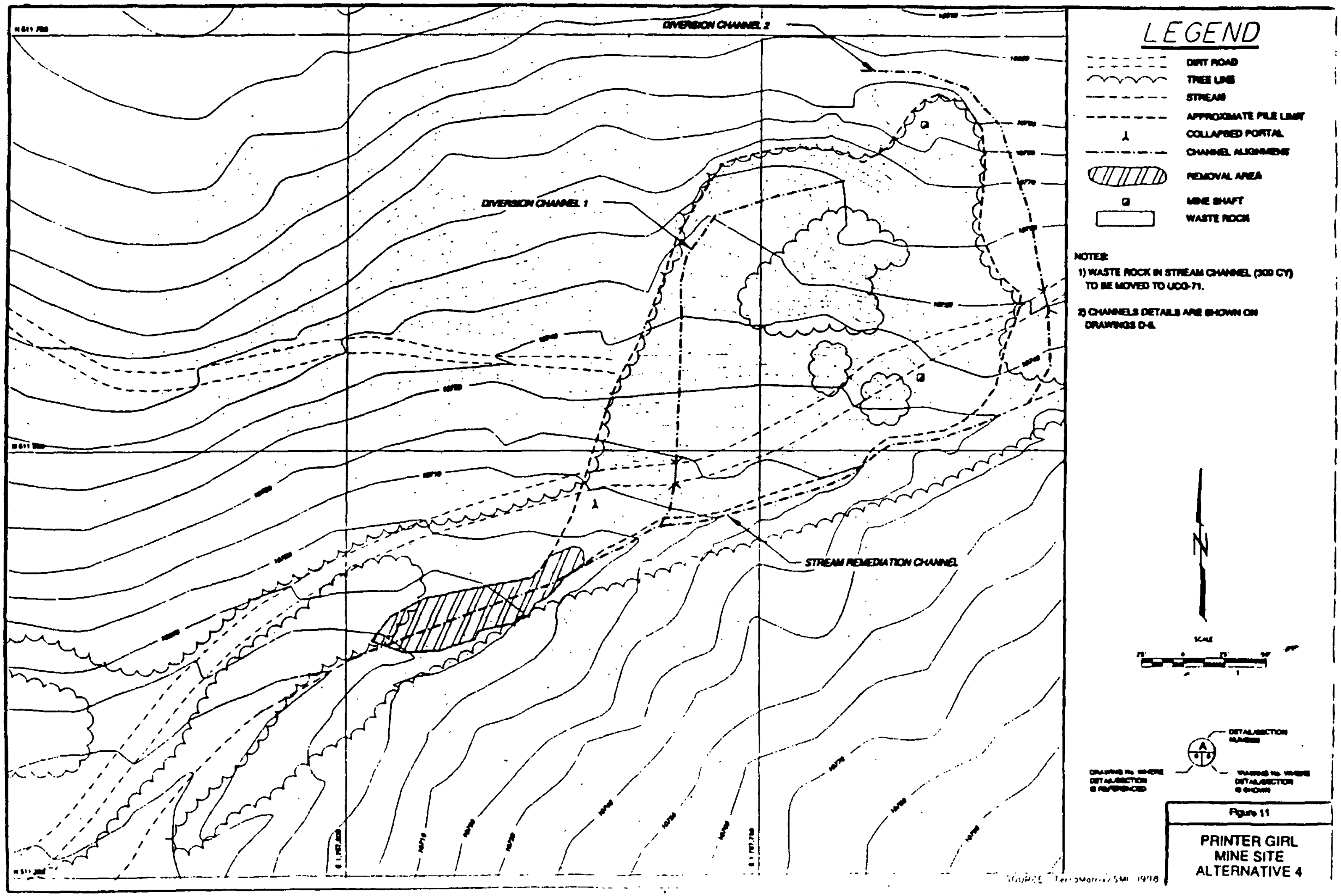


Figure 11

PRINTER GIRL MINE SITE ALTERNATIVE 4

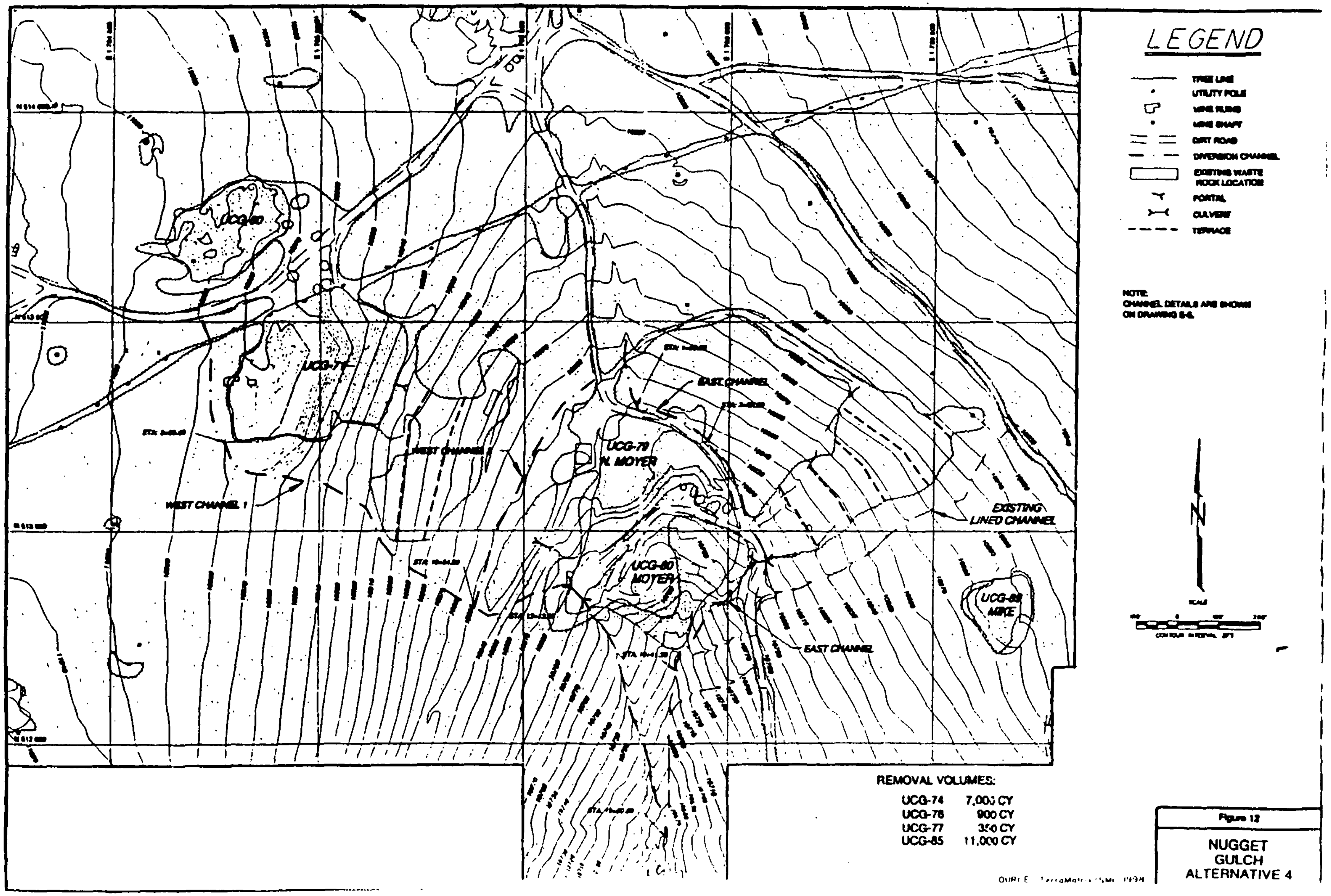


Figure 12

NUGGET GULCH ALTERNATIVE 4

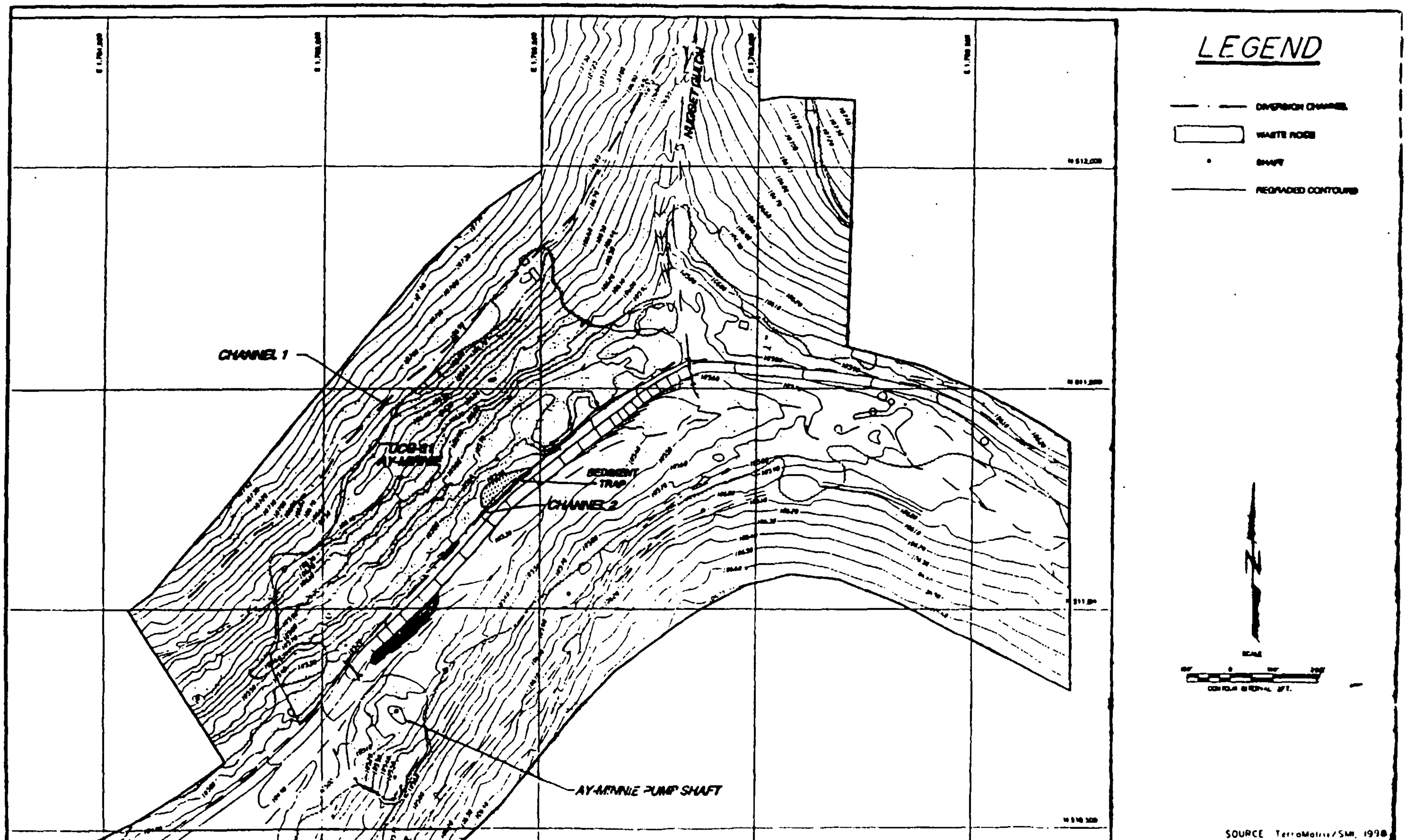


Figure 13

A-Y MINNIE ALTERNATIVE 4

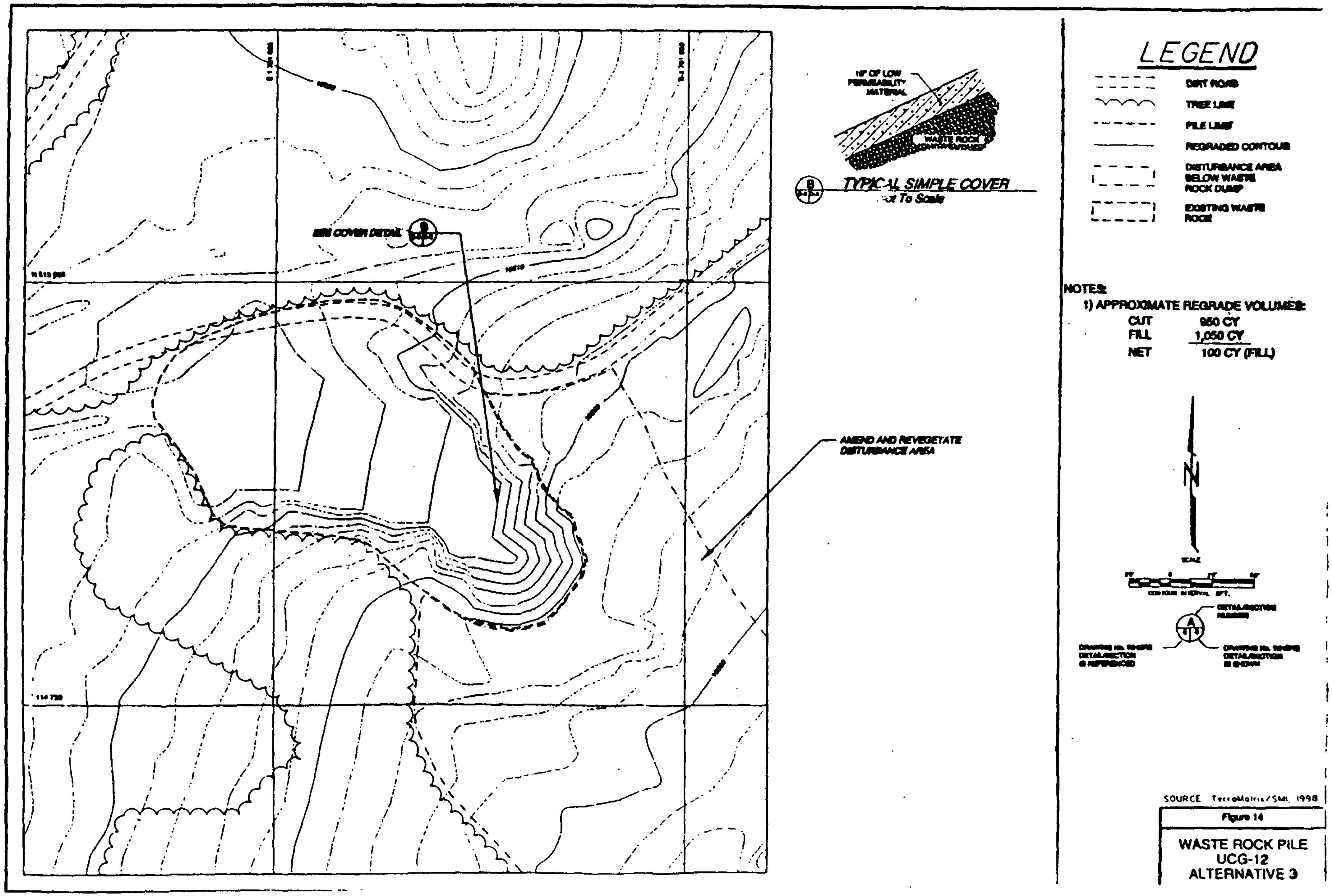
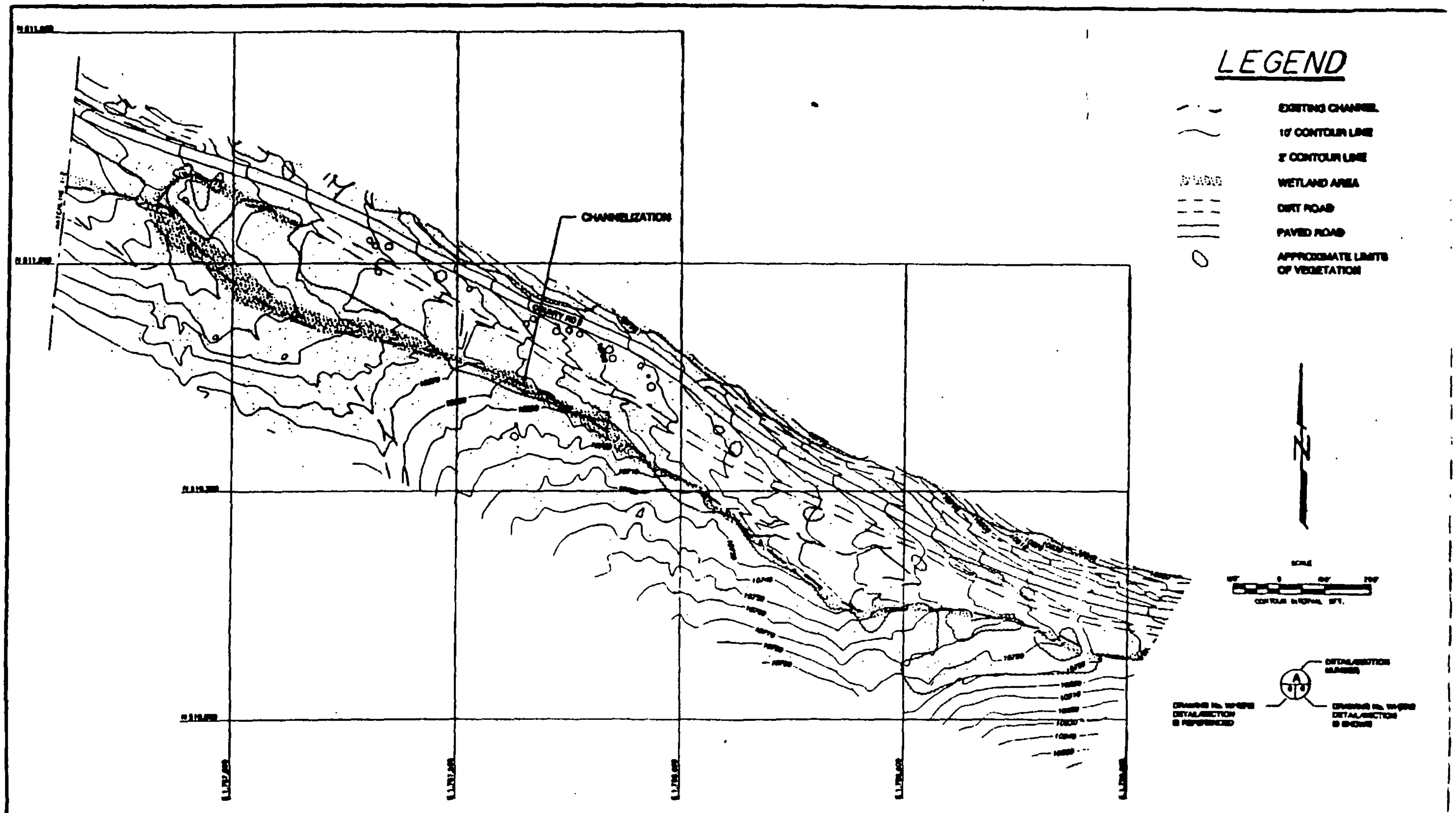


Figure 14

WASTE ROCK PILE
UCG-12
ALTERNATIVE 3



NOTES:

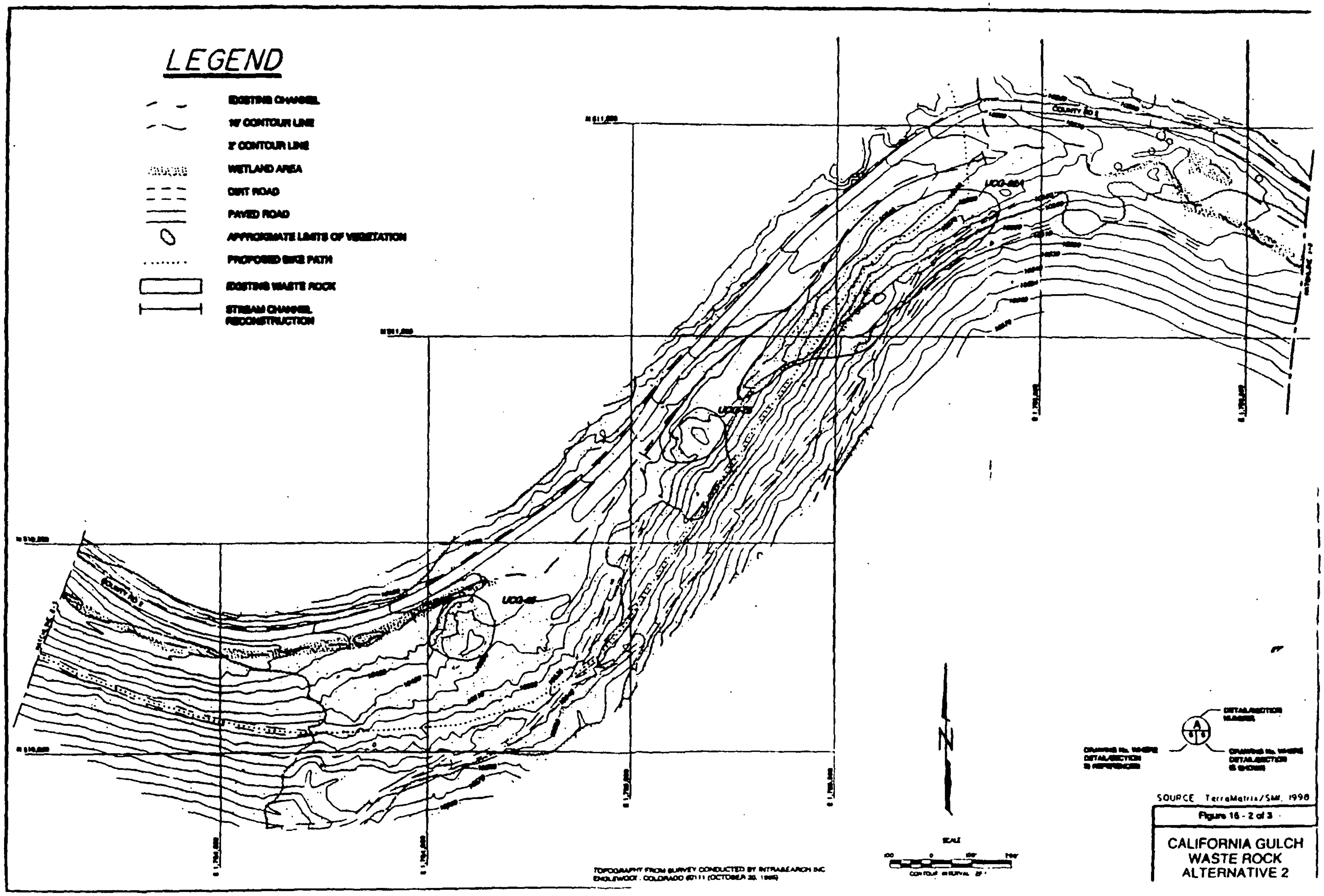
1. SOURCE SURFACE CONTROLS FOR FLUVIAL TAILINGS WILL INCLUDE DIRECT REVEGETATION AND COVERING AND REVEGETATION IN APPROPRIATE AREAS.

2. TOPOGRAPHY FROM SURVEY CONDUCTED BY INTRASEARCH INC. ENGLEWOOD, COLORADO 80111 (OCTOBER 20, [illegible])

SOURCE: TerraMatrix/SMI 1998

Figure 15 - 1 of 3

CALIFORNIA GULCH
WASTE ROCK
ALTERNATIVE 2


LEGEND
EXISTING CHANNEL
10' CONTOUR LINE
2' CONTOUR LINE
WETLAND AREA
DIRT ROAD
PAVED ROAD
APPROXIMATE LIMITS OF VEGETATION
PROPOSED BIKE PATH
EXISTING WASTE ROCK
STREAM CHANNEL RECONSTRUCTION
COUNTY RD 2
UCG-65
UCG-75
UCG-651
N
SCALE
CONTOUR INTERVAL 2'
DETAIL/SECTION NUMBER
DRAWING No. WHERE DETAIL/SECTION IS REFERENCED
DRAWING No. WHERE DETAIL/SECTION IS SHOWN
SOURCE TerraMatrix/SMI, 1990
Figure 16 - 2 of 3
CALIFORNIA GULCH
WASTE ROCK
ALTERNATIVE 2

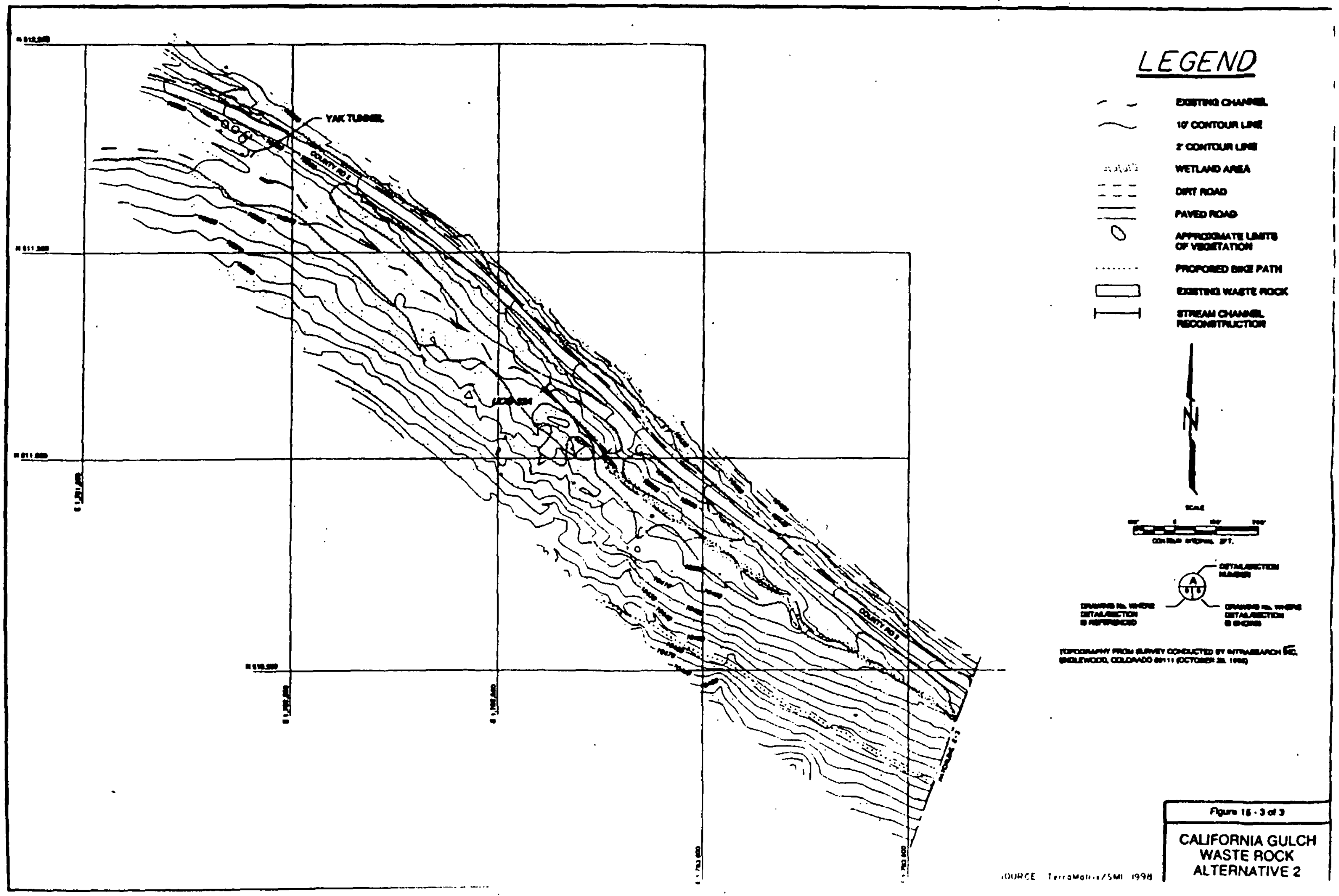


Figure 16 - 3 of 3

CALIFORNIA GULCH WASTE ROCK ALTERNATIVE 2

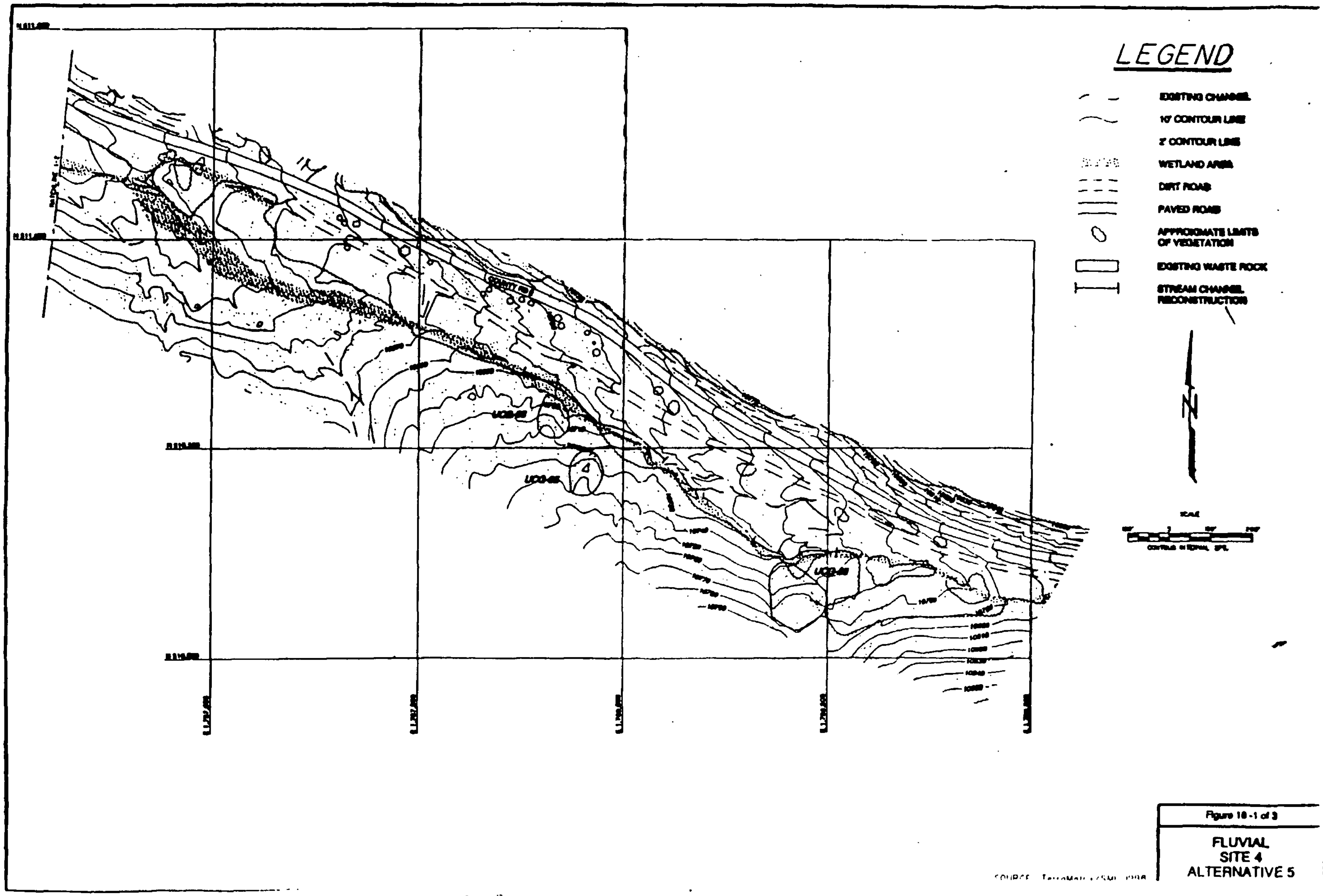
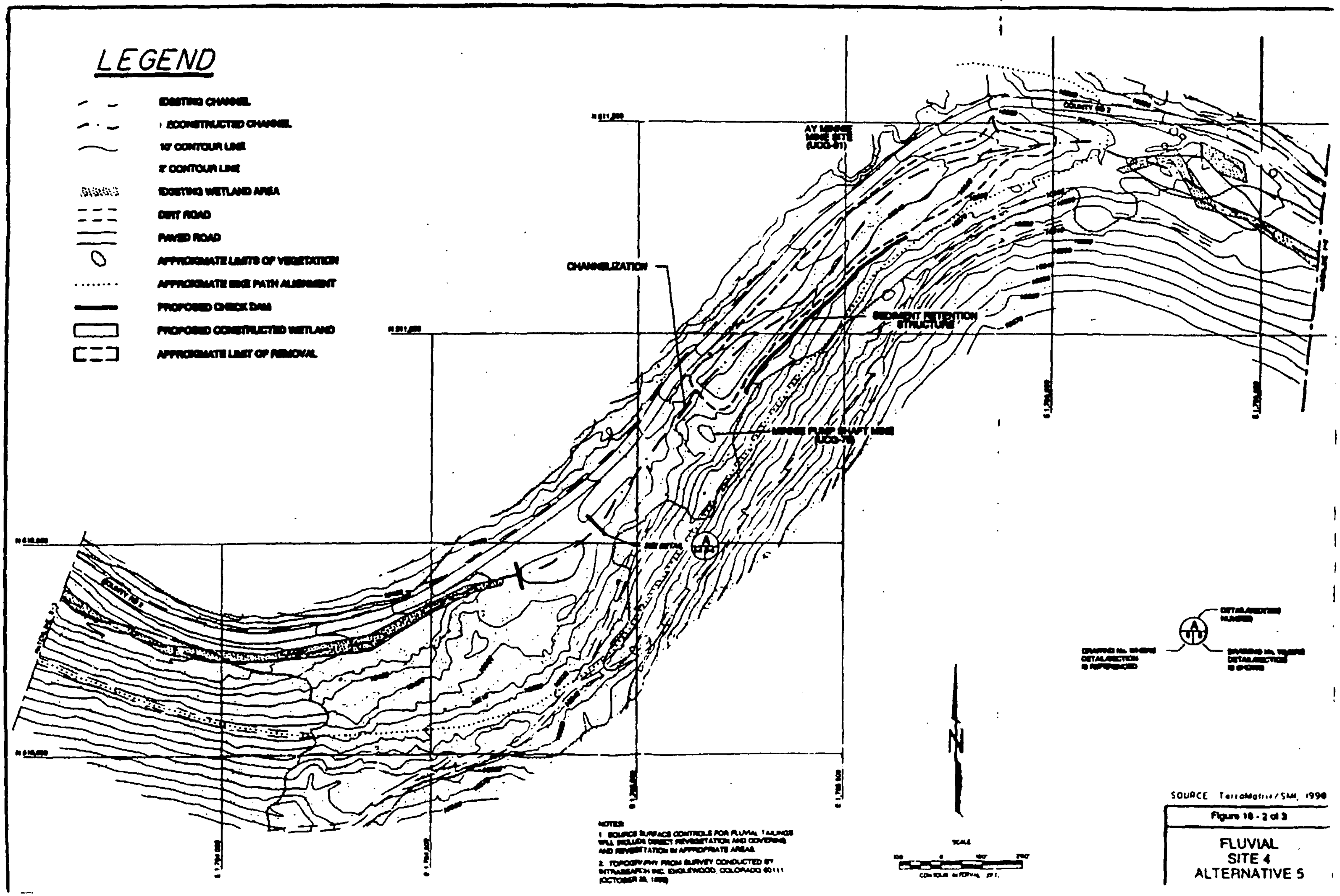


Figure 18-1 of 3

FLUVIAL
SITE 4
ALTERNATIVE 5



SOURCE TerraMatrix/SMI, 1998

Figure 18 - 2 of 3

FLUVIAL
SITE 4
ALTERNATIVE 5

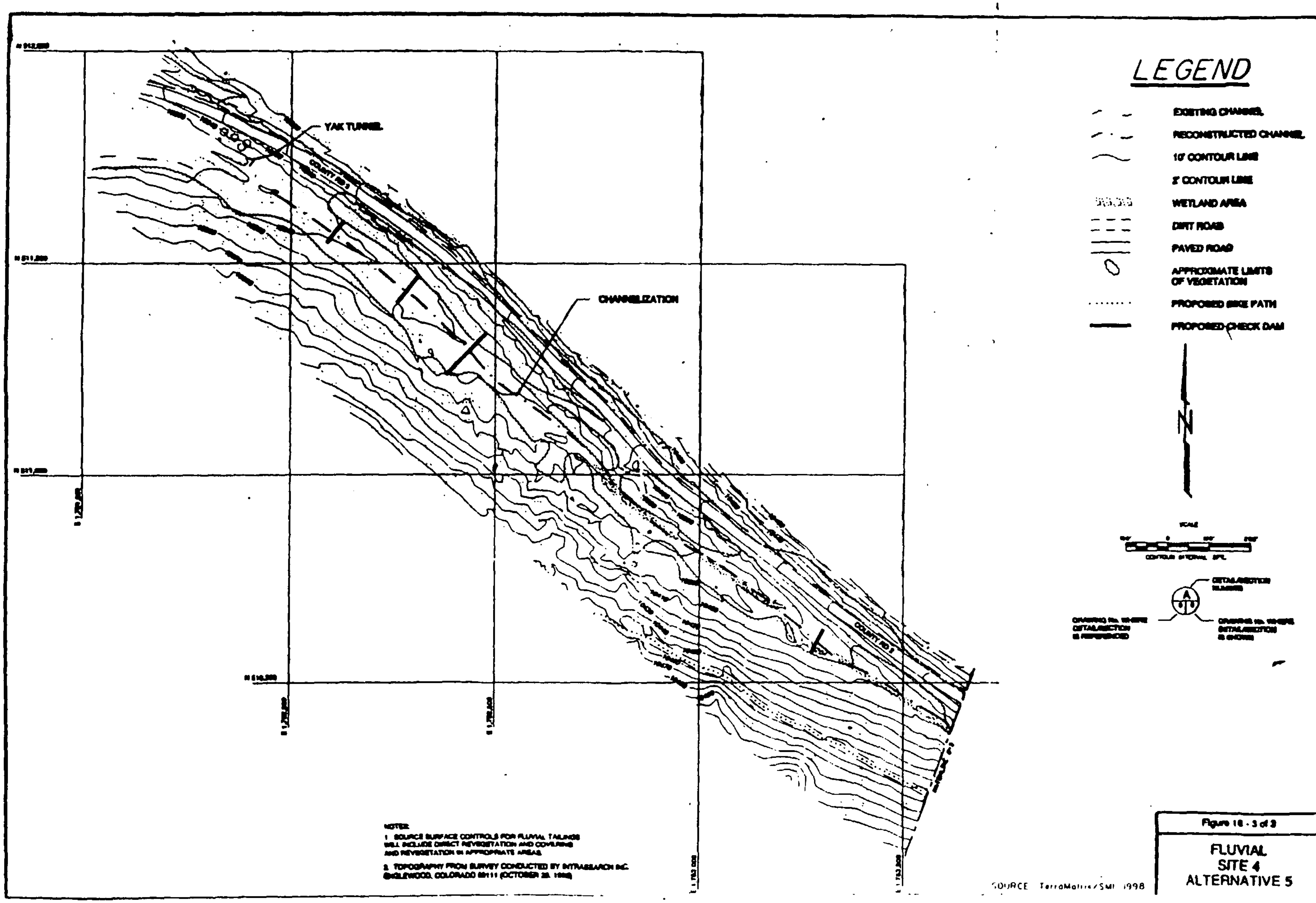


Figure 16 - 3 of 3

FLUVIAL
SITE 4
ALTERNATIVE 5

RESPONSIVENESS SUMMARY

TABLE OF CONTENTS

1.0 INTRODUCTION

The U.S. Environmental Protection Agency (EPA) has prepared the Responsiveness Summary to document and respond to issues and comments raised by the public regarding the Proposed Plan for the Upper California Gulch Operable Unit 4 (OU4) of the California Gulch Superfund Site. Comments were received during the public meeting held on January 29, 1998 at 7:00 p.m. at the Mining Hall of Fame in Leadville, Colorado. These comments, and responses to them, are outlined in this document. By law, the EPA and the Colorado Department of Public Health and Environment (CDPHE) must consider public input prior to making a final decision on a cleanup remedy. Once public comment is reviewed and considered, the final decision on a cleanup remedy will be documented in the Record of Decision (ROD).

This document includes the following sections:

- Background on Recent Community Involvement
- Summary of Comments Received During the Public Meeting and Agency Responses
- Remaining Concerns

2.0 BACKGROUND ON RECENT COMMUNITY INVOLVEMENT

The OU4 Proposed Plan was published in January 1998 and describes the preferred cleanup alternatives for waste rock and fluvial tailing. Based upon consideration of NCP and WAMP criteria, EPA has determined that the following alternatives are the appropriate remedies for the waste rock (Garibaldi Sub-basin, Printer Girl, Nugget Gulch, AY-Minnie, Iron Hill and California Gulch) and the Fluvial Tailing Site 4 located within OU4:

Garibaldi Sub-basin Waste Rock:	Alternative 2 - Diversion of Surface Water and Stream Channel Reconstruction
Printer Girl Waste Rock:	Alternative 4 - Waste Rock Removal
Nugget Gulch Waste Rock:	Alternative 4 - Diversion Ditches, Consolidation and Cover
AY-Minnie Waste Rock:	Alternative 4 - Diversion Ditches and Road Relocation
Iron Hill Waste Rock:	Alternative 3 - Regrade and Cover
California Gulch Waste Rock:	Alternative 2 - Stream Channel Reconstruction
Fluvial Tailing Site 4:	Alternative 5 - Channel Reconstruction, Revegetation, Sediment Dams, Wetlands and Selected Surface Material Removal

A portion of the public meeting held on January 29, 1998 was dedicated to accepting formal oral comments from the public.

3.0 COMMENTS AT THE FORMAL PUBLIC MEETING

The following are comments received at the formal public meeting. The comment is italicized and EPA's response is in regular type.

Comment No. 1: *What are fluvial tailings?*

Response: These are mine waste materials that have been moved and reworked. They have been deposited along streams and drainage channels by the movement of water. Fluvial tailings are more expensive to cleanup due to the location and quantity.

Comment No. 2: *Will work near the AY-Minnie have an effect on the Mineral Belt Bicycle Trail?*

Response: No, any water diversion work will not effect the bike trail. The possibility of incorporating the water diversion into the grading work for the bike trail will be evaluated. Water diverted from above the AY-Minnie will help recharge the wetlands.

Comment No 3: *Where will fluvial tailings be deposited?*

Response: The fluvial tailings will be deposited either at the Colorado #2 site (UCG-71) or used near the gulch during regrading of the area.

Comment No. 4: *How will air quality be addressed during remedial action?*

Response: A fugitive dust plan will be part of the construction work plan, and will include items such as wetting of roads, air monitoring, and traffic restrictions. Due to the downwind location of Operable Unit 4, the Leadville community should not be affected by any fugitive dust emissions.

Comment No. 5: *How will the bidding process work?*

Response: Resurrection will contract the work to an environmental engineering firm.

Comment No. 6: *Will there be any plugging of shafts?*

Response: The North Mike and the Mab may have to be plugged. This will be evaluated during remedial design.

Comment No. 7: *How will the maintenance of the sediment traps be performed?*

Response: This will be developed in the long-term monitoring plan. The sediment loading into the sediment traps will be evaluated for future land use.

Comment No. 8: *What is a simple cover?*

Response: The proposed plan indicates that a simple cover will consist of 18 inches of low permeable earthen material.

Comment No. 9: *How will long-term maintenance be considered?*

Response: The design will be done to minimize the amount of long-term maintenance by reducing the erosion potential and increasing the stability of reworked areas.

Comment No. 10: *What is the WAMP?*

Response: It stands for Work Area Management Plan and is part of the consent decree. It identifies the work areas for the parties and contains procedural requirements about how the work will be performed.

Additional Comment: *After the public meeting, concern was expressed about the road relocation at the A-Y Minnie.*

Response: The specifications for the road relocation will be addressed during design. Interested parties will be able to offer input during the design process.

4.0 REMAINING CONCERNS

Remaining Concerns

Based on review of the oral comments received during the public meeting, there are no outstanding issues associated with implementation of the proposed remedial action.

TABLE 1
SUBBASINS AND CONTAMINATED WASTE ROCK PILES OU4

Sub-Basin	Waste Rock Pile	Surface Area (acres)	Volume (cy)
Garibaldi	UCG-121 (Garibaldi)	1.17	27,900
	UCG-109A (McDermith)	2.50	59,700
Whites Gulch	UCG-92A (Printer Girl)	1.15	6,700
	UCG-104 (Agwalt)	0.77	11,500
Nugget Gulch	UCG-71 (Colorado No. 2)	2.65	17,490
	UCG-74 (Rubie)	0.73	8,315
	UCG-76	0.25	2,498
	UCG-77	0.15	246
	UCG-79 (North Moyer)	1.53	29,612
	UCG-80 (Moyer)	0.47	4,411
	UCG-85 (North Mike)	1.18	11,000
AY-Minnie	UCG-81 (AY-Minnie)	7.10	157,300
Iron Hill	UCG-12 (Mab)	0.70	5,500
Fluvial Tailing Site 4 and South Area	UCG-33A	0.26	6,258
	UCG-65	0.50	7,000
	UCG-75 (Minnie Pump Shaft)	0.45	6,000
	UCG-82A	1.06	25,540
	UCG-93	0.15	769
	UCG-95	0.18	1,174
	UCG-98 (Lower Printer Boy)	0.46	1,345
	TOTAL	23.41 acres	390,258 cy

Source: TerraMatrix/SMI 1998

TABLE 2
GARIBALDI SUB-BASIN WASTE ROCK GEOCHEMICAL DATA[1]

ABA Analysis	Garibaldi Mine Site (UCG-121)	Waste Rock Pile UCG-116	Waste Rock Pile UCG-109A
Sulfur, SO_4 (%)	0.84	0.43	0.18
Sulfur, Pyrite & Organic(%)	1.59	0.32	1.15
Sulfur, Total (%)	2.43	0.68	1.33
AGP (T/KT)	75.9	21	42
Neutralizing Potential (% $CaCO_3$)	0.1	0.1	0.8
ANP (T/KT)	0	<1	8
NNP (T/KT)	-75.9	-21	-32
EPA Method 1312 Extracted Leachate Analysis	**Concentration (mg/l unless noted)**		
Arsenic	0.0015	<0.001	0.022
Cadmium	0.034	0.016	0.007
Calcium	19.11	93.4	19.7
Iron	10.3	0.07	3.25
Lead	4.59	<0.2	<0.2
Magnesium	5.05	7.3	3.6
Mercury	<0.0002	na	na
Potassium	1.78	2.7	1.8
Sodium	2.58	0.3	1.2
Zinc	6.24	1.78	3.80
pH	2.9 s.u.	3.4 s.u.	4.7 s.u.
Alkalinity	2	<2	3
TDS	254	410	170
Chloride	1	<1	<1
Sulfate	345	270	80
Total Metals	**Concentration (mg/kg)**		
Arsenic	115	30	46
Cadmium	0.61	6.5	6.8
Lead	3,570	446	4.63
Zinc	382	518	1,510

Notes: 1) Source: *Draft Operable Units 4, 8, and 10 Reconnaissance Report (TerraMatrix/SMI, 1995d).*

AGP = Acid generation potential
ANP = Acid neutralization potential
NNP = Net neutralization potential
T/KT = Tons per 1,000 tons
mg/l = milligrams per liter
mg/kg = milligrams per kilogram
s.u. = standard units
"<" indicates that the value is less than the instrument detection limit.

Source: TerraMatrix/SMI 1998

TABLE 3

SURFACE WATER COC LOADINGS (lbs/day)

ocation	Sample ID	Flow (cfs)	TSS	Sulfate	As, diss	As, total	Cd, diss	Cd, total	Cu, diss	Cu, total	Pb, diss	Pb, total	Zn, diss	Zn, total
	FLUVIAL SITE 4 and SOUTH AREA SUB-BASIN													
CG-1	1995 Peak Flow	8.81	48949	18059	0.095	10.93	4.28	10.46	49.9	80.8	35.2	632	950	1088
	1996 Peak Flow	8.81	37449	12356	0.048	5.75	5.23	5.70	38.1	45.1	47.0	345	627	803
	spring flow average	3.91	11712	7042	0.032	2.02	3.31	4.19	17.9	23.6	17.5	159	494	545
	1995/1996 spring flow average	5.33	21026	9891	0.035	3.45	4.60	6.32	30.3	39.1	28.1	288	644	737
	pre-removal action spring flow average	3.25	8254	6248	0.030	1.19	3.01	3.83	14.1	19.0	12.2	85.5	460	494
	post-removal action spring flow average	5.55	22948	8308	0.030	4.96	3.60	4.47	28.7	36.1	34.8	423	487	600
CG-1E	1995 Peak Flow	9.34	21866	14107	0.10	3.63	4.03	5.54	44.3	52.9	12.8	10.1	605	695
	1996 Peak Flow	10.3	26447	13334	0.056	2.44	3.89	3.89	44.4	44.4	11.1	107	594	706
	spring flow average	4.37	4337	6317	0.052	0.68	2.01	2.21	16.5	17.7	5.40	17.7	327	343
	1995/1996 spring flow average	6.87	11303	9512	0.049	1.70	3.09	3.58	27.9	31.1	8.15	39.9	474	532
	% of 1995 Peak Flow at CG-1	106.0	44.7	78.1	106	33.2	94.2	53.0	88.8	65.5	35.8	1.59	63.6	63.9
	% of 1996 Peak Flow at CG-1	117	70.6	108	117	42.5	74.4	68.2	123	98.5	23.6	30.9	94.8	87.9
	% of spring flow average at CG-1	112	37.0	89.7	164	33.8	60.6	52.7	92.5	74.9	30.8	11.1	66.3	62.9
	% of 1995/1996 spring flow average at CG-1	129	53.8	96.2	143	49.4	67.1	56.7	92.1	79.7	29.0	13.9	73.6	72.3
CG-1D	1995 Peak Flow	7.53	17466	11373	0.041	1.50	2.44	3.25	28.4	38.2	2.48	29.2	381	414
	1996 Peak Flow	7.27	11765	7843	0.039	0.75	1.33	1.96	23.5	22.7	1.98	12.5	231	258
	spring flow average	3.43	2753	4526	0.033	0.27	1.01	1.16	12.3	12.8	1.25	5.22	181	180
	1995/1996 spring flow average	5.13	6780	6457	0.028	0.54	1.14	1.48	19.4	21.2	1.37	10.8	184	200
	% of 1995 Peak Flow at CG-1	85.5	35.7	63.0	42.7	13.7	57.0	31.1	57.0	47.3	7.05	4.63	38.0	38.1
	% of 1996 Peak Flow at CG-1	82.5	31.4	63.5	82.5	13.0	25.5	34.4	65.1	50.4	4.17	3.63	36.8	32.1
	% of spring flow average at CG-1	87.7	23.5	64.3	105	13.4	30.5	27.7	68.6	54.2	7.11	3.29	36.6	33.0
	% of 1995/1996 spring flow average at CG-1	96.2	32.2	65.3	80.2	15.8	24.8	23.4	63.9	54.3	4.89	3.78	28.5	27.2
CG-1C	1995 Peak Flow	7.11	11889	9205	0.077	1.53	8.44	3.07	20.7	23.8	1.27	11.12	410	410
	1996 Peak Flow	5.15	3445	5000	0.083	0.67	1.11	1.39	11.1	11.7	1.11	5.53	212	228
	spring flow average	2.69	2123	2902	0.029	0.32	1.43	0.80	6.19	6.58	0.50	2.53	121	122
	1995/1996 spring flow average	4.42	3489	4768	0.048	0.52	2.34	1.31	10.2	10.8	0.83	4.16	199	201
	% of 1995 Peak Flow at CG-1	80.7	24.3	51.0	80.7	14.0	197	29.3	41.5	29.4	3.60	1.78	43.2	37.7
	% of 1996 Peak Flow at CG-1	58.5	9.2	40.5	175	11.6	21.3	24.4	30.8	25.8	2.38	1.60	33.7	28.1
	% of spring flow average at CG-1	68.8	18.1	41.2	91.7	15.8	43.1	19.0	34.6	27.9	2.87	1.60	24.6	22.5
	% of 1995/1996 spring flow average at CG-1	82.9	16.6	48.2	138	15.2	50.9	20.8	33.6	27.7	2.94	1.45	31.0	27.3
G-1	1996 Peak Flow	0.03	0.81	3.24	0.0002	0.0002	0.0001	0.0002	0.0002	0.0006	0.0002	0.001	0.005	0.006
	% of 1996 Peak Flow at CG-1	0.34	0.002	0.026	0.34	0.003	0.002	0.003	0.0004	0.001	0.0003	0.0004	0.001	0.001
RIBALDI SUB-BASIN														
CG-1G	1995 Peak Flow	6.85	9238	9607	0.37	3.29	2.59	2.96	26.6	29.6	0.59	11.09	510	528
	1996 Peak Flow	4.74	1278	4602	0.31	0.61	1.02	1.02	11.3	9.97	0.38	1.59	186	194
	pre-removal action spring flow average	1.58	1689	2192	0.041	0.30	0.66	0.65	6.35	6.45	0.48	3.08	111	116
	post-removal action spring flow average	2.15	364	2088	0.056	0.12	0.52	0.50	5.24	5.13	0.16	0.43	91.0	87.7
	1995/1996 spring flow average	2.74	2768	2829	0.076	0.52	0.77	0.77	7.39	8.07	0.72	4.82	138	144
	% of 1995 Peak Flow at CG-1	77.8	18.9	53.2	389	30.1	60.5	28.3	53.3	36.6	1.68	1.75	53.6	48.6

Sour[redacted]n Matrix/SVO 1993

TABLE 3 (Continued)

SURFACE WATER COC LOADINGS (lbs/day)

Location	Sample ID	Flow (cfs)	TSS	Sulfate	As, diss	As, total	Cd, diss	Cd, total	Cu, diss	Cu, total	Pb, diss	Pb, total	Zn, diss	Zn, total
	% of 1996 Peak Flow at CG-1	53.8	3.4	37.2	646	10.7	19.6	17.9	31.1	22.1	0.76	0.46	29.6	24.1
	% of pre-removal action spring flow average at CG-1	48.6	20.5	35.1	138	25.2	21.9	17.0	45.1	33.9	3.90	3.60	24.1	23.5
	% of post-removal action spring flow average at CG-1	38.7	1.6	25.1	186	2.38	14.4	11.3	18.2	14.2	0.45	0.10	18.7	14.6
	% of 1995/1996 spring flow average at CG-1	51.4	13.2	28.6	220	15.1	16.8	12.3	24.4	20.6	2.55	1.68	21.1	19.6
CG-1H	1995 Peak Flow	NM												
	1996 Peak Flow	4.23	548	2054	0.30	0.39	0.41	0.43	3.99	4.08	0.18	0.27	72.3	77.6
	pre-removal action spring flow average	0.04	1.83	263	0.12	0.10	0.084	0.095	0.75	0.71	0.004	0.004	13.8	13.5
	post -removal action spring flow average	1.54	216	748	0.058	0.091	0.13	0.13	1.27	1.28	0.066	0.10	23.5	23.8
	% of 1995 Peak Flow at CG-1G	NA												
	% of 1996 Peak Flow at CG-1G	89.2	42.8	44.6	96.7	63.2	40.2	42.4	35.5	41.0	51.0	17.3	39.0	40.0
	% of pre-removal action spring flow average at CG-1G	2.53	0.11	12.0	289	33.7	12.8	14.6	11.9	11.1	0.84	0.14	12.5	11.6
	% of post-removal action spring flow average at CG-1(	71.6	59.3	35.8	104	77.2	25.6	26.4	24.2	25.0	42.8	23.9	25.8	27.2
GM-1	1995 Peak Flow	0.82	61.9	3937	1.06	1.06	1.77	1.68	11.5	10.6	0.15	0.44	216	222
	1996 Peak Flow	0.006	0.16	64.7	0.015	0.016	0.012	0.018	0.13	0.14	0.000	0.001	2.22	2.35
	pre-removal action spring flow average	0.39	23.6	2090	0.70	0.61	0.74	0.83	5.77	5.71	0.054	0.091	107	110
	post-removal action spring flow average	0.004	0.14	33.2	0.006	0.007	0.007	0.008	0.071	0.071	0.000	0.000	1.23	1.24
	% of 1995 Peak Flow at CG-1G	12.0	0.67	41.0	287.30	32.3	68.4	56.9	43.2	35.9	28.2	3.99	42.3	42.0
	% of 1996 Peak Flow at CG-1G	0.1	0.013	1.41	4.96	2.58	1.15	1.60	1.18	1.42	0.099	0.04	1.19	1.21
	% of pre-removal action spring flow average at CG-1G	24.7	1.40	95.4	1700	203	112	127	90.8	88.5	11.3	2.98	96.6	94.8
	% of post-removal action spring flow average at CG-1(	0.19	0.039	1.59	11.18	5.56	1.26	1.63	1.35	1.39	0.083	0.072	1.35	1.42
GP-1	1995 Peak Flow	0.709	19.1	229	0.004	0.004	0.11	0.046	0.17	0.21	0.038	0.046	4.74	4.78
	1996 Peak Flow	NM												
	1995/1996 spring flow average	0.39	10.5	126	0.002	0.002	0.041	0.022	0.056	0.068	0.012	0.015	2.41	2.37
	% of 1995 Peak Flow at CG-1G	10.4	0.21	2.39	1.04	0.12	4.44	1.55	0.65	0.72	6.47	0.41	0.93	0.90
	% of 1996 Peak Flow at CG-1G	NA												
	% of 1995/1996 spring flow average at CG-1G	14.2	0.38	4.46	2.77	0.40	5.29	2.85	0.75	0.85	1.61	0.31	1.77	1.64
CG-1I	1995 Peak Flow	0.36	23.3	38.8	0.002	0.002	0.058	0.006	0.002	0.012	0.002	0.035	0.31	0.47
	1996 Peak Flow	0.3	8.09	48.5	0.002	0.002	0.003	0.005	0.010	0.018	0.003	0.037	0.55	0.45
	% of 1995 Peak Flow at CG-1G	5.3	0.25	0.40	0.53	0.059	2.25	0.20	0.007	0.039	0.33	0.32	0.061	0.068
	% of 1996 Peak Flow at CG-1G	6.3	0.63	1.05	0.53	0.26	0.33	0.47	0.086	0.18	0.90	2.35	0.30	0.23
CG-1F	1995 Peak Flow	1.48	894	79.8	0.008	0.008	0.240	0.016	0.008	0.048	0.008	0.40	0.16	0.72
	1996 Peak Flow	2.38	64.2	128	0.013	0.013	0.006	0.039	0.013	0.013	0.013	0.064	0.13	0.39
	% of 1995 Peak Flow at CG-1G	21.6	9.68	0.83	2.16	0.24	9.26	0.54	0.03	0.16	1.35	3.60	0.03	0.14
	% of 1996 Peak Flow at CG-1G	50.2	5.02	2.79	4.18	2.09	0.63	3.77	0.11	0.13	3.59	4.05	0.07	0.20
CG-1J	1995 Peak Flow	1.16	904	127	0.006	0.013	0.191	0.102	0.025	0.11	0.01	0.32	2.10	2.93
	1996 Peak Flow	1.14	86	123	0.006	0.006	0.012	0.018	0.025	0.043	0.006	0.068	1.66	1.91
	% of 1995 Peak Flow at CG-1G	17.2	9.78	1.33	1.72	0.39	7.38	3.45	0.10	0.39	1.08	2.87	0.41	0.55
	% of 1996 Peak Flow at CG-1G	24.1	6.73	2.67	2.00	1.00	1.14	1.80	0.22	0.43	1.72	4.27	0.89	0.98
WHITES GULCH SUB-BASIN														
WG-1	1995 Peak Flow	1.63	9408	4132	0.009	0.18	0.097	0.16	14.1	18.5	0.009	4.13	13.1	14.9

Source: TerraMatrix/SMI 1993

TABLE 3 (Continued)

SURFACE WATER COC LOADINGS (lbs/day)

Location	Sample ID	Flow (cfs)	TSS	Sulfate	As, diss	As, total	Cd, diss	Cd, total	Cu, diss	Cu, total	Pb, diss	Pb, total	Zn, diss	Zn, total
	1996 Peak Flow	2.4	129	3884	0.13	0.13	0.26	0.31	21.1	20.8	0.13	0.17	17.7	18.0
	spring flow average	0.83	998	1268	0.006	0.029	0.061	0.070	6.47	6.88	0.015	0.61	5.85	6.04
	base flow average	0.034	9.72	51	0.001	0.001	0.004	0.008	0.31	0.28	0.002	0.002	0.25	0.24
	1995/1996 spring flow average	1.07	1712	1815	0.006	0.044	0.066	0.083	7.81	8.49	0.021	1.02	6.82	7.16
	% of 1995 Peak Flow at CG-1	18.5	19.2	22.9	9.25	1.61	2.26	1.51	28.2	22.9	0.025	0.65	1.38	1.37
	% of 1996 Peak Flow at CG-1	27.2	0.35	31.4	272	2.25	4.95	5.45	58.4	46.2	0.28	0.05	2.83	2.24
	% of spring flow average at CG-1	21.2	8.52	18.0	20.0	1.42	1.84	1.67	36.1	29.1	0.087	0.386	1.18	1.11
	% of 1995/1996 spring flow average at CG-1	20.1	8.14	18.3	18.6	1.28	1.43	1.31	25.8	21.7	0.08	0.36	1.06	0.97
SPR-16A	1995 Peak Flow	0.02	0.54	41.0	0.0001	0.0001	0.003	0.004	0.45	0.53	0.0003	0.001	0.20	0.20
	1996 Peak Flow	0.01	0.27	14.6	0.0001	0.0001	0.001	0.001	0.18	0.20	0.0002	0.000	0.076	0.086
	spring flow average	0.013	0.42	24.1	0.0001	0.0001	0.002	0.003	0.27	0.30	0.0002	0.001	0.12	0.12
	base flow average	0.003	0.11	4.82	0.0001	0.0002	0.001	0.0005	0.034	0.027	0.0001	0.0001	0.023	0.021
	1995/1996 spring flow average	0.013	0.42	24.1	0.0001	0.0001	0.002	0.003	0.27	0.30	0.0002	0.001	0.12	0.12
	% of 1995 Peak Flow at WG-1	1.23	0.006	0.99	1.23	0.06	3.35	2.73	3.22	2.86	3.68	0.018	1.51	1.36
	% of 1996 Peak Flow at WG-1	0.42	0.21	0.38	0.04	0.04	0.54	0.47	0.85	0.98	0.17	0.16	0.43	0.48
	% of spring flow average at WG-1	1.57	0.042	1.90	1.11	0.24	3.69	3.57	4.10	4.32	1.22	0.13	2.01	2.03
	% of base flow average at WG-1	8.82	1.08	9.39	9.65	15.1	13.8	6.1	11.2	9.72	3.71	5.61	9.32	8.62
	% of 1995/1996 spring flow average at WG-1	1.21	0.025	1.33	1.09	0.16	3.40	3.02	3.39	3.50	0.88	0.078	1.72	1.71
SPR-16B	1995 Peak Flow	0.01	0.32	20.5	0.0001	0.0001	0.002	0.002	0.20	0.24	0.001	0.001	0.093	0.097
	1996 Peak Flow	0.01	0.27	14.6	0.0001	0.0001	0.001	0.002	0.19	0.20	0.001	0.0000	0.077	0.085
	spring flow average	0.01	0.29	18.5	0.0001	0.0001	0.002	0.002	0.21	0.21	0.001	0.0005	0.093	0.092
	base flow average	0.003	0.081	4.42	0.0000	0.0001	0.0003	0.0004	0.034	0.033	0.0000	0.0001	0.021	0.020
	1995/1996 spring flow average	0.01	0.29	18.5	0.0001	0.0001	0.002	0.002	0.21	0.21	0.001	0.0005	0.093	0.092
	% of 1995 Peak Flow at WG-1	0.61	0.003	0.50	1.23	0.06	1.73	1.23	1.46	1.29	8.59	0.023	0.71	0.65
	% of 1996 Peak Flow at WG-1	0.42	0.21	0.38	0.083	0.083	0.56	0.52	0.89	0.97	0.58	0.000	0.43	0.47
	% of spring flow average at WG-1	1.20	0.029	1.46	1.42	0.31	2.90	2.72	3.20	3.12	4.00	0.08	1.59	1.52
	% of base flow average at WG-1	8.82	0.83	8.60	1.18	9.63	7.35	5.3	11.2	11.7	2.65	3.61	8.47	8.23
	% of 1995/1996 spring flow average at WG-1	0.93	0.017	1.02	1.40	0.20	2.7	2.3	2.6	2.5	2.9	0.05	1.37	1.29
WG-3	1995 Peak Flow	1.33	4663	4161	0.014	0.12	0.079	0.12	12.2	16.5	0.007	1.22	12.0	12.9
	1996 Peak Flow	1.38	670	2308	0.007	0.022	0.067	0.074	8.56	8.04	0.007	0.16	7.15	7.44
	spring flow average	0.93	1246	1839	0.007	0.035	0.040	0.050	5.43	6.20	0.005	0.33	5.55	5.74
	base flow average	0.020	1.73	21.6	0.0001	0.0001	0.001	0.001	0.063	0.083	0.0003	0.0002	0.072	0.067
	1995/1996 spring flow average	0.93	1246	1839	0.007	0.035	0.040	0.050	5.43	6.20	0.005	0.33	5.55	5.74
	% of 1995 Peak Flow at WG-1	81.6	49.6	101	163	69.4	81.6	77.1	86.7	89.4	81.6	29.5	91.5	86.4
	% of 1996 Peak Flow at WG-1	57.5	518	59.4	5.75	17.3	25.9	24.0	40.6	38.6	5.75	92.9	40.3	41.4
	% of spring flow average at WG-1	112	125	145	105	122	65.4	70.9	64.1	90	32.8	53	95	95
	% of base flow average at WG-1	58.8	17.8	42.0	7.84	10.7	22.4	11.2	20.5	22.3	17.6	10.7	29.0	27.3
	% of 1995/1996 spring flow average at WG-1	86.9	72.8	101	104	79.4	60.3	60.0	69.8	73.1	23.7	32.0	81.4	80.1
AG-1A	1995 Peak Flow	0.54	14.6	1893	0.012	0.006	0.026	0.044	8.16	6.41	0.003	0.003	5.24	3.70
	1996 Peak Flow	0.06	1.62	100	0.001	0.0003	0.003	0.004	0.49	0.52	0.0003	0.0003	0.27	0.34
	spring flow average	0.3	8.09	777	0.005	0.002	0.015	0.021	3.48	3.07	0.002	0.002	2.12	1.87
	base flow average	0.010	0.69	11.2	0.000	0.000	0.0004	0.0004	0.027	0.015	0.0001	0.0002	0.032	0.029
	1995/1996 spring flow average	0.3	8.09	777	0.005	0.002	0.015	0.021	3.48	3.07	0.002	0.002	2.12	1.87
	% of 1995 Peak Flow at WG-1	33.1	0.15	45.8	133	3.31	27.1	27.6	58.0	34.7	33.1	0.070	40.0	24.7

Sour[redacted] TerraMatrix/SMI 1993

TABLE 3 (Continued)

SURFACE WATER COC LOADINGS (lbs/day)

Location	Sample ID	Flow (cfs)	TSS	Sulfate	As, diss	As, total	Cd, diss	Cd, total	Cu, diss	Cu, total	Pb, diss	Pb, total	Zn, diss	Zn, total
	% of 1996 Peak Flow at WG-1	2.5	1.25	2.58	0.50	0.25	1.25	1.15	2.30	2.48	0.25	0.19	1.50	1.87
	% of spring flow average at WG-1	36.1	0.81	61.3	76.5	8.45	25.3	30.0	53.8	44.7	10.6	0.28	36.3	30.9
	% of base flow average at WG-1	29.4	7.1	21.9	29.8	46.0	9.9	5.2	9.0	5.5	7.1	8.6	12.7	11.7
	% of 1995/1996 spring flow average at WG-1	28.0	0.47	42.8	75.7	5.49	23.3	25.4	44.5	38.2	7.65	0.18	31.1	26.1
AG-1B	1995 Peak Flow	0.05	1.35	181	0.003	0.003	0.002	0.005	0.40	0.49	0.0003	0.0003	0.88	0.84
	1996 Peak Flow	0.06	1.62	139	0.001	0.001	0.004	0.004	0.34	0.32	0.0003	0.002	0.57	0.63
	spring flow average	0.05	1.35	148	0.002	0.002	0.003	0.004	0.34	0.38	0.0003	0.001	0.68	0.68
	base flow average	0.034	0.92	37.7	0.0006	0.002	0.001	0.001	0.089	0.035	0.0002	0.0002	0.11	0.11
	1995/1996 spring flow average	0.05	1.35	148	0.002	0.002	0.003	0.004	0.34	0.38	0.0003	0.001	0.68	0.68
	% of 1995 Peak Flow at WG-1	3.07	0.014	4.37	30.67	1.53	2.23	3.07	2.88	2.63	3.07	0.01	6.75	5.63
	% of 1996 Peak Flow at WG-1	2.50	1.25	3.58	1.00	0.75	1.50	1.15	1.61	1.54	0.25	1.35	3.21	3.49
	% of spring flow average at WG-1	6.02	0.14	11.7	29.8	6.1	4.43	5.58	5.32	5.47	1.76	0.18	11.6	11.3
	% of base flow average at WG-1	100	9.4	73.4	40.0	164	32.1	13.0	29.1	12.4	10.0	9.09	43.4	43.1
	% of 1995/1996 spring flow average at WG-1	4.67	0.079	8.17	29.4	3.96	4.08	4.73	4.40	4.43	1.27	0.11	9.97	9.53
AP-1	base flow average	0.015	0.40	12.14	0.000	0.000	0.001	0.001	0.021	0.019	0.0001	0.0001	0.045	0.046
	% of base flow average at WG-1	44	4.16	23.6	5.88	8.02	16.8	9.45	6.89	6.92	4.41	4.01	17.8	18.8
AG-2E	1995 Peak Flow	0.33	8.90	605	0.002	0.002	0.089	0.059	8.19	9.08	0.005	0.002	2.63	2.63
	1996 Peak Flow	0.08	2.16	112	0.000	0.000	0.010	0.009	1.72	1.91	0.001	0.001	0.51	0.58
	1995/1996 spring flow average	0.16	4.32	259	0.001	0.001	0.032	0.024	3.70	4.11	0.003	0.002	1.15	1.22
	% of 1995 Peak Flow at WG-1	20.2	0.095	14.6	20.2	1.01	92.0	37.1	58.2	49.2	60.7	0.043	20.1	17.6
	% of 1996 Peak Flow at WG-1	3.33	1.67	2.89	0.33	0.33	3.83	3.06	8.14	9.17	1.00	0.77	2.90	3.21
	% of 1995/1996 spring flow average at WG-1	15.0	0.25	14.3	13.5	2.0	47.7	28.7	47.4	48.4	12.2	0.17	18.9	17.0
AG-2N	1995 Peak Flow	0.31	8.36	16.7	0.002	0.002	0.010	0.005	0.042	0.047	0.002	0.002	0.050	0.067
	1996 Peak Flow	0.26	7.01	28.0	0.001	0.001	0.001	0.004	0.029	0.036	0.004	0.020	0.042	0.042
	1995/1996 spring flow average	0.16	4.32	12.9	0.001	0.001	0.003	0.003	0.020	0.023	0.002	0.006	0.026	0.030
	% of 1995 Peak Flow at WG-1	19.0	0.09	0.40	19.0	0.95	10.4	3.17	0.30	0.25	19.02	0.04	0.36	0.45
	% of 1996 Peak Flow at WG-1	10.8	5.42	0.72	1.08	1.08	0.27	1.35	0.14	0.17	3.25	11.67	0.24	0.23
	% of 1995/1996 spring flow average at WG-1	15.0	0.25	0.71	13.5	1.95	4.25	3.13	0.25	0.27	8.16	0.63	0.38	0.42
NUGGET GULCH/AY-MINNIE SUB-BASIN														
NG-1	1995 Nugget Gulch Peak Flow	1.1	5115	8663	0.18	1.25	4.15	4.15	48.1	48.3	0.83	1.51	605	574
	1995 Peak Flow	0.21	165	1450	0.003	0.03	0.40	0.57	9.06	10.8	0.14	0.45	87	72
	1996 Nugget Gulch Peak Flow	0.71	3095	4136	0.057	0.21	1.51	1.63	34.7	31.8	0.69	3.68	215	208
	1996 Peak Flow	0.45	12.1	2209	0.005	0.005	0.92	0.94	12.4	12.2	0.18	0.31	136	134
	spring flow average	0.31	449	1991	0.013	0.092	0.64	0.66	14.8	14.6	0.30	0.93	91.7	91.6
	1995/1996 spring flow average	0.42	836	3345	0.022	0.15	1.09	1.14	24.5	24.1	0.29	1.15	155	156
	% of 1995 Nugget Gulch Peak Flow at CG-1	16.5	7.39	42.9	247.0	864.5	38.4	37.2	58.0	42.8	1.8	0.9	42.7	30.9
	% of 1995 Peak Flow at CG-1	2.38	0.34	8.03	3.58	0.31	9.27	5.42	18.2	13.2	0.41	0.07	7.09	6.58
	% of 1996 Nugget Gulch Peak Flow at CG-1	16.2	6.25	47.4	244	1.82	31.9	22.5	78.3	51.2	1.17	0.34	33.1	24.1
	% of 1996 Peak Flow at CG-1	11.5	0.032	17.9	10.2	0.084	17.6	16.5	34.3	27.0	0.34	0.090	21.7	18.7
	% of spring flow average at CG-1	7.93	3.83	28.3	40.4	4.56	19.3	15.8	82.9	61.7	1.71	0.59	18.6	16.6
	% of 1995/1996 spring flow average at CG-1	7.88	3.97	33.8	62.4	4.40	23.7	18.0	80.7	61.6	1.02	0.40	24.1	21.1

Source: TerraMatrix/SMI 1995

TABLE 3 (Continued)

SURFACE WATER COC LOADINGS (lbs/day)

Location	Sample ID	Flow (cfs)	TSS	Sulfate	As, diss	As, total	Cd, diss	Cd, total	Cu, diss	Cu, total	Pb, diss	Pb, total	Zn, diss	Zn, total
NG-2	1995 Peak Flow	0.17	400	1559	0.006	0.10	0.39	3.67	11.0	11.74	0.11	1.02	53.1	56.1
	1996 Peak Flow	0.14	107	755	0.003	0.011	0.20	0.27	6.71	7.48	0.079	0.41	31.0	34.7
	spring flow average	0.15	282	1145	0.015	0.046	0.30	1.06	8.35	8.72	0.087	0.55	44.4	46.4
	1995/1996 spring flow average	0.2	499	1244	0.015	0.070	0.35	1.71	9.09	9.75	0.13	0.95	50.9	53.7
	% of 1995 Peak Flow at NG-1	81.0	242	108	162	294	97	648	121	110	73.3	225	78.8	78.4
	% of 1996 Peak Flow at NG-1	31.1	884	34.2	62.2	217.8	21.8	28.9	54.1	61.3	50.3	131	22.8	25.8
	% of spring flow average at NG-1	48.4	62.8	57.5	117	49.6	46.7	160	56.3	59.8	28.9	59.6	48.4	50.7
	% of 1995/1996 spring flow average at NG-1	47.6	59.7	37.2	71.8	46.2	32.5	151	37.2	40.5	45.6	82.9	32.8	34.5
NM-1	1995 Peak Flow	0.045	12.1	2015	0.010	0.007	1.00	15.8	14.1	14.81	0.003	0.003	102	106
	1996 Peak Flow	0.013	3.65	386	0.001	0.001	0.14	0.14	2.88	2.79	0.003	0.005	21.3	18.8
	spring flow average	0.023	3.97	447	0.002	0.001	0.19	2.08	3.24	3.29	0.011	0.024	23.3	22.7
	1995/1996 spring flow average	0.028	6.44	726	0.003	0.002	0.32	3.38	5.25	5.35	0.018	0.039	37.8	36.8
	% of 1995 Peak Flow at NG-1	21.4	7.34	139	286	20.0	251	2786	155	139	2.19	0.59	152	148
	% of 1996 Peak Flow at NG-1	2.89	30.0	17.5	18.8	14.4	15.1	14.9	23.2	22.9	1.8	1.7	15.7	14.0
	% of spring flow average at NG-1	7.42	0.88	22.5	13.1	1.3	30.4	315.3	21.8	22.6	3.8	2.6	25.4	24.8
	% of 1995/1996 spring flow average at NG-1	6.67	0.77	21.7	12.6	1.33	28.9	297	21.5	22.2	6.35	3.40	24.3	23.7
NM-2	1995 Peak Flow	0.41	61.9	22.1	0.002	0.002	0.001	0.016	0.011	0.027	0.004	0.040	0.066	0.15
	1996 Peak Flow	NM												
	1995/1996 spring flow average	0.54	48.1	43.7	0.003	0.003	0.001	0.013	0.020	0.036	0.006	0.052	0.12	0.19
	% of 1995 Peak Flow at NG-1	195	37.4	1.53	65.1	6.51	0.28	3.12	0.12	0.25	3.07	8.79	0.098	0.22
	% of 1996 Peak Flow at NG-1	NA												
	% of 1995/1996 spring flow average at NG-1	129	5.75	1.31	13.5	1.92	0.13	1.15	0.083	0.15	2.02	4.56	0.075	0.12
NG-4A	1995 loading	0.031	4.68	485	0.008	0.007	0.35	0.35	0.54	NM	0.026	0.060	54.0	52.5
	% of NG-1 on June 1, 1995	7.56	0.62	88.2	192	14.3	153	153	13.4	NM	12.2	5.19	178	174
NG-4B	1995 loading	0.034	118	347	0.068	0.062	0.18	0.22	1.03	NM	0.09	0.37	20.4	20.5
	% of NG-1 on June 1, 1996	8.29	15.7	63.0	1697	127	79.7	95.7	25.7	NM	44.5	32.1	67.0	68.0
NG-3	1995 Peak Flow	0.137	132	22.2	0.001	0.010	0.001	0.044	0.010	0.027	0.005	0.25	0.13	0.41
	1996 Peak Flow	0.05	48.0	8.09	0.0003	0.002	0.0004	0.001	0.004	0.009	0.002	0.089	0.049	0.15
	1995/1996 spring flow average	0.17	133	24.5	0.004	0.007	0.001	0.021	0.013	0.025	0.006	0.24	0.16	0.41
	% of 1995 Peak Flow at NG-1	65.2	79.5	1.53	21.7	28.3	0.21	7.83	0.11	0.26	3.60	55.5	0.20	0.58
	% of 1996 Peak Flow at NG-1	11.1	396	0.37	5.56	44.4	0.047	0.14	0.030	0.077	1.20	28.6	0.036	0.11
	% of 1995/1996 spring flow average at NG-1	40.5	15.9	0.73	17.0	4.83	0.10	1.85	0.051	0.11	2.02	20.6	0.10	0.26
NG-5	1996 Peak Flow	0.004	0.26	75.5	0.004	0.004	0.049	0.047	0.13	0.15	0.016	0.028	6.71	5.83
	% of 1996 Peak Flow at NG-1	0.89	2.13	3.42	74.7	80.0	5.39	4.96	1.07	1.24	10.1	8.89	4.94	4.33
IHW-1	1995 Peak Flow	0.2	17.3	281	0.001	0.001	0.065	0.076	0.092	0.11	0.037	0.11	12.2	12.3
	1996 Peak Flow	0.709	19.1	650	0.004	0.004	0.15	0.15	0.24	0.26	0.12	0.62	23.8	25.4
	spring flow average	1.58	912	1653	0.009	0.18	0.47	0.55	0.80	0.95	0.28	14.3	80.7	83.6
IHW-2	1996 load	0.186	16.1	221	0.001	0.002	0.050	0.050	0.16	0.15	0.055	0.089	7.85	8.23
	% of 1996 load measured at IHW-1	26.2	83.9	34.0	26.2	52.5	32.8	32.8	65.6	60.3	45.1	14.4	33.0	32.3

Source: TerraMatrix/SMI 1995

TABLE 3 (Continued)

SURFACE WATER COC LOADINGS (lbs/day)

Location	Sample ID	Flow (cfs)	TSS	Sulfate	As, diss	As, total	Cd, diss	Cd, total	Cu, diss	Cu, total	Pb, diss	Pb, total	Zn, diss	Zn, total
IHW-3	1996	0.277	44.8	284	0.001	0.001	0.060	0.058	0.21	0.22	0.081	0.19	9.94	10.9
	% of 1996 load measured at IHW-1	39.1	234	43.7	39.1	39.1	39.1	38.1	85.5	84.0	50.1	30.9	41.8	42.8

Source: TerraMatrix/SMO 1998

TABLE 4
GEOCHEMICAL DATA FOR WASTE ROCK SOURCES IN WHITES GULCH[1]

ABA Analysis	Sample Site UCG-104[2]	Sample Site UCG-92ANC[3]	Sample Site UCG92-ASC[3]
Sulfur, SO_4 (%)	0.63	0.22	0.42
Sulfur, Pyrite & Organic (%)	1.06	0.28	0.57
Sulfur, Total (%)	1.69	0.5	0.99
AGP (T/KT)	52.8	15.6	30.9
Neutralizing Potential (%$CaCO_3$)	<0.1	<0.1	<0.1
ANP (T/KT)	0	0	0
NNP (T/KT)	-52.8	-15.6	-30.9
EPA Method 1312 Extracted Leachate Analysis (mg/l unless noted)			
Arsenic	<0.001	<0.001	<0.001
Cadmium	0.003	0.003	<0.003
Calcium	14.3	6.6	0.8
Iron	0.739	0.066	2.53
Lead	0.02	<0.02	1.59
Magnesium	3.69	1.88	0.48
Mercury	<0.0002	<0.0002	<0.0002
Potassium	1.64	1.85	2.08
Sodium	2.25	2.02	2.2
Zinc	0.411	0.571	0.325
pH (units)	3.2 s.u.	3.8 s.u.	3.2 s.u.
Alkalinity (mg/l as $CaCO_3$)	<2	<2	2
TDS	124	56	62
Chloride	<1	<1	<1
Sulfate	148	66	102
Total Metals (mg/kg)			
Arsenic	41.9	20.9	12.8
Cadmium	0.36	0.32	0.33
Lead	138	174	701
Zinc	252	72.9	34.6

Notes:
1. Source: *Draft-Operable Units 4, 8, and 10 Reconnaissance Report (TerraMatrix/SMI. 1995d).*
2. This waste rock pile is also referred to as the Agwalt waste rock pile.
3. This waste rock pile is also referred to as the Printer Girl waste rock pile.

AGP = Acid generation potential
ANP = Acid neutralizaiton potential
NNP = Net neutralization potential
T/KT = Tons per 1,000 tons
mg/l = milligrams per liter
mg/kg = milligrams per kilogram
s.u. = standard units

"<" indicates that the reported value is less than the instrument detection limit (IDL).

Source: TerraMatrix/SMI 1998

TABLE 5
GEOCHEMICAL DATA FOR WASTE ROCK IN THE NUGGET GULCH AND AY-MINNIE SUB-BASINS

ABA Analysis	UCG-79 (North Moyer)	UCG-80 (Moyer)	UCG-85 (North Mike)	UCG-81 (AY-Minnie)
Sulfur, SO_4 (%)	2.27	0.86	1.79	1.04
Sulfur, Pyrite & Organic(%)	3.63	1.15	3.58	1.06
Sulfur, Total (%)	5.9	2.01	5.37	2.1
AGP (T/KT)	184.4	62.8	167.8	65.6
Nuet. Potential (% $CaCO_3$)	13.5	5.5	0.1	13.2
ANP (T/KT)	135	55	0	132
NNP (T/KT)	-49.4	-7.8	-167.8	66.4
EPA Method 1312 Extracted Leachate Analyses (mg/l unless noted otherwise)				
Arsenic	<0.001	<0.001	0.002	<0.001
Cadmium	0.062	0.009	0.081	0.395
Calcium	460	117	167	214
Iron	0.02	0.017	16.2	0.012
Lead	0.02	<0.02	1.04	0.082
Magnesium	30	15.3	7.77	37.8
Mercury	<0.0002	<0.0002	<0.0002	<0.0002
Potassium	0.34	0.477	1.28	0.99
Sodium	1.59	1.49	2.71	1.78
Zinc	1.92	0.123	10.8	25.3
pH	6.2 s.u.	6.3 s.u.	2.7 s.u.	5.7 s.u.
Alkalinity	40	35	<2	15
TDS	2110	564	1050	1210
Chloride	<1	<1	1	1
Sulfate	1320	352	100	843
Total Metals (mg/kg)				
Arsenic	304	145	227	212
Cadmium	253	47	3	113
Lead	4,460	2,940	2,090	11.4
Zinc	28,100	8,160	783	18,000

Notes: 1) Source: *Draft Operable Units 4, 8, and 10 Reconnaissance Report (TerraMatrix/SMI, 1995d).*

AGP = Acid generation potential
ANP = Acid neutralization potential
NNP = Net neutralization potential
T/KT = Tons per 1,000 tons
mg/l = milligram per liter
mg/kg = milligram per kilogram
s.u. = standard units
"<" = indicates that the value is less than the instrument detection limit.

Source: TerraMatrix/SMI 1998

TABLE 6
WASTE ROCK PILE UCG-12 GEOCHEMICAL DATA[1]

ABA Analysis	
Sulfur, SO_4 (%)	3.09
Sulfur, Pyrite & Organic(%)	2.04
Sulfur, Total (%)	5.13
AGP (T/KT)	160.3
Neut. Potential (% $CaCO_3$)	4.4
ANP (T/KT)	44
NNP (T/KT)	-116.3
EPA Method 1312 Extracted Leachate Analyses (mg/l unless noted)	
Arsenic	<0.001
Cadmium	0.137
Calcium	518
Iron	0.084
Lead	0.119
Magnesium	43.3
Mercury	<0.0002
Potassium	0.54
Sodium	1.92
Zinc	5.21
pH (units)	6.9 s.u.
Alkalinity (mg/l as $CaCO_3$)	30
TDS	2520
Chloride	<1
Sulfate	1710
Total Metals (mg/kg)	
Arsenic	290
Cadmium	131
Lead	36,100
Zinc	19,300

Notes: 1) Source: *Draft-Operable Units 4, 8, and 10 Reconnaissance Report (TerraMatrix/SMI 1995d).*

AGP = Acid generation potential
ANP = Acid neutralization potential
NNP = Net neutralization potential
T/KT = Tons per 1,000 tons
mg/l = milligram per liter
mg/kg = milligram per kilogram
s.u. = standard units
"<" = indicates the value is less than the instrument detection limit.

Source: TerraMatrix/SMI 1998

TABLE 7
FLUVIAL TAILING SITE 4 - FLUVIAL TAILING GEOCHEMISTRY DATA

			Total Metals Analysis[1]					EPA Method 1312 Leachate Analysis[2]			
Sample Location[3]	Depth Interval	Sample Type	Arsenic	Cadmium	Copper	Lead	Zinc	Arsenic	Cadmium	Lead	Zinc
Tailing RI Geochemical Samples[4]											
Composite[5]	0 - 0.15'	STC[6]	248	516	271	13200	11300	NM	NM	NM	NM
F4B1	0 - 2'	T[7]	65	- 32	87.9	181	209	- 0.01	0.0159	- 0.003	2.08
F4B1	10 - 12.7'	FS[8]	- 8.6	24.4	339	R	9060	- 0.01	0.870	0.0191	18.6
F4B2	0 - 2'	FS	347	131	NR	17200	2360	- 0.001	0.0789	9.85	8.88
F4B2	8 - 10'	FS	5.9	- 0.56	NR	99.5	190	- 0.01	- 0.005	- 0.001	0.125
F4B3	0 - 2'	T	347	114	NR	18900	2140	- 0.01	0.0971	11.4	6.35
F4B3	8 - 8.8'	FS	6	166	NR	1130	7170	- 0.01	- 0.005	-0.001	- 0.02
F4B4	0 - 2'	T	232	98	NR	14100	18900	- 0.01	0.0304	12.7	4.02
F4B4	10 - 11.8'	FS	3.5	54.3	NR	147	5800	- 0.01	- 0.005	- 0.003	0.101
F4B5	0 - 2'	T	NM	NM	NM	NM	NM	- 0.01	0.492	8.31	4.98
F4B5	2 - 4'	FS	311	501	NR	30100	54900	- 0.01	0.919	4.90	14.1
Terrestrial Ecosystem Risk Assessment Geochemical Samples[9]											
UCG65E	0 - 0.5'	STC	232	24	138	9862	5646	NM	NM	NM	NM
UCG65F	0 - 0.5'	STC	423	86	108	14551	16287	NM	NM	NM	NM
UCG65H	0 - 0.5'	STC	226	17	197	7574	3743	NM	NM	NM	NM
UCG65I	0 - 0.5'	STC	487	24	367	39608	5499	NM	NM	NM	NM

Notes:
1) Total metals analysis results are in mg/l.
2) EPA Method 1312 analysis results are in mg/kg.
3) Sample locations are shown on Figure 2.7, Fluvial Tailing Site 4 Geochemical Sample Locations.
4) Source: Tailing Disposal Area RI (WCC, 1994a).
5) Composite sample: 10 surface samples (0 - 2 inches) were collected and composited as a single sample as described in the Tailing RI (WCC, 1994a).
6) STC - Surface tailing composite sample.
7) T - Subsurface sample, collected at a depth of 0 - 2 feet.
8) FS - Foundation soil sample, sample was collected from foundation soil below the fluvial tailing and intermixed fluvial tailing/fluvial sediment material.
9) Source: Screening-Level Ecological Risk Assessment, Operable Unit No. 4, California Gulch Superfund Site (Stoller, 1996).

"-" - indicates that the reported value is below the instrument detection limit.
NM - Not measured.
NR - Not reported.

Source: TerraMatrix/SMI 1998

TABLE 8
GEOCHEMICAL DATA FOR WASTE ROCK SOURCES SAMPLED IN FLUVIAL SITE 4 AND SOUTH AREA[1]

ABA Analysis	Sample Site UCG-65	Sample Site UCG-75	Sample Site UCG-98
Sulfur, SO_4 (%)	0.63	3.01	0.74
Sulfur, Pyrite & Organic(%)	0.3	1.54	0.06
Sulfur, Total (%)	0.33	1.47	0.68
AGP (T/KT)	19.7	94.1	23.1
Neut. Potential (% $CaCO_3$)	33.9	11.4	0.69
AN (T/KT)	339	114	639
NNP (T/KT)	319.3	19.9	17.1
EPA Method 1312 Extracted Leachate Analyses (mg/l unless noted)			
Arsenic	<0.001	<0.001	<0.001
Cadmium	0.013	0.342	<0.003
Calcium	40.8	249	1.9
Iron	<0.01	0.014	3.21
Lead	<0.02	0.124	<0.02
Magnesium	8.87	32.2	0.542
Mercury	<0.0002	<0.0002	<0.0002
Potassium	1.52	0.772	0.866
Sodium	0.492	1.872	1.932
Zinc	0.058	29.88	0.039
pH (units)	7.4 s.u.	5.8 s.u.	5.9 s.u.
Alkalinity (mg/l as $CaCO_3$)	30	25	5
TDS	200	1330	18
Chloride	<1	<1	<1
Sulfate	119	878	6
Total Metals (mg/kg)			
Arsenic	264	924	28.2
Cadmium	121	96.6	2.9
Lead	15,100	20,800	972
Zinc	29,500	16,700	777

Notes: 1) Source: *Draft-Operable Units 4, 8, and 10 Reconnaissance Report (TerraMatrix/SMI, 1995d).*

AGP = Acid generalization potential
ANP = Acid neutralization potential
NNP = Net neutralization potential
T/KT = Tons per 1,000 tons
mg/l = milligram per liter
mg/kg = milligram per kilogram
s.u. = standard units
"<" = indicates the value is less than the instrument detection limit.

Source: TerraMatrix/SMI 1998

TABLE 9
CULTURAL RESOURCES
(Page 1 of 2)

Number	Abbreviated Description/name	Eligible/ Contributing	Potential Adverse Effect & expected year of impact
5LK.805		no/no	no
5LK.846		yes/yes	no
5LK.851		yes/yes	no
5LK.862		no/yes	yes (98)
5LK.919		no/no	no
5LK.381		yes/yes	no
5LK.383		no/yes	yes (99)
5LK.708		yes/yes	no
5LK.1204		no/yes	yes (98)
5LK.1205		no/yes	yes (98)
5LK.1206		no/yes	yes (98)
5LK.1207		no/yes	yes (98)
5LK.1208		no/yes	yes (98)
5LK.1209		yes/yes	no
5LK.1210		yes/yes	no
5LK.1211		yes/yes	no
5LK.1212		no/yes	no
5LK.1213		no/yes	no
5LK.1214		yes/yes	no
5LK.1215		no/yes	no
5LK.1216		no/yes	no
5LK.1217		yes/yes	no
5LK.1218		yes/yes	no
5LK.1219		no/yes	no
5LK.1220		no/yes	no

TABLE 9
CULTURAL RESOURCES
(Page 2 of 2)

5LK.1221	no/yes	no
5LK.1222	no/yes	no
5LK.1223	no/yes	no
5LK.834	no/yes	no
5LK.1245	no/yes	no
5LK.1246	yes/yes	no
5LK.1224	no/yes	yes (99)
5LK.1225	no/yes	yes (99)
5LK.1226	no/yes	yes (99)
5LK.1227	no/yes	yes (99)
5LK.1228	no/yes	yes (99)
5LK.1229	no/yes	yes (99)
5LK.1230	no/yes	yes (99)
5LK.1231	no/yes	yes (99)
5LK.1232	no/yes	yes (99)
5LK.1233	no/yes	yes (99)

TABLE 10
COMPARISON OF ALTERNATIVES FOR THE GARIBALDI SUB-BASIN WASTE ROCK - NCP CRITERIA

	Alternative 1 No Action	Alternative 2 Diversion of Surface Water and Stream Channel Reconstruction	Alternative 3 Diversion of Surface Water and Selected Removal
Overall Protection of Human Health and the Environment	Does not meet RAOs.	Involves diversion of surface and portal flows minimizing leaching and erosional releases associated with these flow components. Direct precipitation would continue to infiltrate and contribute to erosional releases.	Same as Alternative 2.
Compliance with ARARs	Not an issue.	Complies with ARARs.	Complies with ARARs.
Long-Term Effectiveness and Permanence	No change in long-term effectiveness.	Effective in diverting, and stable under, the 100-year, 24-hour event. Effective in diverting surface runon around the waste rock, but does not prevent direct precipitation from infiltrating through the waste rock.	Same as Alternative 2.
Reduction of Toxicity, Mobility, or Volume through Treatment	Would not reduce the toxicity, mobility, or volume of waste rock and does not include treatment.	Overall volume of water contact waste rock would be reduced, thus reducing leaching and erosional releases from the site.	Same as Alternative 2.
Short-Term Effectiveness	No disturbance to the community. Not effective in reducing short-term risk.	Potential risks to the community include dust emissions and increased road traffic during mobilization and demobilization.	Same as Alternative 2.
Implementability	Not an issue.	Technologies are common and widely accepted. Reliability of design and implementation based on established practice. Unusual permits are not anticipated.	Same as Alternative 2.
Cost[1]	$0	$130,510	$138,413

Source: TerraMatrix/SMI 1998

[1]The No Action alternative will incur incidental costs related to the 5-year review, monitoring and administrative issues.

TABLE 11
COMPARISON OF ALTERNATIVES FOR THE PRINTER GIRL WASTE ROCK - NCP CRITERIA

	Alternative 1 No Action	Alternative 2 Stream Channel Reconstruction	Alternative 3 Stream Channel Reconstruction and Regrading	Alternative 4 Waste Rock Removal
Overall Protection of Human Health and the Environment	Does not meet the RAOs.	Reduces erosion and releases to surface water and groundwater associated with stream flow but not precipitation. Does not address wind erosion.	Similar to Alternative 2, except regrading would help reduce infiltration associated with precipitation. Stability of pile would increase.	All RAOs would be achieved. Provides highest level of protection.
Compliance with ARARs	Not an issue.	Complies with all ARARs.	Complies with all ARARs.	Complies with all ARARs
Long-Term Effectiveness and Permanence	No change in long-term effectiveness.	Minimizes leaching and erosion associated with stream flow but does not prevent infiltration of precipitation through the waste rock.	Similar to Alternative 2 except infiltration would be reduced and stability increased.	Reduces leaching and erosional releases by removing waste rock.
Reduction of Toxicity, Mobility, or Volume through Treatment	Would not reduce the toxicity, mobility, or volume of waste rock. Does not include treatment.	Overall volume of water contacting waste rock would be reduced. Mobility of contaminants from the site would also be reduced. Toxicity is unchanged and treatment is not included.	Overall volume of water contacting waste rock would be reduced. Mobility of contaminants from the site would also be reduced. Toxicity is unchanged and treatment is not included.	Reduces leaching and erosional releases by removing waste rock.
Short-Term Effectiveness	No disturbance to the community. Not effective in reducing short-term risk to the environment.	Engineering controls would be used to reduce the short-term risk to the community due to dust emissions and exposure of workers to contaminants. Road traffic would increase over the short-term.	Engineering controls would be used to reduce the short-term risk to the community due to dust emissions and exposure of workers to contaminants. Road traffic would increase over the short-term.	Similar to Alternatives 2 and 3, except greater impacts to the community and workers from increased traffic and potential dust emissions Engineering controls would be implemented as in Alternatives 2 and 3.
Implementability	Not an issue.	Technologies are common and widely accepted. Unusual permits are not anticipated.	Technologies are common and widely accepted. Unusual permits are not anticipated.	Technologies are common and widely accepted. Unusual permits are not anticipated.
Cost[1]	$0	$54,900	$55,400	$99,300

Source: TerraMatrix/SMI 1998

[1]The No Action alternative will incur incidental costs related to the 5-year review, monitoring and administrative issues.

TABLE 12
COMPARISON OF ALTERNATIVES FOR THE NUGGET GULCH WASTE ROCK - NCP CRITERIA

	Alternative 1 No Action	Alternative 2 Diversion Ditches	Alternative 3 Diversion Ditches and Waste Rock Regrading	Alternative 4 Diversion Ditches, Consolidation, and Cover
Overall Protection of Human Health and the Environment	Does not meet the RAOs.	Reduces erosion and releases to surface water and groundwater associated with stream flow but not precipitation. Does not address wind erosion.	Similar to Alternative 2, except regrading would help reduce infiltration associated with precipitation. Stability of pile would increase.	Similar to Alternative 2, except infiltration would be greatly reduced and erosional releases would be minimized. Wind erosion would be addressed through cover.
Compliance with ARARs	Not an issue.	Complies with all ARARs.	Complies with all ARARs.	Complies with all ARARs.
Long-Term Effectiveness and Permanence	No change in long-term effectiveness.	Minimizes leaching and erosion associated with stream flow but does not prevent precipitation from infiltrating through the waste rock.	Similar to Alternative 2 except stability would be increased.	Similar to Alternative 2, except erosional releases would be minimized by construction of simple cover and revegetation.
Reduction of Toxicity, Mobility, or Volume through Treatment	Would not reduce the toxicity, mobility, or volume of waste rock. Does not include treatment.	Overall volume of water contacting waste rock would be reduced. Mobility of contaminants from the site would also be reduced. Toxicity is unchanged and treatment is not included.	Overall volume of water contacting waste rock would be reduced. Mobility of contaminants from the site would also be reduced. Toxicity is unchanged and treatment is not included.	Similar to Alternatives 2 and 3, except simple cover over consolidated waste rock would even further reduce leaching and loading from the site.
Short-Term Effectiveness	No disturbance to the community. Not effective in reducing short-term risk to the environment.	Engineering controls would be used to reduce the short-term risk to the community due to dust emissions and exposure of workers to contaminants. Road traffic would increase over the short-term.	Engineering controls would be used to reduce the short-term risk to the community due to dust emissions and exposure of workers to contaminants. Road traffic would increase over the short-term.	Similar to Alternatives 2 and 3, except greater impacts to the community and workers from increased traffic and potential dust emissions. Engineering controls would be implemented as in Alternatives 2 and 3.
Implementability	Not an issue.	Technologies are common and widely accepted. Unusual permits are not anticipated.	Technologies are common and widely accepted. Unusual permits are not anticipated.	Technologies are common and widely accepted. Unusual permits are not anticipated
Cost[1]	$0	$299.026	$369.702	$800.012

Source: TerraMatrix/SMI 1998

[1]The No Action alternative will incur incidental costs related to the 5-year review, monitoring and administrative issues.

TABLE 13
COMPARISON OF ALTERNATIVES FOR THE AY-MINNIE - NCP CRITERIA

	Alternative 1 No Action	Alternative 2 Diversion Ditches	Alternative 3 Diversion Ditches and Regrading	Alternative 4 Diversion Ditches and Road Reconstruction
Overall Protection of Human Health and the Environment	Does not meet the RAOs.	Reduces erosion and releases to surface water and groundwater associated with stream flow but not precipitation. Does not address wind erosion.	Similar to Alternative 2, except regrading would help reduce infiltration associated with precipitation. Stability of pile would increase.	Similar to Alternative 2, except realignment of County Road 2 adds further protection to stability of timber cribbing.
Compliance with ARARs	Not an issue.	Complies with all ARARs.	Complies with all ARARs.	Complies with all ARARs.
Long-Term Effectiveness and Permanence	No change in long-term effectiveness.	Minimizes leaching and erosion associated with stream flow but does not prevent precipitation from infiltrating through the waste rock.	Similar to Alternative 2 except stability would be increased.	Similar to Alternative 2, except stability of timber cribbing is addressed.
Reduction of Toxicity, Mobility, or Volume through Treatment	Would not reduce the toxicity, mobility, or volume of waste rock. Does not include treatment.	Overall volume of water contacting waste rock would be reduced. Mobility of contaminants from the site would also be reduced. Toxicity is unchanged and treatment is not included.	Overall volume of water contacting waste rock would be reduced. Mobility of contaminants from the site would also be reduced. Toxicity is unchanged and treatment is not included.	Overall volume of water contacting waste rock would be reduced. Mobility of contaminants from the site would also be reduced. Toxicity is unchanged and treatment is not included.
Short-Term Effectiveness	No disturbance to the community. Not effective in reducing short-term risk to the environment.	Engineering controls would be used to reduce the short-term risk to the community due to dust emissions and exposure of workers to contaminants. Road traffic would increase over the short-term.	Engineering controls would be used to reduce the short-term risk to the community due to dust emissions and exposure of workers to contaminants. Road traffic would increase over the short-term.	Similar to Alternatives 2 and 3, except greater impacts to traffic and greater potential for dust emission during realignment of County Road 2. Engineering controls would be implemented as in Alternatives 2 and 3.
Implementability	Not an issue.	Technologies are common and widely accepted. Unusual permits are not anticipated.	Technologies are common and widely accepted. Unusual permits are not anticipated.	Technologies are common and widely accepted. Unusual permits are not anticipated.
Cost[1]	$0	$169,081	$184,131	$240,820

Source: TerraMatrix/SMI 1998

[1]The No Action alternative will incur incidental costs related to the 5-year review, monitoring and administrative issues.

TABLE 14
COMPARISON OF ALTERNATIVES FOR THE IRON HILL WASTE ROCK - NCP CRITERIA

	Alternative 1 No Action	Alternative 2 Diversion Ditches	Alternative 3 Regrading and Cover	Alternative 4 Waste Rock Consolidation
Overall Protection of Human Health and the Environment	Does not meet the RAOs.	Reduces erosion and releases to surface water and groundwater associated with stream flow but not precipitation. Does not address wind erosion.	Regrading of one pile and covering of the other pile would help reduce infiltration associated with precipitation.	Infiltration would be greatly reduced and erosional releases would be minimized. Wind erosion would be addressed through cover.
Compliance with ARARs	Not an issue.	Complies with all ARARs.	Complies with all ARARs.	Complies with all ARARs.
Long-Term Effectiveness and Permanence	No change in long-term effectiveness.	Minimizes leaching and erosion associated with stream flow but does not prevent precipitation from infiltrating through the waste rock.	Erosional releases and infiltration would be minimized by regrading and construction of simple cover.	Erosional releases and infiltration would be further minimized by consolidation and construction of simple cover.
Reduction of Toxicity, Mobility, or Volume through Treatment	Would not reduce the toxicity, mobility, or volume of waste rock. Does not include treatment.	Overall volume of water contacting waste rock would be reduced. Mobility of contaminants from the site would also be reduced. Toxicity is unchanged and treatment is not included.	Surface area exposed to water would be reduced, thus reducing volume of water contacting waste rock. Mobility of contaminants from the site would also be reduced. Toxicity is unchanged and treatment is not included.	Similar to Alternative 3, except simple cover over consolidated waste rock would even further reduce leaching and loading from the site.
Short-Term Effectiveness	No disturbance to the community. Not effective in reducing short-term risk to the environment.	Engineering controls would be used to reduce the short-term risk to the community due to dust emissions and exposure of workers to contaminants. Road traffic would increase over the short-term.	Engineering controls would be used to reduce the short-term risk to the community due to dust emissions and exposure of workers to contaminants. Road traffic would increase over the short-term.	Engineering controls would be used to reduce the short-term risk to the community due to dust emissions and exposure of workers to contaminants. Road traffic would increase over the short-term.
Implementability	Not an issue.	Technologies are common and widely accepted. Unusual permits are not anticipated.	Technologies are common and widely accepted. Unusual permits are not anticipated.	Technologies are common and widely accepted. Unusual permits are not anticipated.
Cost[1]	$0	$117,189	$159,776	$227,759

Source: TerraMatrix/SMI 1998

[1]The No Action alternative will incur incidental costs related to the 5-year review, monitoring and administrative issues.

TABLE 15
COMPARISON OF ALTERNATIVES FOR THE CALIFORNIA GULCH WASTE ROCK - NCP CRITERIA

	Alternative 1 **No Action**	**Alternative 2** **Channel Reconstruction**	**Alternative 3** **Selected Regrading**	**Alternative 4** **Selected Waste Rock Removal**
Overall Protection of Human Health and the Environment	Does not meet the RAOs.	Reduces erosion and releases to surface water and groundwater associated with stream flow but not precipitation. Does not address wind erosion.	Regrading would help reduce infiltration associated with precipitation. Does not address run-on or wind erosion.	All RAOs would be achieved by removing source at those locations selected for removal. Provides highest level of protection.
Compliance with ARARs	Not an issue.	Complies with all ARARs.	Complies with all ARARs.	Complies with all ARARs.
Long-Term Effectiveness and Permanence	No change in long-term effectiveness.	Minimizes leaching and erosion associated with stream flow but does not prevent precipitation from infiltrating through the waste rock.	Erosional releases and infiltration would be minimized by regrading and stability of piles would be increased.	Reduces leaching and erosional releases by removing waste rock.
Reduction of Toxicity, Mobility, or Volume through Treatment	Would not reduce the toxicity, mobility, or volume of waste rock. Does not include treatment.	Overall volume of water contacting waste rock would be reduced. Mobility of contaminants from the site would also be reduced. Toxicity is unchanged and treatment is not included.	Surface exposed to water would be reduced, thus reducing volume. Mobility of contaminants from the site would also be reduced. Toxicity is unchanged and treatment is not included.	Reduces leaching and erosional releases by removing waste rock.
Short-Term Effectiveness	No disturbance to the community. Not effective in reducing short-term risk to the environment.	Engineering controls would be used to reduce the short-term risk to the community due to dust emissions and exposure of workers to contaminants. Road traffic would increase over the short-term.	Engineering controls would be used to reduce the short-term risk to the community due to dust emissions and exposure of workers to contaminants. Road traffic would increase over the short-term.	Similar to Alternatives 2 and 3, except greater impacts to the community and workers from increased traffic and potential dust emissions. Engineering controls would be implemented as in Alternatives 2 and 3.
Implementability	Not an issue.	Technologies are common and widely accepted. Unusual permits are not anticipated.	Technologies are common and widely accepted. Unusual permits are not anticipated.	Technologies are common and widely accepted. Unusual permits are not anticipated.
Cost[1]	$0	$548,341	$67,085	$425,731

Source: TerraMatrix/SMI 1998

[1]The No Action alternative will incur incidental costs related to the 5-year review, monitoring and administrative issues.

TABLE 16
COMPARISON OF ALTERNATIVES FOR FLUVIAL TAILING SITE 4 - NCP CRITERIA

	Alternative 1 No Action	Alternative 2 Channel Reconstruction and Revegetation	Alternative 3 Channel Reconstruction, Sediment Dams and Wetlands	Alternative 4 Channel Reconstruction, Revegetation,Sediment Dams and Wetlands	Alternative 5 Channel Reconstruction, Revegetation, Sediment Dams, Wetlands, and Selected Surface Material Removal
Overall Protection of Human Health and the Environment	Does not meet the RAOs.	Reduces erosion and releases to surface water and groundwater associated with stream flow but not precipitation. Does not address wind erosion.	Reduces erosion and releases to surface water and groundwater associated with stream flow but not precipitation. Does not address wind erosion.	Reduces erosion and releases to surface water and groundwater associated with stream flow but not precipitation. Does not address wind erosion.	Alternative 5 combines the approaches described for Alternatives 2, 3 and 4. The channel of upper California Gulch would be reconstructed, disturbed areas amended as necessary and revegetated, sediment control dams constructed and wetlands constructed.
Compliance with ARARs	Not an issue.	Complies with all ARARs.	Complies with all ARARs.	Complies with all ARARs.	Same as Alternative 2.
Long-Term Effectiveness and Permanence	No change in long-term effectiveness.	Minimizes leaching and erosion associated with stream flow but does not prevent precipitation from infiltrating through the waste rock.	Similar to Alternative 2 except sediment dams reduce release of sediment downstream.	Combines effectiveness described for Alternatives 2 and 3.	Combines effectiveness described for Alternatives 2, 3 and 4.
Reduction of Toxicity, Mobility, or Volume through Treatment	Would not reduce the toxicity, mobility, or volume of waste rock. Does not include treatment.	Overall volume of water contacting waste rock would be reduced. Mobility of contaminants from the site would also be reduced. Toxicity is unchanged and treatment is not included.	Overall volume of water contacting waste rock would not be reduced but mobility of contaminants from the site would be reduced. Toxicity is unchanged and treatment is not included.	Overall volume of water contacting waste rock would be reduced. Mobility of contaminants from the site would also be reduced. Toxicity is unchanged and treatment is not included.	Combines reductions described for Alternatives 2, 3 and 4.
Short-Term Effectiveness	No disturbance to the community. Not effective in reducing short-term risk to the environment.	Engineering controls would be used to reduce the short-term risk to the community due to dust emissions and exposure of workers to contaminants. Road traffic would increase over the short-term.	Engineering controls would be used to reduce the short-term risk to the community due to dust emissions and exposure of workers to contaminants. Road traffic would increase over the short-term.	Engineering controls would be used to reduce the short-term risk to the community due to dust emissions and exposure of workers to contaminants. Road traffic would increase over the short-term.	Same as Alternatives 2, 3 and 4.
Implementability	Not an issue.	Technologies are common and widely accepted. Unusual permits are not anticipated.	Technologies are common and widely accepted. Unusual permits are not anticipated.	Technologies are common and widely accepted, except wetlands would require studies. Permit may be required for haulage.	Same as Alternatives 2, 3 and 4.
Cost[1]	$0	$2,393,933	$2,226,929	$2,544,293	$2,653,493

Source: TerraMatrix/SMI 1998

[1]The No Action alternative will incur incidental costs related to the 5-year review, monitoring and administrative issues.

TABLE 17
COST SUMMARY: GARIBALDI SUB-BASIN WASTE ROCK ALTERNATIVE 2 - SURFACE WATER DIVERSION, STREAM CHANNEL RECONSTRUCTION

California Gulch NPL Site
OU4 - FFS - UCG -109A
Alternative 2 - Surface Water Diversion, Stream Channel Reconstruction

DIRECT CAPITAL COSTS

Component	Unit	Unit Cost	Quantity	Total Cost		
Channel Construction						
Rip Rap	cy			$6,300		
Lined	sf			$19,125		
Unlined	sf			$2,850		
Culvert	lf			$1,500		
Construct Access Road	lf			$1,575		
Stream Reconstruction	lf			$13,125		
Waste Rock Stabilization	lf			$3,500		
Cultural Resources	lump			$5,000		
Dust Control	lump			$2,000		
Sediment Control	lump			$2,000		
TOTAL DIRECT CAPITAL COSTS					$56,975	
INDIRECT CAPITAL COSTS						
Engineering and Design (10% of Direct)				$5,698		
Contingency (25% of Direct)				$14,244		
Legal Fees (5% of Direct)				$2,849		
Regulatory Cost (5% of Direct)				$2,849		
Mobilization and Demobilization (20% of Direct)				$11,395		
EPA Fees (20% of Engineering, 5% of Direct)				$3,988		
TOTAL INDIRECT CAPITAL COSTS					$41,022	
TOTAL CAPITAL COSTS						$97,997

POST REMEDIATION SITE CONTROL COSTS

Discount 7.00% for present worth

Component	Unit	Unit Cost	Each	Each/year	$/year	Years	Present Worth	
DIRECT OPERATION AND MAINTENANCE								
Inspection	hour	$40	8	4	$1,280	30	$15,884	
Erosion Repair	lump	$2,000	1	1	$2,000	5	$8,200	
Vegetation Repair	lump	$0	1	1	$0	5	$0	
TOTAL DIRECT O&M PRESENT WORTH							$24,084	

Component	Present Worth	
INDIRECT OPERATION AND MAINTENANCE COSTS		
Administration (5% of Annual Direct O&M)	$1,204	
Misc. Fees (5% of Annual Direct O&M)	$1,204	
Reserve (25% of Annual Direct O&M)	$6,021	
TOTAL INDIRECT O&M PRESENT WORTH	$8,429	
TOTAL OPERATION AND MAINTENANCE PRESENT WORTH		$32,513
GRAND TOTAL		***$130,510***

Source: TerraMatrix/SMI 1998

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TABLE 18
COST SUMMARY: GARIBALDI SUB-BASIN WASTE ROCK ALTERNATIVE 3 - SURFACE WATER DIVERSION, SELECTED REMOVAL

California Gulch NPL Site
OU4 - FFS - UCG -109A
Alternative 3 - Surface Water Diversion, Selected Removal

DIRECT CAPITAL COSTS

Component	Unit	Unit Cost	Quantity	Total Cost		
Channel Construction						
Rip Rap	cy			$2,520		
Lined	sf			$19,125		
Unlined	sf			$2,850		
Culvert	lf			$1,500		
Construct Access Road	lf			$1,575		
Waste Rock Toe Stabilization	lf			$15,000		
Waste Rock Removal	cy			$10,000		
Cultural Resources	lump			$5,000		
Dust Control	lump			$2,000		
Sediment Control	lump			$2,000		
TOTAL DIRECT CAPITAL COSTS					$61,570	
INDIRECT CAPITAL COSTS						
Engineering and Design (10% of Direct)				$6,157		
Contingency (25% of Direct)				$15,393		
Legal Fees (5% of Direct)				$3,079		
Regulatory Cost (5% of Direct)				$3,079		
Mobilization and Demobilization (20% of Direct)				$12,314		
EPA Fees (20% of Engineering, 5% of Direct)				$4,310		
TOTAL INDIRECT CAPITAL COSTS					$44,330	
TOTAL CAPITAL COSTS						$105,900

POST REMEDIATION SITE CONTROL COSTS

Discount 7.00% for present worth

Component	Unit	Unit Cost	Each	Each/year	$/year	Years	Present Worth	
DIRECT OPERATION AND MAINTENANCE								
Inspection	hour	$40	8	4	$1,280	30	$15,884	
Erosion Repair	lump	$2,000	1	1	$2,000	5	$8,200	
Vegetation Repair	lump	$0	1	1	$0	5	$0	
TOTAL DIRECT O&M PRESENT WORTH							$24,084	

Component	Present Worth	
INDIRECT OPERATION AND MAINTENANCE COSTS		
Administration (5% of Annual Direct O&M)	$1,204	
Misc. Fees (5% of Annual Direct O&M)	$1,204	
Reserve (25% of Annual Direct O&M)	$6,021	
TOTAL INDIRECT O&M PRESENT WORTH	$8,429	
TOTAL OPERATION AND MAINTENANCE PRESENT WORTH		$32,513
GRAND TOTAL		$138,413

Source: TerraMatrix/SMI 1998

TABLE 19
COST SUMMARY: PRINTER GIRL WASTE ROCK ALTERNATIVE 2 - STREAM CHANNEL RECONSTRUCTION

California Gulch NPL Site
OU4 - FFS - UCG 92A
Alternative 2 - Stream Channel Reconstruction

DIRECT CAPITAL COSTS

Component	Unit	Unit Cost	Quantity	Total Cost		
Improve Access Road	lf	$3.00	700	$2,100		
Channel Construction						
Riprap Placement	cy	$63.00	240	$15,120		
Cultural Resources	lump	$2,000	1	$2,000		
Dust Control	lump	$2,000	1	$2,000		
Sediment Control	lump	$2,000	1	$2,000		
TOTAL DIRECT CAPITAL COSTS					*$23,220*	

INDIRECT CAPITAL COSTS

Engineering and Design (10% of Direct)	$2,322		
Contingency (25% of Direct)	$5,805		
Legal Fees (5% of Direct)	$1,161		
Regulatory Cost (5% of Direct)	$1,161		
Mobilization and Demobilization (20% of Direct)	$4,644		
EPA Fees (20% of Engineering, 5% of Direct)	$1,625		
TOTAL INDIRECT CAPITAL COSTS		*$16,718*	
TOTAL CAPITAL COSTS			*$39,938*

POST REMEDIATION SITE CONTROL COSTS

Discount 7.00% for present worth

Component	Unit	Unit Cost	Each	Each/year	$/year	Years	Present Worth
DIRECT OPERATION AND MAINTENANCE							
Inspection	hour	$40	8	4	$1,280	4	$4,336
Erosion Repair	lump	$2,000	1	1	$2,000	4	$6,774
Vegetation Repair	lump	$1,200	0	0	$0	4	$0
TOTAL DIRECT O&M PRESENT WORTH							*$11,110*

Component	Present Worth	
INDIRECT OPERATION AND MAINTENANCE COSTS		
Administration (5% of Annual Direct O&M)	$556	
Misc. Fees (5% of Annual Direct O&M)	$556	
Reserve (25% of Annual Direct O&M)	$2,778	
TOTAL INDIRECT O&M PRESENT WORTH	*$3,889*	
TOTAL OPERATION AND MAINTENANCE PRESENT WORTH		*$14,999*

GRAND TOTAL	*$54,937*

Source: TerraMatrix/SMI 1998

TABLE 20
COST SUMMARY: PRINTER GIRL WASTE ROCK ALTERNATIVE 2 - STREAM CHANNEL RECONSTRUCTION AND REGRADING

California Gulch NPL Site
OU4 - FFS - UCG 92A
Alternative 3 - Stream Channel Reconstruction/Regrade Waste Rock

DIRECT CAPITAL COSTS

Component	Unit	Unit Cost	Quantity	Total Cost		
Improve Access Road	lf	$3.00	700	$2,100		
Regrade Waste Rock	cu-yd	$1.00	300	$300		
Channel Construction						
Riprap Placement	cy	$63.00	240	$15,120		
Cultural Resources	lump	$2,000	1	$2,000		
Dust Control	lump	$2,000	1	$2,000		
Sediment Control	lump	$2,000	1	$2,000		
TOTAL DIRECT CAPITAL COSTS					*$23,520*	
INDIRECT CAPITAL COSTS						
Engineering and Design (10% of Direct)				$2,352		
Contingency (25% of Direct)				$5,880		
Legal Fees (5% of Direct)				$1,176		
Regulatory Cost (5% of Direct)				$1,176		
Mobilization and Demobilization (20% of Direct)				$4,704		
EPA Fees (20% of Engineering, 5% of Direct)				$1,646		
TOTAL INDIRECT CAPITAL COSTS					*$16,934*	
TOTAL CAPITAL COSTS						*$40,454*

POST REMEDIATION SITE CONTROL COSTS

Discount 7.00% for present worth

Component	Unit	Unit Cost	Each	Each/year	$/year	Years	Present Worth	
DIRECT OPERATION AND MAINTENANCE								
Inspection	hour	$40	8	4	$1,280	4	$4,336	
Erosion Repair	lump	$2,000	1	1	$2,000	4	$6,774	
Vegetation Repair	lump	$1,200	0	0	$0	4	$0	
TOTAL DIRECT O&M PRESENT WORTH							*$11,110*	

Component	Present Worth	
INDIRECT OPERATION AND MAINTENANCE COSTS		
Administration (5% of Direct O&M)	$556	
Misc. Fees (5% of Direct O&M)	$556	
Reserve (25% of Direct O&M)	$2,778	
TOTAL INDIRECT O&M PRESENT WORTH	*$3,889*	
TOTAL OPERATION AND MAINTENANCE PRESENT WORTH		*$14,999*
GRAND TOTAL		*$55,453*

Source: TerraMatrix/SMI 1998

TABLE 21
COST SUMMARY: PRINTER GIRL WASTE ROCK ALTERNATIVE 4 - WASTE ROCK REMOVAL

California Gulch NPL Site
OU-4 Focused Feasibility Study - UCG 92A
Alternative 4 - Remove Waste Rock in Stream to UCG-71/Revegetate

DIRECT CAPITAL COSTS

Component	Unit	Unit Cost	Quantity	Total Cost		
Construct Access Road	lf	$5.25	700	$3,675		
Channel Construction						
Riprap Placement	cy	$63.00	280	$17,640		
Diversion Ditchs	sq-ft	$5.00	1080	$5,400		
Culverts	lf	$50.00	40	$2,000		
Load and Haul Waste Rock	cu-yd	$10.00	300	$3,000		
Amend Soil and Revegetation	acre	$8,100	1.0	$8,100		
Cultural Resources	lump	$2,000	1	$2,000		
Dust Control	lump	$2,000	1	$2,000		
Sediment Control	lump	$2,000	1	$2,000		
TOTAL DIRECT CAPITAL COSTS					*$45,815*	

INDIRECT CAPITAL COSTS

Engineering and Design (10% of Direct)	$4,582		
Contingency (25% of Direct)	$11,454		
Legal Fees (5% of Direct)	$2,291		
Regulatory Cost (5% of Direct)	$2,291		
Mobilization and Demobilization (20% of Direct)	$9,163		
EPA Fees (20% of Engineering, 5% of Direct)	$3,207		
TOTAL INDIRECT CAPITAL COSTS		*$32,987*	
TOTAL CAPITAL COSTS			*$78,802*

POST REMEDIATION SITE CONTROL COSTS

Discount 7.00% for present worth

Component	Unit	Unit Cost	Each	Each/year	$/year	Years	Present Worth
DIRECT OPERATION AND MAINTENANCE							
Inspection	hour	$40	8	4	$1,280	4	$4,336
Erosion Repair	lump	$2,000	1	1	$2,000	4	$6,774
Vegetation Repair	lump	$1,200	1	1	$1,200	4	$4,065
TOTAL DIRECT O&M PRESENT WORTH							*$15,175*

Component	Present Worth	
INDIRECT OPERATION AND MAINTENANCE COSTS		
Administration (5% of Direct O&M)	$759	
Misc. Fees (5% of Direct O&M)	$759	
Reserve (25% of Direct O&M)	$3,794	
TOTAL INDIRECT O&M PRESENT WORTH	*$5,311*	
TOTAL OPERATION AND MAINTENANCE PRESENT WORTH		*$20,486*
GRAND TOTAL		*$99,288*

Source: TerraMatrix/SMI 1998

TABLE 22
COST SUMMARY: NUGGET GULCH WASTE ROCK ALTERNATIVE 2 - DIVERSION DITCHES

California Gulch NPL Site
OU4 - FFS - NUGGET GULCH
Alternative 2 - Diversion Channels

DIRECT CAPITAL COSTS

Component	Unit	Unit Cost	Quantity	Total Cost		
Improve Access Roads	lf	$3.00	200	$600		
Channel Construction						
Riprap	cy	$63.00	370	$23,310		
Lined	sf	$7.50	1,050	$7,875		
Unlined	sf	$2.00	15,600	$31,200		
Culverts	lf	$50.00	60	$3,000		
Drainage Gravel	cy	$17.00	280	$4,760		
Geotextile	sf	$0.35	6,500	$2,275		
Perf. Drain Pipe	lf	$45.00	250	$11,250		
Cultural Resources	lump	$10,000	1	$10,000		
Dust Control	lump	$5,000	1	$5,000		
Sediment Control	lump	$5,000	1	$5,000		
TOTAL DIRECT CAPITAL COSTS					*$104,270*	

INDIRECT CAPITAL COSTS

Engineering and Design (10% of Direct)	$10,427		
Contingency (25% of Direct)	$26,068		
Legal Fees (5% of Direct)	$5,214		
Regulatory Cost (5% of Direct)	$5,214		
Mobilization and Demobilization (20% of Direct)	$20,854		
EPA Fees (20% of Engineering, 5% of Direct)	$7,299		
TOTAL INDIRECT CAPITAL COSTS		*$75,074*	
TOTAL CAPITAL COSTS			*$179,344*

POST REMEDIATION SITE CONTROL COSTS

Discount 7.00% for present worth

Component	Unit	Unit Cost	Each	Each/year	$/year	Years	Present Worth
DIRECT OPERATION AND MAINTENANCE							
Inspection	hour	$40	24	4	$3,840	30	$47,651
Erosion Repair	lump	$10,000	1	1	$10,000	5	$41,002
Vegetation Repair	lump	$0	1	1	$0	5	$0
TOTAL DIRECT O&M PRESENT WORTH							*$88,653*

Component	Present Worth	
INDIRECT OPERATION AND MAINTENANCE COSTS		
Administration (5% of Direct O&M)	$4,433	
Misc. Fees (5% of Direct O&M)	$4,433	
Reserve (25% of Direct O&M)	$22,163	
TOTAL INDIRECT O&M PRESENT WORTH	*$31,029*	
TOTAL OPERATION AND MAINTENANCE PRESENT WORTH		*$119,682*
GRAND TOTAL		*$299,026*

Source: TerraMatrix/SMI 1998

TABLE 23
COST SUMMARY: NUGGET GULCH WASTE ROCK ALTERNATIVE 3 - DIVERSION DITCHES AND WASTE ROCK REGRADING

California Gulch NPL Site
OU4 - FFS - NUGGET GULCH
Alternative 3 - Regrade UCG-71, 74, 76, 77, 85/Diversion Channels/Terraces

DIRECT CAPITAL COSTS

Component	Unit	Unit Cost	Quantity	Total Cost	
Improve Access Road	lf	$3.00	500	$1,500	
Regrading	cy	$1.00	14,200	$14,200	
Channel Construction					
Riprap	cy	$63.00	370	$23,310	
Lined	sf	$7.50	1,050	$7,875	
Unlined	sf	$2.00	15,600	$31,200	
Culverts	lf	$50.00	60	$3,000	
Construct Terraces	lf	$3.00	600	$1,800	
Amend & Reveg	ac	$8,100	1	$8,100	
Drainage Gravel	cy	$17.00	280	$4,760	
Geotextile	sf	$0.35	6,500	$2,275	
Perf. Drain Pipe	lf	$45.00	250	$11,250	
Cultural Resources	lump	$10,000	1	$10,000	
Dust Control	lump	$5,000	1	$5,000	
Sediment Control	lump	$5,000	1	$5,000	
TOTAL DIRECT CAPITAL COSTS					*$129,270*

INDIRECT CAPITAL COSTS

Engineering and Design (10% of Direct)	$12,927		
Contingency (25% of Direct)	$32,318		
Legal Fees (5% of Direct)	$6,464		
Regulatory Cost (5% of Direct)	$6,464		
Mobilization and Demobilization (20% of Direct)	$25,854		
EPA Fees (20% of Engineering, 5% of Direct)	$9,049		
TOTAL INDIRECT CAPITAL COSTS		*$93,074*	
TOTAL CAPITAL COSTS			*$222,344*

POST REMEDIATION SITE CONTROL COSTS

Discount 7.00% for present worth

Component	Unit	Unit Cost	Each	Each/year	$/year	Years	Present Worth
DIRECT OPERATION AND MAINTENANCE							
Inspection	hour	$40	24	4	$3,840	30	$47,651
Erosion Repair	lump	$10,000	1	1	$10,000	5	$41,002
Vegetation Repair	lump	$5,000	1	1	$5,000	5	$20,501
TOTAL DIRECT O&M PRESENT WORTH							*$109,154*

Component	Present Worth	
INDIRECT OPERATION AND MAINTENANCE COSTS		
Administration (5% of Direct O&M)	$5,458	
Misc. Fees (5% of Direct O&M)	$5,458	
Reserve (25% of Direct O&M)	$27,289	
TOTAL INDIRECT O&M PRESENT WORTH	*$38,204*	
TOTAL OPERATION AND MAINTENANCE PRESENT WORTH		*$147,358*
GRAND TOTAL		*$369,702*

Source: TerraMatrix/SMI 1998

TABLE 24
COST SUMMARY: NUGGET GULCH WASTE ROCK ALTERNATIVE 4 - DIVERSION DITCHES, CONSOLIDATION AND COVER

California Gulch NPL Site
OU4 - FFS - NUGGET GULCH
Alternative 4 - Move UCG-74, 76, 77, 85 to UCG-71/Amend and Revegetate UCG-74, 76, 77, 85/
Regrade UCG-71, Simple Cover, Revegetate UCG-71/Diversion Channels/Terraces

DIRECT CAPITAL COSTS

Component	Unit	Unit Cost	Quantity	Total Cost		
Improve Access Road	lf	$3.00	500	$1,500		
Load and Haul Waste Rock	cy	$5.00	19,250	$96,250		
Amend and Revegetation	ac	$8,100	6.00	$48,600		
Cover Material and Placement	cy	$11.75	8,300	$97,525		
Revegetate UCG-71	ac	$8,100	5.00	$40,500		
Regrading	cy	$1.00	19,250	$19,250		
Channel Construction						
Riprap	cy	$63.00	300	$18,900		
Concrete	sf	$7.50	1,050	$7,875		
Unlined	sf	$2.00	10,400	$20,800		
Culverts	lf	$50.00	60	$3,000		
Terraces	lf	$3.00	1,750	$5,250		
Cultural Resources	lump	$10,000	1	$10,000		
Dust Control	lump	$5,000	1	$5,000		
Sediment Control	lump	$5,000	1	$5,000		
TOTAL DIRECT CAPITAL COSTS					$379,450	

INDIRECT CAPITAL COSTS

Engineering and Design (10% of Direct)	$37,945		
Contingency (25% of Direct)	$94,863		
Legal Fees (5% of Direct)	$18,973		
Regulatory Cost (5% of Direct)	$18,973		
Mobilization and Demobilization (20% of Direct)	$75,890		
EPA Fees (20% of Engineering, 5% of Direct)	$26,562		
TOTAL INDIRECT CAPITAL COSTS		$273,204	
TOTAL CAPITAL COSTS			$652,654

POST REMEDIATION SITE CONTROL COSTS

Discount 7.00% for present worth

Component	Unit	Unit Cost	Each	Each/year	$/year	Years	Present Worth
DIRECT OPERATION AND MAINTENANCE							
Inspection	hour	$40	24	4	$3,840	30	$47,651
Erosion Repair	lump	$10,000	1	1	$10,000	5	$41,002
Vegetation Repair	lump	$5,000	1	1	$5,000	5	$20,501
TOTAL DIRECT O&M PRESENT WORTH							$109,154

Component	Present Worth	
INDIRECT OPERATION AND MAINTENANCE COSTS		
Administration (5% of Direct O&M)	$5,458	
Misc. Fees (5% of Direct O&M)	$5,458	
Reserve (25% of Direct O&M)	$27,289	
TOTAL INDIRECT O&M PRESENT WORTH	$38,204	
TOTAL OPERATION AND MAINTENANCE PRESENT WORTH		$147,358
GRAND TOTAL		$800,012

Source: TerraMatrix/SMI 1998

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TABLE 25
COST SUMMARY: AY-MINNIE WASTE ROCK ALTERNATIVE 2 - DIVERSION DITCHES

California Gulch NPL Site
OU4 FFS - AY-MINNIE
Alternative 2 - Diversion Channels

DIRECT CAPITAL COSTS

Component	Unit	Unit Cost	Quantity	Total Cost		
Channel Construction						
Rip Rap	cy	$63.00	350	$22,050		
Lined	sf	$7.50	5,100	$38,250		
Unlined	sf	$2.00	4,300	$8,600		
Culvert	lf	$50.00	30	$1,500		
Cultural Resources	lump	$5,000	1	$5,000		
Dust Control	lump	$2,000	1	$2,000		
Sediment Control	lump	$2,000	1	$2,000		
TOTAL DIRECT CAPITAL COSTS					*$79,400*	

INDIRECT CAPITAL COSTS

Engineering and Design (10% of Direct)	$7,940		
Contingency (25% of Direct)	$19,850		
Legal Fees (5% of Direct)	$3,970		
Regulatory Cost (5% of Direct)	$3,970		
Mobilization and Demobilization (20% of Direct)	$15,880		
EPA Fees (20% of Engineering, 5% of Direct)	$5,558		
TOTAL INDIRECT CAPITAL COSTS		*$57,168*	
TOTAL CAPITAL COSTS			*$136,568*

POST REMEDIATION SITE CONTROL COSTS

Discount 7.00% for present worth

Component	Unit	Unit Cost	Each	Each/year	$/year	Years	Present Worth	
DIRECT OPERATION AND MAINTENANCE								
Inspection	hour	$40	8	4	$1,280	30	$15,884	
Erosion Repair	lump	$2,000	1	1	$2,000	5	$8,200	
Vegetation Repair	lump	$0	1	1	$0	5	$0	
TOTAL DIRECT O&M PRESENT WORTH							*$24,084*	

Component	Present Worth	
INDIRECT OPERATION AND MAINTENANCE COSTS		
Administration (5% of Direct O&M)	$1,204	
Misc. Fees (5% of Direct O&M)	$1,204	
Reserve (25% of Direct O&M)	$6,021	
TOTAL INDIRECT O&M PRESENT WORTH	*$8,429*	
TOTAL OPERATION AND MAINTENANCE PRESENT WORTH		*$32,513*
GRAND TOTAL		*$169,081*

Source: TerraMatrix/SMI 1998

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TABLE 26
COST SUMMARY: AY-MINNIE WASTE ROCK ALTERNATIVE 3 - DIVERSION DITCHES AND REGRADING

California Gulch NPL Site
OU4 FFS - AY-MINNIE
Alternative 3 - Diversion Channels/Regrading

DIRECT CAPITAL COSTS

Component	Unit	Unit Cost	Quantity	Total Cost		
Channel Construction						
Rip Rap	cy	$63.00	350	$22,050		
Lined	sf	$7.50	5,100	$38,250		
Unlined	sf	$2.00	4,300	$8,600		
Culvert	lf	$50.00	30	$1,500		
Regrading	cy	$1.00	8,750	$8,750		
Cultural Resources	lump	$5,000	1	$5,000		
Dust Control	lump	$2,000	1	$2,000		
Sediment Control	lump	$2,000	1	$2,000		
TOTAL DIRECT CAPITAL COSTS					*$88,150*	

INDIRECT CAPITAL COSTS

Engineering and Design (10% of Direct)	$8,815		
Contingency (25% of Direct)	$22,038		
Legal Fees (5% of Direct)	$4,408		
Regulatory Cost (5% of Direct)	$4,408		
Mobilization and Demobilization (20% of Direct)	$17,630		
EPA Fees (20% of Engineering, 5% of Direct)	$6,171		
TOTAL INDIRECT CAPITAL COSTS		*$63,468*	
TOTAL CAPITAL COSTS			*$151,618*

POST REMEDIATION SITE CONTROL COSTS

Discount 7.00% for present worth

Component	Unit	Unit Cost	Each	Each/year	$/year	Years	Present Worth
DIRECT OPERATION AND MAINTENANCE							
Inspection	hour	$40	8	4	$1,280	30	$15,884
Erosion Repair	lump	$2,000	1	1	$2,000	5	$8,200
Vegetation Repair	lump	$0	1	1	$0	5	$0
TOTAL DIRECT O&M PRESENT WORTH							*$24,084*

Component	Present Worth	
INDIRECT OPERATION AND MAINTENANCE COSTS		
Administration (5% of Direct O&M)	$1,204	
Misc. Fees (5% of Direct O&M)	$1,204	
Reserve (25% of Direct O&M)	$6,021	
TOTAL INDIRECT O&M PRESENT WORTH	*$8,429*	
TOTAL OPERATION AND MAINTENANCE PRESENT WORTH		*$32,513*
GRAND TOTAL		*$184,131*

Source: TerraMatrix/SMI 1998

TABLE 27
COST SUMMARY: AY-MINNIE WASTE ROCK ALTERNATIVE 4 - DIVERSION DITCHES AND ROAD RECONSTRUCTION

California Gulch NPL Site
OU4 FFS - AY-MINNIE
Alternative 4 - Diversion Channels/Realign Road/Sediment Pond

DIRECT CAPITAL COSTS

Component	Unit	Unit Cost	Quantity	Total Cost	
Channel Construction					
Rip Rap	cy	$63.00	350	$22,050	
Lined	sf-wp	$7.50	5,100	$38,250	
Unlined	cy	$2.50	4,300	$10,750	
Culvert	lf	$43.00	30	$1,290	
Road Work					
Earthworks	cy	$1.00	1,342	$1,342	
Sub-Base	cy	$36.50	485	$17,703	
Pavement (3 in)	sy	$5.40	2,912	$15,725	
Sediment Dam	lump	$5,000	1	$5,000	
Cultural Resources	lump	$5,000	1	$5,000	
Dust Control	lump	$2,000	1	$2,000	
Sediment Control	lump	$2,000	1	$2,000	
TOTAL DIRECT CAPITAL COSTS					*$121,109*

INDIRECT CAPITAL COSTS

Engineering and Design (10% of Direct)	$12,111		
Contingency (25% of Direct)	$30,277		
Legal Fees (5% of Direct)	$6,055		
Regulatory Cost (5% of Direct)	$6,055		
Mobilization and Demobilization (20% of Direct)	$24,222		
EPA Fees (20% of Engineering, 5% of Direct)	$8,478		
TOTAL INDIRECT CAPITAL COSTS		*$87,198*	
TOTAL CAPITAL COSTS			*$208,307*

POST REMEDIATION SITE CONTROL COSTS

Discount 7.00% for present worth

Component	Unit	Unit Cost	Each	Each/year	$/year	Years	Present Worth
DIRECT OPERATION AND MAINTENANCE							
Inspection	hour	$40	8	4	$1,280	30	$15,884
Sediment Removal	See Fluvial site 4						
Erosion Repair	lump	$2,000	1	1	$2,000	5	$8,200
Vegetation Repair	lump	$0	1	1	$0	5	$0
TOTAL DIRECT O&M PRESENT WORTH							*$24,084*

Component	Present Worth	
INDIRECT OPERATION AND MAINTENANCE COSTS		
Administration (5% of Direct O&M)	$1,204	
Misc. Fees (5% of Direct O&M)	$1,204	
Reserve (25% of Direct O&M)	$6,021	
TOTAL INDIRECT O&M PRESENT WORTH	*$8,429*	
TOTAL OPERATION AND MAINTENANCE PRESENT WORTH		*$32,513*
GRAND TOTAL		*$240,820*

Source: TerraMatrix/SMI 1998

TABLE 28
COST SUMMARY: IRON HILL WASTE ROCK ALTERNATIVE 2 - DIVERSION DITCHES

California Gulch NPL Site
OU4 - FFS - UCG-12
Alternative 2 - Diversion Channels

DIRECT CAPITAL COSTS

Component	Unit	Unit Cost	Quantity	Total Cost		
Improve Access Road	lf	$3.00	2,000	$6,000		
Diversion Channels	sq-ft	$7.50	1,000	$7,500		
Amend Soil and Revegetation	acre	$8,100	3.3	$26,730		
Cultural Resources	lump	$2,000	1	$2,000		
Dust Control	lump	$5,000	1	$5,000		
Sediment Control	lump	$2,000	1	$2,000		
TOTAL DIRECT CAPITAL COSTS					*$49,230*	
INDIRECT CAPITAL COSTS						
Engineering and Design (10% of Direct)				$4,923		
Contingency (25% of Direct)				$12,308		
Legal Fees (5% of Direct)				$2,462		
Regulatory Cost (5% of Direct)				$2,462		
Mobilization and Demobilization (20% of Direct)				$9,846		
EPA Fees (20% of Engineering, 5% of Direct)				$3,446		
TOTAL INDIRECT CAPITAL COSTS					*$35,446*	
TOTAL CAPITAL COSTS						*$84,676*

POST REMEDIATION SITE CONTROL COSTS

Discount 7.00% for present worth

Component	Unit	Unit Cost	Each	Each/year	$/year	Years	Present Worth	
DIRECT OPERATION AND MAINTENANCE								
Inspection	hour	$40	8	4	$1,280	30	$15,884	
Erosion Repair	lump	$2,000	1	1	$2,000	5	$8,200	
Vegetation Repair	lump	$0	1	1	$0	5	$0	
TOTAL DIRECT O&M PRESENT WORTH							*$24,084*	

Component	Present Worth	
INDIRECT OPERATION AND MAINTENANCE COSTS		
Administration (5% of Direct O&M)	$1,204	
Misc. Fees (5% of Direct O&M)	$1,204	
Reserve (25% of Direct O&M)	$6,021	
TOTAL INDIRECT O&M PRESENT WORTH	*$8,429*	
TOTAL OPERATION AND MAINTENANCE PRESENT WORTH		*$32,513*
GRAND TOTAL		*$117,189*

Source: TerraMatrix/SMI 1998

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TABLE 29
COST SUMMARY: IRON HILL WASTE ROCK ALTERNATIVE 3 - REGRADING AND COVER

California Gulch NPL Site
OU4 - FFS - UCG-12
Alternative 3 - Minor Grading/Simple Cover/Revegetation

DIRECT CAPITAL COSTS

Component	Unit	Unit Cost	Quantity	Total Cost		
Improve Access Road	lf	$3.00	2,000	$6,000		
Regrade	cu-yd	$1.00	1,000	$1,000		
Cover Soil Supply	cu-yd	$10.00	1,700	$17,000		
Cover Soil Placement	cu-yd	$1.75	1,700	$2,975		
Revegetation	acre	$8,100	3.7	$29,970		
Cultural Resources	lump	$2,000	1	$2,000		
Dust Control	lump	$5,000	1	$5,000		
Sediment Control	lump	$2,000	1	$2,000		
TOTAL DIRECT CAPITAL COSTS					*$65,945*	

INDIRECT CAPITAL COSTS

Engineering and Design (10% of Direct)	$6,595		
Contingency (25% of Direct)	$16,486		
Legal Fees (5% of Direct)	$3,297		
Regulatory Cost (5% of Direct)	$3,297		
Mobilization and Demobilization (20% of Direct)	$13,189		
EPA Fees (20% of Engineering, 5% of Direct)	$4,616		
TOTAL INDIRECT CAPITAL COSTS		*$47,480*	
TOTAL CAPITAL COSTS			*$113,425*

POST REMEDIATION SITE CONTROL COSTS

Discount 7.00% for present worth

Component	Unit	Unit Cost	Each	Each/year	$/year	Years	Present Worth
DIRECT OPERATION AND MAINTENANCE							
Inspection	hour	$40	8	4	$1,280	30	$15,884
Erosion Repair	lump	$2,000	1	1	$2,000	5	$8,200
Vegetation Repair	lump	$2,500	1	1	$2,500	5	$10,250
TOTAL DIRECT O&M PRESENT WORTH							*$34,334*

Component	Present Worth	
INDIRECT OPERATION AND MAINTENANCE COSTS		
Administration (5% of Direct O&M)	$1,717	
Misc. Fees (5% of Direct O&M)	$1,717	
Reserve (25% of Direct O&M)	$8,584	
TOTAL INDIRECT O&M PRESENT WORTH	*$12,017*	
TOTAL OPERATION AND MAINTENANCE PRESENT WORTH		*$46,351*
GRAND TOTAL		*$159,776*

Source: TerraMatrix/SMI 1998

TABLE 30
COST SUMMARY: IRON HILL WASTE ROCK ALTERNATIVE 4 - WASTE ROCK CONSOLIDATION

California Gulch NPL Site
OU-4 Focused Feasibility Study - UCG 12
Alternative 4 - Remove Waste Rock to UCG-71

DIRECT CAPITAL COSTS

Component	Unit	Unit Cost	Quantity	Total Cost		
Improve Access Road	lf	$3.00	2,000	$6,000		
Load and Haul Waste Rock	cu-yd	$11.00	5,500	$60,500		
Cultural Resources	lump	$2,000	1	$2,000		
Amend Soil and Revegetation	acre	$8,100	3.7	$29,970		
Dust Control	lump	$5,000	1	$5,000		
Sediment Control	lump	$2,000	1	$2,000		
TOTAL DIRECT CAPITAL COSTS					*$105,470*	

INDIRECT CAPITAL COSTS

Engineering and Design (10% of Direct)	$10,547		
Contingency (25% of Direct)	$26,368		
Legal Fees (5% of Direct)	$5,274		
Regulatory Cost (5% of Direct)	$5,274		
Mobilization and Demobilization (20% of Direct)	$21,094		
EPA Fees (20% of Engineering, 5% of Direct)	$7,383		
TOTAL INDIRECT CAPITAL COSTS		*$75,938*	
TOTAL CAPITAL COSTS			*$181,408*

POST REMEDIATION SITE CONTROL COSTS

Discount 7.00% for present worth

Component	Unit	Unit Cost	Each	Each/year	$/year	Years	Present Worth	
DIRECT OPERATION AND MAINTENANCE								
Inspection	hour	$40	8	4	$1,280	30	$15,884	
Erosion Repair	lump	$2,000	1	1	$2,000	5	$8,200	
Vegetation Repair	lump	$2,500	1	1	$2,500	5	$10,250	
TOTAL DIRECT O&M PRESENT WORTH							*$34,334*	

Component	Present Worth	
INDIRECT OPERATION AND MAINTENANCE COSTS		
Administration (5% of Direct O&M)	$1,717	
Misc. Fees (5% of Direct O&M)	$1,717	
Reserve (25% of Direct O&M)	$8,584	
TOTAL INDIRECT O&M PRESENT WORTH	*$12,017*	
TOTAL OPERATION AND MAINTENANCE PRESENT WORTH		*$46,351*
	GRAND TOTAL	*$227,759*

Source: TerraMatrix/SMI 1998

TABLE 31
COST SUMMARY: CALIFORNIA GULCH WASTE ROCK ALTERNATIVE 2 - CHANNEL RECONSTRUCTION

California Gulch NPL Site
OU4 - FFS - California Gulch Waste Rock Piles
Alternative 2 - Stream Channel Reconstruction (~2,150 feet)

DIRECT CAPITAL COSTS

Component	Unit	Unit Cost	Quantity	Total Cost	
Improve Access Road	lf	$3.00	500	$1,500	
Channel Preparation					
Excavation	cy	$2.50	9,175	$22,938	
Grading	cy	$2.50	3,375	$8,438	
Riprap Lining	cy	$63.00	4,175	$263,025	
Surface Regrading	ac	$1,000	4	$4,000	
Amend Soil and Reveg	ac	$8,100	4	$32,400	
Cultural Resources	lump	$10,000	1	$10,000	
Dust Control	lump	$1,000	1	$1,000	
Sediment Control	lump	$1,000	1	$1,000	*$299,900*

INDIRECT CAPITAL COSTS

Engineering and Design (10% of Direct)	$29,990		
Contingency (25% of Direct)	$74,975		
Legal Fees (5% of Direct)	$14,995		
Regulatory Cost (5% of Direct)	$14,995		
Mobilization and Demobilization (20% of Direct)	$59,980		
EPA Fees (20% of Engineering, 5% of Direct)	$20,993		
TOTAL INDIRECT CAPITAL COSTS		*$215,928*	
TOTAL CAPITAL COSTS			*$515,828*

POST REMEDIATION SITE CONTROL COSTS

Discount 7.00% for present worth

Component	Unit	Unit Cost	Each	Each/year	$/year	Years	Present Worth
DIRECT OPERATION AND MAINTENANCE							
Inspection	hour	$40	8	4	$1,280	30	$15,884
Erosion Repair	lump	$2,000	1	1	$2,000	5	$8,200
Vegetation Repair	lump	$0	1	1	$0	5	$0
TOTAL DIRECT O&M PRESENT WORTH							*$24,084*

Component	Present Worth	
INDIRECT OPERATION AND MAINTENANCE COSTS		
Administration (5% of Direct O&M)	$1,204	
Misc. Fees (5% of Direct O&M)	$1,204	
Reserve (25% of Direct O&M)	$6,021	
TOTAL INDIRECT O&M PRESENT WORTH	*$8,429*	
TOTAL OPERATION AND MAINTENANCE PRESENT WORTH		*$32,513*
GRAND TOTAL		*$548,341*

Source: TerraMatrix/SMI 1998

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TABLE 32
COST SUMMARY: CALIFORNIA GULCH WASTE ROCK ALTERNATIVE 3 - SELECTED REGRADING

California Gulch NPL Site
OU4 - FFS - California Gulch Waste Rock Piles
Alternative 3 - Waste Rock Regrading

DIRECT CAPITAL COSTS

Component	Unit	Unit Cost	Quantity	Total Cost		
Improve Access Road	lf	$3.00	1,200	$3,600		
Regrade	cu-yd	$1.00	7,500	$7,500		
Cultural Resources	lump	$2,000	1	$2,000		
Dust Control	lump	$5,000	1	$5,000		
Sediment Control	lump	$2,000	1	$2,000		
TOTAL DIRECT CAPITAL COSTS					*$20,100*	

INDIRECT CAPITAL COSTS

Engineering and Design (10% of Direct)	$2,010		
Contingency (25% of Direct)	$5,025		
Legal Fees (5% of Direct)	$1,005		
Regulatory Cost (5% of Direct)	$1,005		
Mobilization and Demobilization (20% of Direct)	$4,020		
EPA Fees (20% of Engineering, 5% of Direct)	$1,407		
TOTAL INDIRECT CAPITAL COSTS		*$14,472*	
TOTAL CAPITAL COSTS			*$34,572*

POST REMEDIATION SITE CONTROL COSTS

Discount 7.00% for present worth

Component	Unit	Unit Cost	Each	Each/year	$/year	Years	Present Worth	
DIRECT OPERATION AND MAINTENANCE								
Inspection	hour	$40	8	4	$1,280	30	$15,884	
Erosion Repair	lump	$2,000	1	1	$2,000	5	$8,200	
Vegetation Repair	lump	$2,500	0	0	$0	0	$0	
TOTAL DIRECT O&M PRESENT WORTH							*$24,084*	

Component	--	Present Worth	
INDIRECT OPERATION AND MAINTENANCE COSTS			
Administration (5% of Direct O&M)		$1,204	
Misc. Fees (5% of Direct O&M)		$1,204	
Reserve (25% of Direct O&M)		$6,021	
TOTAL INDIRECT O&M PRESENT WORTH		*$8,429*	
TOTAL OPERATION AND MAINTENANCE PRESENT WORTH			*$32,513*
		GRAND TOTAL	*$67,085*

Source: TerraMatrix/SMI 1998

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TABLE 33
COST SUMMARY: CALIFORNIA GULCH WASTE ROCK ALTERNATIVE 4 - SELECTED WASTE ROCK REMOVAL

California Gulch NPL Site
OU4 - FFS - California Gulch Waste Rock Piles
Alternative 4 - Remove Waste Rock to UCG-71

DIRECT CAPITAL COSTS

Component	Unit	Unit Cost	Quantity	Total Cost
Improve Access Roads	lf	$3.00	1,200	$3,600
Load and Haul Waste Rock	cu-yd	$11.00	15,000	$165,000
Cultural Resources	lump	$10,000	1	$10,000
Amend Soil and Revegetation	acre	$8,100	3.7	$29,970
Dust Control	lump	$10,000	1	$10,000
Sediment Control	lump	$2,000	1	$2,000

TOTAL DIRECT CAPITAL COSTS — *$220,570*

INDIRECT CAPITAL COSTS

Engineering and Design (10% of Direct)	$22,057
Contingency (25% of Direct)	$55,143
Legal Fees (5% of Direct)	$11,029
Regulatory Cost (5% of Direct)	$11,029
Mobilization and Demobilization (20% of Direct)	$44,114
EPA Fees (20% of Engineering, 5% of Direct)	$15,440

TOTAL INDIRECT CAPITAL COSTS — *$158,810*

TOTAL CAPITAL COSTS — *$379,380*

POST REMEDIATION SITE CONTROL COSTS

Discount 7.00% for present worth

Component	Unit	Unit Cost	Each	Each/year	$/year	Years	Present Worth
DIRECT OPERATION AND MAINTENANCE							
Inspection	hour	$40	8	4	$1,280	30	$15,884
Erosion Repair	lump	$2,000	1	1	$2,000	5	$8,200
Vegetation Repair	lump	$2,500	1	1	$2,500	5	$10,250
TOTAL DIRECT O&M PRESENT WORTH							*$34,334*

Component	Present Worth
INDIRECT OPERATION AND MAINTENANCE COSTS	
Administration (5% of Direct O&M)	$1,717
Misc. Fees (5% of Direct O&M)	$1,717
Reserve (25% of Direct O&M)	$8,584
TOTAL INDIRECT O&M PRESENT WORTH	*$12,017*

TOTAL OPERATION AND MAINTENANCE PRESENT WORTH — *$46,351*

GRAND TOTAL — *$425,731*

Source: TerraMatrix/SMI 1998

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TABLE 34
COST SUMMARY: FLUVIAL TAILING SITE 4 ALTERNATIVE 2 - CHANNEL RECONSTRUCTION AND REVEGETATION

California Gulch NPL Site
OU4 - FFS - FLUVIAL SITE 4
Alternative 2 - Stream Channel Reconstruction/Surface Stabilization

DIRECT CAPITAL COSTS

Component	Unit	Unit Cost	Quantity	Total Cost		
Improve Access Road	lf	$3.00	700	$2,100		
Channel Preparation						
Excavation	cy	$2.50	36,700	$91,750		
Grading	cy	$2.50	13,500	$33,750		
Riprap Lining	cy	$63.00	16,700	$1,052,100		
Surface Regrading	ac	$1,000	16	$16,000		
Amend Soil and Reveg	ac	$8,100	16	$129,600		
Cultural Resources	lump	$15,000	1	$15,000		
Dust Control	lump	$4,000	1	$4,000		
Sediment Control	lump	$2,000	1	$2,000		
TOTAL DIRECT CAPITAL COSTS					*$1,346,300*	

INDIRECT CAPITAL COSTS

Engineering and Design (15% of Direct)	$201,945		
Contingency (25% of Direct)	$336,575		
Legal Fees (5% of Direct)	$67,315		
Regulatory Cost (5% of Direct)	$67,315		
Mobilization and Demobilization (10% of Direct)	$134,630		
EPA Fees (20% of Engineering, 5% of Direct)	$107,704		
TOTAL INDIRECT CAPITAL COSTS		*$915,484*	
TOTAL CAPITAL COSTS			*$2,261,784*

POST REMEDIATION SITE CONTROL COSTS

Discount 7.00% for present worth

Component	Unit	Unit Cost	Each	Each/year	$/year	Years	Present Worth
DIRECT OPERATION AND MAINTENANCE							
Inspection	hour	$40	8	4	$1,280	30	$15,884
Erosion Repair	lump	$2,000	1	1	$2,000	5	$8,200
Vegetation Repair	lump	$18,000	1	1	$18,000	5	$73,804
TOTAL DIRECT O&M PRESENT WORTH							*$97,888*

Component	Present Worth	
INDIRECT OPERATION AND MAINTENANCE COSTS		
Administration (5% of Direct O&M)	$4,894	
Misc. Fees (5% of Direct O&M)	$4,894	
Reserve (25% of Direct O&M)	$24,472	
TOTAL INDIRECT O&M PRESENT WORTH	*$34,261*	
TOTAL OPERATION AND MAINTENANCE PRESENT WORTH		*$132,149*
GRAND TOTAL		*$2,393,933*

Source: TerraMatrix/SMI 1998

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TABLE 35
COST SUMMARY: FLUVIAL TAILING SITE 4 ALTERNATIVE 3 - CHANNEL RECONSTRUCTION, SEDIMENT DAMS AND WETLANDS

California Gulch NPL Site
OU4 - FFS - FLUVIAL SITE 4
Alternative 3 - Stream Channel Reconstruction/Sediment Dams and Wetlands

DIRECT CAPITAL COSTS

Component	Unit	Unit Cost	Quantity	Total Cost		
Improve Access Road	lf	$3.00	700	$2,100		
Channel Preparation						
Excavation	cy	$2.50	36,700	$91,750		
Grading	cy	$2.50	13,500	$33,750		
Riprap Lining	cy	$63.00	16,700	$1,052,100		
Sediment Dams	lump	$8,000.00	8	$64,000		
Constructed Wetlands	ac	$17,000.00	1.5	$25,500		
Surface Regrading	ac	$1,000	16	$16,000		
Cultural Resources	lump	$15,000	1	$15,000		
Dust Control	lump	$4,000	1	$4,000		
Sediment Control	lump	$2,000	1	$2,000		
TOTAL DIRECT CAPITAL COSTS					*$1,306,200*	
INDIRECT CAPITAL COSTS						
Engineering and Design (15% of Direct)				$195,930		
Contingency (25% of Direct)				$326,550		
Legal Fees (5% of Direct)				$65,310		
Regulatory Cost (5% of Direct)				$65,310		
Mobilization and Demobilization (10% of Direct)				$130,620		
EPA Fees (20% of Engineering, 5% of Direct)				$104,496		
TOTAL INDIRECT CAPITAL COSTS					*$888,216*	
TOTAL CAPITAL COSTS						*$2,194,416*

POST REMEDIATION SITE CONTROL COSTS

Discount 7.00% for present worth

Component	Unit	Unit Cost	Each	Each/year	$/year	Years	Present Worth	
DIRECT OPERATION AND MAINTENANCE								
Inspection	hour	$40	8	4	$1,280	30	$15,884	
Erosion Repair	lump	$2,000	1	1	$2,000	5	$8,200	
TOTAL DIRECT O&M PRESENT WORTH							*$24,084*	

Component	Present Worth	
INDIRECT OPERATION AND MAINTENANCE COSTS		
Administration (5% of Direct O&M)	$1,204	
Misc. Fees (5% of Direct O&M)	$1,204	
Reserve (25% of Direct O&M)	$6,021	
TOTAL INDIRECT O&M PRESENT WORTH	*$8,429*	
TOTAL OPERATION AND MAINTENANCE PRESENT WORTH		*$32,513*
GRAND TOTAL		*$2,226,929*

Source: TerraMatrix/SMI 1998

TABLE 36
COST SUMMARY: FLUVIAL TAILING SITE 4 ALTERNATIVE 4 - STREAM CHANNEL RECONSTRUCTION, SURFACE STABILIZATION, SEDIMENT DAMS AND WETLANDS

California Gulch NPL Site
OU4 - FFS - FLUVIAL SITE 4
Alternative 4 - Stream Channel Reconstruction/Surface Stabilization/Sediment Dams and Wetlands

DIRECT CAPITAL COSTS

Component	Unit	Unit Cost	Quantity	Total Cost		
Improve Access Road	lf	$3.00	700	$2,100		
Channel Preparation						
Excavation	cy	$2.50	36,700	$91,750		
Grading	cy	$2.50	13,500	$33,750		
Riprap Lining	cy	$63.00	16,700	$1,052,100		
Sediment Dams	lump	$8,000.00	8	$64,000		
Constructed Wetlands	ac	$17,000.00	1.5	$25,500		
Amend Soil and Reveg	ac	$8,100	16	$129,600		
Surface Regrading	ac	$1,000	16	$16,000		
Cultural Resources	lump	$15,000	1	$15,000		
Dust Control	lump	$4,000	1	$4,000		
Sediment Control	lump	$2,000	1	$2,000		
TOTAL DIRECT CAPITAL COSTS					*$1,435,800*	
INDIRECT CAPITAL COSTS						
Engineering and Design (15% of Direct)				$215,370		
Contingency (25% of Direct)				$358,950		
Legal Fees (5% of Direct)				$71,790		
Regulatory Cost (5% of Direct)				$71,790		
Mobilization and Demobilization (10% of Direct)				$143,580		
EPA Fees (20% of Engineering, 5% of Direct)				$114,864		
TOTAL INDIRECT CAPITAL COSTS					*$976,344*	
TOTAL CAPITAL COSTS						*$2,412,144*

POST REMEDIATION SITE CONTROL COSTS

Discount 7.00% for present worth

Component	Unit	Unit Cost	Each	Each/year	$/year	Years	Present Worth	
DIRECT OPERATION AND MAINTENANCE								
Inspection	hour	$40	8	4	$1,280	30	$15,884	
Erosion Repair	lump	$2,000	1	1	$2,000	5	$8,200	
Vegetation Repair	lump	$18,000	1	1	$18,000	5	$73,804	
TOTAL DIRECT O&M PRESENT WORTH							*$97,888*	

Component	Present Worth	
INDIRECT OPERATION AND MAINTENANCE COSTS		
Administration (5% of Direct O&M)	$4,894	
Misc. Fees (5% of Direct O&M)	$4,894	
Reserve (25% of Direct O&M)	$24,472	
TOTAL INDIRECT O&M PRESENT WORTH	*$34,261*	
TOTAL OPERATION AND MAINTENANCE PRESENT WORTH		*$132,149*
GRAND TOTAL		*$2,544,293*

Source: TerraMatrix/SMI 1998

TABLE 37
COST SUMMARY: FLUVIAL TAILING SITE 4 ALTERNATIVE 5 - STREAM CHANNEL RECONSTRUCTION, SURFACE STABILIZATION, SELECTED REMOVAL, SEDIMENT DAMS AND WETLANDS

California Gulch NPL Site
OU4 - FFS - FLUVIAL SITE 4
Alternative 5 - Stream Channel Reconstruction/Surface Stabilization/Selected Removal/Sediment Dams and Wetlands

DIRECT CAPITAL COSTS

Component	Unit	Unit Cost	Quantity	Total Cost		
Improve Access Road	lf			$2,100		
Channel Preparation						
Excavation	cy			$91,500		
Grading	cy			$33,750		
Riprap Lining	cy			$1,052,100		
Sediment Dams	lump			$64,000		
Excavate Surface Material	cy			$40,000		
Sediment Retention Cribbing	lf			$25,000		
Constructed Wetlands	ac			$25,500		
Amend Soil and Reveg	ac			$129,600		
Surface Regrading	ac			$16,000		
Cultural Resources	lump			$15,000		
Dust Control	lump			$4,000		
Sediment Control	lump			$2,000		
TOTAL DIRECT CAPITAL COSTS					*$1,500,800*	

INDIRECT CAPITAL COSTS

Engineering and Design (15% of Direct)	$225,120		
Contingency (25% of Direct)	$375,200		
Legal Fees (5% of Direct)	$75,040		
Regulatory Cost (5% of Direct)	$75,040		
Mobilization and Demobilization (10% of Direct)	$150,080		
EPA Fees (20% of Engineering, 5% of Direct)	$120,064		
TOTAL INDIRECT CAPITAL COSTS		*$1,020,544*	
TOTAL CAPITAL COSTS			*$2,521,344*

POST REMEDIATION SITE CONTROL COSTS

Discount 7.00% for present worth

Component	Unit	Unit Cost	Each	Each/year	$/year	Years	Present Worth
DIRECT OPERATION AND MAINTENANCE							
Inspection	hour	$40	8	4	$1,280	30	$15,884
Erosion Repair	lump	$2,000	1	1	$2,000	5	- $8,200
Vegetation Repair	lump	$18,000	1	1	$18,000	5	$73,804
TOTAL DIRECT O&M PRESENT WORTH							$97,888

Component	Present Worth	
INDIRECT OPERATION AND MAINTENANCE COSTS		
Administration (5% of Direct O&M)	$4,894	
Misc. Fees (5% of Direct O&M)	$4,894	
Reserve (25% of Direct O&M)	$24,472	
TOTAL INDIRECT O&M PRESENT WORTH	*$34,261*	
TOTAL OPERATION AND MAINTENANCE PRESENT WORTH		*$132,149*
GRAND TOTAL		*$2,653,493*

Source: TerraMatrix/SMI 1998

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TABLE 38
COMPARISON OF ALTERNATIVES FOR GARIBALDI SUB-BASIN WASTE ROCK - WAMP CRITERIA

	Alternative 1 **No Action**	**Alternative 2** **Diversion of Surface Water and Stream Channel Reconstruction**	**Alternative 3** **Diversion of Surface Water and Selected Removal**
Surface Erosion Stability	No erosional stability measures would be taken. Side slopes may not meet WAMP criteria.	Diversion channels and stream channel reconstruction will divert runon water away from the waste rock reducing surface erosion.	Diversion channels will divert runon water away from the waste rock. Removal will remove waste rock from flood plain.
Slope Stability	Not applicable to existing slopes.	Not applicable to existing slopes.	Retaining wall will be required to meet WAMP criteria.
Flow Capacity and Stability	May not be stable during 100-year event.	Diversion channels will be sized to pass the 100-year event. Channel reconstructed to pass upstream flow and remain stable for 500-year event.	Diversion channels will be sized to pass the 100-year event.
Surface Water and Ground Water Contaminant Loading Reduction	No reduction in potential loading.	Runon will be diverted around waste rock.	Runon will be diverted around waste rock.
Terrestrial Ecosystem Exposure	No change in potential risk to terrestrial ecosystem.	Any risk to the terrestrial ecosystem from the waste rock would be reduced.	Any risk to the terrestrial ecosystem from the waste rock would be reduced.
Non-Residential Soils	Not applicable.	Not applicable.	Not applicable.

Source: TerraMatrix/SMI 1998

TABLE 39
COMPARISON OF ALTERNATIVES FOR THE PRINTER GIRL WASTE ROCK - WAMP CRITERIA

	Alternative 1 No Action	Alternative 2 Stream Channel Reconstruction	Alternative 3 Stream Channel Reconstruction and Regrading	Alternative 4 Waste Rock Removal
Surface Erosion Stability	No change in existing erosional stability; criteria do not apply.	Surface erosion of waste rock would continue.	Surface erosion of waste rock would be reduced.	Would eliminate waste rock as an erosional source.
Slope Stability	Not applicable, no remediation would occur.	Not applicable, no remediation would occur.	Would improve slope stability of waste rock.	Would eliminate waste rock stability as an issue.
Flow Capacity and Stability	No change in existing flow capacity and stability; criteria do not apply.	Waste rock would be stabilized for the 100-year flood event in Whites Gulch.	Waste rock would be stabilized for the 100-year flood event in Whites Gulch.	Would remove waste rock from contact with surface water.
Surface Water (SW) and Groundwater (GW) Contaminant Loading Reduction	No reduction in potential loading.	Reduces erosion and leaching associated with stream channel contact with waste rock.	Reduces erosion and leaching associated with stream channel contact with waste rock.	Eliminates waste rock as a source of contamination.
Terrestrial Ecosystem Exposure	No change in potential risk to terrestial ecosystem.	Any risk to the terrestrial ecosystem from the waste rock would be reduced.	Any risk to the terrestrial ecosystem from the waste rock would be reduced.	Any risk to the terrestrial ecosystem from the waste rock would be eliminated.
Non-Residential Soils	Not applicable.	Not applicable.	Not applicable.	Not applicable.

Source: TerraMatrix/SMI 1998

TABLE 40
COMPARISON OF ALTERNATIVES FOR THE NUGGET GULCH WASTE ROCK - WAMP CRITERIA

	Alternative 1 No Action	Alternative 2 Diversion Ditches	Alternative 3 Diversion Ditches and Waste Rock Regrading	Alternative 4 Diversion Ditches, Consolidation, and Cover
Surface Erosion Stability	No change in existing erosional stability; criteria do not apply.	Diversion channels will divert surface runon away from waste rock, reducing surface erosion.	Diversion channels will divert surface runon away from waste rock, reducing surface erosion.	Consolidation and covering will reduce surface erosion. Terraces and revegetation will stabilize disturbed areas.
Slope Stability	Not applicable, no remediation would occur.	Not applicable, no remediation would occur.	Regrading of waste rock will improve stability.	Consolidation and regrading of waste rock will improve stability.
Flow Capacity and Stability	No change in existing flow capacity and stability; criteria do not apply.	Diversion channels will be designed to pass the 100-year flood event.	Diversion channels will be designed to pass the 100-year flood event.	Diversion channels will be designed to pass the 100-year flood event.
Surface Water (SW) and Groundwater (GW) Contaminant Loading Reduction	No reduction in potential loading.	Diversion channels will prevent runon water from contacting the waste rock, thus decreasing the loading to surface water.	Diversion channels will prevent runon water from contacting the waste rock, thus decreasing the loading to surface water.	Diversion channels, consolidation and cover decreases surface area for direct infiltration and loading to surface water.
Terrestrial Ecosystem Exposure	No change in potential risk to terrestial ecosystem.	Any risk to the terrestrial ecosystem from the waste rock would be reduced.	Any risk to the terrestrial ecosystem from the waste rock would be reduced.	Any risk to the terrestrial ecosystem from the waste rock would be eliminated.
Non-Residential Soils	Not applicable.	Not applicable.	Not applicable.	Not applicable.

Source: TerraMatrix/SMI 1998

TABLE 41
COMPARISON OF ALTERNATIVES FOR THE AY-MINNIE WASTE ROCK - WAMP CRITERIA

	Alternative 1 No Action	Alternative 2 Diversion Ditches	Alternative 3 Diversion Ditches and Regrading	Alternative 4 Diversion Ditches and Road Reconstruction
Surface Erosion Stability	No change in existing erosional stability; criteria do not apply.	Diversion ditches will divert surface runon away from waste rock, reducing surface erosion.	Diversion ditches will divert surface runon away from waste rock, reducing surface erosion.	Diversion ditches will divert surface runon away from waste rock, reducing surface erosion.
Slope Stability	Not applicable, no remediation would occur.	Not applicable, no remediation would occur.	Stability of the slopes would be improved removal of cribbing and regrading.	The hazard presented by failure of the cribbing would be reduced by realignment of county road.
Flow Capacity and Stability	No change in existing flow capacity and stability; criteria do not apply.	Diversion ditches will be designed to pass the 100-year flood event.	Diversion ditches will be designed to pass the 100-year flood event.	Diversion ditches will be designed to pass the 100-year flood event.
Surface Water (SW) and Groundwater (GW) Contaminant Loading Reduction	No reduction in potential loading.	Diversion ditches will prevent runon water from contacting the waste rock, thus decreasing the loading to surface water.	Diversion ditches will prevent runon water from contacting the waste rock, thus decreasing the loading to surface water.	Diversion ditches will prevent runon water from contacting the waste rock, thus decreasing the loading to surface water.
Terrestrial Ecosystem Exposure	No change in potential risk to terrestial ecosystem.	There would be little change in potential risk to terrestial ecosystem.	There would be little change in potential risk to terrestial ecosystem.	There would be little change in potential risk to terrestial ecosystem.
Non-Residential Soils	Not applicable.	Not applicable.	Not applicable.	Not applicable.

Source: TerraMatrix/SMI 1998

TABLE 42
COMPARISON OF ALTERNATIVES FOR THE IRON HILL WASTE ROCK - WAMP CRITERIA

	Alternative 1 No Action	Alternative 2 Diversion Ditches	Alternative 3 Regrading and Cover	Alternative 4 Waste Rock Consolidation
Surface Erosion Stability	No change in existing erosional stability; criteria do not apply.	Diversion channels will divert surface runon away from waste rock, reducing surface erosion.	Regrading of one pile will reduce slopes and erosion potential. Covering of other pile will eliminate erosion.	Consolidation and covering will eliminate surface erosion releases.
Slope Stability	Not applicable, no remediation would occur.	Not applicable, no remediation would occur.	Regrading of slopes would meet WAMP criteria.	Consolidated waste rock would meet WAMP criteria.
Flow Capacity and Stability	No change in existing flow capacity and stability; criteria do not apply.	Diversion channels will be designed to pass the 100-year flood event.	Covered pile would be stabilized for the 100-year flood event.	Covered pile would be stabilized for the 100-year flood event.
Surface Water (SW) and Groundwater (GW) Contaminant Loading Reduction	No reduction in potential loading.	Diversion channels will prevent runon water from contacting the waste rock, thus decreasing the loading to surface water.	One pile would be regraded to reduce the amount of infiltration caused by ponding, the other pile would be covered to reduce leaching.	Consolidation and covering decreases surface area for direct infiltration and loading to surface water.
Terrestrial Ecosystem Exposure	No change in potential risk to terrestial ecosystem.	Little change in potential risk to terrestial ecosystem.	Risk to the terrestrial ecosystem from the waste rock would be reduced through cover.	By reducing contact surface, risk to the terrestrial ecosystem from the waste rock would be reduced.
Non-Residential Soils	Not applicable.	Not applicable.	Not applicable.	Not applicable.

Source: TerraMatrix/SMI 1998

TABLE 43
COMPARISON OF ALTERNATIVES FOR THE CALIFORNIA GULCH WASTE ROCK - WAMP CRITERIA

	Alternative 1 No Action	Alternative 2 Channel Reconstruction	Alternative 3 Selected Regrading	Alternative 4 Selected Waste Rock Removal
Surface Erosion Stability	No change in existing erosional stability; criteria do not apply.	Diversion channels will divert surface runon away from waste rock, reducing surface erosion.	Regrading of slopes will reduce slopes and erosion potential.	Would eliminate waste rock as an erosional source of contamination.
Slope Stability	Not applicable, no remediation would occur.	Not applicable, no remediation would occur.	Regrading of slopes would meet WAMP criteria.	Would eliminate waste rock stability as an issue.
Flow Capacity and Stability	No change in existing flow capacity and stability; criteria do not apply.	Diversion channels will be designed to pass the 500-year flood event.	May not be stable during the 500-year flood event.	Would remove waste rock from contact with surface water.
Surface Water (SW) and Groundwater (GW) Contaminant Loading Reduction	No reduction in potential loading.	Diversion channels will prevent runon water from contacting the waste rock, thus decreasing the loading to surface water.	Regrading reduces the amount of infiltration caused by ponding.	Eliminates waste rock as a source of contamination.
Terrestrial Ecosystem Exposure	No change in potential risk to terrestial ecosystem.	Little change in potential risk to terrestial ecosystem.	Little change in potential risk to terrestial ecosystem.	Any risk to the terrestrial ecosystem from the waste rock would be eliminated.
Non-Residential Soils	Not applicable.	Not applicable.	Not applicable.	Not applicable.

Source: TerraMatrix/SMI 1998

TABLE 44
COMPARISON OF ALTERNATIVES FOR FLUVIAL TAILING SITE 4 - WAMP CRITERIA

	Alternative 1 No Action	Alternative 2 Channel Reconstruction and Revegetation	Alternative 3 Channel Reconstruction, Sediment Dams and Wetlands	Alternative 4 Channel Reconstruction, Revegetation,Sediment Dams and Wetlands	Alternative 5 Channel Reconstruction, Revegetation, Sediment Dams, Wetlands and Selected Surface Material Removal
Surface Erosion Stability	No change in existing erosional stability; criteria do not apply.	Establishment of a vegetated surface will increase stability.	Sediment discharge would be reduced through construction of sediment dams and wetlands.	Sediment discharge would be reduced through construction of sediment dams and wetlands.	Sediment generation and discharge would be reduced due to the revegetation of disturbed area and the catchment of check dams and wetlands.
Slope Stability	Not applicable, no remediation would occur.	Due to its flat topography, slope stability is not an issue.	Due to its flat topography, slope stability is not an issue.	Due to its flat topography, slope stability is not an issue.	Due to its flat topography, slope stability is not an issue.
Flow Capacity and Stability	No change in existing flow capacity and stability; criteria do not apply.	Reconstruction of the upper California Gulch channel and floodplain will have capacity to pass 500-year flood event.	Reconstruction of the upper California Gulch channel and floodplain will have capacity to pass 500-year flood event.	Reconstruction of the upper California Gulch channel and floodplain will have capacity to pass 500-year flood event.	Reconstruction of the upper California Gulch channel and adjacent floodplain will have capacity to pass the 500-year event.
Surface Water (SW) and Groundwater (GW) Contaminant Loading Reduction	No reduction in potential loading.	Loadings would be reduced by limiting contact of water with waste material and increased erosional stability.	Loadings would be reduced by limiting contact of water with waste material and increased erosional stability.	Loadings would be reduced by limiting contact of water with waste material and increased erosional stability.	Loadings would be reduced by limiting contact of water with waste material and increased erosional stability.
Terrestrial Ecosystem Exposure	No change in potential risk to terrestial ecosystem.	Potential risk to terrestrial ecosystem would be reduced.	Potential risk to terrestrial ecosystem would be reduced.	Potential risk to terrestrial ecosystem would be reduced.	Potential risk to terrestrial ecosystem would be reduced.
Non-Residential Soils	Not applicable.	Not applicable.	Not applicable.	Not applicable.	Not applicable.

Source: TerraMatrix/SMI 1998

APPENDIX A

ARARs

APPENDIX A
SUMMARY OF FEDERAL AND STATE ARARs

Standard, Requirement Criteria, or Limitation	Citation	Potentially Applicable	Potentially Relevant and Appropriate	Description
FEDERAL ARARs				
Endangered Species Act	16 USC § 1531 et seq. 50 CFR §§ 200 and 402	No	No	Provides protection for threatened and endangered species and their habitats. However, site-specific studies did not document the presence of threatened or endangered species. If threatened or endangered species are encountered during remedial activities in OU4, then requirements of Act would be applicable.
Fish and Wildlife Coordination Act	16 USC § 661 et seq. 40 CFR § 6.302	No	No	Requires coordination with federal and state agencies to provide protection of fish and wildlife in water resource development programs; regulates actions that impound, divert, control, or modify any body of water. However, proposed remedial action activities in OU4 will not affect fish or wildlife. If it appears that remedial activities may impact wildlife resources, EPA will coordinate with both the U.S. Fish and Wildlife Service and the Colorado Department of Natural Resources.
Wilderness Act	16 USC 1311, 16 USC 668 50 CFR 53, 50 CFR 27	No	No	Limits activities within areas designated as wilderness areas or National Wildlife Refuge Systems.
Executive Order NO. 11988 Floodplain Management	40 CFR § 6.302 & Appendix A	Yes	---	Pertains to floodplain management and construction and impoundments in such areas.
Executive Order NO. 11990 Protection of Wetlands	40 CFR § 6.302(a) and Appendix A	Yes	---	Minimizes adverse impacts on areas designated as wetlands.
Section 404, Clean Water Act (CWA)	33 USC 1251 et seq. 33 CFR Part 330	Yes	---	Regulates discharge of dredged or fill materials into waters of the United States. Substantive requirements of portions of Nationwide Permit No. 38 (General and Specific Conditions) are applicable to OU4 remedial activities conducted within waters of the United States.

Source: TerraMatrix/SMI 1998

APPENDIX A (CONTINUED)
SUMMARY OF FEDERAL AND STATE ARARs
(Page 2 of 7)

Standard, Requirement Criteria, or Limitation	Citation	Potentially Applicable	Potentially Relevant and Appropriate	Description
The Historic and Archaeological Data Preservation Act of 1974	16 USC 469 40 CFR § 6.301(c)	Yes	---	Establishes procedures to preserve historical and archeological data that might be destroyed through alteration of terrain as a result of a federal construction project or a federally licensed activity program. A cultural resource survey was completed in OU4 to identify historic properties which may be affected by removal activity.
National Historic Preservation Act (NHPA)	16 USC § 470 et seq. 40 CFR § 6.301(b) 36 CFR Part 63, Part 65, Part 800	Yes	---	Expands historic preservation programs; requires preservation of resources included in or eligible for listing on the National Register for Historic Places.
Executive Order 11593 Protection and Enhancement of the Cultural Environment	16 USC § 470	Yes	---	Directs federal agencies to institute procedures to ensure programs contribute to the preservation and enhancement of non-federally owned historic resources. Consultation with the Advisory Council on Historic Preservation is required if remedial activities should threaten cultural resources.
Historic Sites Act of 1935	16 USC § 461-467	No	No	Preserves for public use historic sites, buildings, and objects of natural significance.
The Archeological Resources Protection Act of 1979	16 USC §§ 470aa-47011	No	Yes	Requires a permit for any excavation or removal of archeological resources from public lands or Indian lands. May be relevant and appropriate if archeological resources are encountered during remedial action activity.
Resource Conservation and Recovery Act (RCRA), Subtitle D	40 CFR Part 257, Subpart A, §257.3-1 Floodplains, paragraph (a)	Yes	---	Provides general classification criteria for solid waste disposal facilities pertaining to floodplains.

Source: TerraMatrix/SMI 1998

APPENDIX A (CONTINUED)
SUMMARY OF FEDERAL AND STATE ARARs

Standard, Requirement Criteria, or Limitation	Citation	Potentially Applicable	Potentially Relevant and Appropriate	Description
Clean Air Act National Primary and Secondary Ambient Air Quality Standards	40 CFR Part 50	No	No	National ambient air quality standards (NAAQS) are implemented through the New Source Review Program and State Implementation Plans (SIPs). The federal New Source Review program address only major sources. Emissions associated with proposed remedial action in OU4 will be limited to fugitive dust emissions associated with earth moving activities during construction and will occur in isolated areas over a short period of time. Remedial work in OU4 will be completed in industrial zoned areas significant distances from residential areas. In addition, existing topography will further reduce the potential for fugitive dust emissions. These remedial activities will not constitute a major source. Therefore, attainment and maintenance of NAAQS pursuant to the New Source Review Program are not ARARs. See Colorado Air Pollution Prevention and control Act concerning applicability of requirements implemented through the SIP.
RCRA Land Disposal Restrictions (LDRs)	40 CFR Part 268	No	No	RCRA LDRs are not applicable because the materials in issue have been identified as extraction of beneficiation wastes that are specifically exempted from the definition of a hazardous waste. Not relevant and appropriate, see Superfund LDR Guide #7.
Solid Waste Disposal Act as amended by the Resource Conservation and Recovery Act of 1976 (RCRA)	40 CFR Part 257, Subpart A: § 257.3-1 Floodplains, paragraph (a); § 257.3-7 Air, paragraph (b)	Yes	---	Selected portion of Part 257 pertaining to floodplains and air are applicable. These provisions establish criteria for classification of solid waste disposal facilities and practices.
Hazardous Materials Transportation Act	49 USC § 1801-1813 49 CFR 107, 171-177	No	No	Regulates transportation of hazardous materials. Proposed remedial action in OU4 will be conducted on private property and will not entail off-site transportation of hazardous materials.

Source: TerraMatrix/SMI 1998

APPENDIX A (CONTINUED)
SUMMARY OF FEDERAL AND STATE ARARs

Standard, Requirement Criteria, or Limitation	Citation	Potentially Applicable	Potentially Relevant and Appropriate	Description
STATE OF COLORADO ARARs				
Nongame, Endangered or Threatened Species Act	CRS §§ 33-2-101 to 108	No	No	Standards for regulation of nongame wildlife and threatened and endangered species. Site-specific studies did not document the presence of threatened or endangered species. If threatened or endangered species are encountered during remedial activities in OU4, then requirements of Act will be applicable.
Colorado Register of Historic Places	CRS §§ 24-80.1-101 to 108	No	No	Authorizes the State Historical Society to nominate properties for inclusion on the State Register of Historic Places. Applicable only if remedial activities impact an area listed on the Register.
Colorado Historical, Prehistorical, and Archaeological Resources Act	CRS §§ 24-80-401 to 410 1301 to 1305	No	Yes	Concerns historical, prehistorical, and archaeological resources; applies only to areas owned by the State or its political subdivisions. May be relevant and appropriate if remedial activities impact an archaeological site.
Colorado Species of Special Concern and Species of Undetermined Status	Colorado Division of Wildlife Administrative Directive E-1, 1985, modified	No	No	Protects species listed on the Colorado Division of Wildlife generated list. Urges coordination with the Division of Wildlife if wildlife species are to be impacted. No evidence of species of special concern have been identified at this site.
Colorado Natural Areas	Colorado Revised Statutes, Title 33, Article 33, Sec. 104	No	No	Maintains a list of plant species of "special concern". Although not protected by State statue, coordination with Division of Parks and Outdoor Recreation is recommended if activities will impact listed species.
Colorado Solid Waste Disposal Sites and Facilities Act, Colorado Revised Statutes, Title 30, Article 20, Sections 101-118	6 CCR 1007-2 6 CCR 1007-2, Part I	No	No	Establishes regulations for solid waste management facilities, including location standards. Proposed remedial action in OU4 will not establish a solid waste management facility.

Source: TerraMatrix/SMI 1998

APPENDIX A (CONTINUED)
SUMMARY OF FEDERAL AND STATE ARARs

Standard, Requirement Criteria, or Limitation	Citation	Potentially Applicable	Potentially Relevant and Appropriate	Description
Colorado Solid Waste Disposal Sites and Facilities Act	6 CCR 1007-2	No	No	Establishes policy for licensing, locating, constructing and operating solid waste facilities. Proposed remedial action in OU4 will not involve establishment of a solid waste disposal facility.
Colorado Water Quality Control Act, Storm Water Discharge Regulations	5 CCR 1002-2	Yes	---	Establishes requirements for storm water discharges (except portions relating to Site-wide Surface and Groundwater). Substantive requirements for storm water discharges associated with construction activities are applicable.
Colorado Mined Land Reclamation Act	CRS 34-32-101 to 125 Rule 3 of Mineral Rules and Regulations	No	Yes	Regulates all aspects of land use for mining, including the location of mining operations and related reclamation activities and other environmental and socio-economic impacts. Substantive requirements of selected portions of Rule 3 regarding Reclamation Measures, Water-General Requirements (except portions relating to Site-wide Surface and Groundwater), Wildlife, and Revegetation are relevant and appropriate.
Colorado Air Pollution Prevention and Control Act	5 CCR 1001-3; Sections III.D.1.b,c,d. Sections III.D.2.b,c,e,f. Regulation 1	Yes	---	Regulation No. 1 provisions concerning fugitive emissions for construction activities, storage and stockpiling activities, haul roads, and haul trucks are applicable (5 CCR 1001-3; Sections III.D.2.b,c,e,f). Construction activities in OU4 will be conducted in accordance with a fugitive emissions control plan.
Colorado Air Pollution Prevention and Control Act	5 CCR 1001-4 Regulation 2 Odors	Yes	---	Applicable only if remedial action activities cause objectionable odors. Remedial action in OU4 is not expected to produce odors.
Colorado Air Pollution Prevention and Control Act	5 CCR 1001-5 Regulation 3 APENs	Yes	---	Substantive provisions of APENs will be met.

Source: TerraMatrix/SMI 1998

APPENDIX A (CONTINUED)
SUMMARY OF FEDERAL AND STATE ARARs
(Page 6 of 7)

Standard, Requirement Criteria, or Limitation	Citation	Potentially Applicable	Potentially Relevant and Appropriate	Description
Colorado Air Pollution Prevention and Control Act	5 CCR 1001-14 5 CCR 1001-10 Part C (I) & (III) Regulation 8	Yes	---	Pursuant to the Colorado Air Pollution Prevention and Control Act, applicants for construction permits are required to evaluate whether the proposed source will exceed NAAQS. Applicants are also required to evaluate whether the proposed activities would cause the Colorado ambient standard for TSP to be exceeded. Remedial work in OU4 will be completed in industrial zoned areas significant distances from residential areas. In addition, existing topography will further reduce the potential for fugitive emissions through Regulation No. 1. Compliance with applicable provisions of the Colorado air quality requirements will be achieved by adhering to a fugitive emissions control plan prepared in accordance with Regulation No. 1. Regulation 8 sets emission limits for lead and hydrogen sulfide. Applicants are required to evaluate whether the proposed activities would result in the Regulation 8 lead standard being exceeded. The proposed remedial action in OU4 is not projected to exceed the emission levels for lead or hydrogen sulfide, although some lead emissions may occur. Compliance with Regulation 8 will be achieved by adhering to a fugitive emissions control plan prepared in accordance with Regulation No. 1.
Colorado Noise Abatement Act	CRS §§ 25-12-101 to 108	Yes	---	Establishes maximum permissible noise levels for particular time periods and land use related to construction projects. Remedial work in OU4 will be completed in industrial zoned areas a significant distance from residential areas. In addition, the existing topography will reduce noise emission levels.

Source: TerraMatrix/SMI 1998

APPENDIX A (CONTINUED)
SUMMARY OF FEDERAL AND STATE ARARs

Standard, Requirement Criteria, or Limitation	Citation	Potentially Applicable	Potentially Relevant and Appropriate	Description
Regulations on the Collection of Aquatic Life	2 CCR 406-8, Ch. 13, Article III, Sec. 1316	No	No	Requirements governing the collection of wildlife for scientific purposes. Remedial activities within OU4 will not include biological monitoring.
Colorado Hazardous Waste Regulations	6 CCR1007-3, Part 264: Section 264.301, (g), (h), (i), and (j); Section 264.310, (a) (1) through (a) (4); Section 264.310, (b) (1) and (b) (5)	No	Yes	These specific provisions of the hazardous waste regulations may be relevant and appropriate in certain circumstances depending on site specific conditions in OU4. The determination of whether such requirements will be both relevant and appropriate to the activities to be undertaken in OU4 will be based on best professional judgement and is conducted on a site specific basis taking into account the physical nature and location of the media involved, whether the requirements are well suited for the site conditions, and other factors.

Source: TerraMatrix/SMI 1998